TRANSACTIONS

OF THE

EDINBURGH FIELD NATURALISTS'

AND

MICROSCOPICAL SOCIETY

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(*SESSIONS 1898–1902*)

Published for the Society by

WILLIAM BLACKWOOD AND SONS

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OF

The Edinburgh Field Naturalists' and Microscopical Society

SESSION 1898-99

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TRANSACTIONS.

SESSION 1898-99.

I.—*QUEENSLAND TERMITES.*

By Mr ROBERT GRIEVE, J.P., of Broadwater, Brisbane, Queensland.

(*Communicated by* Mr W. C. Crawford, President, *Nov. 23, 1898.*)

The following paper was sent to me by Mr Robert Grieve of Brisbane, Queensland, a few weeks ago. Mr Grieve has lived in Queensland for a very long time—some thirty-five years. He has resided, although not far from the capital of Queensland, in what is virtually the bush. He has therefore been in immediate touch with the fauna of that country, and he is an excellent observer. He has devoted most attention to insects and spiders, chiefly the kinds that destroy fruit-trees and crops. He is the very man to make observations on these extremely interesting and little-known communities, the white ants. I have said "little known," because good authorities on insects tell us that there are in all probability 1000 species of termites, of which only about 100 have been described, and of these only a very few—perhaps half-a-dozen—have been really studied. So some years ago I urged Mr Grieve to study termites, and, on account of his intimate associations with Edinburgh, to write a paper on them for one of the Edinburgh scientific societies. At first he declined, saying I had no idea how difficult a task it was—although the

insects were at his very door. They are injured when they are disturbed or exposed to light—in fact, they cannot stand light at all, as we shall see immediately: then it is believed that different kinds of termites occasionally live together in the same nest—at least Bates says so—without being of any apparent use to each other. Moreover, termites grow very slowly compared with other insects: the life of a worker bee in summer is about six to eight weeks; that of a worker termite, a couple of years or more. These are some of the reasons that make the study of the social life of termites so very difficult.

Following Mr Grieve's suggestion of presenting his paper in the way I think best, I shall make a few introductory remarks about termites, to let us see where we are, because I daresay very few of us have ever seen them alive: I myself never have, although I have seen their nests, and huge structures they are.

If we glance at a text-book we shall find that termites are insects related to dragonflies, or rather between earwigs and dragonflies—*i.e.*, between the Orthoptera and the Neuroptera. Let me refer in a word or two to the literature of termites. Considering the extremely interesting biological problems (and, I might add, social inferences) which spring out of termite life, the literature is extremely small. I think I might safely say that I could carry away all that is of real value in my greatcoat pocket. The first of real importance, what might be called an epoch-making contribution, was made about 120 years ago (1781) to the Royal Society by Smeathman. It is a very interesting and readable account of the author's observations on the west coast of Africa—the Guinea Coast—on *Termes bellicosus*, which is the highest developed termite socially. Then for seventy years or more nothing was recorded. In the 'Fifties of this century two Frenchmen contributed articles on another species, *T. lucifugus*. In the 'Seventies Fritz Müller wrote some articles of value. Hagen also wrote what he had observed in America, and Haviland has been adding more recently to our knowledge of South African forms. I have seen nothing, although I have looked up a good deal of the literature, referring specially to the termites of Australia—I mean as to their social economy;

for though Saville Kent writes a good deal, and publishes a number of very beautiful photographs of termites' nests, he says hardly anything of their life-history. In fact, if I remember correctly, he does not even give scientific names to the termites whose very beautiful dwellings he photographs.

By far the most scientific and best contribution that has been made was published in 1893 and 1894 by a Sicilian, Professor Grassi, and a pupil of his, Dr Sandias. The articles were translated, and appeared in the 'Quarterly Journal of Microscopical Science' last year. They are well worth reading. Two species of termites which live in Sicily are the subjects of their studies.

I shall now allow Mr Grieve to speak for himself.

Perhaps it would be superfluous for one who looks upon Charles Darwin with reverence to seek a teleological reason for the existence of any creature. I shall not do so in the case of termites, but content myself by saying that they fill their place in nature by chewing wood up into a finely comminuted pulp, which is further elaborated in the metabolism of the insect. I regret that I cannot go further, and say that this pulp is, or has ever been, of one particle of use to man. Unlike the earth-worm, that nowadays shines with light from a great name, the termite contributes nothing to the fertility of the land—the late Professor Drummond to the contrary notwithstanding. Unlike the earthworm, where fertility is, the termite is seldom found; but where arid deserts of hopeless sterility face the sun, there is the termite's home, there its dismal monuments stand endless in funereal array.

It will be admitted that fertility of soil is owing mainly to geological causes, and coincides with the presence and decomposition of certain strata. Thus the soil in old or recent volcanic districts is almost invariably fertile. The earthworm contributes its share to this fertility. Termites, so far as I have read their history aright, do not.

When Queensland termites are talked of, it is one of two predominating species which is usually meant—either the mound-builder, whose structures spot the face of every dry and sandy landscape, or the somewhat smaller tree termite, which

fastens its hanging home, like a swallow's nest, on the side of some forest tree.

The Mound-Builder.—I mean to dedicate most of the following remarks to the mound-builder, which is really the white ant *par excellence.* Although no white ant is guiltless, yet this is the great destroyer—this is he who outrivals time as the *edax rerum.* He may fairly be taken as the type of the family.

Tree Termites.—Before dismissing these, the habit they have of orienting their nests to the northern side—that is, to the sunny side—of a tree has been often remarked; and in the absence of sun and compass the nest is a sure guide to the belated traveller. These hanging termitaries become often in course of time the abode of a family of kingfishers —say, either Dacelo, the "laughing jackass" of the colonists, or that much smaller streak of bright blue, Alcyone azurea. It would probably be a safe guess that these birds have acquired, with their apartments, a well-stocked larder to boot. It would be a mistake to suppose that all kingfishers live on fish.

Other Termites.—Besides the two above alluded to, there are several other Queensland species: some with visible termitaries; large ones, as in the lofty conical nests on the Cape York Peninsula referred to by Saville Kent and many less observant travellers; small ones, inconspicuous as a molehill, of peculiar masonry; and unseen ones, the homes of termites which lead an obscure, unprolific, and only half social life, and whose habits have not yet been put down in books. There is also an imported species in Brisbane, which as yet confines its depredations to some of the principal streets.

The Termitary.—As I am about to describe a termitary, I may say at once that I have never seen in Queensland the complicated, composite, and classic architecture figured by Houssay, and reproduced in Chambers's Encyclopædia, as an illustration of the interior of a termitary. That figure, however, represents the dwelling-place of the famous West African termite (*Termes bellicosus*), and the Queensland species have much simpler dwellings.

I have examined hundreds of termitaries. In the instance of the nest I have drawn to accompany this paper (Plate I.),

I made use of a cross-cut saw of large size which bisected the structure and displayed the interior to advantage. Turning to my illustration, it may be noted that it has no external opening. It is all solid masonry that refuses to yield to any pressure less than the single steel tooth of the pick-axe. The tunnels may extend underground laterally for hundreds of yards from the central fortress; these also have no permanent openings to the light. Openings are made and closed up quickly at need, and generally at night. Openings are never made in the main building except to enlarge it. This also is night work, but the morning-dawn sometimes shows a large area still a skeleton, like a sponge, that sinks like pie-crust under the pressure of a finger, and exposes the workers to the uncongenial light.

Temperature.—The internal heat of the structure does not exceed that of the outside air by more than 3° or 4° Fahr.

Workers and Soldiers.—A succession of powerful strokes with the pick-axe breaks off a slab as large as a man cares to lift. The internal tunnels are exposed, and a quick glance shows the workers at their vocations. But only for a moment: before 30 seconds have elapsed the workers have retired, and an aggressive host of little helmeted soldiers have taken their place and are ready to hold the fort.

Now with regard to these soldiers I come to a very curious fact. Observe them well, and it will be seen that they are strikingly different from the workers—so much so, that it is difficult to trace any homology between their anterior end and that of the other inhabitants of the termitary. The soldiers are helmeted like a medieval knight. These curiously helmeted soldiers belong only, so far as I know, to the species I am speaking of (Plate II., *c* and *c'*). Other species have soldiers ever ready to show fight—*e.g.*, the tree termites. Their soldiers, however, are not helmeted like those of the mound-builders, but appear to be only workers with exaggerated mandibles and a cephalic shield, more developed and chitinised than the other workers. In any case, whatever may be the shape of the soldier's head, its chief weapon of offence is a drop of gummy fluid, which is bestowed upon the enemy, to whom both the soldier's jaws and the gum adheres. The juice, harmless to man, causes a small, or even large,

insect to succumb. The fluid does its work by rapidly coagulating and thus clogging the enemy's motions. Whether it be otherwise injurious I cannot say. It may probably be only the cement which is so largely used in building all termite structures, and with which the workers are also furnished.

Structure of Termitary.—If we penetrate still farther into the termitary, and as we approach the ground-line, the tunnels become more numerous and the material more like paper. In fact, it has become papier-maché of the lightest and thinnest texture, instead of the sandy cement or "concrete" which lines the outside. The outer tunnels are often thinly populated, and are much filled up with chopped grass. There are no other stores, such as dead wood or seeds, to be seen. The uses to which the grass is put are difficult to conjecture in view of the fact that rotting timber forms the usual food of termites.

The Queen.—It is in the central and more delicate tunnels that the queen is usually found. Her presence may be suspected by the more intense life; by the crowds of sexually immature individuals; by the myriads of young of all ages which fill the galleries; and even more certainly by masses of eggs, adherent together like a moist white sugar of fine grain (Plate II., *a* and *a'*). I must again ask it to be remembered that I am speaking of the termitaries which I have seen: others, say African ones, may be quite different.

Royal Chamber.—I dismiss the idea of a royal chamber dedicated to the queen: it does not exist in nests I have examined. I have found the queen in any part of the interior, and she possesses a power of locomotion quite belied by her appearance.

Provisional Queens.—The queen, though ever well guarded, is, like other royalties, liable to accident. In the case of death, a plurality of princesses perform her functions provisionally, and are egg-bearers. I have found eight in one nest. The princesses—so to call them—are not queens, and they differ in this wise: (1) They have not lost the normal form of the insect; (2) their abdomen can carry only, say, a tenth part of the usual number of eggs; (3) they have the rudimentary wings common to an early stage of winged insects, instead

of the scars which mark the discarded wings of the true queen.

I have said that the princesses are egg-bearing, and yet it is obvious that they have not made the nuptial flight. This would favour the idea that males are functional inside the termitary. They may well be so, as in the summer season, and previous to swarming—the nuptial flight—the winged males are there by thousands. This leads to the further conclusion that a winged virgin queen may be fecundated during flight, or soon after. This does not exclude the probability of winged males being functional in the nest, perhaps as in the case of the immature princesses, and perhaps also in the case of the mature wingless queen.

Queen's Consort.—As to a single and honoured wingless male, a permanent king, existing in the nest, the negative evidence—from my own observations—is so strong that I cannot help doubting his existence, at least in Queensland.

The Nuptial Flight.—On a summer day towards the evening, and when the air is moist—it usually happens just before the beginning of the rainy season—the air may be found full of winged termites. They are omnipresent inside and outside a house. They enter by every cranny, they explore every nook. The swarms are always mature males, or, it may be, females—developed from nymphs. In my experience they are almost, if not altogether, males. I have examined very many microscopically, and they were only of the male sex. I therefore lean to the opinion that I have missed the winged females, and that their proportional number—as in the case of some Diptera and Hymenoptera—must be very small.

I have said that there is never egress direct from a termitary. The point from which the winged crowd issues may be discovered by following the swarm to its source, a spot some yards in extent. This spot is not near the termitary; it is the last place you might suspect white ants to come from. Observing these temporary openings carefully, a curious fact presents itself, which almost needs a hand lens to verify. Thus observed, the active little heads of soldiers will be seen bobbing up and down at each opening, and we shall see that each point of departure is sentinelled, and that the sentinels regulate, and probably compel, the exit of the

winged stream. In the species under consideration, instead of the flight being from the level ground, temporary towers are erected to form a better starting-point.

Temporary Tower.

Not long after their first and last flight, perhaps half an hour, these creatures—shorter lived than Ephemeras—begin to drop their wings, which they cast aside with what seems a voluntary wrench. Death quickly overtakes most of them, and they fall helpless victims to gathering crowds of black ants, occasional spiders (*Attidæ*), and birds. Some individuals, perhaps with a happier fate, manage to conceal themselves in a hole in the ground, and survive to found a new colony, but such a chance is rare indeed. Such is the honeymoon of the termite, another instance of the prodigality of nature.

Are Termites purely Vegetarian?—It may well be asked, Are any animals purely vegetarian, or purely carnivorous? I doubt it. In Australia cows eat bones in no small quantities, and horses are sometimes fed on salt flesh. In Norway, I am told, cattle are fed on fish. Again, both cats and dogs eat grass. I look round for evidence of the carnivorous tastes of the termites; it may be scanty, but it is conclusive. Outside their nest, almost the worst against them is that they eat leather, but inside the case is much worse—they eat each other. I may give a curious proof of this. It is a common practice to poison a termitary by giving the termites something good to eat steeped in arsenic. The tit-bit may be very small, only sufficient to be eaten by a few. Yet ere long they all die—the living eat up the dead, and so a very little arsenic goes a long way.

Termites can communicate with each other by Sound.—Termites can be heard when not seen. The sound is like the ticking of a watch—more strident, perhaps rather more rasp-

ing, and somewhat slower. It can be heard some yards away, and their line of communication across a building can even be followed by this means. We might think that this was the action of the workers' mandibles upon the wood. It is not so. The sound does not coincide with the working, but has been thought to be an indication of invitation on the part of the soldiers—just as a dog barks when he hears a noise which he does not understand. A few taps with the finger in the neighbourhood of the termites will set the sound agoing.

Destructive Habits.—Undoubtedly the favourite food of termites is decaying wood. Why they should prefer this to grass seed or to things of a richer nature is their secret. I have seen them happy with the contents of a bag of flour, but upon the whole they are more at home with a rotting fence or an old deal board. Fallen timber strews the Australian plains, and is the grist for the termite mills, which are like the mills spoken of in Longfellow's translation—

> "Though the mills of God grind slowly,
> Yet they grind exceeding small."

And let me take care not to exaggerate, as is popularly done, the speed with which these jaws do their work. Indigenous timber, particularly the Eucalyptus, has a tendency to rot at the heart while still comparatively young. The old iron-barks and gums of centuries may present a brave front to the storm and a crown of verdure to the breeze, although they are mere shells, their insides full of red moist paste which has already passed through the "mills" aforesaid. Termites never prey upon healthy, living vegetation. When they attack a building it is with a recognised method worthy of description. They may enter at one corner of a house and make covered ways to the opposite corners, until they find the place which suits them best, and then they go to work. Their original point of entry is also their point of exit. Houses in Queensland, to defeat these attacks, are placed on piles or stumps. And it is a well-recognised fact that if termites are in possession of a house, it is only necessary to cut off their connection with the ground, or, to be more exact, with moisture, and they perish.

For this reason, if for no other, it will be seen how difficult

it is to conduct *experiments* with small colonies in test-tubes or the like. If moisture be excluded, it is fatal; if moisture be present, some fungus, probably a mucor, soon draws a white winding-sheet over the whole contents. Under adverse or winter conditions this fungus also infests the more distant tunnels of the termitary. There are other reasons why experiments under artificial conditions will not succeed, apart from the fact that their way of living does not lend itself to observation so easily as that of bees. Termites in the aggregate are a social mechanism in which it seems to me the individual has—if I may use the expression—no initiative whatever. May we not expect this of Socialism—if it ever succeed so far as to be an accomplished fact?

I shall now draw to a close with a notice of the common parasites of the termitary.

1. An infusorian, a true endo-parasite, is very common in the fluid body-contents of these insects, and may be observed easily with a comparatively low power.

2. Two species of acarina are ectoparasitic and rather common. One of them, probably a gamarid, also runs free about the termitary. Other inhabitants of the termitary are commensal rather than parasitic.

3. A very flat oval bug $\frac{1}{4}$ inch across is frequently found in pairs traversing the tunnels.

4. A colourless and eyeless lepismid is sometimes found, but is equally at home in similar dark abodes. This insect, like campodea, is furnished with abdominal appendages, which have been thought to be the homologues of legs. This, however, is not so, as scolopendrella has both these appendages and also true legs.

5. Small eyeless podurids are very common.

6. Microdon. I have several times found the curious mollusc-like larva of this fly in the external runs.

I do not include true ants of many species, which often make their social homes in the termitary. They are there as active enemies.

[After reading Mr Grieve's paper, the President made some remarks which may be briefly summed up as follows:—

1. Workers and soldiers are of either sex; they are un-

EXPLANATION OF PLATES I.–IV.

PLATE I.

Termitaries.

Fig. to right.—Mound Termitary, about five feet high. The exterior edge is composed of cemented sand; it is of a sandy colour, tinged red or brown according to the colour of the soil. The galleries are within half an inch of the surface. They are there separated from each other by an inch or less of cemented material. In the interior the septa or walls are from $\frac{1}{16}$ to $\frac{1}{32}$ of an inch thick, rounded at the corners: the interior is darker in colour, generally chocolate. This part of the architecture does not go much below the ground-level; tunnellings spread far and near. Many of the galleries are stored with grass stems cut into pieces about half an inch long.

Fig. to left.—Tree termitary, about 18 inches in diameter, the dwelling of a smaller insect than the former, on Iron-bark (*Eucalyptus siderophloia*).

PLATE II.

Termes sp., The Common Mound-Builder of South Queensland.

a, Eggs, natural size, having the appearance of medium-grained white sugar. They occupy with the Queen the central part of the Termitary above the ground-level.

a′, Same, enlarged $7\frac{1}{2}$ times.

b, Very young larva, creamy white.

b′, Same, enlarged $7\frac{1}{2}$ times.

c, Soldier, colour darker, and chitinous.
c', Same, enlarged $7\frac{1}{2}$ times.
d, Worker, colour creamy, sometimes darker, coloured by body contents.
d', Same, enlarged 7 times.
e, Prolongation on front of head of soldier.

PLATE III.

a, Head and thorax of Queen, enlarged $7\frac{1}{2}$ times.
b, Queen, natural size. (In the few minutes in which this specimen was before me alive, she laid 38 eggs: they were deposited by twos and threes as she slowly moved, and were enveloped in a transparent gummy fluid which dried and fixed them at once.)
c, Edge of wing of male $\times$ 180.
d, Winged male.

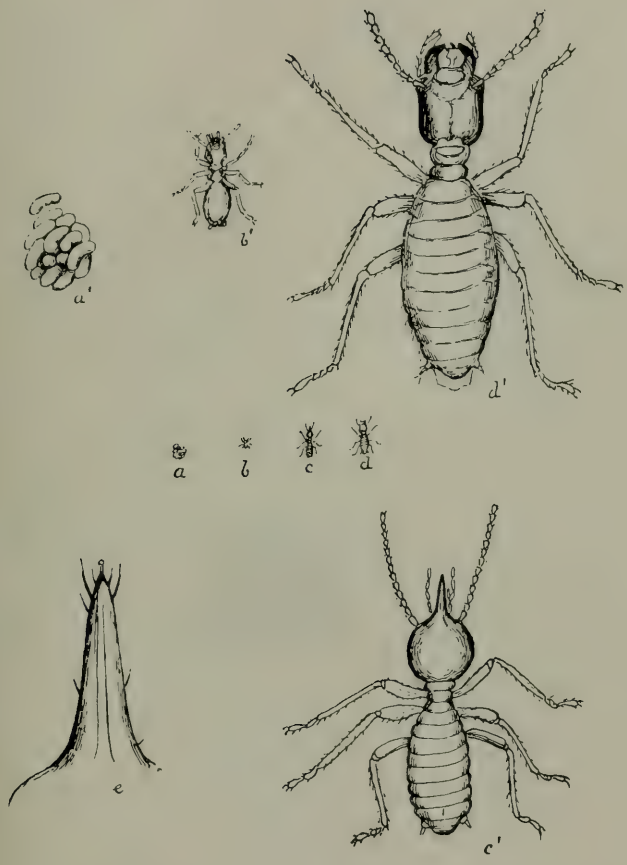
PLATE IV.

a, *b*, *c*, Mouth-organs of worker, enlarged about 60 times.

PLATE I.

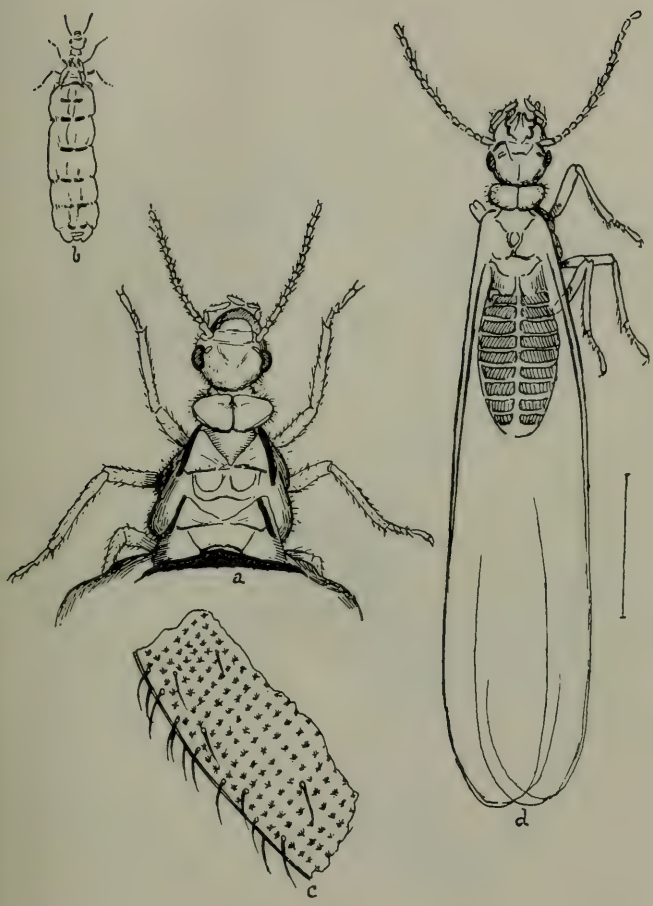
TERMITARIES.

PLATE II.



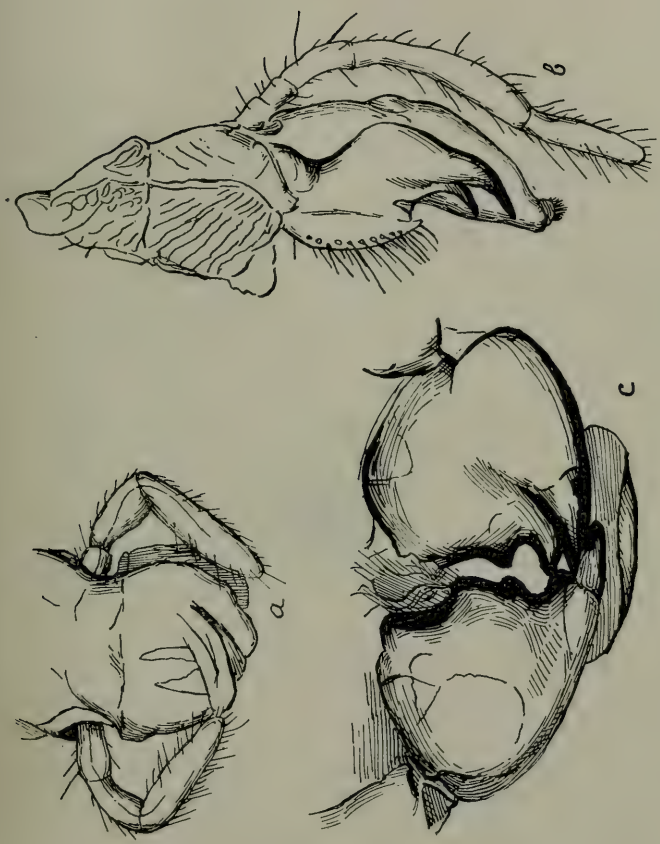
COMMON MOUND-BUILDER OF SOUTH QUEENSLAND.

PLATE III.



QUEEN AND WINGED MALE.

PLATE IV.



MOUTH-ORGANS OF WORKER.

developed males or females; they do not lay eggs. It may be remembered that Darwin said that it needed great confidence in his theory not to renounce it in face of the facts that workers and soldiers are quite different from their parents, and that they exist without reproducing themselves.

2. Grassi believes that the difference between the castes, like that between worker and queen bees, is brought about by feeding. Termites eat up every kind of refuse matter in the nest—dead bodies, as pointed out by Mr Grieve, and cast-off skins; while a favourite food is their own excrement. A soldier cannot gnaw dead wood like a worker on account of the size of its mandibles, and its food is chiefly its dead or ailing fellows. Termites of other species are not eaten.

3. Like queen bees, royal pairs (at least queens) live much longer than workers or soldiers.

4. Termites keep a number of complementary queens and kings, which are immature but can take the place of the true royalties, and be stimulated to reproduction should accident or occasion require it. When these reserve royalties are too numerous they are killed and eaten. Curiously, the nests of *Termes lucifugus* in Sicily have all, or nearly all, substitution royalties: the communities have outlived the life of the true royalties.

5. Reproduction is limited to a single pair or to very few pairs in a single nest. This is true of all social insects.

6. Bees in their social arrangements resemble termites much. Bees are a more intelligent community. The two communities have had quite different origins, and yet in their social systems they are strikingly like. To widen the idea, resembling forms (say allied species) may have had quite different origins.

7. Termites have a slow development individually, bees a rapid. Termites pass through hardly any metamorphosis; bees have a complete metamorphosis. Metamorphosis enables an insect to attain a much higher development in a shorter time.

These propositions are well worthy of the consideration of all Field Naturalists.]

II.—*NOTES ON THE NATURAL HISTORY OF LOCHFYNEHEAD.*

By Mr A. B. STEELE.

(*Read Nov. 23, 1898.*)

The picturesque scenery round the head of Lochfyne frequently induces the lover of Nature to sojourn at the village inn of Cairndow, close to the quaint parish church of Kilmorich, and overlooking the loch from its southern shore. The general appearance of the country is mountainous, presenting great diversity of form. Mountains of mica-schist and chlorite-schist rise almost perpendicularly from each side of the loch upward to a height of 2000 feet, their sloping sides clothed with heath and verdure. Around their base are grouped ridges of naked rock, or low and gentle hillocks covered with trees and a rich undergrowth of brushwood. The district generally is composed of mica-schist, intersected by porphyry, traversed by basalt dykes, and locally interspersed with limestone, chlorite-schist, and diorite. The more quartzose rock forms the hill-tops, and the less quartzose and therefore softer rock the valleys, and frequently abounds with garnets and felspar. Cylindrical rods penetrate through the whole substance of the quartzose rocks, and the present Duke of Argyll, who is a well-known geologist, interested himself some years ago in trying to discover the origin of these rod-like bodies. Geologists ascribed them to mineral concretions, such as pyrites or clay balls drawn out into ovate and linear forms by the effect of shearing or movements of the strata over each other. The Duke was not satisfied with this solution, and sent specimens to the British Museum, when they were declared to be the tubes or burrows of worms similar in their nature and origin to those which had long been familiar in the same rock as it occurred in Ross and Sutherland. The dispute, however, between his Grace and other geologists about the origin of mountains in Scotland cannot be so readily settled. The latter hold that there are no true mountain-ranges in Scotland at all. The so-called ranges, they aver,

are nothing but the remains of great tablelands which were originally raised above the water in the shape of a hog's back, and the cutting and carving of hills and mountains have been due entirely to the "guttering" caused by rains and snows over unnumbered ages. The Duke maintains, on the contrary, that our mountains are true mountains, and have been produced, like the Pyrenees and Alps, by earth movements—subsequently, of course, much denuded and carved out by atmospheric influences. Our mountains had in the most recent geographical times, perhaps just before the introduction of man into this part of the globe, been under water to the extent of at least 1500 or 2000 feet. His Grace is sceptical of those great ice-sheets walking over the tops of our hills, but he believes in a glacial age the conditions of which were exactly the same as glaciers now. If the Duke's theory is correct, that a great submergence of the land and a re-emergence out of the ocean have taken place in quite recent times, all the theories about the slow erosion of valleys are dissipated. The elevation of a submerged land out of the ocean would intensify the action of river valleys and water to such an extent as to make it impossible to measure how much work might have been done, and the time it took under such conditions. The argument that the antiquity of man upon the earth is quite inconceivable, from the fact that human implements have been found in valleys which it must have taken an enormous time to cut out, has often been proved fallacious. Flinders Petrie said the other day in this city that in the valley of the river, and also in the limestone plateau out of which the Nile had carved the valley, palæolithic flints had been found, showing the existence of man as far back as 5000 B.C., and probably farther. But not many years ago Chevalier Bunsen argued in the same way that Egyptian civilisation was many thousand years older than the ordinarily received chronology, basing his argument upon the depth at which certain objects had been found in the alluvial deposit of the Nile valley. Some time afterwards, however, a brick bearing the name of Mehemet Ali, who died in 1849, was found at a still greater depth!

The junction of the porphyry with the mica-schist may be seen at many points in the district. The porphyry varies in

character, being either composed wholly of felspar with only a few crystals of quartz or lighter-coloured felspar, or found with hornblende quartz and some portions of mica. Dykes of greenstone also traverse the porphyry and mica-schist. The chlorite rock occurs in beds of great extent, and masses are strewn over the mountains. It sometimes feels soft and soapy, when it yields easily to the tool of the carver, whose designs may be seen in primitive forms on the copestone of the bridge at the head of the loch. It is used as a building-stone, the Duke of Argyll's castle being constructed of it; and close to the church at Inverary a monument of it is erected to commemorate the execution without trial of seventeen gentlemen of the name of Campbell in 1685.

Bird life is very plentiful throughout the district, and the following were seen in August:—

Golden eagle.
" plover.
Common heron.
Solan goose.
Black-headed gull.
Lesser black-backed gull.
Goatsucker.
Spotted flycatcher.
Corn and reed buntings.
Oyster-catcher.
Barn owl.
Crossbill.
Carrion and hooded crows.
Tree-pipit.
Titlark.
Blue, cole, and long-tailed tits.
Ring ouzel.
Water ouzel.
Kittiwake.
Tree-creeper.

The loch abounds in a great variety of excellent fish. There is a tradition that there was at one time a regular sturgeon fishery in Lochfyne. The herring fishery on the loch is still a thriving industry, and affords employment to many. The superiority of the Lochfyne herring is well known, and their improved condition is said to take place after their entrance to the loch, and to consist not so much in size as in flavour. Banks, especially near the top of the loch, covered with rocks or stones, with an abundant coating of seaweed, are instinctively selected by the herring as the best ground for depositing their spawn. The fishing generally begins about the end of June, and continues till the beginning of January; and the fleet of fishing-boats with their brown sails and yellow hulls is a picturesque sight on the loch at the height of the season.

The district is not distinguished for a great variety of flowering-plants, nor is it remarkable for many rare alpine forms, but it is specially rich in clubmosses and ferns. The

royal fern still spreads its fronds on the wet ledges of several of the rocks, and cryptogams of all kinds abound. The following plants were gathered :—

Lobelia Dortmanna.
Hypericum Androsæmum.
" dubium.
" elodes.
" pulchrum.
Lythrum Salicaria.
Glaux maritima.
*Spergularia rubra.
*Myrrhis odorata.
*Melampyrum pratense.
Gentiana campestris.
Erythræa Centaurium.
" littoralis.
Menyanthes trifoliata.
Drosera rotundifolia.
" anglica.
Parnassia palustris.
Sedum anglicum.
" Rhodiola.
Saxifraga nivalis.
" aizoides.
Saxifraga stellaris.
" hypnoides.
" oppositifolia.
Epilobium alsinifolium.
" alpinum.
Vaccinium Myrtillus.
" Vitis-Idæa.
" uliginosnm.
Arctostaphylos Uva-ursi.
Lycopodium clavatum.
" Selago.
Selaginella selaginoides.
Osmunda regalis.
Hymenophyllum Tunbridgense.
" Wilsoni.
Polystichum lobatum.
Ophioglossum vulgatum.
Asplenium marinum.
" viride.
" Ruta-muraria.

* Not recorded from Argyll in Watson's 'Topographical Botany.'

The woodland here forms a conspicuous feature in the landscape, and is extensive and valuable, covering the greater part of the sub-alpine district. There is also a good deal of enclosed ground, which has either never been planted or has ceased to grow trees of any kind, much of it being covered with brushwood, where the blaeberry and bog-myrtle flourish. Several trees are remarkable for their great size and beauty, particularly two silver firs growing in the grounds of Ardkinglas. From the enormous bole of one of them, apparently the older, two gigantic branches like trees shoot out at some height above the ground. The soil and climate seem well adapted for the growth of all kinds of coniferæ. For this wealth of woodland the country is indebted to the chiefs of the houses of Argyll and Ardkinglas.

A great attraction of this place is the variety of its walks. The round from Cuil, over the Brannies to Benbui, where Rob Roy received wood and water from the house of Argyll while he was in the pay of Montrose, and back through Glenshira by way of Loch Dubh and Dunerave Castle, is most varied and charming. It is a good day's tramp, and most of it

through heather and peat bogs, but it well repays one for all the fatigue undergone. On the way the eye is frequently delighted with the sight of some of the rarer saxifrages and gentians, cudweeds, and cow-wheats blooming among the bogs and by the mountain side. The walk up Glenfyne is also charming and interesting. On either side tower lofty peaks, with precipitous ravines, and wild and lonely corries, where the eagle builds her nest, and which gives to the scenery a wildness and beauty difficult to surpass. At the shooting-lodge, a few miles up the river Fyne, her Majesty rested in 1875, and the chair on which she sat is ornamented with a brass plate to commemorate the date of the royal visit. Perhaps grander and more interesting is the round by Glenkinglas and back by Hell's Glen and Tomdubh. From several points on the route the views are fine and extensive, but the grandest and most impressive is that from "Rest and be Thankful," at the head of Glen Crow, which Wordsworth thought worthy of a sonnet, beginning with the lines—

> "Doubling and doubling with laborious walk,
> Who that has gained at length the wished-for height,
> This brief, this simple wayside call can slight,
> And rests not thankful?"

The ground at many places on the journey is covered with an undergrowth of ling and heath, largely interspersed with the blaeberry, crowberry, and cowberry plants. Higher up the heath-clad hillsides, and sometimes carpeting the ground underneath the heather, is the trailing clubmoss, whose powdery seeds, from their inflammable nature, have been employed on the stage to produce artificial lightning, and are used by apothecaries for coating pills. In a tarn by the ascending path the pale lilac racemes of the water lobelia bloom in great profusion. Among the many walks in the neighbourhood, none is more interesting or more enjoyable, the beauty of the route being due chiefly to the wildness of the surrounding scenery.

Lochfyne fishermen, who occasionally visit the head of the loch during the fishing season, say that it is the dullest and quietest part of all Scotland. Still, it has its attractions. It is a thorough change from city life. No excursionists

by rail or boat as yet disturb its calm. The air is strong and bracing, and pleasant with the sweet scent of heather and honeysuckle and the wholesome odour of pine. As a health-resort it may well be recommended.

III.—*GEOGRAPHICAL DISTRIBUTION OF CERTAIN BRITISH BIRDS AND THEIR ALLIES.*

By Colonel R. G. WARDLAW RAMSAY.

(*Communicated Dec. 28, 1898*)

Colonel Wardlaw Ramsay, at the outset, alluded to the importance of geographical distribution and the increasing interest in the study of it. He regretted, on the other hand, the false value attached by many to British-killed specimens, and the consequent destruction of our rarer visitors. The very wide area of distribution of many of our British birds, or their close allies, was shown, and a large number of painted slides were exhibited to show varieties due to environment or climate. The lecturer gave a brief history of the growth of the study of geographical distribution, indicating the six zoo-geographical regions of the world which at present are recognised by naturalists. It was shown that the area of distribution of certain families, genera, and species, and their varieties, were in some cases world-wide, and in others very restricted —the osprey and the barn-owl being instanced as illustrations of the former, and the azure-winged magpie of Spain and Japan, the sun-bird of the Jordan valley, or our red grouse, of the latter. These areas are sometimes continuous, as in the brambling, or discontinuous, as in the genus *Cyanipœa:* sometimes the areas overlap, as in the case of the long-tailed tits and the azure tit.

The lecturer showed that deep seas, however narrow, had more effect in determining areas of distribution than shallow seas, however broad; and explained this phenomenon in the light of geology and the opinion of naturalists like Dr Wallace

as to the origin of islands. The islands of Bali and Lombok were given in illustration.

Some of the theories of distribution were then described, taking Dr Wallace's illustration of the genus *Garrulus.* The geographical distribution of the various species or local races of this genus were shown on a map. The lecturer then dealt with the geographical distribution of the *Paridæ,* and especially considered the question of insular species, such as in the Canary Islands.

The tree-creepers, nuthatches, chaffinches, bullfinches, kingfishers, barn-owls, and grouse were successively dealt with, and their distribution illustrated both by painted figures and maps.

IV.—*OUR COMMON MIGRANTS.*

By Mr CHARLES CAMPBELL.

(*Read Jan. 25, 1899.*)

To those whose tastes incline to a study of natural history, and who take a delight in watching birds in their native haunts, there is nothing more interesting than to note the coming and going of our migrants. Even from the earliest times this feature of bird life has been remarked, as in Jeremiah we read, "The stork in the heaven knoweth her appointed times; and the turtle and the crane and the swallow observe the time of their coming." There is something almost mysterious in the way in which numbers of small, delicately formed birds are found scattered over a district, where a few hours previous not one of their kind was to be seen or heard. And the manner of their arrival is scarcely more remarkable than the regularity with which they make their appearance. Nearly all of them reach this country after long and protracted flights, crossing the Mediterranean, the Bay of Biscay, and the English Channel. Year after year they arrive in the same localities almost to a day.

The following table will show the dates of a few of our migratory birds for the past seven years :—

DATES OF ARRIVAL OF MIGRATORY BIRDS, 1892-98.

NAME OF BIRD.	1892.	1893.	1894.	1895.	1896.	1897.	1898.
Wheatear .	April 9	April 20	Mar. 28	Mar. 30	Mar. 19	April 1	Mar. 27
Whinchat .	18	May 1	April 6	April 21	May 3	22	April 19
Willow-Wren .	18	April 15	15	15	April 23	21	20
Swallow . .	22	18	14	13	11	18	10
Cuckoo . .	27	26	15	25	16	26	May 1
Redstart . .	26	18	12	22	16	May 2	April 30
Whitethroat .	May 12	26	May 5	28	May 4	1	May 6
Wood-Wren .	8	30	April 20	20	11	April 30	2
Blackcap .	19	23	May 18	May 5	April 25	May 19	20
Flycatcher .	14	May 16	5	4	May 23	22	17

Although within the last few days it seems as if we were just at the beginning of winter, yet the signs of the return of spring have not been awanting. The missel-thrush from the top of some tall tree has been the first to give voice, and the mavis and the blackbird in the mild mornings have already been trying their forgotten melodies. It will not be long before we are able at say, "The winter is past, . . . the flowers appear in the earth; the time of the singing of birds is come."

[With the aid of the beautiful slides belonging to the Society for the Protection of Birds, the lecturer then gave a short account of each species, as it was shown on the screen. The following remarks were made in exhibiting the picture of the great spotted woodpecker.]

In the January number of the 'Annals of Scottish Natural History' there is a detailed account of the appearance of the great spotted woodpecker in the south-east of Scotland. Although breeding and resident in the Midlands and south of England, this bird is very rare in Scotland. It has been known to nest in Duns Castle woods, where it is protected. At irregular intervals it visits our shores in considerable numbers, as has recently been the case; but the appearance of the bird is generally the signal for its slaughter. Were it unmolested on these occasions, there is no doubt this fine bird

would be much more common with us than it is. At least one pair of them have been frequenting Dalmeny woods since November, and it is hoped they may nest this summer. No later than yesterday (January 24, 1899), a male bird was seen close to Dalmeny mansion-house. It was feeding on an oak tree, and was noticed several times to fly up to the small branches and break off a gall-nut. This it carried down to a cleft in the tree, where it broke the gall-nut open for the sake of the grub that was inside. Numbers of gall-nuts, neatly split in two, found under oak trees in different parts of the estate, showed that this was a favourite food of the bird.

There is no chance of any of these birds being shot in Dalmeny; and from personal interviews with the tenants or proprietors, I have been assured they will be equally well guarded if they should happen to stray to the neighbouring grounds of Craigiehall, Cammo, or Cramond. The woodpecker was also noticed in the Dalkeith district on Sunday, so that there is a reasonable chance of this fine bird nesting in the Lothians.

[Writing on the 12th of June, Mr Campbell says:—

"I am sorry that the expectations we formed in the early spring of being able to add the great spotted woodpecker to our nesting species in West Lothian have not been fulfilled, as far as I am aware. Since the first week in May no trace of these birds has been seen in Dalmeny Park, and inquiries made outside lead to no better results. I am afraid they have gone as suddenly as they came."]

At this meeting Dr Traquair, F.R.S., gave a most interesting lecture, with lime-light illustrations, on "The Bearing of Fossil Ichthyology on the Doctrine of Descent."

V.—*ON SOME GEOLOGICAL AGENTS.*

With Illustrations of their Work.

By Mr A. CAMPBELL.

(*Read Feb. 22, 1899.*)

I have here a few specimens of rocks as illustrations of the work of some geological agents that are daily changing and modifying the surface of the earth. The specimens are by no means all that I could wish; but where the material is from 2½ to 3 times heavier than water, transport and time become a matter of consideration.

And the agents: as the most important and universal geological agent, I will take water first. This agent operates in various ways—as vapour; as running water, doing a large amount of mechanical work; chemically, as a solvent of great power in combination with carbonic acid or the carbonates of sodium or potassium; and, if I may use the term, as an explosive force in the form of ice.

The mechanical action of running water can be easily studied, even on the public road, during a heavy shower of rain. The mud—it was dust an hour ago, road metal a week past, and hard basalt or granite in the quarry before that—is now being swept off the surface and carried away by the little rills that have collected into two small streams on the sides of the road. These in their downward progress will join or be joined by other streams, gradually swelling in volume and strength, and in the course of a few miles flow into the main stream of the valley, the river which will ultimately deposit the mud in the sea. But this loose material—mud, sand, gravel—has been doing geological work as it travelled along with the stream, abrading the rocks and stones over which it passed, making more loose matter to be carried seawards in suspension. But a river in flood carries forward an enormous amount of matter apart from the finely divided mud or clay that discolours its waters. Sand and gravel and stones are rolled along the bottom, grinding and reducing each other into materials similar to what is carried in sus-

pension. In mountain torrents we can sometimes hear the grinding action of the stones as they are rolled along, and we can also hear the dull thud as they are knocked against each other by the force of the current.

The power of water to move heavy bodies depends upon its velocity, and the velocity on the volume of water and the angle of slope. Hopkins of Cambridge has stated it in this way: "The force exerted on a surface given in magnitude and position is found to increase with the square of the velocity; and if the force of the current be estimated by the weight of the largest block of a given form which it is capable of transporting, it is found that the force varies as the sixth power of the velocity of the current. Thus a current being able to move a cube of a given weight, another current of double the velocity would move a cube of 64 times the weight of the former; and if the velocity were trebled, that of the first case, the cube moved might be 729 times as great, and so on." Prestwich says, supplementary to the above: "In this manner a spherical block of 5 tons might be moved by a current of 10 miles an hour; a current of 15 miles per hour would move a block of 56 tons, and a current of 20 miles per hour a block of 350 tons and upwards.

In order to make the geological work of rivers—running water—more clear and definite, I will take as an instance the river Tay, the largest of our Scottish rivers, with the view of showing you by figures the mechanical work done by water. But in considering this work, we must always bear in mind that gravel and stones lose about one-third of their weight when immersed in water. The Tay drains an area of some 2400 square miles, and the rainfall in the western gathering-ground is heavy. It discharges about 144,000,000,000 cubic feet of water annually, and the estimated discharge of sediment during the same period is 49,660,000 cubic feet. Now the upper waters or feeders of the Tay have several settling-ponds to keep back the sediment brought down by these feeders: Loch Tay holds back all that is brought down by the Dochart and the Lochy; Lochs Ericht, Rannoch, and Tummel all that comes from the north and west; and yet, with all these four settling-ponds as

I call them, there is an enormous annual amount of geological work done by this one river.

Rivers also hold much matter in solution, such as carbonate of lime, sulphate of lime, &c. The Thames—a river flowing through and draining a calcareous country—carries an estimated quantity of 600,000 tons of carbonate of lime past Kingston annually; and as showing the difference in the quantity of matter carried by a river in suspension and in solution, I will mention the Danube, with nearly 68,000,000 tons in suspension, and 22,521,000 in solution. What is the weight of the material rolled along the bottom of a river in the form of gravel and stones cannot be estimated with any approach to certainty.

Now for one or two illustrations of the chemical power of water. Rain in falling through the atmosphere absorbs or dissolves carbonic acid gas — the carbonic dioxide of the chemist. Decaying vegetation supplies this gas too. As this rain-water, with its supply of carbonic acid, flows over the land or descends into the earth, it dissolves the carbonate out of the limestone, leaving only the impure matter, often called rotten-stone, which is chiefly composed of silicate of alumina, iron, &c. The dissolved carbonate finds its way into springs and streams, sometimes deposited as calcareous tuff or tufa, as at Starleyburn in Fife, and frequently as an incrustation in our kettles and boilers. Where the limestone is very pure, almost the whole of it is dissolved by rain or running water.

But water charged with carbonic acid, &c., does not confine its solvent action to limestone alone. It attacks the lime and potash felspars in rocks, and breaks up their chemical union with other substances. Here is a specimen of granite, where you can see that the felspar has been eaten away, and the quartz particles left standing out in relief. Iron is also dissolved out of rocks, as you can see by the red deposits of some springs. I have here some specimens of bog-iron ore, probably dissolved out of the West Kip, and re-deposited some inches below the surface in the moor lying to the north-east of that hill. Decayed vegetable matter had something to do with the re-deposition.

I must not omit heated waters and vapours. Their solvent

powers are much greater than that of cold water. Hence we must look to them as principal agents in dissolving and re-depositing the metals and ores that fill the mineral veins in Cornwall, Devonshire, Wales, and many other localities.

In concluding my observations on water, I will mention in further proof of its solvent powers that springs in many parts of the world discharge thousands of tons of carbonate and sulphate of lime, silica, sulphur, chloride of sodium, carbonate of soda, iron, manganese, cobalt, &c.—none of which are found in the atmosphere.

I have before said that decaying or decayed vegetation supplied carbonic acid to running water, and so became an important agent in the destruction of various rocks. The thin crust of lichen that incrusts the surface of the rock and the tiny moss that grows in the crevice are agents of change by harbouring moisture, which, as I have pointed out before, dissolves the union of the rock-building substances that go to make what we call granite, basalt, &c. Trees, by the bursting power of their roots, especially on hillsides, are agents of change in a small way; and no doubt the overthrow of a forest by the storm has been the beginning of many of our peat-bogs.

But if plants are agents of destruction and dissolution, they are also agents of protection and reconstruction. Plants afford great protection to the surface of the earth against the action of rain and running water. A good covering of grass, heath-wood, &c., binds and secures the surface-soil from being carried away, except where a stream has cut a channel or bed for itself, which is only natural drainage. Plants are builders too; coralline and chara secrete lime, diatoms silica, and almost all plants secrete one or more mineral substances; while the sphagnum or bog-moss contributes largely to the formation of our peat-beds. So you see plants have a compensating action: in destroying the rock, they are only supplying us with fresh soil—less what may be carried off by water, and even this loss is compensated for by the protection they give against a greater loss.

Water as a Solid, or Ice.—This is a giant that has done mighty work in our land in the past. He is still active and powerful, working and producing changes every day that the thermometer

falls to or below zero. This work is to be seen on the mountain side in the rock detached and thrown down, in quarries, railway cuttings, the steep banks of rivers and streams, and in the stones, gravel, &c., carried down stream by surface and ground ice.

Ice long, long ago had a great deal to do with the configuration and landscape of our own county. Our rounded hills and hillocks, our deep glens and valleys, our beds of boulder-clay, and our scratched and scored rocks, all remind us of the action of ice. Although its work is so conspicuous over all the land, the cause of this Ice Age is still an unsolved problem. The boulder-clay or till is another, with its clay-beds of sandstones, angular and rounded, small and great, and scattered indiscriminately through the moss. Much has been written on the subject, but no theory that has been proposed gives a satisfactory explanation of this deposit.

Ice has been credited by some geologists with excavating our Scottish lochs and English lakes, with Geneva and Superior thrown into the bargain. But it has not yet been proved to my mind that the ice, for instance from the surrounding hill, excavated Loch Tay, some 15 miles long, from half a mile to one mile broad, and from 15 to 100 fathoms deep. If a man has to cut a bar of steel, he requires tools—files as hard or harder than the bar he is to cut. He also requires food to give him the necessary power. After the same manner, if a glacier is to excavate Loch Tay or any similar rock basin, it must have tools—stones or gravel, at least as hard as the rock it is to operate on—and gravity as the equivalent of the man's food. Whether the hills surrounding Loch Tay—after having been subject to denudation for ages before the Glacial Period—could supply the necessary tools and gravitation is what I will not affirm.

I have here a few specimens of undoubted ice-work. One is broken from a boulder weighing about five tons, excavated out of a clay bank about 20 feet thick. It is as smooth as if a planing-machine had passed over it. Another is from the Braid Hills, with the characteristic striæ; and a third from a bank of boulder-clay in the Pentlands, about 1100 feet above sea-level.

Sand is such a common material that we seldom give it a

moment's consideration unless on a windy day, when we get our eyes, mouth, and nostrils filled with it. It forms considerable areas round our coasts, called links. The golfer knows and loves the links, but the ordinary golfer knows nothing about the natural history of the sand that forms these links over which his ball rolls. All that he knows and cares for about sand is its "bunkers." That the sand which forms these tracts of land was blown in from the sea-shore is certain. In fact, it is land recovered from the sea—the wind blowing the sand inland after the tide has retired from the shore. On the East Coast we have large stretches of such land—one of the largest, called Tentsmuir, extending from the mouth of the Eden to the mouth of the Tay. On the north side of the Tay we have Barry Links, and on the south of the Eden the ever-famous golf-links of St Andrews. Much of the sand has been brought by these two rivers.

It is not very clear how all this sand was accumulated, or by what agency the rocks were reduced from the solid to this granular condition. The only way we can account for it is the dissolving of the softer materials—felspar, &c.,—leaving the quartz particles to be carried away by running water.

Sand in motion, by reason of the hardness of the silica, is an agent of tear and wear. I have here a few specimens of its polishing action on rock, by which you can see that it was the origin of the sand-blast so much used nowadays in the industrial arts. It is an abrading agent when carried forward by running water; and driven by wind and wave against the sea-cliff, it undermines it, bringing down large masses of rock, which will likewise be ground into sand and utilised in the same manner and for the same purpose of destruction.

In some countries—France, for instance—large tracts of valuable land have been overwhelmed by the inland movements of sand. In our own country, in Morayshire, some ten square miles of the best arable land in the county were covered to a great depth by sand driven in from the sea-shore. A partial cause of the disaster was "the bad practice of pulling bent and juniper." So said an Act of the Scottish Parliament, dated July 16, 1695.

The sea is a geological agent of the highest importance. It is in a state of perpetual war against the land. Its powers of

destruction were well illustrated round our coast in October last year. Aided by wind and tide, it washed away the land and undermined the solid rock of the cliff by pounding it with materials torn from its own massive side. In this rude and boisterous fashion it eats away the land, forming islands, channels, and bays. And by the same means and in the same manner Great Britain was made an island—to the disgust of our friends on the other side of the Channel, who would fain shake hands with us on some occasions.

And man as the last agent. Man, especially since the time that he discovered the use of fire and metals, has been the cause of geological changes on the surface of the earth. Reading the early history of man in the East, we learn that he brought the greater part of Western Asia into a condition of great fertility, capable of supporting a large population in a high state of civilisation. Looking at the same region in the present day, we see the desert sand covering what were cultivated fields and vineyards in the past: the trees have been cut down, and the water has ceased to flow,—for all which the ignorance of man and bad rulers are responsible.

But if man, through ignorance, idleness, and bad government, has allowed a large area of Asia Minor, Northern Africa, and some other countries on the shores of the Mediterranean to run to waste, he has by industry, perseverance, and science changed the physical features of the earth in many other quarters of the world. In the cold and rigorous climate of Germany, Holland, Great Britain, and North America he has converted the impenetrable forest, the swamp, and the mountain side into fields of wheat, corn, and grassy pasture, producing food and shelter for himself and the useful animals that he has brought under his dominion and protection.

But the cultivation of the soil is an agent of geological change, by frequently exposing the loose surface to the denuding action of rain. It is only necessary to look at a ploughed field on a gentle slope during a heavy shower of rain to be convinced that the soil is being rapidly washed away towards the river, and by the river to the sea. Who can calculate how much the land will be lowered in our own Lothians by the works of men during the next thousand years?

VI.—*A BRYOLOGICAL EXCURSION TO BEN LAWERS.*

By Mr A. MURRAY.

(*Read Feb. 22, 1898.*)

In preparing this paper at the request of our late President, Dr Davies, I had to consider at the outset the lines upon which I should proceed, in order that it might be interesting to the members of the Society. The question was whether I should include my personal experiences, or simply confine myself to a notice of the plants seen and the localities in which they grew. After consulting with the President, I have resolved to give also an account of some of the experiences of the trip. If, therefore, I am sometimes too "personal," you will perhaps pardon me, on the ground that I have erred through my desire to interest you.

For many years I had longed to pay a visit to Ben Lawers, to see for myself, and to collect specimens of, the many rare plants—alpines, ferns, and mosses—which are recorded as to be found there. In my younger days I took a delight in the study of mosses, and a few years ago I made a fresh start with the fascinating study. Since then Ben Lawers has been more in evidence than ever. In every bryological work I referred to I saw him the guardian of many of the rarest mosses. My desire to become acquainted with him grew stronger and stronger, until it culminated in the visit which is the subject of this paper.

One night about the beginning of last year (1898), my friend and fellow-member of the Society, Mr Scott, and I were looking through some specimens of mosses, when we came upon a few from Ben Lawers. Mr Scott remarked jocularly, "I must have a day on Ben Lawers this year." I answered, "If you will allow me, I'll go with you." The joke became a serious undertaking—serious, because of two obstacles, time and cash; or rather, I should say, the want of time and cash. To overcome the former, we laboured early and late in order to bring our work into such a condition that we could leave it for a few days; and to meet the latter, we agreed to put up in the large airy hotels of Mr Glen and Mr Mountain. I fear you will think badly of us when I confess

that we have not paid our hotel bills yet; but there is this much to be said in our favour—they have never been rendered!

About 4 P.M. on the 18th June of last year Mr Scott and I, having left Killin railway station, were on the road for Ben Lawers. The lovely afternoon and charming scenery made us almost forget that the packs on our backs contained our camp utensils and food for three days. But after proceeding two or three miles we began to find out that to carry a provision shop on one's back, on a hot summer day, and at the same time search carefully for botanical specimens, was no light task. It certainly did not suggest a holiday. But to the general holiday tourist a better or a prettier road could not be found. Even before leaving Killin station, the view is magnificent. Here we are at the meeting of three glens, in the very heart of lofty mountains. Richly wooded scenery is around us in the foreground; above tower the bare rugged mountains; while to the north-east is seen the long stretch of Loch Tay—the narrow gorge leading to Glen Lochay to the north-west, and to Glen Dochart with its river on the south-west.

Shortly after crossing Lochay bridge the small but romantic Finlarig burn is passed. Across the bridge, keeping to the right, the road leads to Ben Lawers. At each fresh turn a new and charming view appears. On the other side of Loch Tay are seen the beautiful mansion and wooded park of Achmore, where one of the largest vines in Britain grows. A little farther on a splendid view is obtained of Killin pier, with the woods and old castle of Finlarig to the right. But what is the use of selecting particular views, or endeavouring to describe them?—to realise the beauty of Lochtay-side it must be seen.

The object of Mr Scott and myself was to gather mosses, and we began our collecting at the Larig burn. There was no necessity for us to leave the main road—every tree, bank, dyke, and rock was covered. Many of the plants were, of course, of common species, but we also got a number of rare and fine specimens. In the crevices of the wall of the bridge over the Larig there were quantities of Leersia contorta, Bryum capillare, two or three Tortulas, &c. On the trees we gathered Weissia Bruchii, Orthotrichum affine, O. Lyellii, and Hypnum cupressiforme, *var.* filiforme. At the top of a bank at the roadside a lovely curtain of Antitrichia curtipendula hung over a rock in festoons a foot in length. Farther on many rare

bryological treasures, as well as the common Hypnums, Grimmias, &c., were seen. From an old dyke we took some fine specimens of Brachythecium glareosum, B. populum, B. plumosum, and B. rutabulum; Hypnum cupressiforme in variety, Amblystegium serpens, and Plagiothecium denticulatum —all of which we gathered—and many more which we did not touch. Also Neckera complanata, the type and the *var.* tenella, Grimmia pulvinata, G. apocarpa, and Polytrichum alpinum. A bank above a retaining wall farther on provided fine specimens of Ditrichum flexicaule, as well as Pleuridium subulatum, a lovely little moss whose capsules resemble tiny rubies set in a crown of narrow pointed leaves. Here and all over the course followed were many pretty patches of Breutelia arcuata, but generally dwarf and always barren. Hypnum squarrosum and Hylocomium loreum were also plentiful, and here and there small patches of Leersia alpina and Hylocomium splendens. A liverwort, Preissia commutata, in fine condition, we gathered from a rock close by; while it may interest lovers of ferns to know that a sunk retaining wall which we passed a little later was richly clothed with Cystopteris fragilis, C. denticulata, and Asplenium Trichomanes with fronds nearly a foot long, as well as some very distinct-looking forms of Athyrium Filix-fœmina.

Our route had been sketched solely by the aid of a map, and on meeting a native apparently of the district, we took the opportunity of confirming it. In the course of conversation, after satisfying ourselves as to the best way to ascend the mountain, we mentioned that we were looking for mosses. "There's no' much moss on the tap o' Ben Lawers," said he; "you'll get bigger anes where ye are; if ye'll just gae up the side o' the burn, in the corrie yonder ye'll get the fill o' your boxes and baskets in less than ten minutes." "We are going to sleep on the mountain, so as to be near the mosses," I added. This, apparently, was too much for him: with a curious look at us, and an expressive shake of the head, he said, "Good night."

The glen of the Mhoirneas burn looked so inviting that we were sorely tempted to take our friend's advice, and go to fill our boxes in it. But, according to our plans, we were to ascend the Edramucky burn about a quarter of a mile farther on, so we passed it with some reluctance, little dreaming that ere the night was over we should revisit it and seek its friendly

shelter. Striking off the road to a marshy bit of ground on the east side of the burn, we found ourselves in a perfect flower-garden of terrestrial orchids. The ground was literally covered with them: it was almost impossible to walk without treading on a flower. There were five or six varieties, but as I did not take any note of them I have only my memory to go by. In two other places even finer and larger-flowered orchids were met with, but not more plentifully.

Resuming our moss-hunting, we got here some good specimens of Hedwigia celata and Hypnum scorpioides in fine fruit. The latter I have not seen in the neighbourhood of Edinburgh. It is uncommon to find it in fruit. Hypnum stellatum, Pohlia cruda, Fissidens adiantoides in fruit, and Grimmia acicularis were also found. Swartzia montana was at home here: it was in beautiful fruit, but dwarf.

We were now beginning to realise that the delight of gathering mosses was not of itself sufficient to live on. About 8 P.M. we kindled a fire and made tea. Our last meal had been partaken of about 10.30 A.M. I need scarcely say that no tea was ever more relished. While the kettle was boiling I had a look round. A magnificent view of Loch Tay was before us, with many miles of the opposite shore. Away to the west Meall nan Tarmachan reared his head, 3421 feet above the sea level; and on the north-east, Beinn Ghlas, 3085 feet, hid from sight our friend Ben Lawers.

The vegetation in the Edramucky corrie is neither luxuriant nor varied, being limited to a fair covering of short grass mixed with plenty of carex, a few ferns, heather, &c. I gathered a specimen of Galium sylvestre, and saw some Pinguiculas, Parnassias, Polygalas, &c. After tea we continued our way up the burn. On the bank Mr Scott gathered a single specimen, in fruit, of Oligotrichum incurvum. I have found it on the Pentlands, but it fruits only on the higher mountains. By nine o'clock we were well up the mountain side, but could see no place of shelter where we could camp for the night. We were therefore compelled to retrace our steps, until we came to some large stones, with which we set to work, and in half an hour a fairly good shelter was erected, the sky, however, being the only roof. We now thought of a fire, but, alas! there was nothing to burn, not even heather stalks. We hid our packs and set out to look for better lodging. About half

a mile to the south-west we sighted Mhoirneas corrie, with the tips of some trees showing above the high ground. I went to reconnoitre, and having brought back a favourable account, we returned for our goods and chattels, and made our way deep down in the glen. With hazel and rowan-tree branches we made a roof over a sheltered nook among the rocks, kindled a good fire, and a few minutes past eleven we lay down on our bed of heather and bracken. But—horrible to relate!—we now discovered that we had made our bed within twenty yards of a thundering waterfall! Waterfalls are very pretty, and the noise of falling water pleasant to hear; but to sleep, or rather to attempt to sleep, at the foot of one, is a very unpleasant experience. We had lain for about an hour, taking turns at grumbling at our stupidity and the existence of the waterfall, when, to add to our troubles, the wind changed, and the smoke from the fire blew into our bedroom, making our eyes smart so badly that we had to get up and put out the fire. Again we laid ourselves down to rest, if not to sleep. Then we got up about one o'clock, rekindled the fire, had a good wash in the burn, and breakfasted at 2 A.M. We had finished when it began to rain, but from the broken appearance of the clouds we thought it would only be a shower, so we had a look round, and picked up a few good things—such as Plagiolryum Zierii, Bryum albicans, Hypnum ochraceum, and H. calochroum. About half-past three we started to climb the mountain, but in half an hour a thick mist and heavy rain set in, enveloping us in a dense shroud. Instead of attempting the top of the mountain, it was therefore now decided to keep along the side until we should come to Allt an tuim Bhric, and if then fair to go up that burn. For two or three miles along the side of the mountain we tramped, the rain falling in torrents, and the mist so dense that from ten to twenty yards was the extent of our view; while our legs from the knee downwards were soaked, and the water squirting out at the lace-holes of our boots at every step. No mosses were to be seen: our spirits were at zero. When nearing the corrie, a small patch of Tetraplodon bryoides and of Funaria obtusa improved matters a little. On arriving at Allt an tuim Bhric, there was no improvement in the weather, and the ascent of the Ben seemed hopeless. We were wet and disappointed, and we disagreed as to the next step we should take. Mr Scott was

determined to attempt the climb, mist and rain notwithstanding, and we made a start. Mr Scott, however, thinking from the distance we had come that we were ascending the Lawers burn, insisted that Ben Lawers was on our left, whereas I, believing it to be the Tuim Bhric, was confident that the Ben was on our right. It being impossible to settle the matter in the mist, I turned down the burn, and Mr Scott followed. We had only descended about half a mile when we walked out of the mist and rain into bright sunshine. About this spot we gathered Bryum alpinum, which was new to my collection. Before reaching the road we walked through another garden of orchids, quantities of Meum Athamanticum also filling the air with its peculiar odour, and on past a small pond, where I saw one of the prettiest sights I have ever witnessed. The pond was almost entirely filled with the Buckbean (*Menyanthes trifoliata*), in fine flower, there being as many flowers as leaves, with spikes four inches long. These flowers were of quite abnormal size and beauty.

Reaching the turnpike road, we saw from a milestone that the Lawers burn was still three miles distant. A brisk walk took us to the burn, up which we went about a mile. Our first care was to collect sticks and make a large fire, and while our boots and socks were drying we set to work to make our camp for the night. Having formed a comparatively comfortable shelter, and with plenty of wood for a fire, we were now prepared for whatever kind of weather should come. We then hid our provisions in case of stragglers, and, with nothing but our vasculums to carry, started up the Lawers burn.

The banks were not very productive of what we wanted. In a little pool at the side of the burn I saw a very large frog. I tried hard to catch him, but after a hunt of a quarter of an hour I had to leave him master of the pool, the water having become so muddy that I could no longer see him. Mr Scott was now a long way ahead of me: I hurried until near to him, and came to what appeared to be a ford across the burn. It had been carefully paved, and a zigzag road led up the bank from the water-side. Being anxious to see where such a road would lead to, I followed it. About half way up was a large patch of Oligotrichum incurvum, covered with fruit. I called to Mr Scott, who was not slow in coming up

to it. After gathering what we wanted, I said I was going up to see if I could get a look at the Ben. When we got to the top of the bank—which was of considerable height—we had our first view of Ben Lawers. Clear and temptingly near did it seem, although it was between four and five miles off. I wanted Mr Scott to climb to the top with me, but he said there would not be time to explore it that night. Hearing a noise behind, I turned round, and was surprised to see a boy on a Highland sheltie. "Hallo, boy, do you know where you are going?" "Ay div I." "Where are you going?" "Nae place; I was only bringing ower this horse—it belongs to this side. It was on the other side, and I was just bringing it back." "Where does this road lead to?" I asked. "It used to be the road to a peat-moss, but it's no' used now: are ye gaun to the tap o' the Ben?" "We are just discussing that," I replied. "This is the best way up," he said. "Will we be able to reach the top by six o'clock?—it's now twenty minutes to four." "Oh yes; I can go in two hours frae the road." He directed us how to go, which was of great service to us. Mr Scott consented to accompany me on condition that I would again ascend the next day if the weather was fine. We did not gather much until we were well up the mountain side, when I came upon a patch, about a yard square, of that rare and pretty moss, Splachnum vasculosum, with fruit nearly as large as small black currants and as black. It was the prettiest patch of moss I ever saw. The bright green carpet of leaves dotted over with the black fruit with their red setæ was very striking. We knew this moss had been found on Ben Lawers, so were keeping an eye on every likely spot. I was now perfectly satisfied. These three rare mosses—Tetraplodon, Funaria, and this Splachnum—were worth all my trouble. A little farther up we came upon another marsh below a spring: springs of pure water, cold as ice, were plentiful, in which many mosses were growing, including two new to us—viz., Bryum Duvalii and Pohlia Ludwigii. Grimmias, Polytrichums, &c., were growing higher up, but better specimens were obtained next day.

After a steep climb, we were on a nearly level stretch of 200 yards, or less, between the conical spur to the north-east and the crag up which the path leads to the summit. While crossing this we heard, as if coming up from the glen, on our

right, a terrific noise, which appeared to us to resemble the mingling of many discordant sounds. We stood still wondering what was going to happen, when there came up out of the deep glen and passed in front of us, about twenty yards distant, the most terrible whirlwind I ever heard—nay, I may say *saw*, for we seemed to see the wind. It is impossible for me to make plain the kind of noise we heard. I could scarcely have believed it possible for the wind to make such a noise over smooth ground. We did not take time to look for specimens while crossing here. It will not, however, be surprising that from a hurried survey we found there was nothing growing but a few stinted mosses. We climbed the crag, where, from the top, there is a long steep rise to the summit, along the crest of a narrow ridge, with an almost perpendicular drop of several hundred feet down to Lochan-a-Chait glen. Another very rare moss—Conostomum boreale—was found in fruit here: though none of the capsules were ripe, there was plenty of it in small detached patches. A few heath (*Calluna vulgaris*), a fair covering of Salix herbacea of small growth, a few varieties of moss, chiefly Dicranums, with some Bryums and Hypnums, were the principal other plants to be met with. I can hardly describe how pleased I was to reach the summit of Ben Lawers. No words of mine could do justice to the view. The air was beautifully clear, and standing there almost 4000 feet above sea-level and about 1000 feet above the surrounding mountains, we commanded a prospect of many miles of mountain, loch, moor, and glen, stretching away on every side as far as the eye could reach, probably unsurpassed in grandeur and beauty by any similar view in Britain. To have such a panorama at one's feet is truly worth the climb. I was informed that Ben Nevis may be seen from Ben Lawers. We thought we could distinguish its outline, but were not certain. Of course, one must go to the top of the cairn. It stands upon a peak on the north-east corner of the craig which runs round three sides of a large hollow, having the appearance of a great quarry in which there had been a monster blast, by which enormous masses of rock had been displaced, to lie where they fell. Near the south-east corner is a deep hollow or basin, which had in the centre a large wreath of snow. Close to this wreath I gathered Polytrichum formosum, P. alpinum, and P. sexangulare, the

last showing fruit. The plant itself is rare, being only found on very high mountains, but to find it in fruit is still more rare. Hypnum sulcatum was also found here. We saw, besides, Thymus Chamædrys in bloom, a small Veronica, a Myosotis, Polygala vulgaris, Campanula rotundifolia, and Saxifraga cernua. Salix herbacea was growing on the highest peak: a plant of it I gathered, which might have been twenty or even fifty years of age, was so small that it could be covered by a penny piece, and there were male catkins on it. I forgot to say that we gathered a small plant of Loiseleuria procumbens, or native azalea, on our way up. These were not all the plants on the top of the mountain, but it did not occur to me to make a list.

About 8 P.M., after an hour on the top, we retraced our steps. On the way we gathered Tofieldia palustris, but very few mosses. We reached our camp about 10 P.M., kindled a fire, and made supper. While our kettle was boiling we arranged our collection, and in due time lay down and enjoyed a fairly good night's rest. I awoke at five o'clock next morning with my back nearly roasted by a large fire which Mr Scott had replenished about an hour previously. After breakfast we again secured our stores against any stray wanderer, and started up the Lawers burn, our destination being the glen and small loch (Lochan-a-Chait) at its source, a fine view of which we had from the summit the previous evening. We thought it a good hunting-ground, and it proved to be so. It looked quite near, and we expected to reach it in about an hour, or an hour and a half at most. But after getting to the loch we found we had been five hours on the way. We had not, of course, been idle, and up the burn side we found many fine specimens, including Weissia trichoides, Bryum elongatum, B. filiforme, Hypnum ochraceum, H. sarmentosum, H. fluitans—this in fruit—and many others. About two miles up the burn I got what I consider my best find, Buxbaumia aphylla—a moss I had never before seen, although I had looked long and often for it. But it was not for this I was looking when the small and curious capsules caught my eye. I thought it a strange-looking fungus, and resolved to take a few home to Dr Watson. While taking out a tube to carry it in, I stooped down to get a better look at it. The next moment I was up, and with hat in hand was cheering at

the top of my voice. There was no one, however, to rejoice with me. (It must be understood that although Mr Scott and I always set out together, we were seldom within speaking distance of each other when collecting, and such was the case here. He took the one side of the burn, while I took the other, and for three hours we were not near one another.) I collected all I could see of the Buxbaumia, which was ten capsules. It would be hard to tell how light and easy I went up that burn side after my find! I hurried on to try and get up to Mr Scott, who was by this time more than half a mile above me, and it was nearly an hour before I got up opposite him. I called to him to come over to my side and see something very wonderful. He apparently thought I was joking, and replied that he could not get over without wetting his feet. On turning a sharp corner of the bank, about half a mile farther up, he was on my side of the burn, waiting for me. "What great wonder have you to show me?" he asked. I took out the box in which I had the Bauxbaumia, opened it slowly, and asked him what he thought that was. His face was a study, and nothing would satisfy him but to go back and look for more: it was only by promising to take him to the place, on our return journey, that I was able to persuade him to go on. Probably some may think our conduct, on finding an insignificant moss, very silly, or childish; but I feel sure that at that moment, if a five-pound note had been placed beside the moss and the choice given to me to take either, the moss would have received the preference. This moss is very seldom found: being small and inconspicuous, and of a scattered habit of growth, it may very readily be overlooked. I have never seen it so stated, but I incline to the belief that it is a parasite on other mosses. Small sucker-like discs at the ends of many of the roots were distinctly visible with the microscope. If it is ever my good fortune to gather it again, I shall give more particular attention to this point before the plant becomes dried up. A little above this place we got a fine patch of Tetraplodon bryoides, growing among some wool, possibly from a bit of rabbit's skin. Mr Scott also found the shoulder-bone of a sheep just under the surface, with a thick fringe of Tetraplodon bryoides, *var.* Brewerii, growing round the edges and down the centre.

We were now on the peat-moss to which the road we saw the

day before led. I think there was something about this peat-moss worthy of notice. It was composed almost entirely of one species of moss—namely, Grimmia (Racomitrium) lanuginosum. Some bits of it we took out of the moss were from 18 to 24 inches long. Although there is plenty of the same moss growing there now, there is none approaching that length, showing that long ago it was more luxuriant than at present. Certainly, to form such a peat-moss it must have been more abundant than it is now. At the top of this moss we reach the loch, or rather lochs, for there are two—the first, or lower one, small, not more than an acre in extent, the other covering several acres. I shall notice these again. Here we found fine specimens of Polytrichum strictum in fruit—which is rare—Campylopus flexuosus, *var.* major, and several others. We now separated again, each hunting for himself: two hours later we met high up on the crags and compared notes. We had gathered several rare mosses—Hypnum revolvens, *var.* Cossoni; H. stellatum, *var.* protensum; H. incurvatum, Orthothecium rufescens, Hylocomium rugosum, Pseudoleskea atrovirens, Pterogonium gracile, Pterigynandrum filiforme, and many rare Grimmias, Bartramias, &c. We saw also a beautiful patch of Myosotis alpestris, growing very near the top of the crags, 3600 feet or more in height, exposed to every blast, yet a perfect cushion of intense blue. Round about were hundreds of circular cushion-like patches of Silene acaulis, shading from pure white to very dark red, some nearly crimson. Thalictrum alpinum, Rhodiola rosea, Cerastium alpinum, Armeria alpina, Lychnis alpina, and Antennaria dioica were also to be seen; and one solitary plant in flower of Saxifraga nivalis was found here. Saxifraga oppositifolia, S. aizoides, S. hypnoides, S. cæspitosa, and S. stellaris were common. Of ferns, there were Polystichum Lonchitis, Asplenium viride, A. Trichomanes, A. Adiantum-nigrum, Polypodium Dryopteris, a small patch of Hymenophyllum Wilsoni, and a few roots of others which I cannot name until they put up their fronds.

A descent of about 300 feet of almost perpendicular crags brought us to the loch again. Our vasculums were by this time filled with plants, and our pockets stuffed, while in addition Mr Scott had a bundle in his handkerchief. More specimens we could not carry, and as the calls of hunger were beginning to make themselves felt, we now (about 4 P.M.)

started for our camp. But, hunger notwithstanding, we did not take the most direct route. We first went round Lochan-a-Chait, where some things struck us as being remarkable. For example, there was not a single water-plant growing in the whole loch. One or two small bits of algæ were growing on the stones, but, taken altogether, I do not think there was as much as would have filled a table-spoon. There was no marshy ground around the shores, but between the water and the grass—which began with a clear edge, as if it had been cut off from six inches to a foot in height—there was a causeway of stones, varying in width from three to six feet, firmly packed together, and as level as if put in by the hand of man. Very few of the stones were large, and no loose stones lay about. In the smaller loch adjoining aquatic plants were in abundance. We suggested various theories to account for the remarkable difference in the state of vegetation of the two sheets of water, and of the paving of the shores, all of which were wide of the mark. But before we reached the end of the loch, Æolus came and showed us how it was done. All day the air had been still, when suddenly a terrific hurricane arose among the rocks at the top of the mountain: we could hear it approaching, so we turned and waited. Down it came into the water, lifting a large sheet, which fell back into the loch with a great splash, as if emptied out of a gigantic basin. I have no doubt that the effect of these wind-storms upon the water is the cause of the absence of vegetation and of the paving of the shores. Curiously enough, we felt very little wind; but, as showing the force with which it struck the loch, the water rose at our feet, and covered some large stones which lay between the two lochs, preventing us from crossing, which we were about to do. The water had risen nearly a foot.

It took us a long time to get down to our camp, and we got nothing of special note except a large bed of Hypnum stramineum. We looked for the Buxbaumia, but did not find any more of it. Arriving at camp about 8 o'clock, we put off no time in preparing and eating supper, which was very acceptable, after thirteen hours of fasting and mountain-climbing. After supper we arranged our specimens, but before we had finished it began to rain, and we retired to bed. It continued to rain all night, but we were quite dry, and had a fairly comfortable rest. Next morning, after break-

fast, we packed up and started for Killin, amid heavy rain. Twenty minutes after we started the rain ceased, and the sun shone out so bright and warm that we were nearly melted. The journey from the Lawers burn to Killin took rather longer than we had anticipated. Bryum alpinum is rarely found in fruit, but on the way we were so fortunate as to gather it in fine fruit. According to our original programme, we should have climbed to the top of Creag-na-Caillich to-day; but after bearing a load of Ben Lawers' mosses, &c., on our backs for ten miles, under a broiling sun, we were disinclined to attempt the long ascent of the mountain, with its peak rising 2990 feet. We, however, turned up the Finlarig burn at the foot of the mountain, and picked up a few good specimens, but got nothing new.

I do not know whether I shall ever get back to Ben Lawers again; but if I do, I shall manage differently, and get through more work in the time. To one prepared and willing to rough it for a few days, such a trip would be enjoyable, healthful, and, from a botanical point of view, very profitable.

Just a word, before closing, regarding the fauna of Ben Lawers. I was surprised at the scarcity of it. During the two days we were upon the mountain we saw one common hare, two coveys of grouse—*i.e.*, two hen grouse with young—a very few of the common stone-chuck, and two large hawks, though they were too high up for us to make them out; and up at Lochan-a-Chait we noticed a pair of ring-ousels. Mr Scott found the nest of these birds, high up on the crags, with four eggs in it. These were all the wild creatures we saw on the Ben.

We reached home in due course, a little fatigued, no doubt, but none the worse for our exposure and wetting. Our outing was very enjoyable, and I should have been exceedingly sorry to have missed it.

At the meeting of 22nd March 1899, Mr Crawford, President, referred to the recent death of Sir John Struthers, M.D., LL.D., and dwelt specially on the loss to science in general which had thus been incurred, while speaking also of the great blank which had been made in the membership of this Society by his lamented death.

VII.—*A CORRECT COLOUR CODE,*

For International Adoption for mapping the Zoogeographical Realms, Regions, and Sub-Regions of the World; and for an Eye-Index to Librarians.[1]

By Mr J. A. HARVIE-BROWN, F.R.S.E., F.Z.S.

(*Read April 26, 1899.*)

The object of this paper is to promulgate a Colour Code which, it is hoped, may be found worthy of universal adoption. But before entering upon it, I shall first proceed to consider what ought to be adopted for its basis as regards the zoological regions. On reading and comparing the work of Heilprin[2] with Wallace's writings on the same subject, with Huxley's and Professor Newton's remarks thereon, and with Sclater's well-known papers, and then turning to Beddard's 'Zoogeography' and his very partial analysis of the whole subject, and also after taking into consideration Allen's proposed modifications, I am inclined to consider that Allen's "Arctic Realm" should stand as circumpolar and definite. But if we go farther south and take in Heilprin's "Holarctic," then, while it may claim a value as a Realm, it ought not to be considered quite as definite and stable as Allen's Arctic Realm, and must—or ought to—be divided into Palæarctic and Nearctic Regions, as advocated by Sclater. In the same way, I think we ought to accept an Antarctic Realm; because, if we were to accept only Heilprin's Holarctic, without conceding Old World and New World subdivisions, as Palæarctic and Nearctic Regions, then we may also accept a "Transition Realm" instead of Heilprin's mere "tracts." With the exception of the smaller, but not the less prominent, Transition Tract about Wallace's line,

[1] This paper is the full paper presented to the Fourth International Congress of Zoology, Cambridge, August 22-27, 1898, of which only a short abstract was printed by the Committee of Publication, and which abstract is given in 'The Proceedings of the Fourth International Congress of Zoology, 1898,' published by C. J. Clay & Sons, Cambridge University Press, 1899.

[2] The Geographical and Geological Distribution of Animals (International Scientific Series).

the whole "Transition Tracts" of the Old and New Worlds, lying much along the same lines of the parallels of latitude, appear to me, with as much justice, to be as definite as the Holarctic.

But as we advance farther south beyond these so-called Transition Tracts, the remaining Regional Areas become more difficult to define, breaking away from all attempts at amalgamation as a Realm or series of Realms, running out into insular and peninsular patches, and their faunas differing *inter se* far more determinedly. Therefore I cannot consider that we can for a moment claim any such value as a Realm to include South America and South Africa, the Indian Peninsula, or the Australian Continent and its satellites. Leaving now *Oceana* outside our present purpose, we having given South America (Neotropical), South Africa (*i.e.*, south of the Transition Tract, or Ethiopia), India, and Oriental and Australasian, and others, only regional values: having done this, we come to the Circumpolar Antarctic Realm, and I think it deserves such a value, so far as our present restricted knowledge of it carries us. And none of the other circumpolar divisions should be considered truly deserving of anything greater than regional values except the Arctic and the Antarctic.

It is evident that differentiation occurs to a greater extent towards the far eastern extension of the Holarctic Realm of Heilprin, and south thereof into the Oriental and Australasian islands and peninsulas,—and still more and more complicated and broken up after Wallace's line is passed, than occurs south of the same Realm in the central portions or in the west. In other words, far greater stability is found throughout all the Northern Hemisphere than after the Transition Tracts are crossed, and still less stability is found in the far east than in the west, until the Antarctic Realm is reached.

For these reasons we desire to advocate the following Realms, Regions, and Sub-regions, introductory to the more immediate purposes of this paper:—

An Arctic *Realm.*	An Ethiopian Region.
A Palæarctic Region.	An Oriental Region.
A Nearctic Region.	An Australasian Region.
A Neotropical Region.	An Antarctic *Realm.*

The full title of this paper indicates a desire upon my part to endeavour to obtain an internationally accepted Colour Code with combinations for zoo-geographical purposes, and for facilitating references to the shelves of a library by an eye-index. Before advocating my own, I would wish to glance at other suggestions which have been made for assisting zoologists in such matters, and which have already been referred to and illustrated by Beddard in his 'Zoo-geography' (p. 118).[1]

All previous Colour Codes with which I am acquainted —excepting one, of which I speak later—have been used for descriptive purposes by zoologists,—*i.e.*, for purposes of describing species. Thus Werner's "Nomenclature of Colours," excellent as it was, involved many and various tints, washes, or shades, useful for the purposes intended, but quite too confusing and subtle for those which I have in view. In a similar way, Ridgeway's "Nomenclature of Colours" was similarly intended for descriptive purposes in zoology. Saccardo's 'Chromotaxia seu Nomenclator Colorum' is also useful principally for zoological purposes, apart from zoo-geographical ones. But as Saccardo's true colours are descriptive and convenient, I purpose using them as descriptive of my own—his being in Latin and mine in English.

For zoo-geographical delineation and for eye-index purpose, I find it only desirable to bring into use the three primary colours, the three secondary colours, and two tertiary colours, besides white, grey, and black. Thus:—

Saccardo.	Correct Code Colours.
1. Albus.	1. White.
2. Griseus.	2. Grey.
3. Niger.	3. Black.
4. Ruber.	4. Red.
5. Flavus.	5. Yellow.
6. Cyaneus.	6. Blue.
7. Viridis.	7. Green.
8. Aurantiacus.	8. Orange.
9. Ferrugineus.	9. Russet.
10. Fulvus.	10. Brown.
11. Purpureus *or* Atro-purpureus.	11. Purple.

Saccardo's "Tabellæ Colorum" proves useful in many directions; and the whole paper is a most excellent work of reference.

[1] Zoo-geography (Cambridge Nat. Science Manuals), 1895.

Of Keillor's work we need not speak here, as its aims and objects are, like most of the others, distinctly for descriptive purposes. But Professor Camerano's paper, referred to by Beddard in his 'Zoo-geography' (1895, p. 118), which, unfortunately, I have not seen in its entirety, first, I believe, makes the attempt of applying suitable standards of colours for zoo-geographical purposes. Not having seen this treatise, I cannot say whether his applications of his colours are more suitable, more natural, from topographical standpoints, than the one I am about to propose. Nor can I, therefore, place his and mine in parallel columns for purposes of comparison. So far I take what I can gather from Beddard's analysis (*loc. cit.*, p. 118): "Graphic Methods of representing the facts of Distribution." "The colour might even be made to some extent appropriate" (*loc. cit.*) Then he quotes Camerano:—

Yellow, prevailing colour in Africa.
Grey, " " Asia.

—and so forth. "And," continues Beddard, "Möbius colours the 'Transitional Tracts' (Heilprin's) with a paler tint applied to the *region which they most resemble.*" Heilprin prefers to shade the transitional areas, and then Beddard destroys this idea.

Now, the colours I have selected are, as I have said, the primary, secondary, and tertiary colours of Hay's nomenclature, with the addition of white, grey, and black. These last mentioned are added by me because of a convenience which will become apparent as I proceed. To recapitulate, my Code Colours are—

1. White.	4. Red.	7. Green.
2. Grey.	5. Yellow.	8. Purple.
3. Black.	6. Blue.	9. Orange.

10. Russet, *or* Brown, *or* both.

The above colours I offer as an EYE-INDEX, by which attention may be directed to the books or pamphlet-cases upon the shelves of any library; so that these applied to Realms, Regions, and Sub-regions, may at once indicate the items in the library devoted to each.

But, it may be argued, such an eye-index cannot now be applied to past accumulations of books, or at least to already

bound-up volumes. In reply to this, I say, if not applicable to the volumes on the shelf, there need be no difficulty in applying the code to the shelves on which past accumulations have been placed—to label-plates or to the *whole length* of the shelf-edges.

There is, I believe, in existence an appointed committee presently engaged in a most important piece of work—"The Committee of the Royal Society upon International Bibliography." I do not know whether I record the title correctly, and with the scope of that committee I am not fully acquainted, but it seems to me this question of eye-index is one which should claim a portion of their consideration.

And now let me show the application of my colours to the Realms and Regions; after which I propose to assign the fixed combinations of these colours to the Sub-regions of Dr and Mr W. L. Sclater, and to state the reasons for the beliefs that are within me:—

1. Arctic Realm . . .	colour	White.
2. Antarctic Realm . . .	"	Grey.
3. Ethiopian *Region* . . .	"	Black.

These three may be held as representative for

Day,	Dawn,	Night.
Light,	Twilight,	Darkness.
Knowledge,	Doubt,	Ignorance.
Civilisation,	Transition,	Savagery.

—or other fancies or associations in the mind. My Mind-associations are zoo-geographical. Then—

4. Palæarctic	colour	Red.
5. Neotropical	"	Blue.
6. Australasian . . .	"	Yellow.
7. Oriental	"	Green.
8. Nearctic	"	Russet *or* Brown.
9. { Malagasy, Lemurian / Madagascar } . .	"	Purple.

Purple may be used either as Regional or grafted as a Sub-regional upon Ethiopian.[1]

[1] At the time this paper was read at the Zoological Congress at Cambridge it was intended to exhibit these colours on papers, buckrams, cloths, art linens, and canvases for the purposes of bindings; and also to show rough specimens of *index* volumes for each Realm or Region—if not perfectly matched, yet sufficiently so for illustration.

Now let me give my reasons for the above assignations of the colours to the Regions:—

Arctic, white, is in most men's minds associated with snow, purity, and a certain amount of *knowledge* (*scientia*).

Grey for *Antarctic* is associated with ice; bluish, with a glacier-fringed coast, and a medial position between our knowledge of arctic matters and Ethiopia (Aithiops).

Ethiopian, black, for ignorance, darkness.

Palæarctic, red, because it has been adopted in Heilprin's map for that portion.

Neotropical, blue, for the same reason.

Australasian, yellow, for gold—natural mind association with that colour.

Oriental, green.

Malagasy, purple—"purple isles of the sea."

Orange, colour not appropriated.

Nearctic, brown, because, curiously enough, our cousins show a very predominant partiality to binding their scientific societies' memoirs in this colour (though some are black).

[*Note.*—Black, I take it, may here be associated with History—African History—Ethiopia, Nigger!]

Russet is not appropriated, but might be used for *monographic* publications, or other purposes.

There is, I am aware, room for discussion upon the appropriateness of the above assignations. Now let me show the applications of my code to Sub-regions:—

I. Palæarctic Region.

Names of Sub-regions.	Region.	Sub-region.
European	colours Red, with White label.	
Siberian	" "	Grey "
Trans-Mediterranean . .	" "	Black "
Manchurian . . .	" "	Yellow "
Japanese	" "	Green "
Tartarian	" "	Russet *or* Brown "
Persian	" "	Blue "
But Arctic Realm, Circumpolar, and including Panarctic—		
Old World . . .	colours White, with Red label.	
New World . . .	" "	Brown "

The Regional Colours to occupy the main bulk of the back of a book- or pamphlet-case, and the Sub-regional the differently coloured label on which the book-title and date is lettered (large!); and lower ½ in. or ¾ in. to be white in *all*, for the purpose of a minor division—such as the name of a country, county, or even parish.

II. Nearctic Region.

Canadian—Sub-Arctic .	colours Brown,	with Red	label.
Humid	" "	Green	"
Arid	" "	Yellow	"
		Black	"

But Arctic Circumpolar *White* with Brown.

III. Ethiopian Region.

S. African	colours Black,	with Orange	label.
W. African . . .	" "	Blue	"
S.W. African . . .	" "	Red	"
S.E. African . . .	" "	Yellow	"
N.E. African . . .	" "	White	"
Arabian	" "	Grey (?)	"

IV. Oriental Region.

India and Ceylon . .	colours Green,	with Red	label.
Burma and Malay . .	" "	White	"
Sunda Isles to Wallace's Line	" "	Purple	"
Celebes	" "	Yellow	"
Philippines . . .	" "	Brown	"

V. Neotropical.

Antillean	colours Blue,	with Red	label.
Trans-Panamanic . .	" "	Brown	"
Andean	" "	White	"
Amazonian . . .	" "	Orange	"
S. Brazilian . . .	" "	Yellow	"
Patagonian . . .	" "	Grey	"

The designations of these Sub-regional divisions have been altered in later treatments (see Mr W. L. Sclater's Article and Maps).[1]

[1] The latest "to date" exposition of Dr Sclater's and Mr Wm. Sclater's views are exhibited in a volume recently issued—'The Geography of Mammals,' by W. L. Sclater and P. L. Sclater. Kegan Paul, Trench, Trübner, & Co., 1899.

VI. AUSTRALASIAN.

Papuan	colours Yellow,	with White	label.
Australian . . .	"	"	Red "
Maorian	"	"	Purple "
Pacific	"	"	Green "
Hawaiian	"	"	Brown "

Archipelago . { VII. LEMURIAN. MALAGASY. MADAGASCAR.

This takes Purple, or, if only considered to be a Sub-region of the Ethiopian Region, then—

Purple label grafted on *Black.*

Then we have the Arctic Realm, which is circumpolar:—

Palæarctic, W. . . .	colours White,	with Red	label.
Palæarctic, E. . . .	"	"	Grey "
Nearctic	"	"	Brown "

The various countries within the Arctic Realm can have their literature collected and position shown by their names in black block letters stamped upon the lower white—thus, GREENLAND; or for Old World countries in red, and New World countries in brown, &c.

The ANTARCTIC REALM will include all the islands of the Southern oceans within the Antarctic circle, also South Georgia (but not Falkland Isles), Bouvet, Kerguelen, Crosets, thus: On the grey label or on the white lower fourth—thus, CROSETS.

Having assigned my Code Colours each to its own Region, and their combinations to the Sub-regions, I desire now to show the applications of my scheme in practice. For that purpose I brought with me most of the materials I used from the beginning. These were:—

1. A copy of 'Hay's Nomenclature of Colours,' which I have taken as my text, as the most suitable for my code.
2. A copy of Saccardo's paper, to which I have referred.
3. A series of my Code Colours on manilla papers.[1]
4. The same in white buckram, Winterbottom's "Colour," "Buckram

[1] Should pamphlet-cases be obtained in white *manilla paper* backs, Aspinall's enamel can be painted on equally as well as it can be done upon Winterbottom's "Buckram White No. 1."

No. 1 Colour," which is coloured for purposes of the Code by Aspinall's enamels.

5. Aspinall's Enamels, matching my Code, *to order*, and which colours the Aspinall Company keep in stock.

6. A complete set of the colours used for Regions, and with all the combinations used for the Sub-regions, and *named* on the backs of each slip of paper and of buckram.

7. The Code Colours, matched by Winterbottom in buckrams, art linens, art canvases, for binding according to directions, each coloured cloth being numbered with Winterbottom's colour numbers, a list of which I also give (*infra*) to facilitate orders.

8. A bound series of volumes, with A B C thumb-indexes, in *full colours* of the Regions as assigned by my Code. (Wilson, binder, Castle Hill, Edinburgh.)

9. Aspinall's Enamels to Code.—I did not exhibit the cases of these colours supplied. But the colours were shown under 5 *antea*, as painted upon Winterbottom's white buckram colour, No. 1. This can be used upon pamphlet-case backs—obliterated when the possessor comes to bind off sets in Winterbottom's cloths, and repainted again in enamels.

10. Winterbottom's *thinner* cloths, "Cloth Extra"—Matched to Code for use, in *laying on* the Sub-regional Colours *upon the stronger and more durable canvases* and buckrams (No. 6) by bookbinders' paste or Le Page's fish-glue.

11. A Parcel showing application of my Code Colours to use of "Library Bureau" or Zurich-Strasse *Guide-Cards* to *Regions* and *Sub-regions*.[1]

12. A specimen volume bound, showing—Buckram No. 1, with Aspinall's enamel, label-fourth, meaning "*Nearctic-Arctic*."

13. A specimen volume, roughly bound, showing—Buckrams No. 1, with thinner Winterbottom's cloth (matched) laid on as Sub-regional label-fourth of back.

14. An L. B. case (oak) which contains the Zurich-Strasse Card-Catalogue of the papers on *Vertebrata* for 1896, having applied in it (roughly) my Colour Code Guide-Cards.

15. A map by Mr Bartholomew, who adopts my Code in his next Zoogeographical Atlas on Mercator's Projection for colouring the six Regions

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[1] The Regional Guide-Cards have the guide-top-edges *full* length of the Cards. (L. B. Card.) The Sub-regional Cards have projections "thrown upon" the longer cards in 7ths and 3rds. (L. B. Cards come in between.) It would be very desirable that Zurich-Strasse cards be cut by regular machinery according to this Code. The Library Bureau up to this time has declined to adopt this Code and arrangement for Guide-Cards—no doubt upon the ground of trouble, the expense of new uniform cutters, and the present uncertainty of any demand which would warrant such outlay. Should countries be desired for direct references, an alphabetical code can be easily applied, and letters stamped (or printed) on the L. B. cards between, or by using a greater quantity of the 7th and 3rd projections under each colour, and an alphabetical arrangement of the books or pamphlet-cases could be utilised upon the shelves.

of Sclater, and two Realms—Arctic and Antarctic—showing the application of my Code and of the method of engrafting the Sub-regional Colours on the map.

A map on Mercator's Projection by Mr Bartholomew, in black and white only, for use in colouring the geographical distribution of any genus or species, for object-lessons in a school or museum show-case—as already utilised in the Museums of London, Leeds, Edinburgh, and elsewhere—or for general purposes of illustration.[1]

16. And lastly, a pamphlet-case made to my order by Hugh Stevenson & Sons, box-makers, &c., Ardwick, Manchester, which more than any other in the market combines strength, utility, and endurance with its moderate cost—about 4d. each—backed in buckram (Winterbottom white buckram No. 1), with rings, and patent hinging, and metal-protected edges.

And now let me say that the great trouble I have experienced in preparing this paper and suggested Code has arisen from my endeavours to amalgamate all the trades mentioned. This part has occupied much time, attention, and correspondence, for nearly twelve months. Should my Code find favour in the eyes and minds of those who are devoting attention to bibliographical matters, to be reported to the British Association and the Royal Society, I think it is only on my part due to the tradesmen who have assisted me to give here a list of their names and addresses. I am sure they had as much trouble practically as I had theoretically, and from me they have derived little monetary reward:—

Col. Logan, Stoneywood Paper Works, Denny (John Collins & Co.), for papers matched to Code in Manillas.

Messrs Winterbottom, book-cloth manufacturers, Manchester, for two sets of superior buckrams, art linens, canvases, &c., and thinner cloths, &c., for "laying on" in bindings to order.

Aspinall Enamel Co., for enamels to match Code Colours, and much trouble taken to do so, which colours they now keep in stock as "CCC Colours."

Messrs Hunter & Sons, bookbinders, 28 Queen Street, Edinburgh, who will bind to Code.

Mr Wilson, bookbinder, Castle Hill, Edinburgh, for much trouble taken, and for set of thumb-index volumes for regions in Code Colours.

The Zurich-Strasse "Concilium Bibliographicum, &c.," for the L. B. card-catalogue of vertebrata, 1896.

Mr E. Bidwell, for helping me in the matter of cutting guide-cards to patterns of Code Colours exhibited.

To Mr J. Bartholomew, who saw all my Code materials, and has adopted

[1] These maps might be made of various useful sizes, such as octavo, quarto, and folio, or even of smaller sizes for book-illustration purposes.

the colours for cartographical work in his next Zoo-geographical Atlas (in preparation).

To Hugh Stevenson & Sons, box-makers, &c., Bridge Street, Ardwick, Manchester, for manufacturing strong cheap pamphlet-cases, backed with Winterbottom's white buckram No. 1, and supplied to orders.

To Van Houten Manufacturing Co., 33A Fore Street, London, for "Solid Rubber Type," *as used upon the backs of pamphlet-cases.*[1]

To Messrs Stewart & Co., 92 George Street, Edinburgh, for sample pamphlet-case, stamped, "*Correct Colour Code by J. A. H.-B.*"

REMARKS.

My Code in some details cannot be considered perfect. For instance, "Fixed Colours"—I understand there is no colour which holds ingredients of coal-tar products which is not susceptible to some degree of change from sunlight or damp. Certain purples fade. Red (Ruber) is perhaps the most stable. To fix such few colours is only a matter, we believe, of time and attention and chemical progress.

APPENDIX.

Mr Winterbottom's buckrams, cloths, art linens, and canvases, which match my Code, may be used for binding in Regional Colours.[2]

Strong Buckrams, Etc.

Pattern.	Colour.	Winterbottom's Nos.
Buckram	White	1
Do.	Black	72
Art Vellum	Grey	40
Do.	Dark Grey	42
Art Linen	Red	13
Art Canvas	Do. (Code)	72
Art Vellum	Dark Red	49
Buckram	Deep Red	60½
Art Linen	Blue	2
Buckram	Yellow	4
Art Canvas	Green	70
Art Vellum	Orange (*not good*)	52
Art Canvas	Russet	77
Art Linen	Brown	7
Art Canvas	Do.	71
(?)	Purple	(?)

[1] We have used these stamps also upon Aspinall's Enamel perfectly successfully, and an advantage is—the ink can be *washed off*, and cases be used again and again.

[2] The thinner cloths (see second list) can be used as "laid on" upon the stronger ones, for Sub-Regional indications, by the use of Le Page's fish-glue or bookbinders' best strong pastes.

LIGHTER (THINNER) CLOTHS,

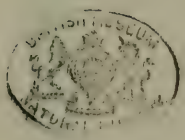
which match my Code Colours as nearly as possible, and as at present kept in stock by Mr Winterbottom:—

Pattern.	Colour.	Winterbottom's Nos.
Buckram	White	1
Cloth (extra)	Black	6
Do.	Grey	23
Do.	Stone	47½
Art Linen	Red	13
Cloth (extra)	Do.	11½
Do.	Blue	150
Buckram	Yellow	4
Cloth (common)	Do.	226
Cloth (common and weak)	Purple	262
Cloth (extra)	Green	17
Art Linen	Dark Purple (*too dark*)	12
Cloth (extra)	Orange	180
Patent lined Art Linen	Brown	2
Cloth (extra)	Do.	51

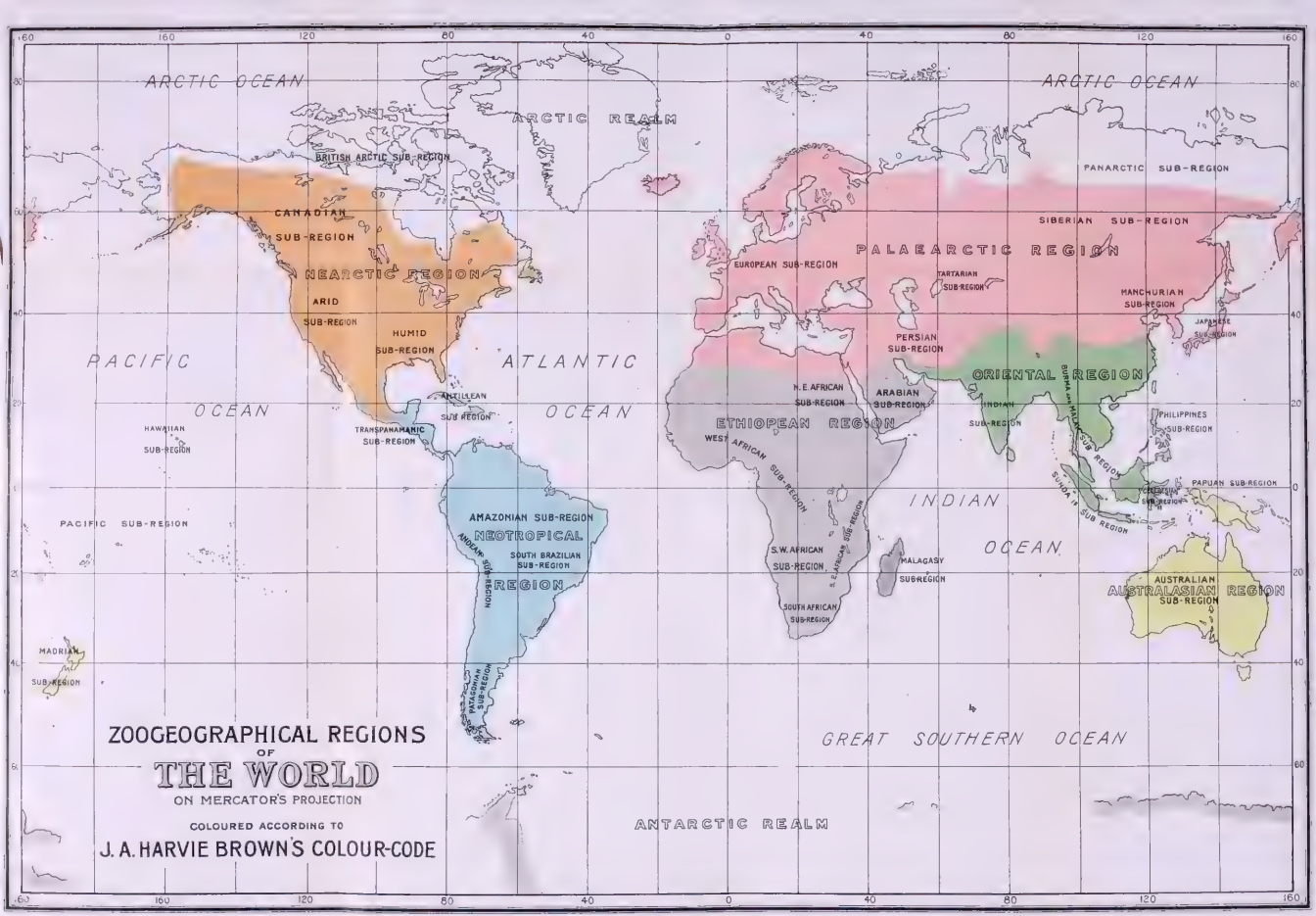
Messrs W. inform me that "if a demand arises" they will match and supply *any* materials to my CCC Colours (*in lit.*, Feb. 1898) in the *stronger series.*

By adopting the Salvin ¾ in. principle of divisions for bookshelves, these pamphlet-cases and book-publishers' sizes placed upon the shelves lose only the minimum of space. The Library Bureau "Adjustable Book-Crates" can also be similarly utilised. I have tested both of these. The Salvin principle is so well known that I need not describe it. But bookshelves, drawers of most suitable depths or any depths which are multiples of ¾ in., can fit in same cases or shelves —¾ in. for flat architects' plans, maps, coins, &c., up to any multiple for innumerable purposes of collections or books.

Another development of my Code Colours may occur—viz., the use of post-cards in these colours for Regions, &c. Thus, if a specialist residing in any Faunal Area—say "Palæarctic, European, England"—used special cards in colours for all connected with his area, recipients who may, for instance, be generalising upon a work on Region, Sub-Region, or Country can at once *file* the colour under its own index. But black and purple are a little troublesome, though not really difficult to use: simply print the *top* of the "guide edge" in black, and write the communication on white beneath. Post-cards to be



CT


ZOOGEOGRAPHICAL REGIONS
OF
THE WORLD
ON MERCATOR'S PROJECTION
COLOURED ACCORDING TO
J. A. HARVIE BROWN'S COLOUR-CODE
ARCTIC OCEAN
ARCTIC REALM
BRITISH ARCTIC SUB-REGION
CANADIAN SUB-REGION
NEARCTIC REGION
ARID SUB-REGION
HUMID SUB-REGION
PACIFIC OCEAN
ATLANTIC OCEAN
HAWAIIAN SUB-REGION
PACIFIC SUB-REGION
ANTILLEAN SUB-REGION
TRANSPANAMANIC SUB-REGION
AMAZONIAN SUB-REGION
NEOTROPICAL REGION
SOUTH BRAZILIAN SUB-REGION
ANDEAN SUB-REGION
PATAGONIAN SUB-REGION
MADRIAN SUB-REGION
PALAEARCTIC REGION
EUROPEAN SUB-REGION
TARTARIAN SUB-REGION
PERSIAN SUB-REGION
SIBERIAN SUB-REGION
PANARCTIC SUB-REGION
MANCHURIAN SUB-REGION
JAPANESE SUB-REGION
ORIENTAL REGION
INDIAN SUB-REGION
BURMA-MALAYAN SUB-REGION
SINO-INDIAN SUB-REGION
PHILIPPINES SUB-REGION
PAPUAN SUB-REGION
ARABIAN SUB-REGION
N.E. AFRICAN SUB-REGION
ETHIOPEAN REGION
WEST AFRICAN SUB-REGION
S.E. AFRICAN SUB-REGION
S.W. AFRICAN SUB-REGION
SOUTH AFRICAN SUB-REGION
MALAGASY SUB-REGION
INDIAN OCEAN
AUSTRALIAN SUB-REGION
AUSTRALASIAN REGION
GREAT SOUTHERN OCEAN
ANTARCTIC REALM

same size as L. B. Cards and Guides. I have *not* put this in practice—it is a mere suggestion.

The Colour Code can be amalgamated with a running No., or with the Dewey system under each colour or guide-card, and the figures stamped, written, or printed upon the guide projections or upon the *top right-hand corner* of the ordinary L. B. Cards.

VIII.—*NOTES ON THE BOURNEMOUTH CLIFFS.*

By Dr T. B. SPRAGUE.

(*Read April 26, 1899.*)

Last autumn I spent six weeks for the benefit of my health at Bournemouth, which is a well known watering-place on the south coast of England, nearly opposite the Isle of Wight. The town itself stands in a valley, which has been excavated by the small stream called the Bourne. Proceeding away from this, the ground gradually becomes higher on each side until, as far as I can make out from the ordnance map, it is rather more than one hundred feet above the sea-level. The sea has, as usual, worn away the land and formed cliffs of about one hundred feet in height. These present some peculiarities which I do not remember to have seen elsewhere; and they are so different from what we are accustomed to in Scotland, that I think the members of the Society will be glad to have a short account of them.

The sea does not now reach the foot of the cliffs, except perhaps in very high tides. The first impression that the cliffs leave on the mind is that they are perpendicular, or even overhanging, so that it seemed as if it would be easy to measure their height by letting down a string with a weight attached. On examination, however, it was found that the appearance was deceptive: it is true that certain parts are very perpendicular, but these parts never extend the whole height of the cliff, and there is always a considerable talus at the base. The cliffs are composed partly of sand, partly of

a very compact gravel, and partly of clay, and exhibit some good specimens of false bedding. The soil on the top is very thin, and the whole country for some miles inland appears to be very barren.

The great feature of the neighbourhood is the extensive pine forests, which consist to a small extent of the Scotch fir (*Pinus sylvestris*), but to a much greater extent of a pine which bears a much larger cone. The town itself has extended very greatly during the last thirty years for which I have known it, and is still increasing very fast. A large number of new roads have lately been cut through the woods, with a view to building operations; and in many cases these have exposed sections, which enable the nature of the strata to be very easily seen. One effect of this laying out of new roads, which are cut principally through the gravel, has been to discolour the water of some artificial lakes, through which a small stream flows to the sea.

As will be readily understood, the cliffs are very easily acted upon by running water. Whenever there is a heavy shower of rain, the water running down the cliffs cuts numerous small channels in them, which often unite and form larger ones; and every shower brings down, and deposits at the base of each channel, a delta of greater or less size. In many cases the deltas do not exhibit a uniform slope downwards, but are composed of a series of layers, each of which falls short of the preceding one, as is often the case when such a substance as melted lead is poured out into a pan. When the channels have reached a certain size, the portion of the cliff they have undermined will fall down bodily; and there are places where such landslips are observed half-way down the cliff, with the trees still growing on them.

As already mentioned, the Bourne has excavated for itself a valley of considerable size; and wherever there is a stream, either temporary or permanent, it has excavated a small valley, generally with nearly perpendicular sides, some of which extend inland for a considerable distance, occasionally for nearly a mile. These valleys are called chines, and there are at least a dozen of them, of different sizes, in the four or five miles to which the cliffs extend. The same word, "chine", is used in the Isle of Wight to denote similar small valleys.

Extract from 'New English Dictionary,' p. 352, *col.* 3, re *the word "chine."*

Chine. I. An open fissure or crack in a surface, a cleft, crack, chink, leak (*obs.*)

II. (*a*) A fissure in the surface of the earth, a crevice, charm (*obs.*) (*b*) On the Isle of Wight and Hampshire coast, a deep and narrow ravine cut in soft rock strata by a stream descending steeply to the sea.

Exs.—1830, *Lyell*, 'Princ. Geol.', i. 281: "One of these chines near Boscomb has been deepened twenty feet within a few years." 1837, *Marryat*, 'Dog Fiend', xv.: "A certain point close to the Black Gang chine." 1879, *Jenkinson*, 'I. of Wight', 69: "The Shanklin chine is the most beautiful of any on the island."

These chines seem to have been formed in several places where there is no regular stream. It seems, in fact, that when once a breach has been made in the line of the cliff it is rapidly increased both in depth and length by the rain. From what I have said I have little doubt that the members will agree with me that these cliffs form an admirable specimen of sub-aerial denudation.

IX.—*A SIMPLE METHOD OF OBTAINING A LARGE FIELD OF VIEW WITH THE COMPOUND MICROSCOPE.*

By Mr WILLIAM FORGAN.

(*Read April 26, 1899.*)

With a tube length of 160 mm., or about 6½ inches, the field of view of a 3-inch object-glass is a circle half an inch in diameter; with a 2-inch object-glass the field is a circle of slightly over three-eighths of an inch in diameter; while with a 1½-inch object-glass it is rather more than one-fourth of an inch in diameter. Hitherto there have been only two means used for increasing the size of the field of view. One of these was devised by Mr Joseph Jackson Lister. It was chiefly intended for the purpose of erecting the image in the ordinary compound microscope, and enabling it to be used as a dissecting one. This was effected by screwing the erecting portion of an ordinary terrestrial eyepiece into the lower end of the

draw-tube of a microscope. This arrangement caused a considerable loss of light. It was devised long before photography was used in connection with the microscope. The only other method of increasing the field of view was by means of a specially constructed object-glass, first introduced by Zeiss, of Jena. This consisted of an achromatic negative lens similar to a Barlow at one end of the objective mount, while at the other end there was a positive achromatic lens. These two separate lenses were so mounted that the distance between them could be made variable, and thus get different powers according to the position in which they were placed. One by Wray gives powers equivalent to a lens of from 4 to 6 inches focus. It is constructed to be used on a 10-inch tube. It is a very excellent objective.

Some time ago, when constructing a small microscope with a Jackson arm, the draw-tube was made out of a short piece of tube which had been used for a different purpose. It was only 4¼ inches long. The Jackson arm was too short to admit of its carrying a 3-inch objective in the ordinary way, and this objective was accordingly screwed into the lower end of the draw-tube. On pulling out this tube it was in this way easy to get the necessary distance to focus the objective. It was found that with the low power eyepiece used a very large field of view was obtained. A crown piece, 1½ inch in diameter, was easily seen in the field, while the definition was everything the most fastidious could desire. The eyepiece used in combination with the 3-inch objective was a No. 0, by Leitz of Wetzlar. It is built on the same principle as the Kellner orthoscopic—that is to say, the focus of the eye lens reaches to the field lens. The eyepiece tube has no diaphragm, as the cell in which the field lens is mounted forms the diaphragm. The only difference between this eyepiece and an orthoscopic is this—the Leitz eyepiece has a plano-convex eye lens, while the orthoscopic has a concavo-convex one. The Leitz No. 0 has an extremely flat field and low power, its equivalent focus being about 2 inches. No other eyepiece is so well adapted for obtaining the large field in the way indicated. With the above combination of 3-inch object-glass and No. 0 eyepiece, smaller fields of view may be obtained by simply pulling out the eyepiece a short distance, say from half an inch to an inch,

and thus slightly lengthening the draw-tube. In this way the field of view may be anything between five-eighths of an inch and 1½ inch. As the object-glass referred to is constructed for a 10-inch tube, it may be objected to its use in the above way that the definition would be affected by reducing the length of tube; but it has to be kept in view that by shortening the tube the magnification is very much reduced, and the objection may be held in this view to be out of court. It will be seen from the above that no adventitious aid is required to

Photo-micrograph of crown piece.

obtain the object in view—just the ordinary object-glass and eyepiece. It has been shown to the Society to be capable of being used in photography, as the photograph of the crown piece handed to the members demonstrated. It is necessary, when using the microscope in this way, to use the very best object-glasses; no second-rate ones will do. The low powers made by Mr Wray have been found among all others to possess the very highest qualities. They have the largest possible lenses, and thus admit much light, coupled with extremely fine definition. Great stress is laid upon the use of the low-power

eyepiece referred to. No one trying to get the large field and fine definition need expect success unless by using the materials indicated or some equally good and of equally low power, especially the same low-power eyepiece.

[A reproduction of a photo-micrograph of a crown piece, which is 1½ inch diameter, is given on the previous page. This was taken by means of the 3-inch Wray microscope object-glass and Leitz No. 0 eyepiece above referred to. Neither of these lenses is corrected for the chemical focus, nor was the silver of the crown piece dimmed in any way to obviate the difference of the reflection of the light from its surface.]

At this meeting, Mr Crawford, President, described a vegetable hybrid which he had raised, the parents being a turnip and a borecole or Scotch kail. The hybrid seeded thrice, but the last seeds had unfortunately been lost. The characteristics of the hybrid—resembling the kail in leaves and the turnip in roots, and the finger-and-toe disease to which it was more liable than the kail—were shown on the screen.

REPORT OF THE MICROSCOPICAL SECTION.

By Mr JAMES RUSSELL, Convener.

This section had fortnightly meetings during the winter and spring months for practical work. The attendance of members was fairly regular, the average number present being about ten. The object of these meetings is to stimulate to work with the microscope in its bearings upon histological research, and in carrying out this object to give mutual assistance, each member communicating of his best for the information of the others, and all learning from each other. Each member is allowed to choose the field of study which is most congenial to his tastes, to work it according to his own methods, and then to communicate the result of his labours for the benefit of his fellows.

In pursuance of this course the following work was done at the various meetings, somewhat in the order here given :—

The various stages in the cleaning and mounting of diatoms, from the crude gathering as taken from the stones in the burn to the finished microscopic slide. At the following meeting was shown the process of taking photographic negatives of microscopic objects.

Three very interesting meetings were spent in watching the various processes in the staining and mounting of sections. The plant chosen for the purpose by the operator was the liverwort. Specimens had been embedded in paraffin and then cut into sections. The sections so cut were brought to the meetings, when the process of putting them on the glass slide so as to get them to adhere, of freeing them from the surrounding paraffin, the staining of them, and finally the mounting in balsam so as to be fit objects for examination under the microscope, were fully shown.

At following meetings the life-history of mosses was demonstrated by diagrams, by specimens shown under the microscope, and by prints from photographic negatives. The life-history of ferns and their allies was in like manner intended to have been taken up, but from want of time this subject had to be left over.

It will be seen that the work of the Section during the session has been confined to the vegetable kingdom. Such work was not only profitable in affording a little knowledge of some of the lowly organisms of nature, but in the highest degree interesting. The only regret is that more of the members of the Society did not join in it. I cannot think that in a Society whose members number upwards of two hundred there are not more than a dozen who take an interest in the microscope. To all who do take such an interest I would appeal to assist: to the skilful and experienced to place some of their rich stores of knowledge at the disposal of their less favoured brethren, and to the unskilled and inexperienced to come that they may share in these stores of knowledge, assured of a kindly welcome.

The field of microscopy is large enough to admit all workers. I would wish, however, not to be misunderstood in my use of the term "field of microscopy." I do not use it in

the sense of being a science apart, but in the sense of the field of natural science—animal, vegetable, and mineral—studied by means of the microscope. The microscope and its capabilities are not to be studied as an end, but merely as a means to an end. The instrument should be used as a means of investigation into the secrets of nature. At every step in our researches we come upon objects too minute for investigation by the unaided eye, but science has placed at our disposal this instrument, which increases our power of vision many hundreds of times, and thus enables us to elucidate many complicated problems in the life-history of animals and plants.

You will thus see that the "field of microscopy" to which I call you is practically limitless. Let each one, according to tastes and inclination, choose a corner for his or her own special work, and try to make himself or herself master or mistress of the same. In this domain, as in every other, if anything of importance is to be achieved there must be a definite aim. The worker must set a goal before him and brace his energies to reach the same. This necessarily limits the area of investigation, but what is lost in breadth of research is gained in depth of insight. As thus the field broadens out there is more and more a call for *specialised* workers.

It is here that the importance comes in of meetings such as the Microscopical Section has. They act as a stimulating power to the individual worker, are a means of comparing notes of progress, and of giving assistance in the interpretation of things obscure.

There is another class of workers, and perhaps in this country the more numerous, who use the microscope as a means of relaxation and refined enjoyment, who do not confine themselves to any one field of examination, but touch lightly upon many, examining now the beautiful mathematical figure of a diatom, then the varied forms of the desmids; now the glowing colours of the scales of a butterfly's wing, and then the pseudo-spirals of the tongue of the blow-fly. Rich fields of examination for such lie on every hand. It would, however, add additional zest to their pleasure if, instead of getting their objects ready prepared and mounted, they would themselves do the preparation and mounting. It may be true that such microscopic slides prepared by themselves would not look so

well in the cabinet, but in their preparation the workers would gain a knowledge of the structure which no amount of examination of the object prepared by another would ever give. Such workers I would also invite to our fortnightly meetings, where I have no doubt they would pick up some hints which would be useful to them. We would impose upon them no conditions of study, ask them to undertake no field of research which did not fall in with their own liking. For of every field of investigation it may be said, in the words of my late lamented friend, M. Julius Deby, in the close of his introduction to 'Pelletan's Diatoms'—

"Il y a près de quarante ans que je m'occupe, pendant mes loisirs, hélas! trop peu nombreux, de l'étude des Diatomées. J'y ai trouvé, pendant cette longue partie de mon existence, un délassement bienfaisant, une récréation saine et de bon aloi, un plaisir continu, qui m'ont maintes fois fait oublier momentanément les petites et les grandes misères d'une vie fort accidentée. Je souhaite à tous ceux qui suivront mes conseils de trouver dans l'étude de ces admirables petits organismes autant de satisfaction que j'en ai trouvé moi-même.

"Un vaste champ reste ouvert pour compléter l'histoire des Diatomées; il y a donc gloire et profit à retirer de leur étude pour celui qui voudra sérieusement l'entreprendre."

REPORT OF THE BRYOLOGICAL SECTION OF THE MICROSCOPICAL SECTION.

By Mr WM. WILLIAMSON.

In submitting the first report of this section, I may state that it is the outcome of an arrangement made at the beginning of the winter session that the work of the Microscopical Section should be carried out by different groups, each selecting some special subject for study. Four or five of the members associated themselves to learn something of the life-history of the moss plant, and it was concluded that the most concise report of the progress made would be to review briefly the

different stages in the life-history of a moss, illustrating the same by means of lantern slides and diagrams of preparations which the members had made.

Taking the spore as the beginning of each independent plant, it is found to consist of protoplasm, containing numerous chloroplasts, with two distinct coverings; the inner cover is thin, and is known as the endospore; the outer is tough and of a brown colour, and is known as the exospore. When seen under a magnification of about 750 diameters, the exospore of Hypnum rutabulum appears to be covered with very fine dots. An essential to the growth of the spore is moisture, which is absorbed till the spore expands and ruptures the exospore. The protoplasm, surrounded by the endospore, begins to protrude and grows outward in the form of a filament. Before growth has proceeded very far, however, cell walls are formed in the filament, dividing it into cells (fig. 1). We observe that cell formation takes place outside of the spore. This is true of all the mosses with the exception of one small group, where cell division takes place within the spore, and before it is ruptured.

This filament, or protonema as we may now call it, marks the second stage of the plant life. It has unlimited power of elongation by apical growth, and is divided into cells by oblique transverse septa lying in different planes (fig. 2). These septa are formed only in the apical cell, as growth by cell division does not take place. These cells, however, have the power of putting out, just behind the anterior principal septum, little protuberances, which are separated by a cell wall from the principal filament (fig. 3). Another cell wall may be formed which divides the protuberance into two cells. One of these cells may grow into a filament penetrating into the soil and becoming a rhizoid. These always become brown by absorption of mineral matter. The other cell may grow out into a secondary filament, lying on the surface of the ground. This becomes green owing to the formation of chlorophyll.

It is generally from these secondary filaments that the young moss plant is developed. The cell that is destined to give rise to a new plant puts out, behind its anterior septum, a protuberance. This is formed into a cell by a cell wall. A change in development now appears. Instead of elongating,

the cell becomes pear-shaped, and three cell walls are then formed (fig. 4), intersecting one another at such an angle that they enclose a mass shaped like an inverted pyramid (fig. 5). This stage brings us to the foundation of the stem with its lateral appendages.

The development of the stem proceeds as follows: A cell wall is formed parallel to one of the three faces of the pyramidal mass, or apical cell, and cuts off a segment (fig. 6). The apical cell is of course reduced in size by this, but begins to grow again till it regains its former size (fig. 7), when a segment is cut off from the second face (fig. 8). Growth again proceeds till the former size is regained, and a segment is cut off from the third face of the apical cell. Growth and segmentation alternate regularly, and it will be observed that the fourth segment is above the first, the fifth above the second, the sixth above the third, the seventh above the first and fourth, and so on—in short, it will be seen that the segments are ranged in a spiral. When once this is grasped, the spiral arrangement of the leaves, which are developments of the segments, will be clearly seen.

Leaving the main stem and observing the segments, we find changes have been taking place, but as this is uniform in all, we will take one segment and follow it out. A wall is formed dividing the segment into an inner and an outer half (fig. 9). The inner half goes towards forming the meristem. The outer half is divided into a lower and an upper cell (fig. 10). The lower cell goes to form the cortex. The upper cell is divided into two cells by a cell wall (fig. 11). The upper of these, by further growth and cell division, develops into a leaf (figs. 12 and 13), while the lower may form a branch, and this explains why branches are never axillary to the leaves.

The development of the leaf from the leaf cell takes place by segmentation arising from the formation of cell walls perpendicular to the surface, and inclined to the right and left (fig. 14). The growth is at first apical, but it is limited, and when that ceases the leaf grows from the base till it is fully developed. The young leaves grow rapidly, and are closely imbricated over the growing point, but the elongation of the stem eventually separates them. They are always sessile, with a broad base inserted into the stem.

The first young leaves are always imperfect, but the older leaves of many mosses possess a midrib which always proceeds from the base. In the row of cells in the middle of the young leaf a wall arises parallel to the surface, dividing these cells into two. By further divisions and growth of the lower of these cells the midrib is formed. The inner cells form the conducting tissue, while the outer become thickened and serve to strengthen the leaf. The structure of the midrib, like the outline of the leaves, varies with the different genera.

It has already been said that the inner half of the segments cut off from the apical cell formed the meristem of the stem. This is brought about by repeated longitudinal and transverse segmentation. Generally speaking, there is very little differentiation of tissue, and the absence of a well-developed vascular system is accounted for by the ability of mosses to absorb nutriment at any point of their surface.

While special prominence was given to the history of the moss plant from the spore to the formation of the antheridia and archegonia, attention was also directed to the capsule, but a detailed study of it has been left over for another season, and may form the subject of a future communication.

EXHIBITS IN NATURAL HISTORY.

At the winter evening meetings during the Session a number of interesting objects in Natural History were exhibited by members. Amongst these, the Secretary (Mr A. B. Steele) showed a specimen of the Jew's-ear fungus (*Hirneola auricula-Judæ*), found in Niddrie grounds. The President (Mr W. C. Crawford) submitted a microscopic section of wood from the supposed "crannog" at Dumbuck, near Dumbarton. Mr C. Campbell exhibited the nest of the long-tailed titmouse. Mr A. Murray displayed a very interesting collection of mosses gathered by him on Ben Lawers, during the excursion described in his paper read to the Society on February 22 (see pp. 28-40). A large number of microscopic objects were also exhibited throughout the Session, including living specimens, and slides prepared by members.

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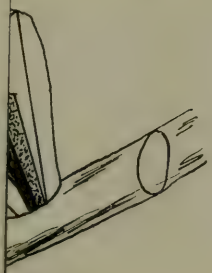

Fig 4

Fig 5

9

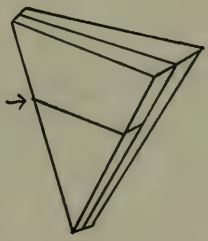

Fig 10

Fig 14

FIGS 1 & 3 & 14 FROM PHOTOGRAPHS AND FIGS 4 TO 13 FROM DIAGRAMS PREPARED BY BRYOLOGICAL SECTION.

W. G. 99.

Fig 1

Fig 2

Fig 3

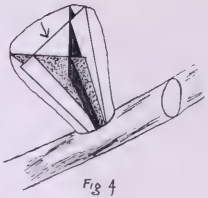

Fig 4

Fig 5

Fig 6

Fig 7

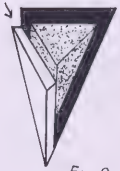

Fig 8

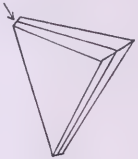

Fig 9

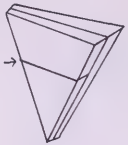

Fig 10

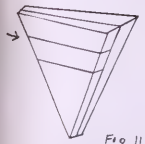

Fig 11

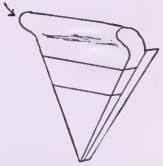

Fig 12

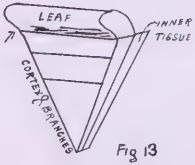

Fig 13

Fig 14

FIGS 1 & 3 & 14 FROM PHOTOGRAPHS AND FIGS 4 TO 13 FROM DIAGRAMS PREPARED BY BRYOLOGICAL SECTION.

W. 699

ANNUAL BUSINESS MEETING.

THE Annual Business Meeting of the Society was held at 20 George Street on the evening of October 23—the President in the Chair. The following report was given in by the Secretary:—

During the past Session 22 meetings (exclusive of the meetings of the Microscopical Section) have been held—viz., 6 indoor and 16 field meetings. There was a slight falling off in the attendance at the indoor meetings, and an increase in that of the field meetings. The aggregate number present at the latter was 390, or an average of 25 at each meeting. Mr Russell, the Convener of the Microscopical Section, has issued a syllabus of the work to be taken up this Session. He has again kindly offered the use of his laboratory for the meetings, and invites members to join the Section. There have been 13 names withdrawn from the roll and 21 names added this year, giving at the close of Session 1898-99 a total roll of ordinary members of 210. During the Session death has deprived the Society of a number of its oldest and most valued members—Mr Malcolm Dunn, Mr John Henderson, Mrs Sprague, Sir John Struthers, and Mr William Penman—leaving only 8 members who resigned, and four of these were reluctantly compelled to withdraw their names. The fact of so few resignations from such a large and increasing membership, and of its flourishing financial condition, speaks more for the prosperity of the Society than anything I could say about it.

The Treasurer drew attention to the Statement of Income and Expenditure for the past year, printed and in the hands of members. The Society, he remarked, had passed through a very prosperous year, financially, and the balance in hand —£48, 7s. 2d.—was the largest which had ever stood at the credit of the Society.

The election of Office-bearers was next proceeded with. The names recommended by the Council to the Society were placed in the ballot-box, and afterwards examined by two scrutineers chosen at the meeting, when it was found that all those proposed by the Council had been unanimously elected. The following is the complete list of Office-bearers for Session 1899-1900, the names of the new Office-bearers elected at the meeting being printed in *italics:* President—W. C. Crawford, F.R.S.E.; Vice-Presidents—W. Ranken, A. Hewat, F.F.A., and *A. B. Steele;* Secretary—*W. Williamson;* Treasurer—

G. Cleland; Editor of 'Transactions'—J. Lindsay; Auditors—R. C. Millar, C.A., and J. T. Mack; Councillors—Lieut.-Col. Pennefather, E. Denson, Mrs Deuchar, Miss Sprague, T. Laidlaw, C. Campbell, Jas. Russell, *Miss Oxley*, *Dr Watson*, *Dr Davies*, *Wm. Forgan*, and *A. Murray*.

Dr Davies proposed a vote of thanks to Mr A. B. Steele, who had retired from the secretaryship, after having held that office for five years. Dr Davies said that for the greater part of the period during which Mr Steele had been Secretary, he himself had held the office of President, and had thus been brought into close relationship with Mr Steele as regards the conducting of the affairs of the Society. He could therefore speak with knowledge of Mr Steele's scientific attainments, and of his thorough business qualities. The remarks of Dr Davies having been endorsed by the Chairman, Mr Steele briefly replied; and the newly appointed Secretary, Mr Williamson, assumed the duties, after having thanked the members for the honour done him in calling him to this office.

The Meeting next considered a proposed alteration of the Rules, submitted by Messrs Forgan and Steele—viz., "The President shall not hold office for more than two years, and the Secretary for more than five years each in succession, and they shall not be eligible for re-election for a year." This motion was duly proposed and seconded, as also an amendment that no change be made on the Rules, when, on a show of hands, the amendment was carried by a large majority.

The President proposed a vote of thanks to Mr Russell for his kindness in again granting the use of his laboratory for the meetings of the Microscopical Section, and for his labours as Convener of that Section: also to Mr Peck, the City Astronomer, for his generously presenting the Society with 100 tickets of admission to the Observatory. The Meeting then adjourned.

LIST OF PAST PRESIDENTS.

Dr Robt. Brown (*deceased*),	1869.
Mr R. Scot Skirving,	1869–1874.
Mr Wm. Gorrie (*deceased*),	1874–1877.
Rev. R. F. Colvin (*deceased*),	1877–1879.
Mr John Walcot,	1879–1882.
Mr A. B. Herbert,	1882–1885.
Mr Symington Grieve,	1885–1888.
Dr William Watson,	1888–1891.
Dr Sprague,	1891–1895.
Dr Davies,	1895–1898.

OFFICE-BEARERS, 1898-99.

President.

W. C. Crawford, F.R.S.E.

Vice-Presidents.

T. C. Day, F.C.S. | W. Ranken. | A. Hewat, F.F.A.

Council.

T. M. Pittendrigh.
R. Smith.
Col. Sconce.
Dr Sprague.
Lieut.-Col. Pennefather.
E. Denson.
Mrs Deuchar.
Miss Sprague.
T. Laidlaw.
C. Campbell.
Jas. Russell.
W. Williamson.

Editor of 'Transactions.'

John Lindsay.

Secretary.

A. B. Steele.

Treasurer.

George Cleland.

Auditors.

R. C. Millar, C.A.; J. T. Mack.

LIST OF MEMBERS, 1898-99.

Honorary Members.

Henderson, Prof. John R., M.B., C.M., The College, Madras.
Herbert, A. B., Sunnyside, Mitcham, London.
King, M., 120 Pitt Street, Bonnington.
Macfarlane, Prof. J. M., Pennsylvania, U.S.A.
Walcot, John, Craiglockhart Hydropathic, Slateford.

Corresponding Members.

Archibald, Stewart, Carroch, Kirriemuir.
Cruickshank, T. M., South Ronaldshay.
Hobkirk, Charles P., Huddersfield.
Hossack, B. H., Craigie Field, Kirkwall.

Ordinary Members.

(As at October 15, 1899.)

Adam, James, Comely Park, Dunfermline.
Anderson, James, 55 York Place.
Anderson, R., 67 Princes Street.
Armstrong, J. Muirhead, Polwarth Terrace.
Banks, William, 2 Kilmaurs Road.
Betts, Robert, 14 Argyle Crescent, Portobello.
Bird, George, 31 Inverleith Row.
Blacklock, William, 19 Bruntsfield Avenue.
Bonnar, William, 8 Spence Street.
10 Braid, Mrs, 12 Wilton Road, Craigmillar.
Braid, W. W., 4A St Andrew Sq.
Brewis, Dr, 23 Rutland Street.
Brotherston, George M., 18 St John Street.
Broun, Miss, 108 George Street.
Brown, J. C., 2 Eden Terrace.
Bryce, George F., 2 Albyn Place.
Bryden, Miss, Linksfield, Aberlady.
Bryden, Mrs, Linksfield, Aberlady.
Buncle, James, 21 Maitland Street.
20 Burnett, Robert, 10 Brighton Ter., Joppa.
Butchard, J. B., 10 Montagu Ter.
Cairns, Miss Mina, 27 Dick Place.
Calder, A., 2 James St., Portobello.
Campbell, Alexander, 62 Marchmont Road.
Campbell, Bruce, British Linen Company Bank, St Andrew Square.
Campbell, Charles, North British and Mercantile Insurance Company, 64 Princes Street.
Carey, Walter T., 12 Comely Bank Place.
Carment, Samuel, 3 Woodburn Ter.
Carter, Albert, Selville Cottage, Portobello.
30 Chapman, M., Torbrex Nursery, St Ninians, Stirling.
Clapperton, Miss Mary E., 10 Greenhill Terrace.
Clapperton, Mrs W., Stamford Hall, Gullane.
Clarke, William Eagle, 35 Braid Road.
Cleland, George, Bank of Scotland, 61 Leith Walk—*Treasurer.*
Coats, William, 10 Duddingston Crescent, Portobello.
Cockburn, A. Myrtle, M.A., 10 Braidburn Crescent.
Cowan, Alex., Woodslee, Penicuik.
Cowan, Charles Wm., Valleyfield, Penicuik.
Craig, Archibald, 38 Fountainhall Road.
40 Crawford, Francis Chalmers, 19 Royal Terrace.
Crawford, Miss Jane C., 1 Lockharton Gardens, Slateford.
Crawford, Mrs, 1 Lockharton Gardens, Slateford.
Crawford, W. C., 1 Lockharton Gardens, Slateford—*President.*
Davidson, Miss M. E., Dalry House, Orwell Place.
Davies, Dr, Tweedbank, West Savile Road.
Day, T. C., 36 Hillside Crescent.
Denson, E., 83 Comiston Road.
Deuchar, Mrs, Harlaw, Hope Terrace.
Dewar, John F., Hamilton Lodge, Joppa.
50 Dickie, James, 40 Princes Street.
Dowell, Miss, 13 Palmerston Place.
Dowell, Mrs, 13 Palmerston Place.
Duncan, James Patrick, 3 Cobden Road.
Durham, Frederick W., Seaforth House, Portobello.
Elliot, Miss, 1 Merchiston Bank Terrace.
Elliot, Miss I., 1 Merchiston Bank Terrace.
Ewart, James, 1 Dundas Street.
Farquharson, John K., 100 Thirlestane Road.
Ferguson, Rev. A. W., The Manse, Crichton.
60 Ferguson, John, 15 Brighton Place, Portobello.
Forgan, John, S.S.C., 20 George St.
Forgan, William, 3 Warriston Crescent.

Forrest, John L., 8 Glengyle Terrace.
Foulis, Thos. N., 27 Cluny Gardens.
Fraser, Hugh, 223 Leith Walk.
Fraser, James, 5 Park Pl., Leith.
Gartshore, Miss Murray, Ravelston House.
Gloag, David, 9 Barnton Terrace.
Goodchild, J. G., 2 Dalhousie Ter.
70 Grahame, Major G., 16 Carlton Street, Stockbridge.
Gray, J. R. Leslie, 34 Chalmers Street.
Grieve, Sommerville, 21 Queen's Crescent.
Grieve, Symington, 11 Lauder Road.
Grieve, Mrs Symington, 11 Lauder Road.
Hamilton, G. R., 14 Caledonian Road.
Harris, Charles Kerr, 13 Argyle Crescent, Portobello.
Harrison, H. J., 10 Cluny Place.
Harvie-Brown, J. A., Dunipace, Larbert.
Heggie, John, 149 Warrender Park Road.
80 Hetherton, Miss M., 13 Sciennes Road.
Hewat, Archibald, 13 Eton Terrace.
Huie, Miss Lily, Hollywood, Colinton Road.
Humphries, John, Easter Duddingston Lodge.
Humphries, William, Easter Duddingston Lodge.
Hunter, John, Waverley Cottage, Regent Street, Portobello.
Hunter, Robt., 8 Abercromby Place.
Hutton, Mrs, 27 Gardner's Cres.
Jamieson, Miss, 9 Fergus Place, Kirkcaldy.
Johnson, W. H., Tweed Villa, Relugas Road.
90 Johnston, J. A., 7 Annandale St.
Keith, Sydney, Fairlight, Whitton, Middlesex.
Kerr, Thomas, 15 Gilmour Road.
Kilgour, Thos. W., 22 Nile Grove.
Laidlaw, Thomas J., 6 Oxford St.
Laing, Rev. G., 17 Buckingham Ter.
Lamb, D. B., 33 Argyle Crescent, Portobello.
Law, Mrs, 41 Heriot Row.
Lawrie, Rev. James H., Sydney, New South Wales.
Lewis, David, Roselea Villa, Grange.
100 Lindsay, John, 43 James St., Pilrig —*Editor of 'Transactions.'*
Lindsay, William, 18 South St Andrew Street.
Lonie, Peter, 6 Carlton Street.
Macadam, Prof. W. Ivison, Slioch, Lady Road, Craigmillar Park.
Macdonald, Dr Alex., 11 Ardmillan Terrace.
Macdonald, J. J., Commercial Bank, Comrie.
M'Donald, J., 76 Marchmont Crescent.
MacDougall, R. Stewart, M.A., D.Sc., Royal Botanic Garden.
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M'Intosh, James, 42 Queen Street.
110 Macintyre, John, 9 Woodburn Ter.
Mack, J. T., 101 George Street.
M'Kean, Miss Minnie, 7 Montagu Terrace, Golden Acre.
MacLauchlan, J. J., 8 Merchiston Bank Terrace.
Macvicar, Miss K., 34 Morningside Road.
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Masterton, J. L., Dannebrog, 45 Cluny Gardens.
Maxwell, John, 125 George Street.
Maxwell, Mrs, 61 Braid Road.
Millar, R. C., 8 Broughton Place.
120 Millar, T. J., 8 Broughton Place.
Millar, W. F., 22 Howard Place.
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Smith, Dr James, 4 Brunton Place.
170 Smith, Rupert, 51 Minto Street.
Smith, Thomas J., 21 Warrender Park Terrace.
Smith, Miss W., 5 Greenhill Ter.
Smith, W. A., Falcon Lodge, Murrayfield.
Smith, Sheriff W. C., 57 Northumberland Street.
Speedie, M. H., 2 Alford Pl., Mayfield Terrace.
Speedy, Tom, The Inch, Liberton.
Speedy, William Hogg, Braeside, Liberton.
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Sprague, Thomas Archibald, 29 Buckingham Terrace.
180 Sprague, Miss, 29 Buckingham Ter.
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Watson, John, B.A., Comiston Drive.
Watson, Robert, M.A., 12 Chalmers Street.
Watson, Dr Wm., Waverley House, Slateford.
Watson, Mrs, Waverley House, Slateford.
200 Weir, James Mullo, S.S.C., 5 W. Brighton Crescent, Portobello.
Welsh, Mrs, Ericstane, Moffat.
White, Alexander Espie, 153 Mayfield Road.
Wilkie, W. F. Rollo, 122 George St.
Williamson, Wm., 4 Meadowbank Terrace.
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Wood, T. A. D., Viewforth, Brunstane Road, Joppa.
Wright, J. P., 6 Grosvenor Cres.
Wright, Miss E., Aberarder, Polwarth Terrace.
Wright, Thomas, 12 Brunton Ter.
210 Young, David E., 131 Mayfield Rd.

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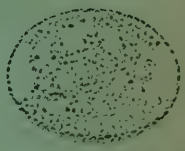

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SESSION 1899-1900.

I.—*THE MIGRATION OF BIRDS.*

By Mr W. EAGLE CLARKE.

(*Read Nov. 22, 1899.*)

Mr Clarke remarked, at the beginning of his paper, that the British Isles were eminently suited to observe bird migration in all its aspects, the majority of British birds being purely migratory, while the geographical position of the islands and the climatic changes experienced also afforded the naturalist opportunity to study those species which made this country a temporary home in their passage to other climes. Illustrations were then thrown on the screen of the different species met with in Great Britain, and the migrational routes that were followed—it being observed by Mr Clarke that migration, instead of being exceptional, was almost universal. Explaining why birds went northwards in spring and southwards in autumn, he asked what would become of the birds if they attempted to winter in the north? The answer was that they would certainly perish, not from cold, as was popularly supposed, but from want of food, migratory birds being largely dependent on special food, chiefly insects. Some doubt might be felt whether, in the return movement in spring, scarcity of food was again the cause. It might be urged that, while fitted for a winter resort, the tropical regions were not suited as a nursery. On the other hand, summer in the temperate northern region afforded an abundant food-supply,

while places of solitude were also found. Again, in the tenacity with which birds were known to return to their breeding-place perhaps lay the whole stimulus for them to undertake the long journeys. Next, discussing how birds were guided in their migrations, he said they were there face to face with the greatest of mysteries. The birds travelled mostly at night, and at a very great height, when the organ of sight would not be of very much use, while the younger birds migrated apart from the parents. Mr Clarke further gave as an explanation of why the migrations took place at night, that most of the daytime was taken up with the search for food, and that by flying at night no single hour was lost.

II.—*FURTHER NOTES ON QUEENSLAND TERMITES.*

By Mr ROBERT GRIEVE, J.P., of Broadwater, Brisbane, Queensland.

(*Communicated by* Mr W. C. Crawford, President, *Dec. 27, 1899.*)

The thoroughness with which Grassi and his pupil Sandias take up the Sicilian termites is very praiseworthy. I may again say that I think his book a treat. He has drawn their bad habits (speaking from a human point of view) with a graphic pen, from which I for one have learned much. As to his pencil, it is perhaps rather too diagrammatic. I am at least hardly prepared to believe that the two Sicilian genera have heads quite so bald, quite so round, or quite so free of visible organs, as represented in two of his plates. One of the facts the book helps me to realise is, that only the fringe of termite history is touched as yet, apparently, by anybody; and just as termes differs from calotermes in important details of habit and economy, so over the face of the tropic earth, including Africa and Australia, there must be hundreds of species differing still more widely from them. Each different form of termitary is probably constructed by a different species

of termite, differing in important points from other termites, and from the other clans in the same localities inhabiting less conspicuous dwellings.

Calotermes and termes in Sicily are little communities fighting for a slender existence at the outside bourn of their race.[1] The European termites bear a like relation to their Australian kin that the people of St Kilda do to those of London. The comparative numbers are about the same. Taking the cubic contents of a termitary at 50 cubic feet, I arrived at a rough estimate of the individuals in one of our average nests thus:—

Thickly populated part . .	= 20	cubic feet.
More thinly populated part .	= 20	„
Nearly empty (a quantity which may be neglected) . .	= 10	„

Individuals absent on foraging and distant expeditions were too numerous to be counted in, but these may be reckoned as equal to a thickly populated part of 30 cubic feet. I counted the dwellers in a thickly populated block of 592 inches, and found them to be 90 per cubic inch. We thus arrive at the following calculation: $90 \times 1728 \times 30 = 4{,}665{,}600$ termites in an average termitary.

Grassi gives the number 500 as a high average of individuals for calotermes: termes' dwellings have a considerably larger population. It is only to be expected that a community of mound-builders in South Queensland such as I am using for comparison in these remarks should have an organisation more complex than calotermes. Without speculating on the secret by which order is maintained and work distributed in these large communities, it is certain that the one queen is the motive, and represents authority there. When she dies the community perishes. This is to be inferred from numerous experiments. There are other Australian species which create complementary or substitute queens, as calotermes does, but not this one. Taking this species, the one I know best, I find its economy differs at

[1] Mr Grieve means that in Europe there are very few places where termites are found. Sicily is their principal home, although they are also found at Genoa, and have been imported to Bordeaux.—W. C. C.

important points from the species which dwell around it, and *a fortiori* from those described by Grassi. It alone, so far as I know, has the soldier caste armed with the peculiarly modified head. Compare it with the more typical head. Is the strange proboscis formed by the fusion of the labrum and mandibles? The maxillæ, labium, and palps remain normal. It will occur to you that Diptera and Hemiptera show analogous but quite different fusion. It may be suspected that in the other large termitaries soldiers will have this speciality, and many other specific and generic characters of their own.

Among other differences between Australian and Sicilian species, the following are prominent:—

1. The Australian species are mound-builders; the Sicilian are not, and, as I gather, use no earth as building material. Calotermes makes no tubes at all. Termes lucifugus uses a compound of fæcal and disgorged matter to make gutters, the tubes being always less than two inches long. The two species often share together the same vegetable host without any partition, and have no interests external to their dwelling. The mound-builders, on the contrary, annex and penetrate all the surrounding country.

2. Calotermes lays only 12 eggs a-day. The mound-builder queen, swollen and gravid, probably lays a thousand or more. Such numbers may be seen lying on a heap, evidently the result of one effort. I find by a rough calculation that the queen is capable of containing 20,000 eggs in a nearly ripe condition. Even this large number is insufficient to provide for the needs of the community, and hints at renewed intercourse with the male during her long life. I take this opportunity of saying that functional males are only to be seen in the termitary shortly before swarming: very different is this from the Sicilian arrangements.

3. In the Sicilians, sexes swarm at different times. I have seen nothing to distinguish two sexes in Australian swarms. I interpret this to mean that those which I have observed are males, and that winged females in the swarm are very rare, and so escape observation.

4. Grassi refers in calotermes to what he calls genital appendices, which he regards as a link between the Corro-

dentia and the Thysanura (Poduridæ ?). He says these organs are the homologue of those on the ninth abdominal sternite, and he guards us from confounding these organs with the anal appendices. I can only say that I have observed no traces of such an organ in Australian species.

5. The total absence of workers in calotermes, according to Grassi, is very remarkable, and even the soldiers are as 1 to 20. In Termes lucifugus the soldiers also are said to be very scarce. Probably the proportion of soldiers depends upon seasonal, climatic, and accidental influences. It is so in Australia. I have frequently seen soldiers in greatly predominating numbers, and at other times relatively scarce.

6. Grassi says that the winged forms of Termes lucifugus do not form colonies. I am not inclined to say this of Australian species. I have no direct evidence. It is difficult to determine the fate of the last survivors of the myriads that are seen in flight. It is certain that nature, with her usual liberality, disposes of most of them as a food-supply. But new colonies under suitable conditions spring up like mushrooms. It is easy to account for this as the settling in life of winged queens, but very difficult otherwise.

I made another attempt at tube culture, which was rather more successful than my earlier experiments. When I used a quart jar I secured for them life and considerable activity, but even so very little progress. Grassi's experiments were made with calotermes, but he also failed with termes. The quart jar contains from 200 to 300 individuals of several grades—from the undifferentiated little larvæ, so white, so tender, and so weak, to the thick-skinned and highly chitinised mature workers and soldiers. As a basis of operations, I included with them a piece of old material, and as food a supply of pine sawdust—*i.e.*, Araucaria and Damara. Eucalyptus is only consumed by termites when it is in a state of decay. I do not see much building going on in the jar, but a good deal of marching to and fro, palp drill, and the characteristic crepitation.

The cultural difficulties which have to be contended with are the following:—

1. The adjustment of temperature and moisture. When

too dry, animals shrivel; when too moist, mould becomes injurious.

2. The habit of the insects is to work in the dark, and to obscure every transparency with clay. Calotermes does not do this, as it is only an excavator, and not a tube-builder.

3. The limitation of area. Australian termites are accustomed to work with unlimited material in unbounded space.

4. The want of the stimulus of the queen's presence.

I shall try to introduce a queen, and watch the results.

III.—*A SECOND BRYOLOGICAL EXCURSION TO BEN LAWERS.*

By Mr A. MURRAY.

(*Read Dec. 27, 1899.*)

I should like to say a few words about a second excursion I had among the mosses of Ben Lawers last summer, as I know there are several members of the Society who are interested in these beautiful little gems of the plant world. About the middle of June last two fellow-members of the Society—Mr Harrison and Mr Russell—encamped with me near the top of Lochan-a-Chait. It was dark before we arrived there, so after a cup of tea we crawled under some large pieces of rock, and rested fairly well. I awoke about 2 A.M., and lay for an hour listening to the monotonous "yelp" of some young hawks on the crags above. Then I got up, had a cup of tea and a sandwich, and at once started on my botanical hunt among the rocks and crags on the north-west side of Lochan-a-Chait glen. I went a different way from that of last year, when we visited the same crags. Here I got some very fine specimens: many of them I had already gathered, but some I had not yet got. A few of those now found can only be gathered on Ben Lawers.

About 6 A.M. Mr Harrison joined me, and directed my

attention to one of the finest cloud scenes any one could witness. Here we were above the clouds, about 3700 feet above sea-level, and, looking south-east, the glen and Loch Tay for miles—in fact, as far as the eye could reach—were completely covered by a stratum of clouds, practically level, but with a broken, rolling surface, while three or four mountain-tops stood up through the clouds, like islands in a sea. If we had not known where we were, it would have been hard to believe that it was not a sea dotted with islands that we beheld. In about an hour the clouds began to disappear, when we could get glimpses of Loch Tay and the glen through them.

Here, on the crags, there was a perfect flower-garden. I had never before seen the globe-flower (*Trollius europæus*) in its native habitat, and did not expect to find it so high up and on rocky crags, yet here it was by the thousand, and with flowers very much resembling mandarin oranges in shape and size, though not in colour, as the globe-flower is a bright lemon. The stalks were from eighteen to twenty-four inches in height, with flowers in all stages, from the bud to the full bloom. Mixed with the globe-flower were large patches of the bright pink Silene acaulis, with here and there a little tuft of intense blue Myosotis alpestris, and numerous beds of Cerastium alpinum with its pure white flowers; so that with blue, pink, white, and yellow, the effect was very fine. On the crags here I gathered good pieces of Myurella julacea and Pylaisia polyantha: the latter is not common. Hylocomium pyrenaicum is a very rare moss, only found on two or three of the highest Scottish mountains. Here also were got Anœctangium Mougeotii and A. Lapponicum, besides a very large variety of the former. A. Lapponicum is a pretty little moss when in fruit, but does not show well when mounted.

Coming down a little after 8 A.M., we had breakfast, and at 9.30 started for the summit of Ben Lawers. I went up the north-east side of the mountain this time, as I wished to visit the snow-wreaths on that side. On the way I got two or three good Hypnums. After reaching the first snow-wreath I was rather disappointed in my finds. Owing to the drought and heat the wreath was much reduced, and for a width of several yards around it there was not a vestige of living

vegetation, showing that the snow was seldom off that part; and where mosses were present, the great heat had caused them to grow so tall and straggling, after their long rest under the snow, that they were quite unrecognisable. Between this and the summit I got some extra fine bits of Polytrichum sexangulare and Conostomum boreale, both of which I gathered last year, but in small bits: in fact, P. sexangulare was very small, but those now shown are as fine as a specimen I possess which was gathered in Norway. It is only found on Ben Nevis and Ben Lawers, and is said to fruit only on the former, but I now got it in fruit on Ben Lawers.

It was 1.30 P.M. before I got to the summit of the mountain, where I found everything dried up by the three weeks' drought. Here I got Hypnum sulcatum. Returning by the usual path down the east side, I gathered fine specimens of Hypnum trifarium, Tetraplodon bryoides, and Gymnocybe palustre, the last in fine fruit. Getting down to Lochan-a-Chait, I explored the upper portion of the glen, but did not get anything new.

Next morning we started for the west glen,—Allt an tuim Bhric. To visit this glen was the principal reason for my going at this time, as I was informed that there are some very fine mosses to be found in it, and also that here Gentiana nivalis grows. So I was counting upon some good finds; but the well-known couplet—

> "The best-laid schemes o' mice and men
> Gang aft a-gley"—

was verified in my case, as I have not yet explored the west glen. After a long tramp we reached it. I left Mr Harrison and Mr Russell to do some cooking, and made a start, but had not gone more than half a mile when a thick mist set in, and in a very short time a heavy rain, so that I could see nothing, and therefore returned, to the amazement of my friends, as I was to be away for five or six hours. Although still fair here, it soon began to rain, and as there was no shelter we started for Finlarig, a walk of about seven miles, in a regular downpour of rain. It faired just as we reached Finlarig wood, where we kindled a large fire and dried our clothes.

Next morning was fine, so I started for Creag-na-Caillich, and,

after a long weary tramp through rough heather, reached the top, when rain came on again, and I had to beat a retreat. Reaching camp, it began to thunder, and rain fell in torrents, so instead of waiting till night, we took the mid-day train home, which we reached in a rather moist condition. My moss collecting was not such a success as I expected it to be, but nevertheless I got some good things. Altogether, in my three days at Ben Lawers I gathered over 250 species and varieties of mosses and hepatics.

I append a classified list of all the mosses I have collected on Ben Lawers and neighbourhood, which may prove a guide to others as regards what to look for. Of course I have not got *all* the mosses that grow there.

List of Mosses collected on Ben Lawers and neighbourhood, June 1898 and June 1899.

ACROCARPOUS MOSSES.

Sect. I. Schistocarpi.

Fam. *Andreæaceæ.*

Andreæa petrophila.
  var. acuminata.
  alpina.
    var. compacta.
    — flavicans.
  Rothii.
    var. frigida.
    — hamata.
  nivalis.

Sect. II. Stegocarpi.

Fam. *Buxbaumiaceæ.*

Buxbaumia aphylla.

Fam. *Georgiaceæ.*

Georgia pellucida.

Fam. *Polytrichaceæ.*

Catharinea undulata.
Oligotrichum incurvum.
Polytrichum aloides.
  urnigerum.
  alpinum.
  sexangulare.
Polytrichum gracile.
  attenuatum.
  piliferum.
  strictum.
  commune, with two or three vars.

Fam. *Fissidentaceæ.*

Fissidens osmundoides.
  taxifolius.
  adiantoides.

Fam. *Leucobryaceæ.*

Leucobryum glaucum.

Fam. *Dicranaceæ.*

Pleuridium subulatum.
Ditrichum homomallum.
    var. zonatum.
  subulatum.
  flexicaule.
    var. densum.
Swartzia montana.
Dicranella heteromalla.
  curvata.
  crispa.
Anisothecium squarrosum.
  crispum.
Brachydontium trichodes.

Blindia cæspiticia.
acuta.
Campylopus pyriformis.
flexuosus, var. paludosus.
Shawii.
atrovirens.
Dicranoweissia crispula.
cirrata.
Dicranum scoparium.
var. paludosum.
— turfosum.
majus.
fuscescens.
molle.
falcatum.
Scottii.
Bonjeani, var. juniperifolium.
Bergeri.
uncinatum.
schisti.
longifolium.
Dichodontium pellucidum.
Oncophorus Bruntoni.
Ceratodon purpureus.

Fam. *Tortulaceæ.*

Pottia Heimii.
Tortula lævipila.
Mollia tortuosa.
fragilis.
Barbula curvirostis.
fallax.
spadicea.
rigidula.
unguiculata.
Leersia alpina.
rhabdocarpa.
contorta.
Webera sessilis.

Fam. *Grimmiaceæ.*

Grimmia conferta.
var. pruinosa.
apocarpa.
var. alpicola.
— rivularis.
— gracilis.
— pumila.
incurva.
funalis.
Stirtoni.
ovata.
ovalis.
microcarpa.
atrata.
unicolor.
elliptica.
Grimmia patens.
affinis.
var. gracilescens.
heterosticha.
hypnoides.
canescens.
Glyphomitrium polyphyllum.
Ancœtangium Lapponicum.
Mougeotii.
Pleurozygodon æstivus.
Orthotrichum affine.
striatum.
Weissia Bruchii.
ulophylla.

Fam. *Splachnaceæ.*

Splachnum vasculosum.
pedunculatum.
Tetraplodon bryoides.
Tayloria tenuis.

Fam. *Funariaceæ.*

Funaria obtusa.
hygrometrica.

Fam. *Bryaceæ.*

Pohlia cruda.
nutans.
Ludwigii.
commutata.
albicans.
var. gracilis.
Plagiobryum Zierii.
Bryum filiforme.
bimum.
pallescens, var. contextum.
alpinum.
var. viride.
pallens.
var. speciosum.
Duvalii.
turbinatum.
capillare.
var. obconicum.
cæspiticium.

Fam. *Bartramiaceæ.*

Conostomum boreale.
Bartramia Oederi.
pomiformis.
norvegica.
ithyphylla.
Philonotis fontana.
var. capillaris.
Breutelia chrysocoma.

Fam. *Meeseaceæ.*

Meesea trichodes.
var. alpina.
Gymnocybe palustris.

Fam. *Mniaceæ.*

Mnium hornum.
Mnium rostratum.
undulatum.
punctatum.
Hedwigia ciliata.
leucophæa.
viridis.

PLEUROCARPOUS MOSSES.

Fam. *Neckeraceæ.*

Neckera crispa.
complanata.
var. tenella.

Fam. *Leucodentaceæ.*

Pterogonium gracile.
Antitrichia curtipendula.
Porotrichum alopecurum.

Fam. *Leskeaceæ.*

Myurella julacea.
Anomodon attenuatus.
viticulosus.
Pterigynandrum filiforme.
Pseudoleskea atrovirens.
Thuidium tamariscinum.

Fam. *Hypnaceæ.*

Climacium dendroides.
Cylindrothecium concinnum.
Pylaisia polyantha.
Orthothecium rufescens.
Brachythecium plicatum.
glariosum.
albicans.
salebrosum.
var. palustre.
Starkii.
purum.
Eurhynchium cirrosum.
piliferum.
prælongum.
Swartzii.
myosuroides.
rusciforme.
Plagiothecium depressum.
denticulatum.
undulatum.
Amblystegium serpens.
curvicaule.
Hypnum stellatum.
var. protensum.
Sendtneri.
fluitans.
exannulatum.
uncinatum.
var. plumulosum.
vernicosum.
revolvens.
var. Cossoni.
intermedium.
falcatum.
var. gracilescens.
sulcatum.
incurvatum.
cupressiforme.
var. resupinatum.
— filiforme.
— ericetorum.
— tectorum.
revolutum.
callichroum.
molluscum.
crista-castrensis.
ochraceum.
eugyrium.
stramineum.
trifarium.
sarmentosum.
cuspidatum.
cæspitosum.
Schreberi.
Hylocomium splendens.
pyrenaicum.
brevirostre.
loreum.
squarrosum.
triquetrum.
rugosum.

IV.—*THE BIRDS OF BUTE AND ARRAN.*

By Mr ARCHIBALD CRAIG.

(*Read Jan. 24, 1900.*)

It is no part of my present purpose to give anything like a lengthened description of the scenery or topography of those well-known islands, Bute and Arran; in all likelihood most of you are familiar with them already. In general appearance, contour, &c., there is a marked contrast between the two: Bute, save at the north end, where the mountains rise steeply from the shores of the narrow and beautiful strait known as the Kyles, is, compared with the sister island, lowland in its aspect. The bulk of the country is undulating, none of the hills being of great height, and almost all the available ground is under cultivation or pasture. The production of milk and butter is the staple industry, and, in a word, one might almost characterise the island as a huge dairy farm. Some parts are well, even richly, wooded, and give shelter to a considerable variety of small birds, but of those more anon. To the antiquarian Bute will always be a place of interest, for its ancient chapels, stone circles, and other relics of the past.

Arran, again, is totally different, being a typical Highland district, with, particularly in the north, a magnificent chain of rugged and precipitous mountains, intersected with wild and lonely glens without a trace of human habitation. It would hardly be possible to conceive of a more desolate and weird-like locality than the head of Glen Rosa or the upper parts of Glen Sannox; even the feathered tribe seem to shun the spot, as, with the exception of an odd raven now and then and a few meadow pipits, hardly any bird life is to be observed.

Save about Brodick, where there is a wealth of fine wood, the other parts of Arran, more especially the southern end, are, comparatively speaking, bare, and the scenery of the latter district is not nearly so fine nor romantic. One marked feature of difference between Arran and many other Highland districts is the almost total absence in the former of lochs, such as do exist being mere tarns. In Bute, again, there are several sheets of water—Loch Fad, for example, behind the town of Rothesay,

being very pretty, and its shores well wooded. This want of water of course accounts for the absence of many aquatic species, which might otherwise haunt the place if their favourite breeding-grounds were more plentiful. The climate of both islands is, on the whole, very mild, hence the fact of Bute being such a resort of invalids; but as an offset to that advantage, it must be confessed that in some seasons the quantity of rain that falls is sufficient to more than satisfy the needs of the most ardent hydropathist or rabid teetotaller. This very cursory sketch of the islands must suffice, so let us turn to the bird life.

It will be within the memory of most of you that May 1899 was a most inclement, cold, and backward month, just about the very worst possible for observing the feathered fauna, and to this I attribute the circumstance that my list is so meagre, and nothing like so full as many other stations in Scotland can show under more favourable climatic conditions. It would take up too much time to separately describe all the species observed in both islands, as many of them are duplicated; so to avoid this, I purpose appending to the paper two lists showing the species noted in Bute during May, and in Arran during June, 1899.

Of the Falconidæ or Strigidæ (that is to say, the hawks and owls) I never happened to identify one solitary specimen, although no doubt several exist. They cannot be plentiful, however; probably their numbers are well kept down for the benefit of the almighty game, but upon that vexed and controversial subject it may be as well to draw the veil. The Corvidæ, or crows, were fairly well represented. Chief among them is the raven, which was identified several times in Arran, at the head of Glen Cloy, also in Glen Sannox, where two pairs were observed about a mile apart. No ground could be more suitable for rearing their young, as the cliffs in many places are perfectly inaccessible; and there are so many solitary spots admirably adapted for nesting purposes, that it is not likely they will become extinct in our day, although persecuted with unyielding rigour. The carrion crow also frequents this island, although I found no trace of the grey or hooded species at the time of year indicated. Naturally, the rook was, as elsewhere, in evidence, and our cunning and

somewhat impudent friend the jackdaw winds up the list. In some parts great colonies of these last-named noisy birds were to be seen, evidently nesting in the rocks above the seashore.

Apropos of crows, as is well known partial albinism is not uncommon among the genus, and one of the most curious instances of it that ever came under my own observation occurred some years ago at Temple, near Gorebridge, when a rook with its wings almost white flew across the road a few yards in front of our party. Rooks also with white feathers scattered here and there amidst the plumage are by no means rare.

Taking now the species that more or less haunt the seashore, we find the following. The cormorant is very common, and numbers may be noticed off the steamers swimming and diving in the Firth of Clyde, and in all the numerous arms of the sea that add so much to the beauty of the west coast. Favourite resting-places are the tops of those miniature lighthouses that are dotted up and down the Clyde to warn shipmasters to avoid sandbanks, sunken rocks, &c., and they are also fond of sitting on the floating buoys. I have not included in my list the shag or green cormorant, as I am not absolutely certain of its occurrence, although it is more than probable that it exists. As is matter of history, cormorants used to be trained to catch fish in rivers and ponds, a thong being tied round the lower part of the neck to prevent the fish being completely swallowed. This practice is not much in vogue nowadays, although it was revived several years ago on the Eddleston Water near Portmore. Of the Gull tribe only four species were noted—viz., the common, black-headed, lesser black-backed, and herring gulls, the latter the least plentiful. Gannets do not breed on Arran; but these birds are frequently seen flying in the vicinity, having wandered north from Ailsa Craig. The oyster-catcher was far from uncommon. This bird is a great ornament to a sea-beach, its beautifully contrasted plumage of pure white and black, along with its orange-red mandibles and reddish-purple legs, having a pleasing effect on the eye. Where this species frequents one is almost certain to find redshanks and ringed plovers. The last mentioned are most lively and interesting little creatures, and it is a pretty

sight to watch them running along the shore in small flocks, keeping, as a rule, near the water's edge, and sounding the while their melancholy notes. In the Kyles of Bute one evening I counted sixteen, all clustered on the top of a small boulder, not in the least shy, as they permitted me to approach within a few yards,—so much so that it would have been possible to knock several of them over with a stone, if one had been cruelly-minded enough to make the attempt. This little bird lays its eggs in a small hollow either on the grass or among the shingle, and, in common with the peewit, has the knack of pretending to have a broken wing or leg, so that one is induced to follow it up, which is just what it wants, in order to draw the trespasser away from its eggs or young, as the case may be. Herons, although not nearly so plentiful as in some other west-coast localities, are to be seen pretty well all along the shores; and among other seafaring and seashore haunting species may be noted the common guillemot, the common sandpiper, or, as it is called in some parts of Scotland, the sandy laverock (also found in large numbers by the sides of burns and rivers), and that ever-watchful species, the curlew or whaup. As you are aware, this last bird retires to the muirs to nest; but in small islands such as are being treated of, it does a good deal of its feeding among the tangle, mud, and sand left bare by the receding tide. Peewits are fairly distributed; but in my opinion this species is decreasing, save perhaps in very outlying and unfrequented districts. The cause of this diminution in numbers can, no doubt, to a certain extent be traced to the ever-increasing demand for what are known as "plovers' eggs," and it is perfectly amazing the quantities that find their way to the markets of large cities, not excluding our own town of Edinburgh. This habit of collecting eggs is much to be deplored, as it would be hard to find a prettier or more useful bird than what we are wont to designate in this country the "peaseweep."

Before taking up the smaller fauna, there are a few odd species that may be briefly commented upon.

Of birds that come under the heading of game might be instanced black and red grouse, pheasant, and partridge, and under this section can be included woodcock and snipe. The only duck noted was the mallard or common wild duck,

although another species was seen, but at such a great distance over the water that it could not be accurately identified with the naked eye. Corncrakes or landrails made their presence known in all suitable quarters by their most grating and unmelodious cry. This sound, as is matter of notoriety, is very puzzling at times to locate, as at one moment it seems to be quite close at hand and the next to be some distance off, giving rise to the idea that the bird is a ventriloquist. This theory is, however, not accepted by most of our well-known ornithological authors, who account for this peculiarity by the swiftness with which the bird moves about from place to place. I have myself seen it hastening rapidly amidst the short herbage, not yet long enough to hide it completely, and noticed its head and neck were quite erect while the harsh sound was being emitted. There is one thing, however, that I do not feel competent to decide upon, and that is—if the disagreeable note is sounded while the bird is running, or if it always stops still while calling, or if it is made under both conditions.

That parasitical species the cuckoo was abundant in Bute, and, for the matter of that, in Arran as well. The fact of this bird making no nest of its own, but utilising that of other species in which to deposit its egg, is so well known as to necessitate no further remark. It certainly is a most curious and instructive sight to watch the foster-parents feeding the young cuckoo. The latter is usually four or five times larger than the others, and when it opens its big gape to receive the food, one would think it had serious intentions of swallowing the smaller creature *in toto.* In muirland districts the titlark, or moss-cheeper to give it its Scottish cognomen, seems to be the bird that, in the majority of cases, has given to it the task of rearing this intruder. In passing, the existence of the wood-pigeon may be mentioned, as also that of the coot and water-hen—the two latter chiefly in Bute, as the scarcity of sheets of water in Arran prevents them frequenting the island in any great numbers.

I have now to call your attention, and that shortly, to the smaller fauna. The swallow, house and sand martins, as well as the swift, were common in Bute, but not so numerous in the other island. The night-jar is not included in the list, as it was not observed, from the fact that I never happened to

be in suitable localities during the evening when it comes out to feed; but that it occurs is certain. While glancing lately at a very old ornithological work, I came across a curious description of how swallows were reputed to be an unfailing specific for various disorders that afflict humanity. The writer, whose name was Schroder (a German, most likely), goes on to indicate how, if swallows were eaten whole, or if their ashes were mixed with honey and taken as physic, that a certain cure for the falling sickness, dimness of sight, and blear eyes would take place. He does not explain, however, whether "blear eyes" are the product of excessive indulgence in alcohol or attributable to other causes—he leaves that to our imagination. Among other complaints that various parts and preparations of the swallow are supposed to mitigate, if not to cure finally, is the squinancy or quinsy: but not to prolong this matter, I will only mention other two maladies that fly before this sovereign balm—viz., the biting of a mad dog and the colic—a fairly representative list of diseases. All three species of pipits — the meadow, tree, and rock varieties—were found, the latter, of course, frequenting the sea-beach; and that lovely songster, the skylark, occurred, but, as far as my observation went, it was rather sparsely distributed.

Glancing rapidly over some of the others, we have to record the starling (on the increase, as elsewhere); and the thrush family consisted of missel-thrush, mavis, and blackbird: but it was a disappointment not to be able to include the ring-ouzel, as many parts seemed likely to suit its wants. Chaffinches, greenfinches, redbreasts, hedge-accentors, all were plentiful; and it goes without saying that house-sparrows were as numerous and as impertinent as in other places. These last-named birds are increasing in far too great a ratio as compared with many much more interesting and less destructive species: in fact, in the suburbs of our large cities it is a rare thing now to see a house-martin's nest in the corners of the buildings or windows, the sparrows waging constant warfare against the more delicate race. The titmice identified were only three in number—the great, cole, and blue tits. Common wrens abounded, and there were also a goodly

number of goldcrests, creepers, and redpoles, also corn and yellow buntings.

Leaving the warblers to the last for a reason, it only falls to run over the following to exhaust the list. Wagtails consisted of the pied and grey species; the spotted flycatcher was the sole representative of his genus; and, so far as the chats are concerned, three species were common in Arran—namely, the wheatear, whinchat, and stonechat. The last-named birds, although by no means rare, seem to be irregularly distributed in Scotland, as many apparently suitable habitats are without them altogether. In Arran they were to be seen in a great many different places, chiefly up the wild glens, but there were also several pairs on the roadside between Brodick and Lamlash. A most sprightly and taking species is this same stonechat, and one always interesting to an ornithologist for its smart movements and fearlessness when its nesting-ground is intruded upon.

The saying that a lady's mind is best expressed in her postscript is a trite one and familiar to us all, but, in a measure, is applicable to the present case, for the simple reason that I have held over to the end of this otherwise unimportant paper the only item worth recording. The warblers are now the last of the category. The commoner and better-known species, such as the willow wren, wood warbler, and whitethroat, haunted the woodlands and hedgerows, and may be dismissed without further comment. The chiffchaff, although not what one would call abundant, was not uncommon, its monotonous double note, from which its name seems to be derived, being heard in the woods about Rothesay, and also in the policy surrounding Brodick Castle. This species is much more numerous in England than in Scotland; in Warwickshire especially the numbers are so great that it is positively tiresome to listen to the constantly recurring song, if such a sound can be dignified by that epithet. In Scotland its distribution might almost be called erratic, as its presence has been chronicled in localities that do not seem to be so suitable to its habits as others where it is unknown. The farthest northerly point where I have personally identified it is the Pass of Inverfarigaig, on Loch Ness side, although it has been found much farther north. The similarity in

general appearance and plumage to that of the willow wren makes it a matter of considerable difficulty to distinguish between dead specimens of both. There is a difference, as the size of the chiffchaff is a trifle less, and its legs and feet are darker than those of the willow wren; but it appears to me that if a dozen dead bodies of each were mixed up, it would take an expert naturalist indeed to divide them properly.

The last species to be notified, and, as already indicated, the most important, is the grasshopper warbler. I must at once confess that, beyond what was gleaned from standard ornithological works, the bird was hitherto quite unknown to me, and I hesitated at first to place its occurrence on record entirely on my own responsibility; but from subsequent inquiries made, I think I am justified in saying that the bird was none other than *Salicaria locustella.* Passing one morning along the shore of Loch Fad near Rothesay, where it was skirted by a very thick young larch wood, my attention was attracted by a sound resembling that of a grasshopper. It struck me, considering the very cold weather and the early time of year, that it was rather peculiar to hear this noise; so I waited a little in the hope that it might be repeated, and was soon rewarded. The note, although bearing a marked resemblance to the noise made by the insect, was louder; and occasionally there intervened a sharp note such as is emitted by some of the Sylviidæ, which made me conclude that I was listening for the first time to the cricket-bird, as it is called in some parts of England. Owing to its shy and skulking nature this species is at all times difficult to see, and in this particular instance the undergrowth was so dense that it was quite impossible to get a view of it. All I could trace was a slight movement of the herbage, showing that the bird was on the move. I returned on various occasions to the same neighbourhood, but never heard its note again—which was not to be wondered at, as there was such a stretch of wood that, unless one stumbled accidentally on the nesting spot, it would only be by the merest chance that it could be located. Many instances are quoted of this species being identified in different parts of Scotland, but I cannot find its presence marked in Bute in any natural history work consulted. As it has been

heard in Argyleshire, close at hand, more than likely this is not the first time it has visited Bute; but apparently those visits have been overlooked, or not made public. In any case, it is safe to say that, take it all round, it must be classed as a *rara avis* so far as our country of Scotland is concerned.

I must now bring these remarks to a close by again expressing disappointment at the scanty numbers of the feathered fauna brought under your notice; but without devoting one's time specially to the subject, and making careful observations at all periods of the year, so as to include both summer and winter migrants, also chance stragglers, it would be foolish, not to say unjust, to jump to the conclusion that those two islands, taking into account their general characteristics, are more devoid of variety in bird life than other parts of our native land.

BIRDS NOTED IN BUTE DURING MAY 1899.

Rook.
Jackdaw.
Common gull.
Black-headed gull.
Oyster-catcher.
Redshank.
Ringed plover.
Guillemot.
Heron.
Curlew.
Peewit.
Cormorant.
Common sandpiper.
Cuckoo.
Partridge.
Red grouse.
Mallard.
Corncrake.
Rock-pipit.
Meadow-pipit.
Tree-pipit.
Missel-thrush.
Mavis.
Blackbird.
Starling.
Corn-bunting.
Yellow bunting.
Swift.
Swallow.
House-martin.
Sand-martin.
Chaffinch.
Greenfinch.
Whitethroat.
Willow warbler.
Wood warbler.
Chiffchaff warbler.
Grasshopper warbler.
Wheatear.
Whinchat.
Robin.
Hedge-accentor.
Redpole.
Wren.
Goldcrest.
Pied wagtail.
Grey wagtail.
House-sparrow.
Great tit.
Cole tit.
Blue tit.
Skylark.
Wood-pigeon.
Water-hen.
Coot.

BIRDS NOTED IN ARRAN DURING JUNE 1899.

Raven.	Starling.
Carrion crow.	Missel-thrush.
Rook.	Mavis.
Jackdaw.	Blackbird.
Common gull.	Yellow bunting.
Herring gull.	Swallow.
Black-headed gull.	House-martin.
Lesser black-backed gull.	Chaffinch.
Oyster-catcher.	Greenfinch.
Cormorant.	Willow warbler.
Guillemot.	Wood warbler.
Heron.	Chiffchaff warbler.
Curlew.	Whitethroat warbler.
Peewit.	Wheatear.
Common sandpiper.	Whinchat.
Cuckoo.	Stonechat.
Red grouse.	Robin.
Black grouse.	Hedge-accentor.
Pheasant.	Redpole.
Woodcock.	Wren
Snipe.	Creeper.
Mallard.	Goldcrest.
Corncrake.	House-sparrow.
Rock-pipit.	Great tit.
Meadow-pipit.	Blue tit.
Tree-pipit.	Cole tit.
Spotted flycatcher.	Pied wagtail.
Wood-pigeon.	Grey wagtail.

V.—*THE BOTANY OF A RAILWAY STATION.*

BY MR A. CAMPBELL.

(*Read Feb. 28, 1900.*)

WHEN residing at Burntisland a good many years ago, I became interested in the number of plants that grew on the railway lines connected with the station. And at the outset it will be as well to define what I mean by "railway station." To the ordinary passenger it means the booking office, platform, waiting-rooms—and to some, that important modern institution, the refreshment-room. To the man in charge it means the main line from distant signal-posts and all the sidings connected therewith — west to the seashore

below Rossend Castle, with all the engines, carriages, and waggons required for working railway traffic. The length of the line, exclusive of sidings, would be fully a mile.

Bordering the main line from the signal there is a narrow stripe of permanent grass on each side for about 500 yards. On these borders many flowering-plants and grasses are permanently established, subject to being cut down once a-year for the sake of appearance. But it is quite different with the plants that grow, or attempt to grow, on the line or in the sidings, subject twice a-year to the surfaceman's shovel,—and the wielder thereof regards every vestige of vegetation as a weed, in the full sense and meaning of the word, and as such to be destroyed off the face of the earth.

The soil, an important factor at all times and in all places for the growth of plants, consisted here almost entirely of travelled material, gradually covered over with a coating of engine-ashes, cinders, and small coal dropping from waggons in shunting operations extending over many years. Of course the material selected by railway engineers for ballasting purposes is not intended for the growth of plants, and some of what was laid down here came from some of the kames or eskars in the north of Fife; while the old Oakley iron-works supplied broken slag, with a strong pungent smell of sulphur. No plants grew on this part of the line for some years. But "Time changes a' thing"—like Bonnie Bessie Lee. The slag got gradually broken down and covered over, and vegetation began to take root and find nourishment. The rocks at the east end of the passenger station retained soil on ledges and in crevices: various plants grew here free and safe from shovel and hoe. The western portion of the station was formed of soil—mainly ballast deposited there from ships. When this material was left undisturbed, even for a short time, a luxurious vegetation sprang up in the summer months. With the exception of the rocks referred to above, all the ground is only a few feet above high-water mark.

The distribution of seeds in the case of plants growing on the line is effected in the usual way, the wind being perhaps the most active agent. But the seeds of many plants from distant parts are scattered along railway lines by passing trains Almost all railway waggons used in the conveyance

of general merchandise are bedded with straw, grass, reeds, &c., grown at home or abroad—on the banks of the Tay (reeds) or the banks of the Elbe (meadow-hay, &c.), as the case may be — and seeds foreign to the locality drop out on the line through the bottom or sides of the waggons. In this way one may pick up a south of England plant growing on the railway in the Howe of Fife or the valley of the Spey. Garden escapes are also common near towns and villages.

And here I may mention that I was partly induced to make the following list of plants by the late Mr Sadler, whc was at that time Curator of the Botanic Garden, Edinburgh. He told me that there was a proposal to publish a Flora of the Firth of Forth from Dunbar to Bo'ness on the south side, and from Crail to Crombie Point on the north side—points given in M'Laren's 'Geology of Fife and the Lothians.' The list—if my memory serves me—was to include all plants from high-water mark up to the 100-foot beach. So far as I know, it came to nothing except the dry list of names, which I will now give. The Cryptogams I have left severely alone.

Ranunculaceæ.
Ranunculus acris, R. repens, and R. hirsutus.

Papaveraceæ.
Papaver Argemone, P. Rhœas, P. somniferum, and Glaucium luteum.

Fumariaceæ.
Fumaria officinalis.

Cruciferæ.
Coronopus didyma and C. Ruellii, Thlaspi arvense, Capsella Bursa-pastoris, Lepidium latifolium, L. draba, L. ruderale, Draba verna, Camelina sativa, Alyssum calycinum, Arabis hirsuta, Barbarea vulgaris, Sisymbrium officinale, S. Irio, Cheiranthus Cheiri, Sinapis arvensis, Raphanus Raphanistrum, Diplotaxis tenuifolia and D. muralis.

Resedaceæ.
Reseda lutea and R. Luteola.

Violaceæ.
Viola canina.

Caryophyllaceæ.
Saponaria officinalis, Silene inflata, S. maritima, S. anglica, Lychnis diurna, L. vespertina, L. Githago, Sagina procumbens, Spergula arvensis, Honckenya peploides, Stellaria media, Cerastium glomeratum and C. arvense.

Linaceæ.
Linum usitatissimum.

Malvaceæ.
Malva sylvestris, M. rotundifolia, and Lavatera arborea. A single plant of the Lavatera grew on the rocks, but it was destroyed by some tame rabbits. It is found on the Bass Rock.

Hypericineæ.
Hypericum perforatum.
Aceraceæ.
Acer pseudo-platanus.
Geraniaceæ.
Geranium rotundifolium, G. molle, G. Robertianum, G. sanguineum, and Erodium cicutarium.
Leguminosæ.
Sarothamnus scoparius, Ulex europæus, Ononis arvensis, Anthyllis vulneraria, Medicago lupulina, Melilotus officinalis, M. arvensis, M. alba, Trifolium repens, T. tomentosa, Lotus corniculatus, Astraglus glycyphyllos, and A. hypoglottis.
Rosaceæ.
Prunus communis on rocks, Potentilla anserina, Rosa canina, R. spinosissima, Rubus fruticosus, Alchemilla vulgaris, Cratægus Oxyacantha.
Onagraceæ.
Epilobium montanum, Œnothera biennis.
Grossulariaceæ.
Ribes nigrum.
Crassulaceæ.
Sedum acre.
Hederaceæ.
Hedera Helix.
Umbelliferæ.
Conium maculatum, Petrosilenum sativum, Ægopodium Podagraria, Pimpinella Saxifraga, Bupleurum rotundifolium, Æthusa Cynapium, Fœniculum vulgare, Heracleum Spondylium, Daucus carota, Torilis nodosa, and Scandix Pecten-Veneris.
Rubiaceæ.
Galium aparine, Sherardia arvensis.
Valerianaceæ.
Centranthus ruber, Valerianella olitoria and V. dentata.
Dipsaceæ.
Dipsacus sylvestris, Knautia arvensis.
Compositæ.
Tragopogon pratensis, Sonchus oleraceus, Hieracium Pilosella, H. murorum, Taraxacum officinale, Lapsana communis, Arctium Lappa, Cichorium Intybus (only one plant seen), Carduus nutans, C. crispus, C. Marianus, C. arvensis, Centaurea nigra, C. Cyanus, Artemisia vulgaris, Tussilago Farfara, Solidago Virgaurea, Senecio vulgaris, S. Jacobæa, Bellis perennis, Chrysanthemum segetum, C. Leucanthemum, Matricaria Parthenium, M. inodora, Achillea Millefolium.
Campanulaceæ.
Campanula rotundifolia, C. glomerata.
Apocynaceæ.
Vinca major.
Convolvulaceæ.
Convolvulus arvensis.
Solanaceæ.
Hyoscyamus niger. (This plant would grow in some places for a year or two in profusion, then suddenly disappear for a season. After taking a twelvemonth's rest, it would reappear in greater profusion than ever.) Solanum nigrum.
Scrophulariaceæ.
Verbascum Thapsus, Veronica serpyllifolia, V. Chamædrys, Linaria Cymbalaria.

Labiatæ.
Salvia Verbenaca, Mentha arvensis, Teucrium Scorodonia, Lamium amplexicaule, Galeopsis Tetrahit, Stachys arvensis.

Boraginaceæ.
Myosotis arvensis, Lithospermum officinale, L. arvense, Lycopsis arvensis, Echinospermum Lappula (one single plant once found on ballast).

Primulaceæ.
Anagallis arvensis, A. cærulea (one single plant once found on line), Primula veris.

Plantaginaceæ.
Plantago major, P. lanceolata, P. Coronopus.

Chenopodiaceæ.
Chenopodium olidum, C. rubrum, C. glaucum (ballast).

Polygonaceæ.
Polygonum Persicaria, P. aviculare, P. Convolvulus, Rumex obtusifolius, R. maritimus, R. crispus.

Euphorbiaceæ.
Euphorbia Peplus, E. Helioscopia.

Urticaceæ.
Urtica urens, U. dioica.

Gramineæ.
Setaria viridis, Phalaris canariensis, Apera Spica-ventis, Agrostis alba, Avena pratensis, A. pubescens, Arrhenatherum avenaceum, Schlerochloa maritima, S. rigida, Poa annua, P. pratensis, P. trivialis, Cynosurus cristatus, Dactylis glomerata, Bromus sterilis, B. erectus, Triticum repens, T. junceum, Hordeum murinum, Lolium perenne, Elymus arenarius, Ægilops ovata (once found growing on ballast).

VI.—*SPLASHES, STUDIED BY THE AID OF INSTANTANEOUS PHOTOGRAPHY.*

By Mr R. S. COLE, M.A. Cantab.

(*Communicated Feb. 28, 1900.*)

[Professor Worthington and Mr R. S. Cole lately made a large number of most interesting experiments regarding the "splashes" produced by liquid falling into liquid and by solid falling into liquid. These splashes were carefully and successfully photographed by the experimenters, and the pictures thus secured were in some cases rather startling. At the request of the Council, Mr Cole very kindly showed these photographs on the screen at an evening meeting of the Society, and explained at the same time how the results had been obtained. By the courtesy of the editor of

'Pearson's Magazine,' — where two articles by Professor Worthington on the subject appeared in July and August 1898,—a number of illustrations prepared from the photographs are here reproduced. (See Plates V.-X.) The following are Mr Cole's explanations of the different stages of the splashes, and of the mode by which the photographs were taken.]

The photographs were taken by Professor Worthington, F.R.S., and the lecturer, with a view to studying the phenomena of the splashes produced by drops of liquid and solid bodies falling into liquid. The splashes were made in a dark room, and illuminated by an electric spark from Leyden jars outside the room: previously a camera had been placed in position and focussed, and the sensitive plate exposed so that when the flash occurred the image was thrown on the plate. Electrically controlled arrangements were made, whereby the drops of liquid or the solid were released inside the dark room, and at the same time a metal ball was also released outside, which in falling discharged the Leyden jars and produced the required illumination of the splash. The heights of fall in both cases could be varied, thus enabling the height of fall of the liquid drop or of the metal ball to be varied, which permitted, on the one hand, the nature of the splash to be varied, and on the other hand the flash to be produced at any stage of the phenomenon required. From the photograph of a disc whirling so that its edge, which was graduated, travelled at the rate of 78 miles an hour, it was estimated that the duration of the flash did not exceed three millionths of a second.

Several series of photographs were shown:—

I. A drop of liquid falling 40 centimetres into water rendered visible by the addition of milk. The series of events are as follows: 1, A crater-like hollow of liquid is formed, with arms shooting out, and segmenting into drops. 2, The crater subsides, and the arms die away. 3, The floor of the crater rises and shoots up in the centre, forming a thick column of liquid. 4, The column subsides, and a hole is formed; meanwhile the liquid forming the column spreads out to form a plate whose edge constitutes the first outrushing ripple. 5, The column again rises and subsides; a second

PLATE V., SERIES 1.

PLATE VI., SERIES 1—*continued.*

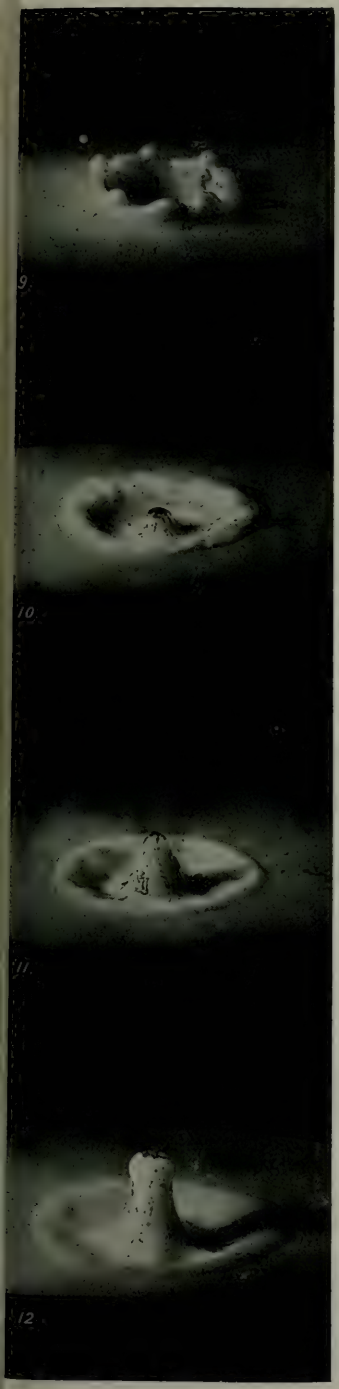
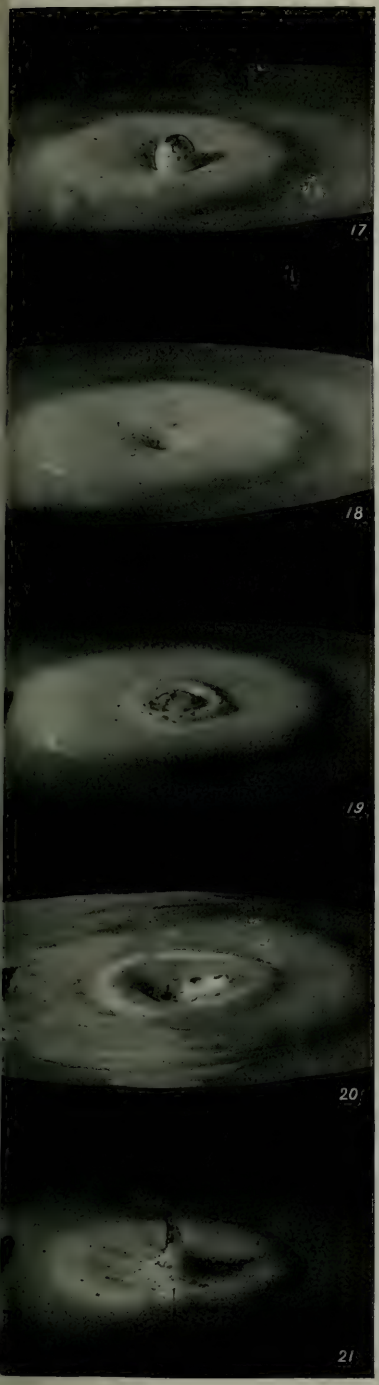


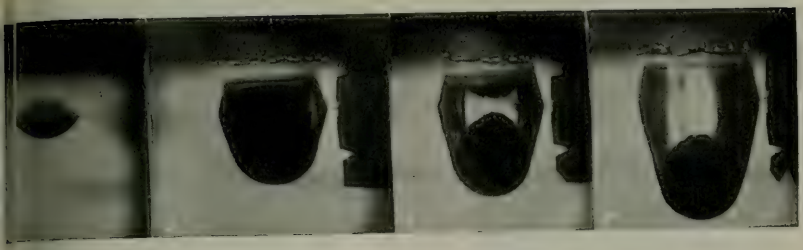
PLATE VII., SERIES 1—*continued.*

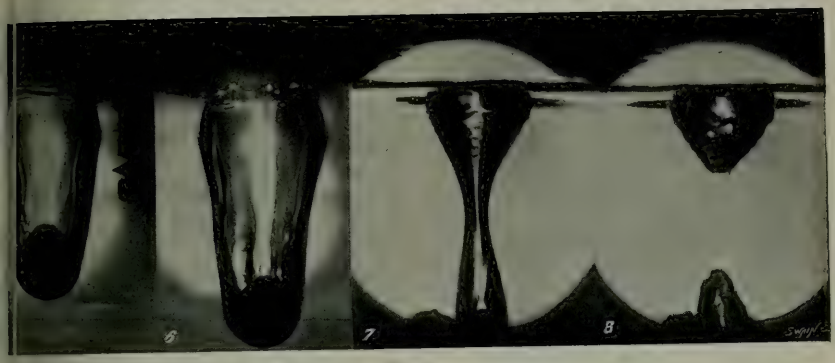


SERIES 2.

PLATE VIII., SERIES 3.

PLATE IX., SERIES 4.





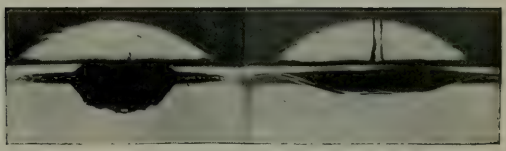


PLATE X., SERIES 5.

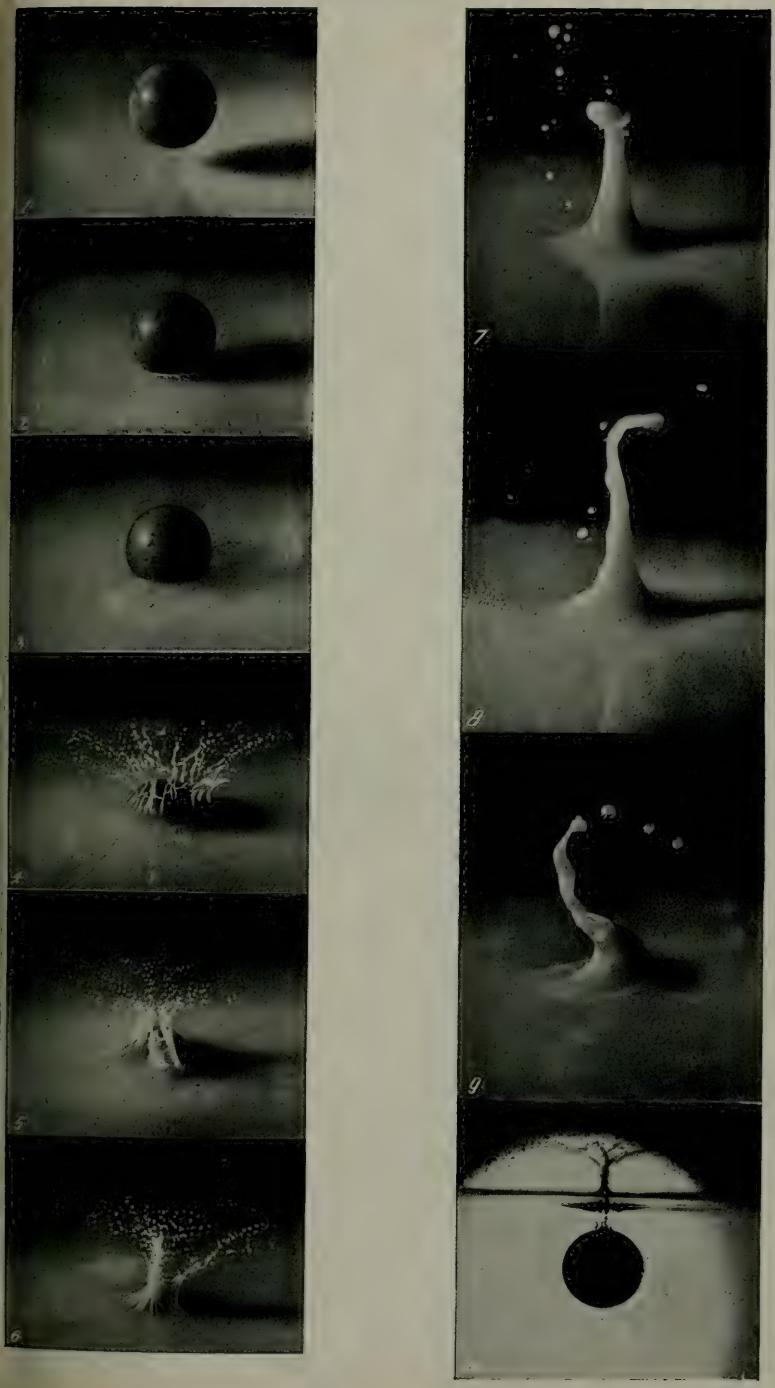


plate and ripple are formed. 6, The column again emerges, and behaves as before. The series terminates at this point. (See Plates V.-VII., Series 1.)

II. *A liquid drop falling* 100 *centimetres into liquid.*—The initial stage of the phenomenon is the same as in I., but the crater here tends to contract and close in to form a bubble. Sometimes the bubble bursts in time to allow the column to emerge, and at others the column becomes entangled with the bubble, producing a confused mass of liquid. (See Plate VII., Series 2, and Plate VIII., Series 3.)

Solid spheres falling into liquid.—In this case considerable difference was observed between the phenomena when the sphere was smooth and when it was rough.

III. *Rough sphere falling* 15 *centimetres into liquid.*—When the sphere enters the surface the liquid appears to be repelled from it. The initial stages are similar to 1 and 2 of Series I.; but subsequently, in place of the thick column, a thin thread of liquid is squirted to a considerable height. Much air is taken down. (See Plate IX., Series 4, showing what happens to the sphere under water.)

IV. *Smooth sphere falling* 60 *centimetres into liquid.*—Here the liquid clings to the sphere, and even runs up it, closing over it before it is all below the original surface of the liquid. The phenomenon is quite silent, and no air is taken down as in Series III. The surface of the liquid is left smooth, and then out of it rises an unsymmetrical column of liquid. (See Plate X., Series 5.)

Then experiments were described which were undertaken with a view to determining the reason for the differences between Series III. and IV.; the conclusion being that the "rough" phenomenon is due to the presence of dust and projections on the surface of the sphere, which allow the uprushing liquid to get free from the molecular attraction of the solid surface and rush off at a tangent.

In conclusion, there was shown a photograph of the effect of a shot on a steel armour-plate, and attention was drawn to the similarity with a liquid splash. Full information can be found in the 'Philosophical Transactions' of the Royal Society (London)—vol. 189 (1897), pp. 137-148; vol. 194 (1900), pp. 175-200.

VII.—*NATURAL HISTORY NOTES ON TENBY.*

By Dr DAVIES.

(*Read March 28, 1900.*)

Attractive to the ordinary tourist from the beauty of its situation, the extent and firmness of its sands, and the unusual salubrity of its climate, Tenby is specially interesting to the naturalist on account of the richness of its marine fauna and flora, in which respect it is excelled by few, if any, places on the British coast. It is situated on a somewhat lofty promontory, washed on both sides by the sea, the eastern extremity of which forms Tenby Head, or, as it is more commonly called, from the fragmentary ruins of the old castle which are located on it, the Castle Hill. Its coast offers many caves and recesses, forming highly suitable habitations for the lower forms of animal and vegetable life. The richest spot, however, in this respect, is undoubtedly a rugged mass of limestone situated at a short distance from the Castle Hill, known as St Catherine's Rock or St Catherine's Island. This rock is surrounded by the sea for two or three hours before and after high water, but at other times it is readily accessible across the sand left dry to a greater or less extent, according to the state of the tide. Penetrated by caverns and intersected by numerous caves and recesses, it offers a rich and almost exhaustless field of research for the naturalist working at the various forms of life which there abound. Round the coast are Monkstone Point and Lydstep caverns, two and a half miles to the north and four miles to the west respectively; while some two miles out at sea, marked by a lofty beacon, are the sharp and rugged Woolhouse Rocks. All these are rich in life, similar, though differing in detail, to that of Tenby Head and St Catherine's Rock.

It is this last, however, as already said, which offers the richest hunting-ground. About two hours after the tide has commenced to ebb we may reach its western point, and, rounding the extreme end, find ourselves opposite the first

Fig. 1.—TENBY HARBOUR AND CASTLE HILL.

Fig. 2.—CAVE No. 2, ST CATHERINE'S ROCK.

cavern. This is the smallest, and perhaps the least productive, of the three caverns which penetrate the rock, yet it is well worthy of attention. Here, as well as in other parts of the rock, occur in abundance the dog whelk (*Purpura lapillus*), with its beautiful little egg-cases, which stud the walls in all directions; anemones, chiefly the beadlet (*Actinia mesembryanthemum*) in several varieties, are plentiful; the acorn-shell barnacles, both Balanus Balanoides and B. porcatus, abound; while the walls of the cave, from the ground to a height of twelve or fifteen feet, are covered, though perhaps not so abundantly as in the second cavern, with hydroid zoophytes.

The second cavern, the entrance to which is but a few yards seaward from the first, like it penetrates the rock and emerges at the other side. Like it, too, it is always accessible at low water of ordinary tides. Larger than the first, it is divided in the centre by a vast pillar of rock, and the eastern of the two compartments thus formed is far the richer in animal life. Here occurs in abundance that beautiful little anemone, the snowy-disk (*Sagartia nivea*). In one small rock-pool three or four feet from the ground, and when the tide has receded presenting a surface of less than a square yard and not many inches in depth, I counted on one occasion about a hundred of these animals. As in the first case, the beadlet anemone is abundant, while the walls are covered with barnacles, and with zoophytes belonging chiefly to the genus Obelia, and in less abundance several other genera—Hydrallmania, Sertularia, Plumularia, Diphasia, &c. Sponges, except the crumb-of-bread sponge (*Halichondria panicea*), though abundant on other parts of the rock, are not common here.

The third cavern is more pretentious than either of the other two, but is accessible only at low water of spring tides, and easily so only at the equinoctial tides of March and September. This, like the others, penetrates the entire width of the rock, but it is not so easy to traverse. Towards the centre the passage is much constricted, and it is necessary, in order to pass through, to scramble up the rock, squeeze through a narrow opening, and then, having jumped down some eight or ten feet, to wade a deepish pool which remains even after the tide has receded. It is easier, instead of doing

this, to return, pass round the western extremity of the rock, and go into the cave again by its northern entrance. This is by far the richest of the three caverns. Here many species of zoophytes occur. Sponges, such as Grantia compressa, G. ciliata, G. botryoides, Halichondria panicea, and other species, abound; whilst of the Polyzoa, Bowerbankia imbricata, Cellularia circularia, Alcyonidium hirsutum, and other species, occur in great abundance. The hydroid zoophytes are not so conspicuous as in the other caverns, but careful search reveals a greater number of species. Adhering to the rocks like patches of coagulated jelly are numbers of compound ascidians,—Botryllus and other members of the family Botryllidæ; whilst the strawberry ascidian (*Amaroucium proliferum*) is found in great abundance. The Mermaid's fingers (*Alcyonium digitatum*) also occurs here somewhat plentifully, especially in the darker portion of the cavern, light appearing to be detrimental to the growth of this animal.

But the interest of this little rock is not confined to the interior of the caverns. All round, but especially on the northern side, where in many parts the overhanging rock forms shaded recesses, it offers rich spoils to the naturalist. Many parts are riddled by the rock-boring mollusc, Saxicava rugosa, known locally as "red-nose"; and a few specimens of Pholas may at times be found. Nudibranchs (*Eolis* and other genera), Brittle-stars (*Ophiocoma*, &c.), and the common star-fish (*Uraster rubens*), are frequent, the last often in enormous quantities. Of the larger algæ, Laminaria, Enteromorpha, Porphyra, Delesseria, Rhodomenia, Ulva, and the beautiful Bryopsis plumosa, may be cited; whilst a closer search on the rock and amongst the fronds of the larger algæ reveals many smaller and rarer species.

Nor are the attractions of Tenby, from a naturalist point of view, limited to St Catherine's rock. Tenby Head, Monkstone Point, and Lydstep are equally productive. St Margaret's Island, some three miles out from Tenby, has caverns more magnificent than St Catherine's or Lydstep, though less rich in animal life. The Woolhouse Rocks, at high-water submerged to the extent of fifteen or twenty feet, and accessible only at low tide by boat, also afford a rich field of study. Here the pretty little cat-limpet (*Patella pellucida*) is found in

PLATE XII.

ST CATHERINE'S ROCK, TENBY.

great quantity on the stems and fronds of Laminaria. At Scotsborough, now separated from it by a mile of cultivated land, the sea would seem to have ebbed and flowed less than two centuries ago, for, writing from this place under date of Feb. 28, 1697, Edward Lloyd, antiquary and naturalist, says that he had "discovered many undescribed zoophytes by dredging here, and many new sorts of figured fossils, amongst which a figure of a flat-fish represents one of the greatest curiosities hitherto observed by the curious."

The land flora is no less interesting than the marine. Within an easily accessible distance something like one-third of all the plants recorded in Great Britain may be found, 671 species being said to occur in the district. On the old town walls the pretty little purple toadflax (*Linaria Cymbalaria*) hangs down in graceful clusters; whilst between Tenby and Penally the bloody crane's-bill (*Geranium sanguineum*) is not uncommon. On the cliffs below the esplanade the red and the white Valerian (*Centranthus ruber* and *Valeriana officinalis*) grow in profusion; and in the marshy ground near Holloway Bridge may be found the motherwort (*Leonurus cardiaca*), the bog myrtle (*Myrica Gale*), the marsh cinquefoil (*Comarum palustre*), the bog asphodel (*Narthecium ossifragum*), and the water bedstraw (*Galium palustre*), as well as the meadow-sweet (*Spiræa Ulmaria*) and many other flowering-plants. Of ferns, the Osmunda is most conspicuous; whilst on old walls and rocks in the neighbourhood Ceterach officinarum, Asplenium Trichomanes, A. Ruta-muraria, A. Adiantum-nigrum, and A. marinum are far from uncommon.

Of the geology and palæontology of Tenby I have said nothing; nor can I do more than mention the bone caves of Hoyle's Mouth and Longbury bank, of Caldy Island and the Black Rock. These have been explored by Professor Rolleston, Professor Boyd Dawkins, Mr E. Laws, and the Rev. G. N. Smith, and have yielded large collections of human and animal remains,—bones of sheep, deer, roebuck, rhinoceros, and bear; flint and bronze implements and weapons; and human bones and teeth. Many of these are preserved in the admirable local museum on the Castle Hill.

[In illustration of the above, a large number of lantern

slides, from photographs by Dr Davies, were thrown on the screen. These included views of the town of Tenby and the surrounding district — Gumfreston, Scotsborough, Pembroke, and Lydstep,—besides several views of St Catherine's Rock and its caverns, as well as the Woolhouse Rocks, fishing-boats off Tenby, &c. In addition, the marine zoology of Tenby was represented by illustrations of its zoophytes, sponges, starfishes, and sea-anemones. Three of the views shown are here reproduced—viz., St Catherine's Rock; Second Cavern, St Catherine's; and the harbour of Tenby.]

VIII.—*NOTES ON THE FROG.*

By Mr A. MURRAY.

(*Read April 25, 1900.*)

In submitting my few notes on observations made in connection with the rearing of the common frog from the ovum, I cannot promise anything new, but only what must be known to many careful observers. Of course we know there are many observers who are not careful as regards the numerous small details that are peculiar to the habits of different animals. Some seem to think that in order to study the habits of an animal it is only necessary to confine it in some receptacle where it can be observed now and then as fancy prompts. Now I feel sure that is *not* the proper way to study the life-history or natural habits of any creature. Nature must be imitated as nearly as possible, and it is only as this is done that a true insight can be got into the life-history and habits of any animal.

Before saying anything about my own observations, I should like to read to you a short paragraph from a lesson on tadpoles in a certain schoolbook:—

"I went with a tin quart-pot in my hand toe-biter hunting on Clapham Common, and brought home exactly a quart of tadpoles; these I emptied

into a tub in the beer-cellar. There they lived, being fed on meat several days, till one evening, on sending for a glass of the all-refreshing fluid, up comes John with half a smile on his face, and simpers out: "If you please, sir, I have brought the beer, but I have upset the tadpoles."

On arriving at the scene of the disaster, there were the poor things high and dry on the floor. I restored them to their tub, but forgot to put back their meat. The next morning I found some that had not recovered from their accident, and round the bodies of their departed brethren were crowded the cannibal survivors, eating and pulling away each for himself. After this I left them much to themselves, and their numbers diminished considerably, the cook's opinion being as usual that that omnivorous creature "the cat" had a hand in it, bringing forward as an argument, which is not strictly zoological as applied to tadpoles, that the "cat is fond of fish."

Now I believe there are many who, upon hearing this read or reading it for themselves, would say that the writer was not a very advanced student in natural history, or at any rate not a careful observer. That was *my* first thought. I may add that it was one of my little girls who read the paragraph to me, not naming the author. Could it be imagined there was any attempt to imitate nature in emptying a "quart of tadpoles" into a tub in a beer-cellar, which is usually poorly lighted, if at all? The story about the servant upsetting the tub was all the more reason that he should have put them in a better place. I think we may conclude there was little or no light, hence no chance of vegetable growth for the tadpoles to feed upon. Was it any wonder they should have become cannibals, as it is said they did? But seeing his careful servant upset the tub once, he may have done it oftener, which would account for their loss. It need not cause wonder that wrong ideas are spread abroad after such a study of tadpoles as that. I can assure you it surprised me very much when I read the name of Frank Buckland at the end of that lesson.

Now for my own notes. About the middle of April 1897 I accompanied several members of the Society to Balerno Moss, where we came upon a small pool almost filled with frog-spawn. I made the remark that it would be a sight when the tadpoles were hatched, for there would scarcely be room for them to swim about. Some one replied that the tadpoles would soon cure that, as they would devour one another. I filled a tube with the ova, and took it with me,

resolved to prove to my own satisfaction, if possible, whether they ate each other or not. There were thirteen ova in the tube, and these I put in a large basin holding about four gallons of water. In the basin I placed a pot in which grew several aquatic plants. I also threw in some duckweed, which floated on the surface of the water, and set the basin in a greenhouse exposed to the light and sunshine. Here twelve of the ova hatched, and several times each day I carefully noted their movements, changes, &c. In a week they were hatched, although they did not leave the gelatinous mass that surrounded the ova until it was all consumed, which took about eight days. I considered they were hatched when the tadpoles straightened out. For four or five days or longer, although seemingly perfectly formed, they remained rolled up like a scroll. After leaving the thin, almost invisible, fibrous material that seemed to hold the spawn mass together, there was easily seen a very small branched opening on each side near the head, which nearly in every case disappeared in from two to four days. After they began to swim about, until the head—or to be exact, the body, as there is no distinct head—got round or tumid, they almost constantly kept in groups when feeding, which at the first was always upon the stalks of the plants. Very often there was a line of six or eight, almost touching one another, along the one side of a branch of Ranunculus aquatilis, where they would stick for hours at a time, as if pinned by the head to the plant. After the body got plump, however, they became more lively, and moved about more, seemed more independent of each other's company, and never fed long at a time without shifting their position. They now began to feed more upon the confervoid growth which covered the sides of the flower-pot and basin.

It was now, after they had been nearly four weeks swimming about, that I thought of trying them with some special food. I dropped into the basin one or two small caterpillars first, which they paid no attention to. Then I tried some small worms. They now evinced a little interest, but upon the worms making the slightest move they were off as fast as they could swim. All along they were very shy and timid, the slightest shake, or the passing of the hand over the basin, sending them

all hiding. I next got very small worms, which I cut in pieces about the size of a pin-head: these I let slip down the side of the basin. Soon after, one of the tadpoles happened to rest upon the place where the worms slid down, and got very excited. Then two or three more came along, and also got infected, keeping up the side of the basin to the surface of the water, as if in search of the worms. It gave me the impression that they smelt where the worm had passed. In a short time each tadpole got a small bit of worm, and lay and sucked at it for an hour, or an hour and a half, before it disappeared. A few of them attacked a second bit, but as a rule some pieces were still lying the next day, and the tadpoles quietly feeding on the algæ on the side of the basin, though they never failed to eat all the worm. After this I gave them one or two worms cut in small bits every alternate day. It seemed necessary that they should be thus cut: a whole worm killed and put in lay for a week untouched, when it began to develop fungus. I am sure that the whole twelve tadpoles in twelve days did not eat the bulk of one of themselves in worms. Of course they ate lots of vegetable substances, and I have no doubt other small organisms, yet they did not seem ravenous feeders, as one would expect of creatures that are accused of devouring each other.

The tadpoles now grew in size at a great rate, and were a source of much pleasure and interest to me. About the beginning of the last week in May I first noticed two small warty-looking growths appear upon one, and one upon another, and next day there were one or two more showing like protuberances, while the tadpole which had only one protuberance the day before had two now, and very much lengthened. I need scarcely say these were the hind limbs. One of them had its hind legs and feet perfectly formed, although not fully developed, in five weeks after it was hatched, but it was quite eight weeks before the last one was provided with these limbs. Some of them now began to show the fore limbs, and these were even more erratic in coming than the hind ones. Sometimes one limb would shoot out in a few hours, showing joints, toes, &c., but would remain undeveloped from eight to ten days: in fact, there seems to be no rule for the period these limbs require to develop, but from the time the first tadpole

showed the hind limbs until the last one had finished its fore ones was about seven weeks.

After the limbs were fairly formed the creatures seemed to stop feeding, the head began to flatten and the mouth to enlarge. They also began to change colour: from being of a uniform greyish black, some turned brown and yellow picked out with black, some entirely yellow with black markings, but scarcely two of them exactly the same colour. At this time the tails also began to vanish. Some of them did so in about twenty-four hours, while others took over a week: in fact, one of the frogs left the water with a small stump of a tail. In from twelve to fifteen weeks after they were hatched they had all left the water, and were hopping about the greenhouse, and would readily swallow a small worm about an inch long, although during all the time of their tadpole state I never saw any attempt to attack, or in any way interfere with, each other. On the contrary, they seemed a happy and contented family.

I did not yet consider it certain that they would not harm each other, so next year I got sixteen ova, and reared them in much the same way as before, except that I only fed them once each week with worms, and each time only the same proportion that I had given the first ones every alternate day. Yet, with one exception, they all came to perfect frogs in about fifteen weeks, as large and as lively as the first ones, and never showed the least attempt at cannibalism. Last year I again reared some more, this time over thirty, and during their lifetime as tadpoles they got no special feeding of worms or anything else. Of course there was plenty of vegetable growth. It was a much larger dish than before that was used, and it stood in the open air all the time. These also reached the perfect frog state without any of them being devoured, although receiving no special animal food except what the water naturally contained in the shape of animalculæ, &c., and they arrived at maturity in much the same way and time as the others did. This year, if I can manage it, I intend to tempt them in a slight degree to cannibalism by restricting their vegetable diet.

Now, after these three years' experiments and observations, I am perfectly satisfied that tadpoles in their natural state

do *not* devour each other. Yet I know for certain that any one going to a pool on Monday may find it swarming with tadpoles, while on Saturday very few, if any, will be present. Why? because some wild ducks took a fancy to them. Newts, also, eat a great many. I have seen a black newt swallow three fully grown, with the limbs showing, almost as quickly as one could say he had done so.

I have one of my first year's frogs yet. I had three last year, but two of them got away last autumn. They were all quite tame, and not at all shy. It is very amusing to see them feeding, if there are two for the same worm. Drop a worm before them — it can scarcely be too large. One would think they would at once pick it up, but no: they will sit and steadily watch the worm for a while, then have a look at each other, and so on for some time, alternately looking at the worm and at each other. One day two of them caught the same worm, which happened to be a large one. It was a sight to witness that tug of war! The worm parted, and they both rolled off the shelf they were on. Another day I dropped a worm between two of them: after contemplating that worm for some time, one of them swallowed it. The other jumped at and bit its companion two or three times on the side of the head. I then put down another worm for the unsuccessful frog, but he studied it so long that No. 1 took it also. No. 2 looked up, seemingly astonished and enraged, for he gave a croak, jumped upon the back of No. 1, and dug his forefeet so hard into the other's sides that he squealed loud and long. They struggled with each other, rolling over and over, for two or three minutes, after which they separated, and No. 2 got his worm in peace.

For the benefit of any who may not have studied frog life, I may say a few words about how frogs pass the winter. In a natural state they usually bury themselves in the loose mud and decaying vegetable matter round the weedy sides of lochs, ditches, and small streams. I have many a time turned up numbers of them while removing the accumulation of leaves, &c., from the bottom of some of these streams. I have also seen many turned up by the sides of lochs which had got stirred up while drawing ice ashore for filling ice-houses. I believe frogs will sometimes pass the winter in damp holes

among accumulations of moss, leaves, &c., if sufficiently deep to be beyond the effect of frost. In confinement some of them have buried themselves under moss in a corner, or even under the half of a broken flower-pot, but usually in the bottom of the water-tank. One thing they often do in the summer season is rather interesting. I have several common tumblers and other glass vessels in which I keep various aquatics and other things for microscopic purposes. Mr Frog will get over the edge of one of these glasses, quietly drop himself to the bottom, and lie there for some days at a time. On coming out he generally carries proof of his visit by his back being covered with duckweed, or whatever the glass may have contained.

One of my frogs this year deposited a quantity of spawn, but not having a male in the frame, of course it came to nothing. I shall endeavour to get a male, so as to note the time the ova are in hatching, after they are deposited. I have not been able to add anything to my information about tadpoles. I got some, but unfortunately put two sticklebacks into the same tank, and in three days the tadpoles were all killed by these little fish eating off the tails of their black companions.

One of our members reared a few tadpoles this summer, and from some cause or other he has had several deaths when nearing the perfect stage. He tells me that if he leaves a dead one in the dish the others immediately begin to eat it. This seems very strange, as, with me, when nearing the perfect state, they seemed to stop feeding, while after they were matured they fed ravenously, swallowing worms nearly as large as themselves. Can any other members of the Society give their experiences of frog-hatching?

At this meeting Mr W. C. Crawford, President, read a paper entitled "The Excursions of a Field-Naturalist, with some Meditations thereon."

NOTES ON THE EXCURSIONS OF 1900.

By Mr WM. WILLIAMSON, Secretary.

I.—WEMYSS CASTLE.

The first excursion for the season was held on 28th April, when the members proceeded to Wemyss, principally with the object of seeing the caves which stud the coast-line, and which have attracted the attention of archæologists by reason of the sculpturings to be found on the walls.

On arrival at Wemyss, the party first visited the ruins of Kennoway Castle—or the Thanes' Castle—which dates from 1057. Many of the stones in the walls are now well honeycombed as a result of the severe weathering action to which they are exposed. Entering from the shore, and right beneath the Thanes' Castle, is Jonathan's Cave. This place is about 70 feet long and 20 feet wide. Farther east is the Doocot Cave, which is much larger; while beyond this are the Court and the Glass Caves. As stated before, prominence has been given to these caves on account of the rude sculpturings of animals, &c., found on the walls. Tradition has it that some of the missionaries among the early inhabitants of that part resorted to these caves, and it has been suggested that they were the artists, from the resemblance of the sculptures to those found on monuments of the period.

Afterwards, by permission, a visit was paid to the grounds of Wemyss Castle, where for some time stood a battery of 19 guns, believed to have been carried on the Great Michael in the beginning of the sixteenth century. These guns—4 single-barrelled, 11 double-barrelled, and 4 multi-barrelled—were made of iron plate rolled into tubes, the breeches being closed by iron plugs forced in and the ends of the tube turned over by hammering. At the time of our visit these guns were under cover and locked up for preservation, and we were unable to see them.

Before leaving East Wemyss a visit was paid to the fine old cruciform parish church, the architectural features being pointed out by the Rev. J. Kennedy, minister of the parish.

II.—CRAIGMILLAR.

The evening of Wednesday, May 2nd, was devoted to the old Castle of Craigmillar. In the unavoidable absence of Mr Speedy, the party were taken over the Castle by Miss Priestley, who pointed out the various features of interest.

From the top of the Castle Mr J. A. Johnston gave an interesting account of the geology of the district, which was listened to with much attention.

III.—TEMPLE AND ARNISTON.

On 12th May the members of the Society renewed their acquaintance with this neighbourhood, which had not been visited for a number of years. Mr Arch. Hewat, F.F.A., and the Rev. Mr Blake, minister of the parish of Temple, were to have conducted the party; but as Mr Blake was not able to be present, the Rev. Mr Wilson, of Stobhill, placed himself at the disposal of Mr Hewat and the members for the afternoon. Entering the Arniston policies at Gorebridge, the party followed the course of the South Esk till they came to Arniston House. Near this is Temple glen, through which the members walked till they came to Temple. The principal object of interest here is the ruins of the old church. Great interest attaches to this place, as it is believed to be all that remains of the chapel of an establishment founded by David I. of Scotland—the "sair sanct"—for the use of the Knights Templars, or Red Friars as they were also called. One of the stones in the belfry has some leaden letters sunk into it, but what they signify is not at all clear. Before setting out on the return journey, through the courtesy of the Rev. Mr and Mrs Blake, the party, to the number of thirty-four, were hospitably entertained at the manse. The return journey was made partly through the Arniston policies and partly by the road. Before leaving the policies, Mr Hewat pointed out what used to be the high road from Edinburgh to the South. Those members who visited Torwoodlee on July 7 saw another

portion of the same road—viz., that which led from Galashiels northwards.

Although the limestone, freestone, and coal formations call for the attention of the geologist, it is to the botanist that the district appeals most strongly, by reason of the abundant floral treasures which are to be found. Some trees of considerable girth were observed, and a note of the measurements—about 4 to 5 feet from the ground—were made. These were: Spanish chestnut, 15 ft. 6 in.; ash, 14 ft. 9½ in.; beech, 14 ft. 9 in.; and a cedar and larch each 12 ft. 5 in.

IV.—CAROLINE PARK.

Through the courtesy of Messrs A. B. Fleming & Co., we paid a visit to the old mansion-house of Caroline Park and Royston Castle on Wednesday, 16th May. Caroline Park is an old-fashioned grey-stone building, with a central quadrangle. It adjoins the ruins of Royston Castle. The mansion-house was built in 1685 by Viscount Tarbat when he was Prime Minister of Scotland. The present name was given to it by a Duke of Argyll, whose Duchess had been Maid of Honour to Queen Caroline when she was Princess of Wales.

Some little time was spent in the gardens examining a collection of herbaceous plants.

V.—BASS ROCK.

Many of the members looked forward to this excursion on Saturday, May 26. The day was all that could be desired, but on arriving at Canty Bay it was found that, owing to a heavy swell, it would be impossible to land visitors on the rock. Most of the members returned to town by an early train.

VI.—DUDDINGSTON LOCH.

On the evening of Wednesday, May 30, a party met at Duddingston Loch, under the leadership of Mr Terras, for the

purpose of observing the aquatic plants which grow here. Through the courtesy of Mr Affleck, the overseer on the estate, the party also visited the Prestonfield grounds, and returned by Newington.

On 18th July we again visited the loch. Our best find was the Butomus umbellatus, or flowering rush, in full bloom. This plant appears to have been overlooked for some years, and was latterly considered to be extinct here.

VII.—MILLPORT.

Saturday, June 2, was devoted to visiting the Marine Biological Station near Keppel Pier. The day was as fine as could be desired, and those botanically inclined had plenty of opportunity to indulge themselves on the way out to the station. The principal attraction was a dredging excursion, but this proved a failure. Owing to a strong current running contrary to the direction of a light wind, the dredge could not take the bottom sufficiently for a good haul, and only two sea-urchins were brought up. The rest of the time was spent in inspecting the museum and laboratories, which latter are being much improved by the addition of concrete sea-water tanks, so that it will now be possible to keep material for any length of time. A steamer is to be added to the equipment of the station, and with these increased facilities some good work will no doubt be done.

VIII.—HOWIETOUN FISH-HATCHERY.

A joint excursion was fixed with the Natural History Society of Glasgow to visit the Howietoun Fish-Hatchery on Saturday, June 9. Owing to the interest attaching to the place, it was expected that there would be a good attendance of members, but the inclemency of the weather prevented this. Several members proceeded by the morning train to Stirling, with the intention of visiting Bannockburn and the other historical places in the neighbourhood, under the guidance of Dr Watson. On arriving at Stirling it was found useless to

attempt to visit the district, as rain was falling heavily, and this continued till about 4 P.M. When those members who travelled by the afternoon train reached Stirling, they were met by the morning party, and an informal meeting was held to determine what should be done. Some resolved to return home by the first train, and others to proceed to Howietoun, despite the inclemency of the weather. A 'bus was ultimately hired, and the party set out for the Hatchery. A separate account of the visit then paid, and of the interesting processes witnessed and described, has been drawn up, and will be found farther on (see p. 114). Despite the dismal weather and the damp grass, our visit was most thoroughly enjoyed, and a cordial vote of thanks was given to Mr Thomson, the manager, for the trouble he had taken and for the amount of interesting information he had imparted to the members.

IX.—LOWER ELF LOCH.

On the evening of Wednesday, June 13, a small party visited the loch in the Mortonhall grounds, through the courtesy of Mr Mackenzie, factor on the estate. The resources of this loch—the "Elf Loch" proper—have repeatedly been brought under the notice of the members of the Society, in connection with the labours of our members, Mr Thos. Scott, F.L.S., and Mr J. Lindsay, on the "Upper Elf Loch," as they have named the neighbouring sheet of water. On the occasion of this visit a number of interesting specimens were collected.

X.—LIBERTON NURSERIES.

A large party met at Newington station at 3 P.M. on Saturday, June 16. Before proceeding to Bridgend, a visit was paid to the grounds of the Royal Blind Asylum. Mr Murray opened one of his frame hives to allow of a close inspection of the bees at work, and at the same time showed

how the comb was built up on a wax foundation set into the frames. As a proof of his skill in handling the hives, not a single person was stung, despite the large numbers of bees flying about. After a very cordial vote of thanks to Mr Murray for his interesting demonstration, the party set out for Bridgend. On arriving there, Mr Massie, of Messrs Dicksons & Co., assisted by two of his foremen, conducted the party round the extensive grounds. Some of the plants in the houses, particularly a fine show of calceolarias, were much admired, as well as the fine collection of conifers in the grounds. Much interest was manifested in the immense number of seedlings destined to become trees, and in the means resorted to in order to prevent the destruction of the young shoots by birds. Before leaving, each lady received a bouquet of flowers, and Mr Massie was heartily thanked for his courtesy.

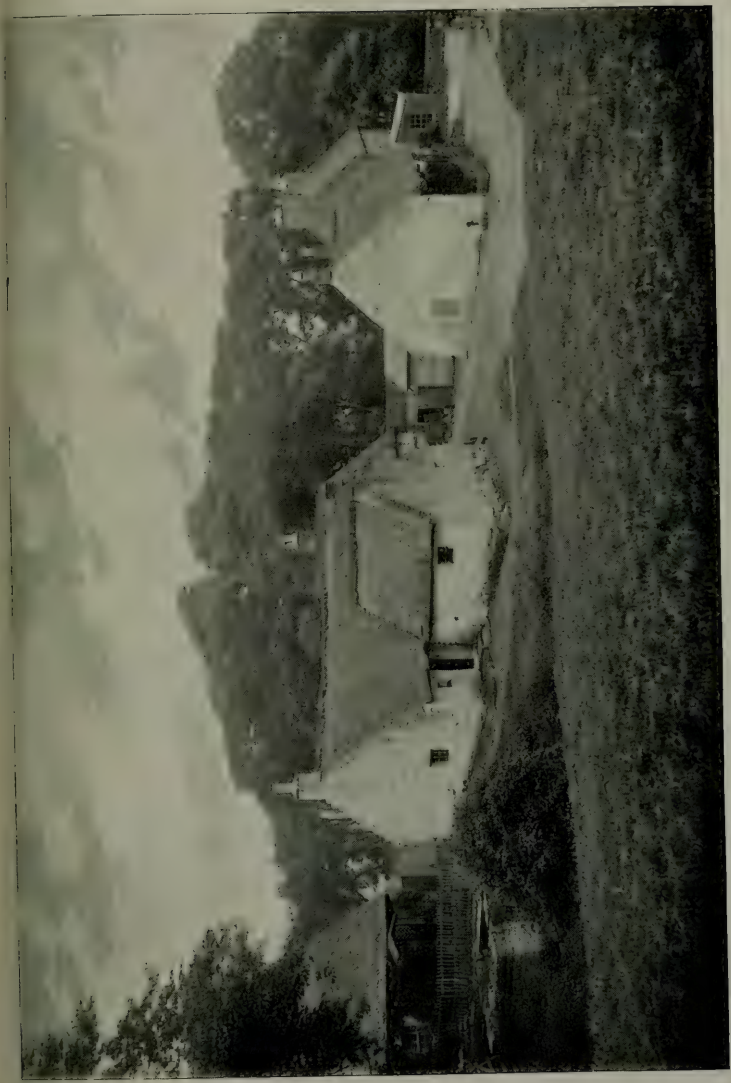
XI.—THE PENTLANDS.

A fairly large party met on June 23 to walk from Colinton by Glencorse Reservoir and House o' Muir to Penicuik. Owing to the restrictions on Bonally Hill, botanising was impossible; and on reaching Glencorse, as most of the members evinced a desire to return by an early train to town, the journey to Penicuik was postponed.

XII.—SWANSTON.

On the evening of June 27 we walked from Morningside to the foot of the Pentlands through the Swanston estate, passing the house where R. L. Stevenson resided, and returned to town through Swanston village and Lothianburn golf-course, and by the Braid Road. The village of Swanston is very quaint, especially the older part, and owes much of its fame to the writings of Robert Louis Stevenson, whose "roaring shepherd" was a well-known character in the little community. A view of the village, from a photograph taken on this occasion by Dr Davies, is here given.

PLATE XIII.



SWANSTON VILLAGE, FROM THE SOUTH.

XIII.—BEN LOMOND.

It was intended to have had a joint excursion on June 30 to Ben Lomond with the Glasgow Natural History and Geological Societies, for the purpose of studying the geological features of the district and the alpine flora. Owing to a considerable alteration in the time of the departure of the trains, it was found that our members could not join the Glasgow party, unless by going to Glasgow or Rowardennan the previous day and staying over-night. It was therefore decided to abandon the excursion, and this proved wise, as it was afterwards learnt that the weather had been very unfavourable in the West.

XIV.—THE TWEED DISTRICT.

On July 7, under the leadership of Dr Stevenson Macadam, a visit was paid to the Broch of Torwoodlee, when a most interesting account of that ancient structure was given by the leader. This account has been kindly written out by Dr Stevenson Macadam, and will be found as a separate paper farther on (see p. 117). The extensive vineries at Clovenfords were also visited, by permission of Messrs Thomson. The company were hospitably entertained by Mr and Mrs Gibson of Torwoodlee Mains.

XV.—STONEYHILL.

The evening of Wednesday, July 11, was set apart for a visit to the Marl Pit at Davidson's Mains, but owing to a change of circumstances it was decided that the evening should be spent in botanising the banks of the Esk at Musselburgh. On the way back the party visited the gardens and grounds of the ancient residence of Stoneyhill, through the courtesy of General Govan and Mr Howden of Stoneyhill. The garden is one of the oldest in Scotland, fruit having been grown in it for more than three hundred years. The great buttressed walls surrounding the garden bear witness to its age. The evidences of what was at one time a high-road are still seen across the

garden and in an old plan which was exhibited to the party. The present house was originally the offices of an older mansion-house, the residence of Sir Wm. Sharpe, a son of the famous Archbishop, who was on his way back from a visit to this place when he was murdered on Magus Moor. Later it was the abode of the notorious Colonel Charteris, who is depicted in Hogarth's picture of the Rake's Progress, and who is so often referred to by Pope. Not far from Stoneyhill is the Bogle's Hole, where the witches used to be burned.

XVI.—NORTH QUEENSFERRY AND CHARLESTON.

It had been arranged for July 21 that we should walk from North Queensferry to Charleston, to look especially for galls, under the leadership of the Rev. A. S. Wilson, who is well versed in the subject. The day was exceptionally wet, and in the circumstances an excursion was out of the question.

XVII.—ROCKVILLE, MURRAYFIELD.

The evening of Wednesday, July 25, was most enjoyably spent in the grounds at Rockville. A large party was received by Mr and Mrs Fraser, and entertained to tea. Thereafter, under Mr Fraser's guidance, the party made a tour of the grounds, examining the well-known collection of ferns grown in the open air, as well as the tropical and other forms in the houses.

XVIII.—ROSLIN TO POLTON.

Our first cryptogamic excursion for the season was held on October 6, on the afternoon of which day a visit was paid to the familiar Roslin woods, the walk being continued by the side of the North Esk to Polton. A number of interesting

fungi, as well as hepaticæ, were picked up by the way, but all attempts at thorough collecting had to be given up, on account of the heavy rain, which began when Roslin was reached, and continued till well on in the evening.

XIX.—ARNISTON GROUNDS.

Our second cryptogamic excursion was held on 13th October to Arniston grounds, under the leadership of Mr Steele. The weather was again unfavourable, and we had a small attendance consequently. A number of specimens were obtained, among them being Helvella crispa, Leotia lubrica, Tremella sarcoides, Stereum purpureum, and Polyporus varius.

[It has always been the desire of the Council to make the summer excursions as attractive and interesting as possible; and, in order to further this desire, a small Committee has now been appointed to fix upon suitable localities, especially such as have not hitherto been visited by the Society. It would aid this Committee much if members would, at any time, send in to the President or to the Secretary a note of places they consider worth a visit, with particulars as to nearest railway station, distance to be walked, and objects of interest to be seen. Such information would greatly facilitate the drawing up of the annual lists of excursions.]

FISH-HATCHING AT HOWIETOUN.

By Mr WM. WILLIAMSON, Secretary.

As recorded in the "Notes on the Excursions of 1900," a visit was paid to the Howietoun Fish-Hatchery on June 9. On arriving at the hatching-ponds, the members were met by Mr John Thomson, the manager, who gave an account of the work which has to be done at the ponds and at the hatching-houses, which were afterwards visited. Mr Thomson has been associated with the place since the time when the first experiments were undertaken to hatch out trout eggs in 1874. These were begun by Sir J. R. Gibson Maitland, with some assistance from Mr Francis Day, C.I.E., as a result of certain remarks made by the late Frank Buckland. A very interesting account of successes and failures of these early experiments is given by Sir J. Maitland in his large book on Howietoun. One great result is that the proportion of ova which do not develop into fish by artificial hatching is exceedingly small: under the ordinary conditions of nature the reverse is the case. The general time of spawning is from October to January. This may be advanced or retarded by treatment of the fish early in the season. By means of a net which is shaped to the pond, all the fish can be collected at one point. The ripe females are then stripped of the ova, which are collected in large plates. Suitable males are then stripped of the milt, which is expressed over the ova, and these, when they have been thus fertilised, are prepared for the hatching-house. Prior to this the hatching-boxes have been charred by means of hot irons, and all distributing boxes and pipes thoroughly cleaned, as it appears essential that no workmen should be employed about the houses during the time of hatching. The eggs are conveyed to the hatching-houses and poured by measures over grilles in the hatching-boxes. These grilles are trays made of a large number of short lengths of glass tubes or rods, lying side by side and held in position by a light wooden frame. The eggs are then arranged in rows between the glass tubes by means of a feather, and from now onwards a daily record is kept of the eggs in each hatching-

box. From statistics of temperature of the water, it is possible to predict with accuracy the date at which any particular batch will hatch out.

In fish culture there are five distinct stages. The first, or mulberry stage, occurs about the close of segmentation. The round disc rises in all ova during the first twenty-four hours, but during the period of segmentation the disc in properly fertilised eggs becomes hard, and in unimpregnated eggs annular. At the close of the period of segmentation the disc in properly fertilised eggs enlarges, and has a soft appearance, so that it is easy to detect and remove all ova likely to develop imperfectly. Absolutely unimpregnated eggs show a well-defined annular ring when a third of the period of incubation is over, and they can then easily be removed. Imperfectly impregnated ova call for some care, as they do not show the well-marked embryotic layers.

The second stage is known as the spectacle stage, and is occasioned by the appearance of a loop of globules anterior to the embryotic line. This loop gradually enlarges and passes backwards over more than half the sphere, giving the egg at one time the appearance of a pair of spectacles minus one eye. The left side of the eye of the spectacle stops in the position shortly to be occupied by the principal duct of the yolk-sac circulation, and the right side gradually disappears. From the time of the appearance of this spectacle marking and the rate of its development, the vitality of the embryo can be estimated.

The third stage is the eye stage, and at this time the tail is free. The addition of warmth causes a slight movement of the tail, and it is important that ova are not packed for export until this movement can be discerned.

The fourth stage is marked by the appearance of red blood, and one-half of the period of incubation is passed. The ova can now stand any fair usage, and can be packed for export and endure a long journey.

The fifth stage—the completion of the embryonic circle—immediately precedes hatching. The tail curls round generally to the right, and passes the nose. The body of the embryo has now become dark, and the yoke globules have mostly collected immediately below the stomach.

When the eggs are ready to hatch, they are washed off the grilles on to the bottom of the hatching-box, and the grilles are then removed. Shortly after hatching, the young fish, or *alevins* as they may now be termed, congregate together against the sides and in the corners of the hatching-boxes. A close inspection discloses the fact that they are all lying with their heads together, and that the pectoral fins are moving very rapidly. Water currents are thus created, which convey fresh oxygen supplies to the closely crowded fish, and so their destruction from suffocation is prevented. This grouping of the alevins has very aptly been described by Sir J. R. Gibson Maitland as "a gigantic co-operative breathing association." After the fry have herded together for a few weeks, they are seized with a roaming and inquisitive spirit. Very little attention beyond regulating the flow of water is required for the alevins. The boxes do not need much cleaning, as the fish in their incessant motion scour the bottom and keep it clean.

As the young fish grow, the provision made by nature for their sustenance decreases, till a stage is reached when artificial feeding is absolutely necessary. The food in use is a paste made of eggs and a sort of mince, made from beef which has been pounded in a mortar and passed through a sieve. When feeding is about to take place, the paste is made into a fine vermicelli by being forced through a spoon formed of fine perforated zinc, and these fine paste-threads are then dropped into the hatching-boxes and greedily seized by the fry. After a fortnight's feeding on this prepared food, raw sheep's liver, finely sieved, is added. Then horse flesh, very finely reduced, is substituted; and when the fry have become accustomed to this, they are transplanted to the ponds.

After the fish are turned out into the ponds, they have to be taught to collect together for feeding. An attendant with a feeding spoon scatters a small quantity of prepared food over the deeper parts of the pond. As a little time elapses before it can reach the bottom, a scrimmage ensues among the fish in the immediate neighbourhood for the food. The commotion attracts others, and by repeating the dealing out of the food in small quantities, the fish are all

attracted to these places. After a pond has been fed in this way for about a fortnight the fish collect very quickly, and can be fed in a few minutes.

The varieties of trout which are reared are the Salmo levenensis or Loch Leven trout, S. fario or common trout, S. fontinalis, and S. irideus or rainbow trout. Of these last a number were netted and taken out of one of the ponds for our inspection, but at the time of our visit the characteristic iridescence had not developed itself.

That the hatchery is not a mere experimental station but a commercial enterprise is evidenced by the large number of ova packing-cases and fish travelling-tanks and railway vans built specially for the live-fish traffic. That the enterprise is successful is evidenced by the demand being greatly in excess of the supply, necessitating the construction of new ponds capable of rearing 50,000 more yearlings. Ova are sent to all parts of the world, packed in trays with perforated zinc bottoms. To supply the oxygen necessary to the life of the ova, they are packed between layers of fresh sphagnum moss. Fry and older fish are conveyed in specially constructed tanks of galvanised iron. Considerable attention has to be given to the aëration and temperature of the water; and before despatching, the fish have to undergo a course of treatment to fit them for the journey.

THE BROCH OF TORWOODLEE.

By Dr STEVENSON MACADAM.

The doings of our ancestors or predecessors in prehistoric times are chronicled, not in writings or even in folk-lore, but in the remains of their places of abode and the fragments of their contents. The earliest places of shelter appear to have been cave dwellings, where the natural cavities in the rocks were taken advantage of, and such were gradually developed into earth dwellings, which were scooped out of the ground and often mounded over, forming chambered cairns or eirde

houses, ultimately with underground galleries, stone lined and earth covered. These were succeeded by massive, circular stone towers of great strength, now known as brochs, and those were followed by the castle or peel towers, so numerously observed all over the Tweed district, and which were not only strong places of defence, but also served as signalling towers.

For the purposes of this excursion, we confine ourselves to the brochs, for much of the information concerning which we are indebted to papers in the 'Proceedings of the Society of Antiquaries of Scotland,' and especially those by Drs Anderson, Fergusson, and Christison, and Mr James Curle. The measurements of a large number of these brochs showed that the external diameter of these massive round towers ranged from 34 to 90 feet, the internal court from 25 to 50 feet, the thickness of the walls from 9 to 19 feet, and the probable height from 30 to 50 feet. Hundreds of these brochs, more or less in ruins, have been found in the north of Scotland, including the Shetland and Orkney islands, but only three have as yet been found south of the Tweed—(1) at Edens Hall, Cockburnspath, in Berwickshire; (2) at Bowshank, on the Gala, about two miles north of this Torwoodlee site; and (3) on the ground we are now standing upon. The property is that of Torwoodlee, or Towerwoodlee, belonging to Captain Pringle, R.N., and tenanted by Mr Thomas Gibson, to the latter of whom we have been indebted for liberty to inspect, and facilities and assistance in exhibiting, the details of the broch.

Besides being the site of a broch, the spot is further interesting as being the northern end of the Catrail or Picts work ditch, which can be traced down the hill to the southwards, across the Tweed, on the south side of which the Catrail can still be clearly observable at numerous places by Peatlaw, and onwards as far as Peel Fell in Northumberland. At Torwoodlee the Catrail and broch merge practically into each other, and the site is surrounded by a number of ditches or entrenchments, known locally as the "Rings of Torwoodlee." It was not till 1891 that the Gala Ramblers' Club visited Torwoodlee and made all the necessary arrangements for the excavation of the remains of the broch. They were induced to do so because three years previously they had discovered another broch at Bowshank, only some two miles away.

The excavations at Torwoodlee gradually revealed the remains of a large broch, almost circular in form, with a total diameter of 75 feet, and with an interior court of 40 feet diameter. The remaining part of the wall, which was laid bare, and which we now see, was 3 feet in height, and in greater part 17½ feet in width or thickness, though at the south-west corner it was 19 feet. The entrance was at the east side, with a general width of 3 feet 9 inches right through the 17½ feet thick wall; but near the middle of this entrance passage there was a rebate on both sides to admit of a heavy door being opened and swung back. Within this door, and on the south side of the main passage, there was another narrow passage, which led into the guard chamber, still well outlined, and which was apparently 6½ feet in width and of some considerable length. Entering the interior court, there was observable at the south-west side a third passage, leading to a chamber formed within the 19 feet wall at this part, and which is still in good preservation, being well built, and measuring about 14 feet in length, with a flight of steps at the farther end, apparently leading to upper chambers in the wall. These beehived apartments or honeycombed recesses in the thick walls were apparently used as retiring chambers, and have been observed in many other brochs.

The building construction of the Torwoodlee broch was in all respects good—large placed stones formed the outside ring of the wall, and smaller stones the inner ring, with loose rubble between. The masonry at the entrance to the chambers was very creditable to the builders. Indeed it is said that three generations ago the broch was used as a quarry, some 2000 cartloads of stones being removed from the site of the broch and its entrenchments and used for building neighbouring dykes and outbuildings.

On carefully examining the inner court or central area, it was found covered with a thin layer—1 to 2 inches—of ashes, which were carefully sifted, and yielded principally fragments of pottery, of a kind better than the broch pottery of the North, being manufactured on the wheel and fired by the potters' kiln, and were mainly Roman in origin. There were fragments of bowls and other vessels, of bright-red glazed Samian ware; other fragments of red but not glazed, known as false Samian ware; pieces of jars of hard blueish-black ware, known

as Roman-British fragments of culinary vessels; and amphoræ, used for oil and water; whilst only two fragments of coarsely made native pottery were found. As the broch was situated within convenient distance of two Roman stations—Inveresk and Newstead—there need be no mystery as to where the Roman remains came from, either through pillage or barter. Besides, fragments of glass vessels of various colours were found, such as are always obtained at Roman sites. One small coin of the Emperor Vespasian (69 to 79 A.D.) was sifted out, as also some Celtic remains of a glass armlet and a bronze harness ring and button, some bits of rusty iron, a few shaped stones, and the bones of swine and oxen were also found.

To sum up, the main relics indicated the possession, by the dwellers in the broch, of vessels, &c., having some connection with Roman civilisation, and to a lesser degree to native manufacture. Probably, however, some of the latter, being less well made and fired, may have crumbled away by age.

The question now remains, Who constructed those brochs, and this broch in particular? Who occupied and were sheltered by them? On the construction of brochs generally two opposite opinions have been decidedly expressed—one, that they were built as refuges for defence by the native Celtic population—the Picts or Celts—who were known to be stone-builders and stone-workers; and the other, that they were constructed by the Norwegians or Vikings—the Norse robber kings—for aggressive purposes. The latter view is scarcely tenable, because the Norse invaders were accustomed in their own country to wood building, and not to stone building. The only support to the Viking view is the fact that the greater number of the brochs are found in the more northern parts on the sea-shore, or within easy access to the sea; but even this view has two sides, for every position which gave facilities for the sea invaders to land and occupy for pillage in the locality was necessarily also one which called for the native Celtæ to erect the broch shelters for the defence of their territory and belongings. In the broch of Torwoodlee, which is similar in construction to all the other brochs either on shore or somewhat inland, we have an undoubted broch built away from the sea and the incursions

of the Norse robber kings, and clearly connected with the northern end of the Picts' or Celts' ditch—a defensive pathway, stretching for many a mile southwards into England.

The Roman remains of pottery and glass found in the broch may raise the question of the Romans themselves forming an entrenchment on the spot; but it is much more likely that the Roman ware and other articles were acquired from one of the near Roman stations, either by exchange or otherwise. The Vespasian coin, 69 to 79 A.D., does not prove anything either as to date or occupation, because such would be available for purchase or barter for long after its true date.

The construction of brochs in general has been ascribed to a period ranging from 500 to 1000 A.D., but the Torwoodlee broch would point to an earlier date. The Romans under Agricola invaded Scotland in 80 A.D., followed by Hadrian in 135 A.D., whilst the Roman legions were withdrawn in 410 A.D. It is reasonable to suppose that the broch was then occupied. The Roman ware points to a date not later than the fifth century. Of course it is possible that the Romans may have occupied the site at an earlier period, and that the broch was constructed by the Celtæ afterwards. The main evidence from the remains, however, including their resting-place in the inner court, would point to the broch being constructed and occupied by the native population—Picts or Celts—at a time contemporaneous with the presence of the Romans in their neighbouring stronghold at Newstead.

It may be said that in attributing the building of the well-constructed stonework to the handicraft of the native Celtæ, we are ascribing to them rather more skill and enterprise than they are entitled to be credited with. But we must remember that, even before the Roman invasion, the Picts or Celts in Scotland were good artificers, especially in metals. The remains of their bronze and other metallic work exhibited in our National Museum prove conclusively the intelligent skill of the natives even before the Christian era, and would lead us to consider that in other branches of handiwork, as in stone construction, they would not be behind. The brochs were apparently stone towers for shelter—defensive, and not offensive—and the Picts or Celtæ were intelligent enough to construct them, and were the only parties likely to use them.

REPORT OF THE MICROSCOPICAL SECTION.

By Mr JAMES RUSSELL, Convener.

The Crustacea formed the subject of study of the section during this session, and the type chosen was the Crayfish (*Astacus fluviatilis*). The text-books referred to were Huxley's 'The Crayfish' and Huxley's 'Practical Biology,' by Howes and Scott. The course followed was to study the general characters and different organs in detail, and for this purpose a supply of crayfish was kindly obtained for the section by Dr Davies.

The Crustacea form a large and important class of animals, ranked under the sub-kingdom *Articulata*, better called *Annulosa* (ringed animals). The crayfish, the type studied, consists of twenty rings or somites, to each of which appendages are attached. The somites are divided into three sections—the head, the thorax, and the abdomen. The head and thorax are joined together in one solid mass, termed the cephalo-thorax, covered by a strong hard shield called the carapace; the abdomen is jointed or hinged to the thorax, and each of its somites is hinged to the one immediately in front, so that the whole of the abdomen can be bent inwards upon itself. The back of the crayfish is termed the tergum, and the under side the sternum, and the part which unites the two the pleuron, or, in the plural, pleura; while the whole of the outer covering is called the exoskeleton.

Of the somites, into which the exoskeleton is divided, six belong to the region of the head, eight to the region of the thorax, and six to the abdominal regions. The first somite of the head carries the eyestalks, on the ends of which are situate the compound eyes; the second somite bears the antennules, or lesser antennæ, on the upper side of the basal joint of which are situate the auditory organs, the opening to which is protected by a tuft of delicate setæ. These antennules have each two branches, which bear fine setæ; but on the outer branch there are, in addition to these setæ, several bundles of curious appendages, which are thought by some to have olfactory functions. The third somite bears the greater

antennæ, or feelers, which act as organs of touch. The next somite in order bears a pair of mandibles, or jaws, which are actuated by a pair of very powerful muscles. These are the principal external organs for crushing the food of the crayfish. The fifth and sixth somites bear each a pair of maxillæ, or lesser jaws.

The next somites in order are situate in the region of the thorax, and of these the seventh, eighth, and ninth bear each a pair of maxillipedes, or foot jaws, so called from being organs of mastication and at the same time having a general resemblance to legs. They are called the first, second, and third maxillipedes, of which the last is strongly toothed along the inner edge. The tenth somite bears the great forceps, or chelæ, the principal prehensile organs of the crayfish. The chelate part of these organs, or hand as it is sometimes termed, is moved by very powerful muscles called the adductor and abductor muscles, the former of which especially is attached to a very powerful tendon, thus enabling the animal to seize and hold its prey very securely. The next four somites bear each a pair of ambulatory or walking legs, and of these the first two pairs are chelate, and thus help in tearing the food; the other two pairs end in simple claws.

With the fifteenth somite begins the first of the abdominal ones, of which there are six. To each of these, except the last, are attached a pair of small appendages called swimmerets. The last somite has two large broad plates attached, one on each side of the animal, with a third plate between called the telson, and these three plates constitute the flapper of the crayfish, by aid of which it is enabled to move very rapidly backwards. By some naturalists the telson, with the plate on each side, is held to constitute an additional somite, and those who so hold reckon the number of somites as twenty-one.

The exoskeleton, or outer covering of the crayfish, is a calcified hard substance, except at the joints, where it is soft and flexible. If a bit of the calcified part is put into a weak solution of chromic acid for a week or ten days, it becomes soft, and thus thin sections of it can be made for examination under the microscope. Under a high power, say of one-eighth or one-tenth of an inch, cross sections exhibit a beautiful

striation. Three distinct layers are discernible. The outer, called the epiostracum, is a thin tough areolated substance; subjacent to this is a layer called the ectostracum, which is made up of thin laminæ traversed by delicate striæ; the rest of the section consists of a layer termed the endostracum, which is also a beautifully striated substance.

This slight glance at the external covering of the crayfish permits us to proceed to our examination of the internal organs, and the first to engage our attention is the *muscular system.* The principal muscles are—(1) the *flexor abdominis muscle,* a powerful mass extending along the lower interior side of the abdomen, from near the anterior border of the thorax to the base of the telson, and united in its course by a series of winding slips to each of the abdominal sterna. Its function is to bend the abdomen inwards upon itself. (2) The *extensor abdominis muscle,* a much less powerful mass, running along the upper interior side of the abdomen, and attached to cords of the abdominal terga. Its function is to straighten the abdomen. (3) The *levator abdominis muscle,* arising immediately above the extensor, and passing obliquely backwards to be inserted into the first abdominal segment. (4) The adductor muscles of the great forceps or chelæ, very powerful masses, the functions of which are to close the forceps so as to enable them to grip anything; and (5) the smaller abductor muscles of the same, whose function is to open the forceps. (6) Adductor muscles of the mandibles, strong fan-shaped masses passing from the hinder edge of the mandibles to the cephalic shield. In addition to these, several muscles pass from the stomach and antennary organ to be attached to the adjacent exoskeleton.

The alimentary organs.—The mouth of the crayfish is a longitudinal parallel-sided opening on the sternal or under side of the head. It is bounded by two lips, called respectively the labrum and metastoma, while it is protected externally by the powerful mandibles, and also by the two pairs of maxillæ, while the three pairs of maxillipedes also lie adjacent to it. The mouth leads into the stomach by a wide opening called the œsophagus or gullet.

The stomach is a beautiful complicated organ divided by a constriction into two chambers, the anterior and larger called

the cardiac, the posterior and smaller called the pyloric. The gullet opens directly into the floor of the cardiac chamber, and here the food which has not been sufficiently crushed and divided by the mandibles and other external grinding surfaces encounters another complicated set of crushing apparatus called the gastric teeth. These consist of two powerful lateral teeth and a median one, together with two accessory lateral ones, all actuated by muscles, so that they form a very complete mill, by which the food is so finely divided that it can be passed on to the pyloric chamber. The entrance to this chamber is still further guarded. In addition to the constriction of the side-walls, a projection something like a hood rises in the centre, and thus leaves only a narrow slit or opening on each side. These openings are again protected by a fringe of delicate setæ, which spring from the side walls, so that the entrance is closed to everything but the most finely divided particles of food. This part of the stomach is called the cardio-pyloric valve. There are other accessory valves, the function of the whole being to prevent any particles of food not sufficiently divided from entering the intestine. All such particles are understood to be ultimately ejected through the gullet. For a low power, of from 6 to 10 diameters, which enables the whole organ to be seen at the same time, the interior of the stomach of the crayfish is a beautiful microscopic object.

The *respiratory organs* consist of gills, or branchiæ, placed in a chamber on each side of the thorax. The part of the exoskeleton which forms the covering of these chambers is called the branchiostegite. On the tergal aspect the branchiostegite forms a solid mass with the exoskeleton of the thorax, but on the ventral aspect it has a free edge, thus permitting free access to the surrounding water. In each of the branchial chambers there are eighteen functional gills, arranged in three sets, grouped around each of the thoracic limbs, except the first maxillipede and the last ambulatory limb. The following is the arrangement: attached to the basal joint of each of these limbs is a gill, six in number, called podobranchiæ, while in the soft interarticular parts of these limbs are another set of six, called arthrobranchiæ; a little more to the interior of the branchial chamber is a set of

five, called pleurobranchiæ, while attached to the side of the thorax, above the basal joint of the last ambulatory limb, is a single gill, called also a pleurobranchia, thus making the number eighteen. They may be summarised thus: 3 ambulatory limbs, the great chela, and the third maxillipede, each with 3 branchiæ, making together 15; the second maxillipede with 2, and the pleurobranchia apart 1=18. In addition, there are one or two rudimentary branchiæ.

Each of the podobranchiæ consists of two parts: the plume, a feathery-like appendage, and the lamina, a broad thin plate plaited into about a dozen folds; while the arthrobranchiæ and the pleurobranchiæ have only the plume or feathery part. Owing to the branchiostegite being open in its ventral aspect, the water in which the crayfish moves has free access to the branchial chambers, so that the gills are continually bathed in this element. The amount of water at any one time in the branchial chambers is very small, so that the supply must be constantly renewed. The branchiæ, being attached to certain of the limbs and interarticular parts, are actuated by the motions of these limbs, and thus cause a current of fresh water to pass over the gills; while to hasten the flow of this current a peculiar arrangement exists in the anterior part of the branchial chambers. In the channel which leads from the interior of these chambers forwards to the outside there lies a broad oval-shaped plate, called the scaphognathite, which is attached to the base of the second maxilla. This plate acts as a scoop to bale the water out of the chamber; and as the water is baled out, fresh water comes in to supply its place, and thus a constant current over the gills is maintained. It is from this water that the oxygen necessary for the renovation of the vitiated blood is obtained. This brings us to the consideration of the organs which serve for the circulation of the blood.

The circulatory organs.—In the crayfish, equally as in the higher animals, the heart is the driving-wheel in the circulation of the blood. This organ lies near the posterior end of the thorax, on the tergal aspect of the animal. It is a thick muscular body, of an irregular hexagonal shape, lying in a comparatively large cavity called the pericardial sinus, to the sides of which it is attached by bands of fibrous tissue. The

walls of the heart are pierced by six small holes, of which two are on the tergal aspect, two on the ventral, and one on each side. Each of these holes is provided with a valve opening inwards, while from the heart radiate several arteries, each of which is also provided with a valve opening inwards to the tube of the artery.

The principal arteries which radiate from the heart are the following: the *superior abdominal artery*, arising from the posterior end of the heart and passing backwards above the intestine, giving off many branches; the *ophthalmic artery*, arising from the anterior end of the heart and passing forward above the stomach, giving off branches to the eyestalks and adjacent parts; the *sternal artery*, arising in the junction of the superior abdominal artery and the heart and passing directly downwards to the nervous system, where it subdivides into an *antero-ventral*, which passes forward, giving off branches to the various appendages surrounding the mouth; and a *postero-ventral*, which passes backward to the telson, giving off branches to the intermediate parts; the *antennary artery*, arising at the junction of the ophthalmic artery and the heart and passing downwards and forwards to the antennæ. All these arteries give off numerous branches, and all end in capillary ramifications.

The cavity of the heart, and the space between the heart and the walls of the pericardial sinus, are filled with blood. During life the heart contracts and expands with a regular motion. At each contraction the blood in its cavity is forced into the various arteries, and is prevented from returning by the valves at the origin of these; while at each expansion the surrounding blood in the pericardial sinus flows in through the small apertures in the walls of the heart to refill the cavity, and it is prevented from returning by the valves on these apertures. Thus by the expansion and contraction of the heart a constant flow of blood is maintained from the pericardial sinus to the cavity of the heart, and from the cavity of the heart to the arteries.

The blood thus forced into the arteries finds it way by their various ramifications into sinuses or channels, by which it is conducted to the gills. These blood sinuses may be considered as analogous to the veins in the higher animals. The blood in

its passage from the heart to the gills loses part of its oxygen, and takes up a corresponding quantity of carbonic acid. This latter must be got rid of and the former renewed, which interchange is effected by means of the gills. In these there are vascular channels which break up into a fine network, and the blood brought from the arteries by the sinuses is forced into these channels, where it is separated by a very thin chitinous membrane from the surrounding water in the branchial chamber. Here the blood becomes aerated, giving off its carbonic acid and taking up a corresponding quantity of oxygen. Thus renovated, it is forced by the succeeding currents of blood into other sinuses, which in turn conduct it into the pericardial sinus, so that it may again with its life-supporting oxygen enter the heart.

The *nervous system* of the crayfish runs in the middle line of the ventral aspect of the body close to the integument from the eyestalks to the telson. At this hinder end the nerve cord is divided up into several distinct branches, each proceeding to a different part of the telson and adjacent places. At each of the abdominal somites there is a ganglionic mass giving off branches to the muscles: equally in the thorax there are six ganglionic masses giving off branches to the muscles of the various appendages. When the main nerve cord reaches the gullet, it divides into two branches, one running on each side of the gullet, afterwards uniting in front of it into a mass called the cerebral ganglion, from which nerve fibres run out to the antennæ and eyestalks.

The *organs of vision.*—These are borne on the first somite of the head, and consist of a pair of compound eyes placed in a cavity at the end of comparatively long eyestalks. These eyestalks are calcified the same as other parts of the exoskeleton, and at their end is placed the cornea, a transparent substance divided into a large number of minute squares, which, under the microscope, resemble mosaic work. Attached to the inside of each of these squares or facets is a rod called the *visual rod*, which runs back to a bulb in the eyestalk. This bulb is the expansion of the optic nerve. The luminous sensations are carried along these rods to the optic nerve, whence they are conveyed to the brain. On examining a longitudinal section of the eye under the microscope, it is found that the visual rods consist of several bands or zones of

a darker and lighter colour. Next the cornea is a broad band of dark pigment called the outer dark zone; this is followed by a pale band called the outer white zone, which is followed by another dark band called the middle dark zone, followed in turn by a white line called the inner white zone, after which comes the bulb of the optic nerve heavily charged with a dark pigment, and which is called the inner dark zone. The difference in colour in these various zones arises from the greater or less amount of dark pigment contained in them. How these different zones act in the transmission of the luminous ether is not known. If a crayfish is examined with a light in a darkened room, the corneæ are seen to glow like two small points of fire.

This brings us to the end of our task, which is not a treatise on the crayfish, but a report of the work accomplished during the Session by the Microscopical Section.

HONEY-BEES IN WARM CLIMATES.

At the evening meeting of December 27, 1899, the following query was submitted to the members: "It is said that bees —say British bees—when taken to a genial sub-tropical climate, where there are flowers all the year, cease to store honey as they do in the old country. Is this true?" In the course of the discussion which ensued, the following important communication from Mr Robert Grieve, of Brisbane, was read by the President:—

"As to the question whether bees do not store honey in warm climates, I make answer that there is not a particle of truth in it—as to Australia, at least. Bees store honey in much greater quantity and much quicker near Brisbane (*i.e.*, in South Queensland) than in England—wax also. These facts are due to their food-supply being much more abundant and constant. Eucalypts are their chief food-supply. Tons of honey can be bought here at any time at a price something under 2d. per lb.

"Far to the north, at Townsville (the capital of North Queensland), which is far within the tropics (latitude 19° S.), I know that bees also do well, and I have every reason to think that what I have said about bees near Brisbane applies there also."

EXHIBITS IN NATURAL HISTORY.

THE following interesting objects in Natural History were exhibited at winter evening meetings during the Session by members of the Society. Mr Forgan showed a robin's nest inside a basket; and Mr Chas. Campbell exhibited sections of Scotch fir to exemplify the ravages made by the wood-boring insect, Sirex juvencus: specimens of the perfect insect, as well as the grub or caterpillar stage of it, were included. Miss Rose showed a large and interesting example of a wasp's nest. A specimen of rock (blue ground) containing diamonds, from Kimberley, was shown by the President; a transverse section of tree "Sipo Cruz," from Brazil, showing white and dark coloured woods, the white having assumed the form of a complete Maltese cross, was exhibited by Mr James Adam; while Mr Pinkerton showed a specimen of the butterfly Vanessa atalanta, with markings which suggested mimicry. Three adders from Aros, island of Mull, were also shown by Mr A. B. Steele. At various times during the Session numbers of microscopic slides were exhibited by members.

ANNUAL BUSINESS MEETING.

THE Society held its Annual Business Meeting on the evening of October 24, at 20 George Street, the President occupying the Chair. The Secretary read his Report, as follows:—

During the winter season 1899-1900 six evening meetings (exclusive of the meetings of the Microscopical Section) have been held. The attend-

ances have been very satisfactory, the hall being quite filled on two occasions. For the summer season of 1900 twenty meetings were arranged. Two of these were not held: one to North Queensferry, on account of very stormy weather, and the other to Ben Lomond, owing to the difficulty of suitable train connections. At the remaining eighteen there was an aggregate attendance of 426, or an average of about 23 at each meeting. Through the courtesy of Dr Davies, meetings were held at his house after the excursions for the purpose of discussing and carefully examining the collections, and several members regularly availed themselves of these very pleasant evenings.

Mr Russell, Convener of the Microscopical Section, held at his house a number of meetings, of which the members were notified in the billets. He has again kindly offered the use of his house for the ensuing season, and hopes an increased number of members will avail themselves of the opportunity of taking up the study of the Entomostraca.

It is but right to place on record that much is owing to Mr Crawford, our President, Dr Davies, ex-President, and Mr Russell, Convener of the Microscopical Section, for their liberality in allowing us the use of their valuable scientific books and apparatus for the furtherance of the interests of the Society.

During the year 28 names have been removed from the list of ordinary members. Of these 17 have resigned, one (Colonel Pennefather) has died, and one (Mr Thomas Scott, F.L.S.) has been elected an honorary member. The number of new members who have joined the Society is 24, and our membership now stands as follows: Honorary members, 7; corresponding members, 4; and ordinary members, 206.

The prosperity of the Society has thus been maintained, and it is hoped that in the new Session it may be largely increased.

The Treasurer, in tabling his printed balance-sheet for the past year, drew attention to one or two items of extra expenditure, and to the outstanding arrears, which latter amounted to £5, 10s. In spite of these, he was able to show a balance to the credit of the Society of £47, 3s. 10d.

The new Office-bearers were then elected by ballot, when the complete list was adjusted as follows, the names in italics being those now added: President—W. C. Crawford, F.R.S.E.; Vice-Presidents—Arch. Hewat, F.F.A., A. B. Steele, and *Jas. Russell;* Secretary—W. Williamson; Treasurer—G. Cleland; Editor of 'Transactions'—J. Lindsay; Auditors—R. C. Millar, C.A., and J. T. Mack; Councillors—T. Laidlaw, C. Campbell, Miss Oxley, Dr Watson, Dr Davies, Wm. Forgan, A. Murray, *A. R. Calder*, *Jas. Fraser*, *Major Grahame*, *Miss I. Elliot*, and *Mrs Maxwell.*

The President having thanked the Society for the honour

done him in his re-election to office, Mr Hewat moved a vote of thanks to the Secretary and the Treasurer for their labours in connection with the working of the Society during the past year. The President also thanked Mr Russell and Dr Davies, in name of the Society, for their kindness in granting the use of their houses to the members for the meetings of the Microscopical Section, and for the Monday evening meetings during summer for the examination of plants gathered at the excursions. These gentlemen having replied, the meeting soon afterwards terminated.

LIST OF PAST PRESIDENTS.

Dr Robt. Brown (*deceased*),	1869.	Mr John Walcot,	1879–1882.
Mr R. Scot Skirving,	1869–1874.	Mr A. B. Herbert,	1882–1885.
Mr Wm. Gorrie (*deceased*),	1874–1877.	Mr Symington Grieve,	1885–1888.
Rev. R. F. Colvin (*deceased*),	1877–1879.	Dr William Watson,	1888–1891.
		Dr Sprague,	1891–1895.
		Dr Davies,	1895–1898.

OFFICE-BEARERS, 1899-1900.

President.

W. C. Crawford, F.R.S.E.

Vice-Presidents.

W. Ranken. | A. Hewat, F.F.A. | A. B. Steele.

Council.

E. Denson.
Mrs Deuchar.
Miss Sprague.
T. Laidlaw.
C. Campbell.
Jas. Russell.
Miss Oxley.
Dr Watson.
Dr Davies.
W. Forgan.
A. Murray.

Editor of 'Transactions.'

John Lindsay.

Secretary.

W. Williamson.

Treasurer.

George Cleland.

Auditors.

R. C. Millar, C.A.; J. T. Mack.

LIST OF MEMBERS. 1899-1900.

Honorary Members.

Fraser, Hugh, 223 Leith Walk, Leith.
Henderson, Prof. John R., M.B., C.M., The College, Madras.
Herbert, A. B., Sunnyside, Mitcham, London.
King, M., 120 Pitt Street, Bonnington, Leith.
Macfarlane, Prof. J. M., University of Pennsylvania, Philadelphia, U.S.A.
Scott, Thos., F.L.S., 3 Menzies Road, Torry, Aberdeen.
Walcot, John, Craiglockhart Hydropathic, Slateford.

Corresponding Members.

Archibald, Stewart, Dalarossie Schoolhouse, Tomatin, Inverness.
Cruickshank, T. M., South Ronaldshay.
Hobkirk, Charles P., Easthorpe House, Mirfield, Normanton, Yorks.
Hossack, B. H., Craigie Field, Kirkwall.

Ordinary Members.

(*As at October 15, 1900.*)

Adam, James, Comely Park, Dunfermline.
Anderson, James, 55 York Place.
Anderson, R., 67 Princes Street.
Armstrong, J. Muirhead, Aberarder, Polwarth Terrace.
Banks, William, 2 Kilmaurs Road.
Bird, George, 38 Inverleith Place.
Blacklock, William, 19 Bruntsfield Avenue.
Bonnar, William, 8 Spence Street.
Braid, Mrs, 12 Wilton Road, Craigmillar.
10 Braid, W. W., 4A St Andrew Sq.
Brotherston, George M., 18 St John Street.
Bryce, George F., 2 Albyn Place.
Bryden, Miss, Linksfield, Aberlady.
Bryden, Mrs, Linksfield, Aberlady.
Buncle, James, 21 Maitland Street.
Burnett, Robert, 10 Brighton Ter., Joppa.
Butchard, J. B., 10 Montagu Terrace.
Cairns, Miss Mina, 27 Dick Place.
Calder, A., 2 James St., Portobello.
20 Campbell, Alexander, 62 Marchmont Road.
Campbell, Bruce, British Linen Company Bank, St Andrew Square.
Campbell, Charles, North British and Mercantile Insurance Company, 64 Princes Street.
Carey, Walter T., 12 Comely Bank Place.
Carment, Samuel, 11 Keir Street.
Carter, Albert, Selville Cottage, Portobello.
Chapman, M., Torbrex Nursery, St Ninians, Stirling.
Clapperton, Miss Mary E., 10 Greenhill Terrace.
Clapperton, Mrs W., Stamford Hall, Gullane.
Clarke, William Eagle, 35 Braid Road.
30 Cleland, George, Bank of Scotland, 61 Leith Walk—*Treasurer.*
Coats, William, 10 Duddingston Crescent, Portobello.
Cockburn, A. Myrtle, M.A., 1 Braidburn Crescent.
Cowan, Alex., Woodslee, Penicuik.
Cowan, Charles Wm., Valleyfield Penicuik.
Craig, Archibald, 38 Fountainhall Road.
Crawford, Francis Chalmers, 1 Royal Terrace.
Crawford, Miss Jane C., 1 Lockharton Gardens, Colinton Road.
Crawford, Mrs, 1 Lockharton Gardens, Colinton Road.
Crawford, W. C., 1 Lockharton Gardens, Colinton Road—*President.*
40 Crocket, Wm., 10 Gillespie Crescent.
Davidson, Miss M. E., Dalry House, Orwell Place.
Davies, Dr, Tweedbank, West Savile Road.
Day, T. C., 36 Hillside Crescent.
Deas, Miss L. C., 16 Gilmore Place.
Denson, E., 83 Comiston Road.
Deuchar, Mrs, Harlaw, Hope Terrace.
Dewar, John F., Hamilton Lodge, Joppa.
Dickie, James, 40 Princes Street.
Dowell, Miss, 13 Palmerston Place.
50 Dowell, Mrs, 13 Palmerston Place.
Duncan, James Patrick, 3 Cobden Road.
Durham, Frederick W., 2 Argyle Crescent, Portobello.
Eaton, F. A., 207 Dalkeith Road.
Elliot, Andrew, 8 Rillbank Terrace.
Elliot, Miss E., 1 Merchiston Bank Terrace.
Elliot, Miss I., 1 Merchiston Bank Terrace.
Ewart, James, 1 Dundas Street.
Fairley, Captain J. H., 32 Comely Bank Avenue.
Farquharson, John K., 100 Thirlestane Road.
60 Forgan, John, S.S.C., 20 George St.
Forgan, William, 3 Warriston Crescent.
Forrest, John L., 8 Glengyle Terrace.

Foulis, Thos. N., 27 Cluny Gardens.
Fraser, James, 18 Park Road, Leith.
Gartshore, Miss Murray, Ravelston House.
Gibson, John, M.A., 19 Bernard Terrace.
Gloag, David, 9 Barnton Terrace.
Goodchild, J. G., 2 Dalhousie Ter.
Grahame, Major G., 2 St Bernard's Crescent.
0 Gray, Miss Edith M. H., 59 George Street.
Grieve, Sommerville, 21 Queen's Crescent.
Grieve, Symington, 11 Lauder Road.
Grieve, Mrs Symington, 11 Lauder Road.
Hamilton, G. R., 14 Caledonian Road.
Harris, Charles Kerr, 13 Argyle Crescent, Portobello.
Harrison, H. J., Craiglockhart.
Harvie-Brown, J. A., Dunipace, Larbert.
Heggie, John, 149 Warrender Park Road.
Hetherton, Miss M., 13 Sciennes Road.
50 Hewat, Archibald, 13 Eton Terrace.
Huie, Miss Lily, Hollywood, Colinton Road.
Humphries, John, Easter Duddingston Lodge.
Hunter, John, Waverley Cottage, Regent Street, Portobello.
Hunter, Robt., 8 Abercromby Place.
Hutton, Mrs, 27 Gardner's Cres.
Johnson, W. H., Tweed Villa, Relugas Road.
Johnston, J. A., 7 Annandale St.
Kerr, Thomas, 15 Gilmour Road.
Kilgour, Thos. W., 22 Nile Grove.
90 Laidlaw, Thomas J., 2 Oxford St.
Laing, Rev. G., 17 Buckingham Ter.
Law, Mrs, 41 Heriot Row.
Lewis, David, Roselea Villa, Grange.
Lindsay, John, 43 James St., Pilrig —*Editor of 'Transactions.'*
Lindsay, William, 18 South St Andrew Street.
Lonie, Peter, 6 Carlton Street.
Macadam, Prof. W. Ivison, Slioch, Lady Road, Craigmillar Park.
Macdonald, J. J., Commercial Bank, Comrie.
M'Donald, J., 9 Brunstane Gardens, Joppa.
100 MacDougall, R. Stewart, M.A., D.Sc., Royal Botanic Garden.
M'Gillivray, Wm., 4 Rothesay Pl.
M'Intosh, James, 42 Queen Street.
Macintyre, John, care of Cameron, 342 Morningside Road.
Mack, J. T., 101 George Street.
M'Kean, Miss Minnie, 7 Montagu Terrace, Golden Acre.
MacLauchlan, J. J., 8 Merchiston Bank Terrace.
Macvicar, Miss K., 34 Morningside Road.
Malcolm, C. A., 8 Keir Street, Lauriston.
Mason, J. Gordon, S.S.C., 51 Hanover Street.
110 Masson, Miss, 2 Lockharton Gardens.
Masson, Mrs, 2 Lockharton Gardens.
Maxwell, John, 125 George Street.
Maxwell, Mrs, 61 Braid Road.
Millar, R. C., 6 Regent Terrace.
Millar, T. J., 27 Albany Street.
Millar, W. F., 22 Howard Place.
Miller, R. Pairman, 12 East Preston Street.
Milne, James, Muirend, Colinton.
Mitchell, Miss M., 153 Warrender Park Road
120 Moncur, Miss, 16 Eildon Street.
Morison, Peter, 24 Great King St.
Morrison, Hew, Librarian, Public Library, George IV. Bridge.
Mossman, Robert C., 10 Blacket Pl.
Muir, John, 24 Barnton Terrace.
Munro, John Gordon, 7 Howe Street.
Murray, Alister, Blind Asylum, Craigmillar Park.
Nesbit, John, 162 High Street, Portobello.
Nisbet, Alex., 2 Bruce Street.
Normand, J. Hill, of Whitehill, Aberdour.
130 Oliphant, J. C., 23 Charlotte Square
Oliver, C. M., 13 Fountainhall Road.
Oliver, John S., 12 Greenhill Park.
Osler, Alexander, 7 Tanfield.
Oxley, Miss M. E., Dalry House, Orwell Place.
Parkes, C. W., Inland Revenue, Dundee.
Paton, John, Scotland Street Tunnel.
Paul, Rev. D., LL.D., Carrielee, Fountainhall Road.
Paulin, George Alex., 6 Forres St.
Pentland, Miss, 73 Inverleith Row.

140 Pierce, W. J., 16 Forrest Road.
Pillans, Hugh H., 12 Dryden Place.
Pinkerton, Allan A., 39 Viewforth.
Pittendrigh, T. M., 29 Comely Bank Road.
Pyatt, W., M.A., Fettes College.
Raeburn, Harold, 32 Castle Terrace.
Ranken, William, 11 Spence Street.
Ranken, William Ford, 11 Spence Street.
Reid, Andrew, 1 Laverockbank Terrace, Trinity Road.
Richardson, A. D., Royal Botanic Garden.
150 Richardson, Mrs Ralph, 10 Magdala Place.
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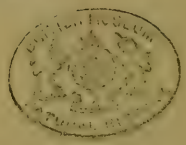
SESSION 1900-1901



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SESSION 1900-1901.

I.—*A FIELD NATURALIST'S HOLIDAY AT THE PARIS EXHIBITION.*

By Mr W. C. CRAWFORD, F.R.S.E., President.

(*Read November 28, 1900.*)

[Abbreviated.]

In the beginning of September of this year (1900) I went to Bradford to attend the meeting of the British Association; and when it was over I went direct to Paris to see the Exhibition, and be present at the Botanical Congress. I had arranged the time of my visit for that purpose. And although I arrived in Paris more than a fortnight before the Congress met, that was not too long to see the finest museum of contemporary art, science, and industry that has ever existed: that I have no hesitation in saying, for I have seen four great Exhibitions in Paris—in fact, all except the first. I was away from home six weeks in all, and I am sure I never had in a similar time so much and so varied intellectual food presented to me for intellectual digestion.

We soon had our first glimpse of the fairy land which the Exhibition had created. It was evening and dark, and on our way from the Gare St Lazare to the Boulevard St Germain—near to which Boulevard we lived—we passed the Porte Monumentale, illuminated. It came upon us unexpectedly, and its enormous size, with its brilliant electric lamps of many well-harmonised colours, was very striking. In fact, I have never seen anything when illuminated artificially look so effective.

Next day we paid our first visit to the Exhibition, and passed through the Porte Monumentale, which we took time to study a little in brilliant sunlight. From its shining green-and-gold decoration the irreverent Parisians dubbed it the Salamander. By daylight it was also very striking. It is known to few, I daresay, of those who saw it that the architect who designed it studied for some time carefully at the Museum of Natural History the most lowly forms of animal life, the beautiful patterns of foraminifera and radiolaria, to give him the necessary inspiration for his work: and the lattice-work of this great monumental gate is covered over with magnified casts of these beautiful organisms—what Haeckel would call the "Kunst formen der Natur," and to illustrate which he is publishing just now a large handsome volume. Is it not a very fine idea to pass through the lowliest of living things and yet some of the most beautiful to be admitted into the great world show where there are displayed the most developed results of human labour and thought? The Exhibition is full of such ideas, artistic ideas—not objects and facts scattered altogether at random, but connected by threads of synthetic thought, which the tourist who goes to the Exhibition for a few days mostly fails entirely to notice.

As I have said, I went to Paris a good fortnight before the Congress, and I spent nearly all that time about the Exhibition. The Exhibition covers, with its annex at Vincennes, 500 acres, and all the buildings had galleries. Supposing that I had spent a solid fortnight in seeing the Exhibition, that would have given me 33 acres a-day to go over, not including the galleries. The most of it, of course, one only walked through, and perhaps three-fourths of the Exhibition I did not attempt to see at all. Still, I believe I walked a good twelve miles every day, and so by the end of my first fortnight I had a fairly good idea how to find my way about. Now suppose, after I knew my way about, I had met a party of Edinburgh Field Naturalists, it would have given me much pleasure to have had a few walks with them to places in the Exhibition, to see which would have given them great delight. I propose to take you now to some of these places.

We have entered by the Porte Monumentale, and we walk along a broad avenue, having for a third of a mile two rows

of conservatories on either side of it. These conservatories were exhibited by hothouse builders, and contained in some cases interesting collections of plants,—one of cactuses, for example, struck me; but they are far too numerous to try to describe. We pass the greater and the lesser Palaces of Art. If we pause, however, in the space between them, and look over the new bridge, we shall see the most magnificent piece of city architecture in the world. On either side we have the permanent homes of art—which stand on the place of the Exhibition building of 1855—the Palais d'Industrie. The beautiful white stone of which they are constructed has been tinted with primrose and lilac so slightly as just to give it a feeling of colour, with the happiest effect. We leave the great avenue at the Pont des Invalides and go down towards the river. There we shall find in a little ravine a spot to delight the field naturalist. It is just at the side of the foot-bridge which crosses the Seine. There is a collection of aquatics and succulent plants, opuntias and house-leeks, melo-cactuses and agaves and euphorbias, besides water-lilies and reeds and Egyptian papyri. We have here a picture—a *tableau vivant*—of how the plant suits itself to its surroundings—the lilies and other aquatics living in water, the cactuses and the agaves reducing their leaf-surface as much as possible to prevent evaporation and economise water. We may notice amongst the plants a Euphorbia resenifera, which has very much the appearance of a cactus—although euphorbias and cactuses are a considerable way apart in the vegetable kingdom. The euphorbia has assumed the habit of the cactus to suit desert conditions. This little ravine, like so many other bits of the Paris Exhibition, is an object-lesson arranged with a deeper significance than a few rocks and pools with pretty plants might at first sight suggest. It is a thought-model of how the organism grows to suit the environment.

We now come to the Palace of Horticulture, where all the fruit- and flower-shows are held. These shows took place weekly, I think. Every week or so different lots of plants and flowers and fruits were exhibited. Once when the new supplies for the week had been brought in, I walked through the show. There were a great many asters of all colours, having the habit of Aster Tripolium. There was a striking

collection of montbretias, strawberries with long fruit, a great many cactus dahlias, and most striking lots of begonias; coxcombs of all colours, scarlet and orange, pink and greenish-yellow and cream colour. There were brilliant cannas in masses, and gladioli, and dahlias with little flowers not much bigger than a penny. Then there were waggon-loads of the finest apples and pears and oranges and plums from almost all parts of the world, and in the most beautiful condition. The horticultural shows which I saw were good, but they were not anything like one I saw in Paris some years ago in the Tuileries gardens. It was in May, and the exhibition was in great tents: rhododendrons and azaleas were placed in baskets and arranged in masses: the cut flowers were not put in bare tin stands, but surrounded with leaves and moss. The artistic effect was great: I have never seen a flower-show like it. That was a great summer flower-show, and as the Exhibition Shows went on all the summer, the same excellence could not be maintained.

We leave the Palace of Horticulture and go towards the river. Outside the buildings we may notice many conifers and roses, and, had we been earlier in the year, rhododendrons. The number of different kinds of plants in the Exhibition grounds is immense. There were some hundreds of varieties of pears; there were 650 different kinds of trees and shrubs in the Champ de Mars alone. Along one bank, for a quarter of a mile or so, there were fruit-trees trained on espaliers of all forms. I have never seen trees trained with such regularity.

We are now in the Pavilion of Forestry, Hunting, and Fishing. We see models of the manner in which hills are planted with trees, and, as they are cut, how they are replanted. There are diagrams showing the importance of forests. It is very probable that the coasts of the Mediterranean—Greece, the Adriatic, South Italy, as far as Gibraltar—became decadent more from the destruction of forests than from anything else. There were all kinds of nets and traps for catching fish; there were sponge culture, oyster culture, pearl culture, exhibits from marine stations. There were instruments used in hunting animals: here were skins by the thousand, many prepared for the market. I saw here some of

the best photographs of wild animals I ever saw—by far the best. They were taken by a rich American, Mr Shiras. He began by studying the habits of the animal he wished to photograph. He paid particular attention to its nocturnal habits—where it went to drink or to lick salt. He placed several cameras in position, and made them work automatically: he placed wires in the grass, which, being pulled, discharged a spark of electricity, and so fired in some way magnesium powder. One would think he must have spoiled a vast number of plates: still, those he exhibited were masterpieces.

We go on now to the Champ de Mars—the largest of all the parts of the Exhibition. We neglect the piles of cloth (the textile industries), the gallery after gallery of bottles of chemicals and apparatus used in chemical industries. We go straight to the Science and Art and Education section. I want to tell you of only two or three things. One exhibit interested me much. It was six ants' nests, with their commensals and parasites all alive and displaying the utmost activity. The nests were made of red terra-cotta—very like what better-class flower-pots are made of: they were in the shape of square tiles about an inch thick and about a foot on each side. They had deep grooves in them, made, when the clay was moist, by an inch gouge. The grooves made a scroll figure. One side of the tile was kept moist—a moist chamber—and the whole was covered by a plate of glass, and that again by a thick curtain. When the curtain was drawn aside, there were the insects at work. I do not know what they were fed on. The exhibitor, M. Charles Janet, has written a pamphlet on them, which I have just got. Beside each nest there was a long description of the insects it contained. The reading of this was not easy, because there were generally several people waiting their turn to have a look. There is a nest of red ants (*Myrmica rubra*); in it there are a commensal and a parasite: the one—*Platyarthus Hoffmannseggi*—is a little land crustacean. It is white, and it is blind. It seems to find its way about by its sense of smell. An organ of smell is said to be placed in the antennæ. It eats animal and vegetable matter, which it finds in the galleries, and it moves about little The other is a parasite

—one of the Thysanuridæ—and is exceedingly active,—*Lepismina polypoda.* It is yellow, and blind like the crustacean. The ants kill it if they can catch it. It lives in an extraordinary way. Ants carry a nutritive fluid in their crop, and feed other ants by disgorging it into their mouths. When that operation is going on the Lepismina comes up cautiously and catches a little drop, and then runs off as fast as it can. Like the Platyarthus, it seems to have a most acute scent, and to smell the droplets. Its usual food is the young ant larvæ.

The *Formica fusca* occupied another nest beside it. There was a colony of a very small ant, *Salenopsis fugæ.* Its habit is to have its nest beside that of the Formica, and to make a communication between the two nests by very narrow galleries, by which it gets access to the nest of the larger ant, and lives on the undeveloped young.

I was greatly interested in these ants' nests—all the more so when I learned that M. Janet, who exhibited them, was not a naturalist by profession, but an engineer who occupied himself very much with social questions. I have written to M. Janet asking him where I could get any of his earthenware nests, so I may be able to show them at some future meeting of this Society. If some of us could start a few ants' nests, it would be most interesting, and I do not see any more difficulty in doing so than in keeping half a dozen beehives.

Farther on in the same building there is a large exhibit of objects connected with bee-keeping. On account of the fine climate bees are very much kept in France—so far as my own observation goes, too much in the old-fashioned straw skep. There were splendid collections of insects injurious to bees and to plants in general. About the time I arrived in Paris there was an Apicultural Congress, and I must mention to you one of the communications made to that congress by M. Giraud Pabout. All the members know that it is only the queen in a hive which lays the eggs, and she lays an immense number. The workers have short lives—a few weeks only—and the bee society is continually recruited by the new brood. It is of the greatest importance, therefore, to have good queens, so as to have good bees. An American has invented a way of manufacturing queens on an extensive scale, and the results

were shown in the cases of the Central Apicultural Society. The members know that there are three kinds of cells in a hive: small hexagonal cells—the workers' cells; larger hexagonal cells—the drone cells; and a few very large cells, not unlike strawberries that have been hollowed out by snails,—these last are the queen cells. Now in a hive, although the social organisation is so highly developed, the work goes on with the routine of the War Office. The queen lays eggs at the rate of many hundreds a day: if she lays an egg in a small cell, the other bees give it a worker's fare, and it grows up into an undeveloped female, or worker—shall we say the *new woman* of bee society? When she lays an egg in one of the large strawberry cells, the nurserymaids of the hive feed it with much richer food, and it grows into a queen. Now every bee-keeper knows that the more queen cells there are in a hive the more queens will be produced; so he removes the queen cells—all but one, just as he removes the drone cells except a few. Two Americans went on another tack to attain their object—good queens. They had 600 hives, and they noticed that one hive particularly worked extremely well, while the rest did moderately well or badly. They made artificial queen cells, little hanging capsules attached to laths. The queen soon did her routine duty, laid a fertile egg in one of the cells, and the workers did theirs. When it had hatched into a larva, they put in some royal jelly beside it. The bee-keepers transferred the capsule into the hives needing improvement—the workers there did the rest: they fed the young larva with more royal food, and in due time the hive had a new queen of the most desirable kind. In this way in a very short time they had all their 600 hives supplied. This is a wholesale way of improving animal societies.

We continue our walk, and have time for only one more visit. We go now to the Rue des Nations, and look into one of the houses there, of great interest to the field naturalist. It is the villa of the Prince of Monaco. It contains samples of all kinds of apparatus used by the Prince in his ocean explorations—dredges, and traps of all kinds, some very ingenious, which the Prince used in his explorations in the "Hirondelle" and the "Princess Alice" I. and II. Here was an unrivalled collection for an amateur to make. There

was a rosy feather-star on its stem, like an encrinite, called after the "Hirondelle"; and there was a cuttle-fish with scales.

We might have gone to many other places to interest a field naturalist. The aquarium was not much for us who live beside the sea, but in it there were some pillars of the Temple of Serapis from near Naples. Now, although I had seen the temple several times before at Pozzuoli, I don't think I ever touched a pillar of it: here I put my finger into the holes the boring shells had made when it was under the sea. The Temple of Serapis is one of the few records we have of a great change of sea-level—a great sinking and a considerable rising again—within historic times.

Before leaving the Exhibition for good I must go to have one more look at what I think is the most wonderful instrument I have ever seen. It is the telephonograph, invented by a Dane, Poulsen. It consists of a cylinder very much like that of an ordinary phonograph, but instead of being made of wax it has wire coiled round it of steel or nickel. A small electro-magnet the size of half an inch of an ordinary pencil comes down upon the coil, so that the wire passes between the poles. Now, the extraordinary thing is that the molecular condition of the wire is changed: it preserves a record of what has been spoken, and by beginning again and listening instead of speaking, the steel wire will repeat all that has been spoken. The wire retains the words, it is said, for some years at least. The whole may be obliterated instantly by an electric current passed through the wire. Have we not here an extraordinary demonstration of the wonderful structure of matter?—shall we call it the memory of matter?

17*th Oct.* 1901.—In his evening discourse on "Movement of Plants" at the meeting of the British Association at Glasgow last month, Prof. Francis Darwin expressed his opinion that plant movement might be regarded as psychological, involving some kind of memory or consciousness. He referred particularly to Prof. Hering's lecture, "On Memory as a Universal Function of Organised Matter," delivered before the Vienna Academy of Sciences, 1870, and also to Samuel Butler's "Life and Habit," 1878, and "Unconscious Memory," 1880, as supporting this view. Possibly, in the controversy

between those who believe that the phenomena of life may be explained by chemistry and physics and those who do not regard these as sufficient, the materialists and the vitalists, old or new, might do well to remember the telephonograph as a thought model: it seems to present the problem in a still simpler form.

II.—*BADGERS.*

By Mr TOM SPEEDY.

(*Read Nov. 28, 1900.*)

As most of you are aware, I am a native of the historic Borderland—a descendant of the Border thieves, who

> "Stole the beeves that made their broth,
> From England and from Scotland both."

At an early age the habits of the birds and beasts that peopled the district were to me subjects of intense interest. Inheriting the hunting spirit of my ancestors, to engage in a badger, a fox, or an otter hunt was in my boyish imagination the chief end of man. My curiosity was whetted by an old gamekeeper rehearsing to me the stories of his adventures with the wild beasts referred to. He was not at that time old, but in my youthful arrogance I imagined every one old when the slightest indication of grey hairs made their appearance. I have somewhat changed my mind on that subject now. This man, Bassett by name, was a native of Sussex, but was taken to Morayshire by the late Charles St John, with whom he acted as keeper. Subsequently he was with Sir William Gordon Cumming, grandfather of the present baronet of Altyre and Gordonstoun, and eventually came to Ladykirk, where he acted for forty years as head-keeper on that estate. About the time referred to Mr St John's book on 'Wild Sports in the Highlands' made its appearance, and was the first book on natural history I ever read. Even to this

day he is one of my favourite authors. His anecdotes about badgers keenly whetted my appetite, and I resolved at least to try and see one. In a deep ravine between the estates of Ladykirk and Milnegraden were, I had often heard, a number of badger holes, and I started one day to try and discover them. This was a simple matter, as they were easily found in consequence of the many tons of earth which they had drawn out, and which indicated that the burrows were of great depth. Though a considerable distance apart, the burrows connected inside. This I found out in subsequent years, as on putting a ferret into one of the holes a couple of foxes bolted twenty-five yards from where the ferret was put in. It was in the winter months, and I presume if badgers were inside they were sleeping. I have frequently bolted foxes and cats with ferrets, but never badgers; neither have I ever lost a ferret in a badger's hole. It has been frequently asserted that foxes and badgers will not remain in the same earth. This I know to be at variance with fact, though I cannot speak minutely of the domestic arrangements of fox and badger.

I was exceedingly interested in seeing the big burrows of the badgers and the prints of their feet on the sandy bank. A popular notion prevailed at that time among country-folks that the legs of badgers were shorter on one side than on the other—a provision of nature for enabling them to run along the steep hillsides. Observing their tracks both up and down the glen from the "earth," I began to wonder how one would manage if the side with the short legs was down hill. I carefully measured the length of the limbs of the first badger I saw killed, and needless to say from that date I consigned the belief to the region of romance. Though then only ten years of age, I was continually asking the keeper about a badger-hunt, and he at last consented to have one, on condition that I was to sit and "sack" the badger. I am certain I never would have engaged in a badger-hunt had I known the treatment to which I was to be subjected. The two keepers arranged to play a trick and frighten me, so that I would never trouble them again with badger-hunting. I have too vivid a recollection of that night ever to forget it. The moon was about its first quarter, and went down a little after midnight. We were to start before eleven o'clock. I was to be

the victim of as contemptible a trick as was ever perpetrated on a boy of tender years; but, as events turned out, I scored against them, and was made a hero in spite of myself. Bassett had over a dozen rabbit terriers, half of which were well-bred and the other half a motley group of mongrels. I could not better describe them than in the words of Dándy Dinmont: "There was old Pepper and old Mustard, young Pepper and young Mustard, little Pepper and little Mustard." Then there was Nettle, Mischief, Venom, Tartar, and others, whose names I have long since forgotten. Besides the well-bred Dandies, there were "mongrel, whelp, and cur of low degree," but having had large experience among rats, cats, stoats, weasels, and badgers, they would turn tail to no creature covered with hair.

While the sacks were being prepared the terriers, knowing what was up, kept yelping in wild excitement. It was therefore arranged that the under-keeper and I were to start and put the sacks in the holes, having a string from each of them a considerable way up the bank and secured to the branch of a tree. The sacks being duly inserted and pinned round the entrances to the burrows, I was told to sit near the tree with the strings in my hand. On leaving, the keeper asked if I was "feared." To tell the truth, I was terrified, but this need not be wondered at, considering my youth. However frightened I was at being left alone, I was ten times more so to be called a coward; so, though trembling from head to foot and my voice husky with excitement, I replied, "No, I'm no' feared." I saw the keeper's head and shoulders between me and the sky, and when he disappeared I felt as if my last hour had come. It was a dark ravine closely overshadowed by trees. The agony of that night still haunts me. The glen was, and I presume still is, a favourite resort of owls, and that night I could safely say in the words of Burns that

> "The cry o' hoolets maks me eerie."

Little did I then think that the same eerie cries would afford me so much pleasure in after life. I at last heard the yelping of the terriers in the distance, and felt some relief, as I thought the keepers would come to me. I strained my ears to listen, but the excited yelping of the terriers died away,

and no sounds were audible except those of nature—the loud hooting of the owl, the sighing breeze, the tinkling of cascades in the brook flowing down the glen, and the bleating in the distance of sheep which had evidently been disturbed by the keepers and terriers.

The moon disappeared beneath the horizon, and the inky darkness was almost palpable to the touch. I am not ashamed to confess that I was terribly frightened, but as time wore on I must have become somewhat reconciled to the situation, as I fell sound asleep. How long I slept I know not, but I awoke shivering with cold. Presently I heard a rustle among the grass and leaves, and a low grunting noise. I sprang to my feet and screamed with terror. My doing so was the means of frightening a badger, which bolted for the hole, and immediately the tugging string gave indications of his entanglement in the sack. I have since frequently heard badgers emitting that low grunting noise when they happened to pass in the darkness, but whether they do so only when they suspect danger I am not prepared to state. What was to be done? I dared not go near the sack, as I had some idea of the terrible teeth of badgers from wounds inflicted on the terriers in previous fights. I held on to the string and yelled at the pitch of my voice for assistance, but got no response except the echo from the opposite side of the glen. To have run away would have been arrant cowardice, so I cut the string from the branch and rolled it round my arm till I got near the sack. I knew the running noose would secure the mouth of the sack, and as I got near I found most of the sack in the burrow with the mouth kept outwards by the string. With considerable difficulty I pulled sack and badger out, taking care to tightly twist the sack, till I got the badger in the bottom, unable to move. I then threw him over my back and made tracks for home, leaving the other sacks in the positions we had placed them. On the way home I felt like Robinson Crusoe after seeing the footprints in the sand. I took every bush I saw for a man or a ghost. As I proceeded the clock on the stable tower struck three, and I knew that I must have slept for some hours. Where by this time were the keepers with the terriers? I had forgotten about them in my sleep, and events since I awoke had driven

them out of my head. On nearing the kennels the dogs began to bark, and I soon discovered that the keepers were home. Why, I wondered, had they gone home without me? Little did I then think it was an organised plot.

Scenting the badger, the entire kennel—from the loud bark of retrievers, pointers, and setters, to the yelping of the terriers—kept up an excited pandemonium. The bell rang again and again in vain, no attention being paid to it. Why a bell should be rung to make dogs quiet may not generally be understood. A bell is fixed in the kennel with the pull at the keeper's bedside. When the dogs bark during the day this bell is rung, and the keeper then goes out with a whip and lashes them into their bed. Learning to associate the bell with the whip, they generally become quiet with the first ring, but on this occasion it had no effect. Bassett had therefore no alternative but to get up, and on coming out, cried, "Who is there?" Amid the noise I shouted "It's me, and I've got a badger." With his assistance I had it secured in a box, and went home to bed. As the news spread on the following day I was regarded as a hero, but the awful agony I suffered from fear was carefully suppressed, and I do not think has ever been divulged till now.

From the fact of the badger being nocturnal in its habits, few people ever see one, even in districts where they are plentiful. We have yet a great deal to learn regarding the habits of this quaint night-pig, and much nonsense has been written on the subject. Although it generally adheres to the district near its burrows, I have known one caught and worried by foxhounds several miles from an "earth." Only a few weeks ago one was caught and worried by the Jedforest hounds. It was a male, and weighed 32 lb. When driving the woods in Lauderdale last week, one of the guns shot a badger which broke cover. It was also a male, and weighed 30 lb. I have also trapped badgers far from their haunts. Notwithstanding their short legs, they run at a remarkable pace. I have several times in my younger days come upon them, giving chase, and found I could keep up with them for a couple of hundred yards, but though I was always "speedy," in every case they soon distanced me in the race.

The presence of badgers in a district is soon discovered by the wasp-bikes being dug up, the comb scattered all round, and the young wasps picked out. There is no mistaking their footprints, which resemble those of a miniature bear. They appear to be omnivorous, eating anything that comes in the way. I have trapped them with eggs as a bait, and also with part of a rabbit. I have noticed half-chewed wheat in their droppings, and I have found that in confinement they become exceedingly fat on dog's ordinary food.

In former times the badger was subjected to the most horrible cruelty. Drawing the badger along with cockfighting used to be favourite pastimes even well on in the nineteenth century. "Drawing the badger" never failed to gather a crowd, a badger frequently being kept for the purpose at low public-houses. This cruel sport, however, was prohibited by Act of Parliament in 1850. Yet long after the passing of the Act it was now and then indulged in by the lower stratum of society in rural districts. I have an indistinct recollection, from this distance of time, of a band of travelling gipsies camping on a disused road, and having with them a badger in a box for carrying on this illegal sport. My remembrance of the box is that it was six or seven feet long and about eighteen inches in width and depth. A number of people brought their dogs to "draw the badger." Not one of them could accomplish it, and those game enough to try generally came out with ugly cuts about the head. Some of the terriers got hold of the badger, and for a time it looked as if they would fetch him out; but in every case they failed, and the reason was obvious. Being largely endowed with curiosity, I got on my knees and looked into the box. I saw the white stripes of the badger's face and his small eyes like fiery orbs, no doubt expecting an encounter from another adversary. For half the length of the box next the badger spars were nailed across the bottom, so that he could get a hold for his feet, and consequently it required considerable strength to dislodge him. On the other hand, it was alleged that the bottom near the entrance had been rubbed over with soft-soap, so that once past the spars, the slippery floor rendered "drawing the badger" impossible. I was not old enough to take notice of the stakes, but I remember money changed

hands, and the language used, as is generally the case in such low species of gambling, was more expulsive than refined.

An amusing story used to be told of a young miner in the Scremerston district, near Berwick, who had a well-bred young dog which he purposed training to "draw the badger." The story is of some antiquity, and perhaps not altogether to be depended on. When the dog was about eight months old, the lad induced his father to put a badger-skin over his head and shoulders, and crawl into the room on his hands and knees to see how the dog would act. Being well-bred, it rushed at its supposed natural enemy and fastened on the nose of the old gentleman, who shrieked out at the pitch of his voice. Without attempting to render assistance, the young scamp cried out, "Bide it, man, faither, bide it, man; it'll be the makin' o' the pup."

The manner in which badgers were persecuted has added a word to the English language, the term "badgered" being very expressive. "Drawing the badger" is also a favourite phrase applied to asking questions with the view of eliciting information when the person questioned is not disposed to be communicative.

There is a simile in Burns's poems I cannot agree with, and which to my mind constitutes one case where this acute observer of nature had not studied the animal in question for himself, but quotes from the well-known Scotch proverb. When referring to the gentry in his "Twa Dogs," he says:—

> "They gang as saucy by puir folk
> As I wad by a stinkin' brock."

Now, badgers are the cleanliest animals in the world. Like the model housewife, they have their spring and autumn cleaning, clearing out their beds and replacing them with fresh material. This they generally do early in February, in anticipation of the wants of the nursery. Badgers in their normal state have not an offensive smell, and in order to have this corroborated I would suggest that on one of their excursions next summer the members of the Edinburgh Naturalists' Society should go to Rutherford and see the beautiful and interesting creatures to be presently mentioned

as now kept there. I am certain that one and all will then agree with me that "stinkin' brock" is a misnomer. Of course any animal, if confined in a box with a total disregard to sanitary laws, will have an unpleasant odour. I am not overlooking the fact that, as a means of defence, the badger has a glandular apparatus from which an offensive matter exudes when the animal is being "badgered." I hold, however, that a badger has no right to be "badgered," and if let alone "stinkin' brock" is not applicable.

The period of gestation in the badger has been a subject of much discussion in many journals, and notably in the 'Field' newspaper—the exact time never having been satisfactorily demonstrated. Several interesting circumstances bearing upon this subject have appeared at intervals in the columns of the 'Field.' In the issue of that popular newspaper for 5th April 1861 Mr H. Shaw of Shrewsbury states that a badger which had been kept in confinement at Haughton Hall, Salop, from April 3, 1860, brought forth two young on 12th March 1861, more than eleven months after she commenced her solitary life. Again, under date 25th June 1864, Mr F. Heycock of Bedford says that he caught a badger, and kept her for thirteen months, when she brought forth a young one. We further learn from the 'Field' of 17th September 1864, on the authority of Mr John Seaman, superintendent of the Hull Zoological Gardens, that a badger brought forth young after being shut up in a cage there for fifteen months. Again, on 22nd March 1868, we learn from the same source that a ratcatcher named Butler, living near Oxford, had kept a female badger in his possession from November 1866, and had her locked up in an iron cage. On the first of March 1868, after she had thus been in confinement for fifteen months, she gave birth to four young.

I have thus far quoted from the 'Field' newspaper, but am glad to say that I can now from personal knowledge speak with some degree of certainty on this point. My friend Mr Paterson of Rutherford possesses a number of badgers, already referred to: three generations have been bred in captivity. Finer pets I never saw. They are very tame, eating out of my hand, but they are very shy if anything

unusual attracts their attention. In a recent visit I tried to photograph them, but this was by no means easily accomplished. Mr Paterson informed me that the operation would have been managed with less difficulty during the long summer days, but as the time for hibernation approaches they become restless, excited, come little out, and scarcely eat any food. In summer they eat a great quantity of food, but for four months in winter hardly any. Even if not dormant, they move little about, and are seldom seen during the winter. For many weeks I have known the earths stopped and covered with snow. At the same time, I have occasionally seen their footprints in snow, but not during a settled storm with hard frost. The period of gestation is from the beginning of July till near the end of February. I have known four in a brood, and possibly there may be more; two and three are common. Last spring one produced her young on the same day of the month as she was herself born. When the young are born they are void of hair, and, like the weasel tribe, cannot see till six weeks old. It is the opinion of Mr Paterson, who has made badgers the study of his life, that in the heat of the mother the young lie dormant for some time, and weeks elapse before they suckle their dam. When they begin to move about they grow very rapidly, but do not breed the first year.

I cannot speak of the longevity of badgers, but doubtless will find out a good deal in this direction during the next few years, though it is always dangerous to rest any theory upon an experiment which dissociates wild creatures from their natural environment. At this time of the year badgers are so fat that any person seeing them dissected would jump to the conclusion that they had been grossly over-fed. There is no doubt, however, that it is their normal condition at this season. At least I have always found them so, and I have skinned a considerable number. It is otherwise in the spring months, as when then skinned the fat had all disappeared.

Badgers are becoming scarce, the traps of the rabbit-catcher being instrumental in reducing their number. It is gratifying to learn that some proprietors are now reintroducing them on

their estates, and giving orders that they are to be protected. Among these I may mention the Earl of Rosebery, and an exceedingly interesting paper on "A Badger Colony in Dalmeny Park" was read to this Society in March 1897 by Mr Charles Campbell. I cannot do better than solicit you all to peruse it again in our 'Transactions.' In conclusion, I may say that I believe the day is yet far distant when the extinction of the badger will have to be deplored.

III.—*THE MOLE* (TALPA EUROPÆA).

By Mr ALLAN A. PINKERTON.

(*Read Dec. 26, 1900.*)

I WELL recall my first introduction to a mole-catcher. Sitting by the roadside one lovely summer day, some few years ago, examining a butterfly, I was accosted by the remark that it was a warm day. On looking up, I saw a tall man with shoulders like Hercules and a beard about two feet long. His skin was as brown as a berry. Dressed in a grey suit, with boots one could see were specially made for tramping, he had on his left arm several traps, and in his right hand as a staff he was carrying a spade with a slender shaft and a blade about 3 to 4 inches square. Having replied to the salutation, which is a pleasant feature of country folks, I was cogitating on the use of the traps, and allowed him to reach a distance before I assured myself that if I never asked I would never know. The same day saw my first introduction to the practical study of the mole.

The mole in appearance is rather a handsome creature. Its fur, smooth as velvet, is generally black, with a slight brown colour in adults on the breast and the belly. In size it is about 5½ inches, but as a rule larger in mossy land. The male also is considerably larger than the female. It is adapted for its calling; and as it passes its existence in the

earth, its body is nearly cylindrical. The snout is long and wedge-shaped. Nature, by adaptation and modification, is ever adjusting its creatures to their ends, and nowhere are its operations more excellently displayed than in the mole. It is generally thought the common mole has no eyes. This, however, is an error. But as the sense of sight is not required in its method of living, the eyes, which are very minute, are hardly discerned, though none the less there, and they can readily be observed in the embryos which are now exhibited. The external ears on first view would seem also to be conspicuous by their absence, but closer inspection reveals their presence. It is supposed that the senses of hearing, smell, and taste are very acute and highly developed.

The head is connected with the body by no perceptible neck. In proportion to the animal, its two front paws are enormous. They are broad and flat, having five digits, each armed with a sharp, curved claw. Used by the animals for digging, they are not covered with fur, and the slight hairiness on the back of the foot which is present in the young is very soon destroyed, and the skin thus left bare becomes very tough. They are turned slightly outwards, and are admirably fitted for burrowing. The hind feet, which have also five sharp claws, are used chiefly for propelling the animal, and consequently they are not broad like the front paws. In the young the hind feet are very like those of the mouse, and when on the surface of the ground the young moles really gallop. In the adult they become more adapted to their ultimate use. A small stump of a tail about an inch long, covered with fur and tipped with a few white hairs, completes the mole's external appearance.

The mole is relegated to insectivorous mammals because of its dentition. As the hedgehog belongs also to the Insectivores, and is larger, I have exhibited a skull of that animal, from which you will see the molar teeth are furnished with numerous small pointed eminences for crushing insects. If you take a look at the other teeth of the moles exhibited, you will observe they are very sharp. I will not trouble you with the anatomy of the mole, which can be got from any text-book, but I should like to draw your attention to two points. First, to the humerus bone, of which a specimen is exhibited.

You will observe that it would seem to be deformed, but that is not so, for it assists the lateral movement of the paws enormously. The second reference is to the additional bone of the paw, which increases the breadth of it. The upper- and fore-arm bones are also exhibited for inspection. From the study of the internal parts it is seen that the whole concentration of muscular strength is thrown into the front paws, the two tendons of which are very large. To illustrate the remarkable strength of the mole, we experimented with a young animal placed on the surface of a piece of ground into which I could not push my walking-stick, so hard was it. Into this in an incredibly short time the beast completely submerged itself.

The mole's abode is always under the soil, and its food consists of worms, grubs, &c., in search for which, and guided by the sense of smell, it makes runs in all directions and at various depths. In very cold weather it must make deep runs in search of worms, for then these recede into the depths of the soil. In the case of the young mole, the runs are very zigzag and not at all deep. In fact, you can see the earth moving as it burrows. The young therefore require experience before they can make deep runs, and, as a consequence, in dry seasons young moles are often killed by drought and the heat of the sun, accompanied by the want of food. Weather has a peculiar effect on the moles, in the direction of inciting them to make fresh runs, the mole-catcher's experience being that for a few weeks hardly a fresh mole-hill is to be seen, whereas at other times new workings can be observed in every direction. The mole-hills one sees are ejected soil made by means of shafts. At the first sight the method of burrowing might be thought, from the shape of the snout and the position of the fore-limbs, to be after the manner of swimming, but this is not so. While so engaged, the animal rests on its left side, first gives three or four scratches with its right paw, then turning on to its right side it similarly uses the left paw and thus alternately propels itself. During summer the mole makes few hillocks, but with the first touch of frost it makes deeper runs, and therefore more mole-hills. The more severe the weather the deeper the runs and the larger the hills. Possibly this is caused in their search for worms. We may take it as

an axiom that the deeper the runs the fewer and larger are the mole-hills. This is evidently to save shafts to the surface. These shafts are not necessarily perpendicular to the runs. In the case of a slope they may be parallel. In making these shafts to the surface the mole is guided by the nature of the soil, both as to their number and direction. Another feature is that the runs always continue past the last mole-hill.

In its manner of eating the mole is epicurean. Having caught the worm, it immediately makes for the tail, cuts a bit off, and returns to the head. Then holding the worm between its paws, it proceeds to eat, cleaning its victim at the same time by the pressure of the forepaws. Nor does it forget the piece cut off. We experimented on this several times by giving the mole the worm by the head. If you put a stick into ground where there are worm-castings and heave the soil, you will very soon see worms coming to the surface. The explanation of this may be that the worm is trying to escape from its natural enemy. The mole, from its sense of smell, has found this out. And occasionally after burrowing it proceeds to the surface, with the view of alleviating the perturbation of the worms!

It is sometimes said that moles make for water, but this seems erroneous. Worms dwell in moist soil, and feeding on them one can well imagine would not necessitate thirst.

The voracity of the mole is so great that it cannot live many hours without food. In view of this it is thought that having gorged itself it falls asleep and in a little time awakes to repeat its diet, not distinguishing between day and night, summer or winter. Mr Alexander M'Leish, mole-catcher, Corstorphine, a most observant naturalist, informs me that twice he has observed the mole carrying worms along its run, drawing them backwards, most likely to form stores, as one would think one place would do as well as another for eating. On half-a-dozen occasions he found hoards of worms in their runs in considerable quantities, say as large as a man's fist. These worms do not seem to have power to depart, and bear every appearance of having been paralysed.

The mole-hills seen over the country-side are not to be mistaken for the mole's nest. As has been already said, they are formed by the soil ejected at the shafts. The nest is

under a hillock of earth larger than the mole-hills, and without any effort at concealment. We have in most of our articles on moles a mathematical design of galleries and passages in symmetry as beautiful as a spider's web, but this is all wrong. A French naturalist, Le Court, is said to have been the originator of this plan, which goes to show the danger of plagiarism. The nest consists of dry grass or leaves, whichever is most obtainable. The passages leading into it vary from one to five, but there are usually two or three on a level with one another, while another leads downwards and all join the runs.

The mole is polygamous. If you see a female hare running across a field and watch for a few minutes, you will soon observe a few others following in its spoor. In the same way in the breeding season the mole-catcher often catches several males in one run. During this period there are many fights between males. This is evidenced by the fur on the breast being scratched at this time, most likely by the forefeet. The skin on the breast is very thick. Young moles are occasionally noticed in the autumn, but whether there are two litters in a season is not quite certain. If the district is what is technically known as "dirty," only two or three are born; but if "clean," as many as four to six. There are six teats on the female.

During the breeding season it is rather curious that for a fortnight or so only males are caught, and it would appear that the females hide themselves. But immediately following this the males seem to retire from public life, and in their turn females for a like period are the only moles caught. The mole has been said to leave its runs in hot summer nights, but this is questionable. With few exceptions they pass their lives under the soil. One exception I have already mentioned. Another is after the young have grown to maturity they get notice to quit. If they do not depart, the male immediately kills them. In their haste to escape some of these young moles arrive at the top, where they fall a prey to their enemies the weasel, the hooded crow, and the jay. This seemingly cruel proceeding is of course necessary, as the food-supply required must in the case of a family be very great. As a rule, moles live singly, and it is only in the

early spring that there is any intercommunication. How long they live has not been ascertained. Their numbers are, however, great. In a "dirty" piece of ground as many as 112 have been caught in a day.

A rather curious coincidence might be remarked here. The worm, as you know, is very useful for disintegrating the soil. The mole, its natural enemy, carries on the same work, and so the balance of nature is maintained.

The enemies of the mole, I have said, are the weasel, the hooded crow, and the jay. In its endeavours to reach its prey the weasel enters the runs, and to avoid it the mole burrows fresh ones, throwing the earth behind itself and sometimes digging perpendicularly downwards.

Some of you will perhaps wonder why the farmer should have such an antipathy to moles, seeing that they are not vegetable eaters, but feed exclusively on worms, insects, grubs, and the like. In a field with young turnips great injury is caused to the crop by drought, the runs of the mole along the drills over the field acting as so many tunnels, depriving the plant of moisture. In the case of young grass, injury is caused by the mole-hills covering the field, and rotting out the grass. In pasture each mole-hill simply deprives the sheep of so much grazing, and the mole is of course partial to the richest bits of the land where its food is most plentiful. When, therefore, there are numbers of moles on a farm, it is a very material loss. On the moors, too, it is troublesome on account of filling up the surface-drains made to carry away the water. In its progress it of course takes the easiest way, and when it accidentally feels the soil easier on the side of the water-channel it takes its course parallel with that, turning the soil into it. On the other hand, it carries on a good work in keeping down insects which might grow too plentiful and be very injurious to crops, &c. Whether we would benefit by its extermination is an open question. In Scotland, however, it is destroyed on almost every occasion.

The diseases of a mole is a difficult matter to say anything on. Being treated as vermin, there is not much consideration given to this, but it is known that by their promiscuity they contract a venereal disease which dispenses with the services of a mole-catcher; and of course they are subject to parasitic

insects such as the Pulicidæ. It is also known that they are troubled with the cystic form of a tape-worm, which you are aware requires two hosts.

There are three ways of destroying moles: by strychnine, by laudanum, and by traps. The strychnine method is to apply it to a worm and then to insert the worm into a run. That by means of laudanum is to pour laudanum into the run and cover the orifice quickly. The common way is by a trap, which usually strangulates the mole when caught. Sometimes the mole will not enter a trap, but will dig a run immediately round it. When it is difficult to catch, the strychnine worm is more generally resorted to.

The fur of the mole is peculiar, inasmuch as, from its insertion in the skin, it can lie in any direction. Thus it is very useful to the animal in its runs. Whether moving forward or backward, the fur assumes the direction in which it is stroked.

The skin of the mole is not in great demand commercially, and consequently the mole-catcher throws the skins away, as they are hardly saleable at a halfpenny each.

I have had the privilege of attending the burial of a mole. In my wanderings with the mole-catcher I have come across moles which, as I have remarked, are just dropped out of the traps and left to rot. In one case I remember we found that very interesting insect, the sexton beetle (*Necrophorus vespillo*), at work. It is perhaps not pertinent to the subject, but the mode of operation of this beetle might be mentioned. The burying beetles, having by their sense of smell located the carcass of a mole, rat, bird, or other small animal, proceed to scrape the soil at the side of the dead animal, which falls down as the earth is removed. The female beetle then lays her eggs in the body, where the grubs are hatched and live on the carrion.

The description and habits of the mole I have described are those of the common species, *Talpa europæa*, in which considerable variation in colouring is found to occur, such as sandy-brown, creamy-white, iron-grey, green-black, otherwise called mossy, blue-black, which is most common, piebald or black-and-white, black tipped with white hairs, and black with white belly, which colour points to its being a surface animal

originally, for surface animals are of lighter colouring on the belly than on the back. It is less disadvantage to the mole to depart from the ordinary colour than with other animals. An albino rabbit, being more conspicuous than an ordinary grey one, is consequently in more danger, but any colour to the mole in the dark is the same.

The common mole ranges over the greater part of Europe and Asia north of the Himalayas, occurring as far eastwards as Japan, and it is also found in the Altai Mountains. It is said not to occur in Ireland. Dr Scharff of Dublin, confirming this, tells me that the explanation usually given for its absence from that country is that the mole came to the British Islands from the Continent, but that Ireland was already separated from Great Britain when England was still connected with the Continent.

Of the Talpidæ there are something like a dozen representatives. All are limited to temperate regions of Europe, Asia, North America, and South Africa. The greater number of them have digging habits, but a few are aquatic and cursorial. The eyes of some are covered with skin, as in the *Talpa cæca* of Italy.

In point of antiquity moles are very old, and their fossil remains have been found in the Tertiary strata of Europe.

In conclusion, I should like to say that my contribution to this communication is infinitesimal compared with that of my friend Mr M'Leish, to whom I have already referred.

IV.—*NATURAL FORESTS AND THE GROWTH OF CONES.*

By Mr S. ARCHIBALD, Tomatin, Inverness,
Corresponding Member.

(*Read Dec. 26, 1900.*)

In ancient days, as every one knows, large tracts of this country were covered with dense woods, and when the Romans invaded it they had to cut their way through the pathless

forests of Caledonia. Many changes have taken place since those days. These ancient forests were gradually cleared away to make room for corn-fields, and many generations of trees have been planted (on limited areas), have grown to maturity, and been cut down for their timber. On some parts of the Grampians "still stand" a few patches of "the forest primeval," and in many mosses the roots of trees, the remains of old forests, are found in abundance. A curious and interesting example of this was brought to light not far from here, when the new Aviemore and Inverness Railway was being made. East from Tomatin, and between it and The Slochd (*slock*), the railway passes through a deep cutting of moss and bluish clay. In the moss, which will be nearly 10 feet deep, are the remains (tree roots standing *in situ*) of three successive forests. After the first one was cut down, a deep layer of moss had been formed completely covering the roots. On this a new forest had been planted, and so on, the third also being completely covered, the country for miles now presenting the appearance of an ordinary heath-covered moss, on the outskirts of which people have been cutting their peats for generations, I suppose. In many other mosses in this neighbourhood the roots of trees are quite common, but mostly of birch, of which there are large natural plantations and scattered trees in the glen, and these add much to its beauty. A number of thriving young plantations, mostly of fir, are rapidly growing up around, giving more beauty to the glen, as well as affording shelter for game; and they will in course of time produce useful timber. These young forests afford good opportunities for the study of the growth of trees.

The fir tree is monœcious (unisexual), the male and female flowers being separate, but on the same tree, though it is quite common to see a tree appropriated almost or altogether exclusively by flowers of one sex. The male or pollen-bearing flowers arrange themselves in dense spikes of very small catkins at the *base* of the part which has grown during the season, and preferably on trees where the season's growth on branches and branchlets is very short, and they shed their pollen in clouds, forming the well-known "sulphur" of rustics. The embryo female cones form close outside the buds on the

top of the season's growth, singly, or in two's or three's; sometimes more. The female cones require three summers to come to maturity, growing to about the size of peas the first year, to their full size the second year, and in the third the scales become dry and open out to allow the now ripened seeds to escape, the cones at the same time dropping off.

Cones seem to be plentiful all round this year (1900), and some trees are densely covered with them, in two's and three's and half-dozens, and frequently in large clusters, though none that have as yet come under my observation are equal to some that I saw in the fir woods of "The Mearns" nearly fifty years ago. They would contain fifty or sixty or more cones each, arranged in a dense spike nearly the whole length of the season's growth. Since then I have seen nothing to equal them, but this year the abundance of cones, and the prevalence of good-sized clusters or spikes, containing from ten to thirty or more cones each, form rather a remarkable feature, and seem worthy of being taken notice of by the naturalist. On the tree from which the specimens now exhibited were taken there were eight or ten good-sized clusters, and some larger ones are to be seen, but, being on central stems, could not be removed without spoiling the tree. One tree, besides bearing several such clusters, has at the tops of the *same* shoots large spikes of embryo cones, which promise to continue the feature for another season. In the few places in the neighbourhood where spruces have been planted and attained any considerable size, a great profusion of spruce cones is quite a feature almost every year.

In connection with the foregoing, it may be noted that the past summer was a great fruit season. In this strath, black currants, which seem to be the chief fruit grown, were a heavy crop everywhere. In our own garden, 1074 feet above sea-level, the crop on the few bushes we have was extraordinary. On account of want of shelter from strong westerly winds, the bushes have to be pruned like gooseberry bushes, to keep them low and the branches strong; but even with that, the branches had to be supported to prevent them being broken with the weight of fruit.

In the case of either fruit bushes or trees, a season of

plenty (of fruit or cones) must be preceded by at least one good summer for ripening the wood and forming good buds. The summer of last year was such an one, having been warm on the whole, and very dry till the middle of October. What may follow this one it is hard to say, but all through it has been bad enough—wet, cold, and sunless; and seemingly it means to keep up its character to the end of the year. Let us hope that the opening year of a new century may bring us something better.

As regards the different kinds of conifers which grow and thrive in this district, I may add in conclusion that I visited lately Corrybrough, near Tomatin, where there is a large mansion-house with many fine trees growing around it. Accompanied by the gardener, who received me very kindly and lent me every assistance, I noted the following trees, all of which were strong and healthy, and evidently growing rapidly:—

1. Sequoia gigantea, planted in 1872, now about 60 feet high, and 6 feet 4 inches in circumference at 3 feet from the ground; a grand specimen.
2. Douglas Fir, about same age, nearly 40 feet high, and with an enormous spread of branches.
3. Thuia Lobbi semper aurea.
4. Thuia gigantea, a young tree, growing rapidly.
5. Thuiopsis borealis (=Cupressus Nootkatensis).
6. Cupressus Lawsoniana elegans.
7. Cupressus Lawsoniana, a seedling variety.
8. Retinispora, a young tree 4 feet high.
9. Retinispora plumosa aurea (=Cupressus pisifera plumosa aurea).
10. Pinus excelsa.
11. Pinus cembra (Swiss Stone pine), a tree of considerable age, about 40 feet high, the trunk nearly 2 feet in diameter, well shaped, and very dense; a grand tree, said to be the second best of its kind in this part of the country.
12. Firs in great variety, including silver fir.
13. In nursery beds, numbers of young trees of most of the above species preparing for planting out, and all evidently thriving well.

V.—*NOTES ON THE TOPOGRAPHY AND FLORA OF STRATHDEARN.*

By Mr S. ARCHIBALD, Tomatin, Inverness,
Corresponding Member.

(*Read Dec. 26, 1900.*)

Somewhat to the east of the middle of Inverness-shire a large area is covered by a billowy sea of mountains, called the Monadhliath (Mon-a-le′-a) Mountains, with many summits, the highest, Carn Mairg, rising to a height of 3087 feet. Down the steep sides of these mountains rush an immense number of small streams to form and to feed the Findhorn, which has a rapid course of about 70 miles in a N.N.E. direction. The Gaelic name of the river is *Eire*, genitive *Eireann*. Hence Strath(d)eireann, or Strathdearn (the *d* being euphonic) is the valley of the Findhorn, the name being more particularly applied to the upper part. Dalarossie (pronounced Dal-ar′-os-sie) is Dail Fhearghuis, the Dulergusy of 1224-42, the "Dale of St Fergus," to whom the chapel there was dedicated.

Near the middle of its course the Findhorn is crossed by the highroad from Perth to Inverness, and a little over half a mile farther down by the new Aviemore and Inverness Railway, the former on a substantial iron girder bridge built in 1881, and the latter on an immense girder viaduct. The following notes apply to the part of the strath upwards from the highroad, from which a road leads up the glen for about fifteen miles. The whole of this part of the strath is essentially Highland. Where the glen road leaves the highroad, the elevation is about 980 feet; at nine miles up it is 1220 feet—a rise of about 240 feet. In the next six miles it rises 400 feet or more. For ten miles or so of this part of the strath there is a narrow strip of cultivated or cultivable land, with mountains rising abruptly on each side. Near this place (Dalarossie) the glen, which here lies E. and W., widens out considerably, sweeps round to the south, receiving affluents from two tributary glens on the outside of the

curve, with farms and shooting-lodges around; then through a narrow gorge with precipitous mountains on either side, which become higher and wilder as one advances up the glen. Some distance farther, or about nine miles from the high-road, one comes to another widening of the strath, surrounded by an amphitheatre of still higher mountains. This picturesque, peaceful-looking, and very secluded little valley is the abode of a colony of crofters, who all appear to be in comfortable circumstances. This and the previous expansion of the valley seem to be the beds of ancient lakes with the remains of the natural embankments which gave them being. Beyond the Coigs (the names of these crofters' homes all begin with *Coig*) the glen becomes wilder, and is entirely given up to game, one of the chief being deer. (The whole of this district is great in game.) A palatial shooting-lodge, with its electric light, &c., has recently been erected just about three miles short of the end of the road.

The prevailing rock of the district is granite, of many varieties as to size of grain. A coarse kind of limestone is got in some of the hills near, but is not now worked, though not many years ago a good deal was quarried and burned, chiefly for manure; and at each farm-steading, whether standing or in ruins, the remains of a lime-kiln are to be seen.

Strathdearn, like Strathnaver and many other Highland glens, has become greatly depopulated within the last forty years or so; but it seems to have come about more naturally than in the case of "Bonnie Strathnaver," about which the late Professor Blackie sang so touchingly.

In a bend of the river three and a quarter miles up from the bridge on the highroad stands the half-ruinous parish church of Dalarossie, surrounded by its ancient burying-ground. In the churchyard there is a stone of very great interest, but whose history it is not easy to read. In shape it is a roughly made circular basin about 18 inches wide inside, and at present it is sunk in the ground in an unused part of the burying-ground nearly to the level of the brim. From what was said before, it will be seen that Dalarossie (Dulergusy) dates from a remote time, and the popular tradition makes this stone to have been the font for the "holy water"

in the days of old when the Roman Catholic religion was the religion of the country.

In the days of witchcraft, Dalarossie churchyard was considered a very holy spot—sufficiently so to afford sanctuary to the spirits of the unfortunate creatures who had sold themselves to his satanic majesty, if, after quitting connection with their mortal bodies, they could but reach the holy spot before being caught by their master. A story is told of one notorious witch, who lived at Laggan in Strathspey, and who in her lifetime had done an enormous amount of mischief. On her demise her spirit-form made for Dalarossie churchyard, distant about fifty miles, with all the speed of which she was capable, thinking to cheat her master of his due; but, mounted on the proverbial black steed, and accompanied by his faithful hounds, he was soon after her in full cry, and caught her just outside the gate of the sanctuary.

Of the flora, which is, of course, of a sub-alpine character, I have not made anything like an exhaustive study, but endeavour to keep my eyes open as far as possible for anything that is rare or interesting—and it would be a very poor locality indeed that did not yield a considerable number of interesting subjects, and perhaps a rare one here and there. As there is "nocht like Heelant heather," we will begin with this most plentiful production of all our Highland mountains, and even of our Lowland plains, but which is beautiful everywhere. There is no need for me to enlarge on the charms which it imparts to the landscape wherever found. Erica cinerea and E. tetralix are also plentiful, the latter, with its lovely waxy bells, growing in great profusion on some of the places on the hills where we cut our peats. Native birch, I need hardly say, is abundant. Juniper is quite a feature, some slopes being almost completely covered with it. It may be noted that juniper belongs to the Coniferæ, and that, like fir cones, the juniper berries take three years to ripen. Another shrub worthy of note for the profusion in which it grows "down the country" is Myrica gale. On the hills around, Loiseleura (Azalea) is plentiful. In spring and early summer, primroses are abundant, followed by Anemone and Trientalis. By the river there is abundance of Trollius, Geranium sylvaticum, and here and elsewhere Carduus hetero-

phyllus rears its lordly head. By the side of the river are also to be found, but sparingly, Saxifraga stellaris and Oxyria reniformis. Parnassia and Menyanthes, the two rival belles in the floral world, are frequently met with. While admiring to the full the exceeding loveliness of each, there is another flower with whose beauty I was much struck when I met with it (for the first and only time) in a wood in Ayrshire, and which in my opinion will make a very close third. I refer to Cephalanthera ensifolia, with its graceful, sword-shaped leaves (as its name implies) and handsome spike of pure white flowers. Of the Orchis family in this district I have noted Orchis maculata in great profusion, Gymnadenia frequent, Habenaria bifolia and H. albida sparingly, and a few plants of the rare Malaxis. Drosera rotundifolia, Pinguicula vulgaris, and Narthecium ossifragum are plentiful. This past summer I noticed growing by the roadside a few plants of Pedicularis sylvatica with pure white flowers. In autumn Scabiosa succisa is abundant everywhere in great variety of colour, occasionally white. *White* bluebells are also met with sometimes. (I always look with great interest at white specimens of our native flora whose normal colour is a dark hue. Some other plants which I have noticed with white flowers are Agraphis in Fife, Geranium sylvaticum in Pitroddie Den above Errol, and Digitalis near Kilmalcolm in Renfrewshire.)

The most interesting fern I have observed is Botrychium (Moonwort), of which there are a few plants in and around our school-grounds here, and plenty in an old pasture half a mile away.

Of Lycopods, L. clavatum and L. alpinum are plentiful, and L. Selago and Selaginella selaginoides frequent. Equisetums are represented by E. arvense, E. sylvaticum, and others. Mosses, especially the commoner Hypnums, are in strong evidence. So are also the Sphagnums in our peat-mosses, and many other genera and species in their proper localities.

Although I do not know much of birds, I have noticed several pairs of bullfinches, and for the first time have seen the night-jar.

Altogether, from what I have observed in a cursory way, Strathdearn seems to present a good field of observation and study for the naturalist.

VI.—*A GEOLOGICAL TRIP TO AULTNACALLAGACH AND INCHNADAMFF.*

By Mr T. CUTHBERT DAY.

(*Read Feb. 6, 1901.*)

Far away in the north-west of Scotland we have exposed to view some of the very oldest rocks, geologically speaking, that are to be found in the world. In addition to this, great dislocation and overthrusting of the strata have taken place in this district, which has had the effect of complicating in a very great degree the geological study of the rocks. The tract of country to which I allude stretches in a narrow strip from a little to the east of Cape Wrath—namely, Whitten Head on Loch Erriboll—to the island of Skye. It was known for a long time as the "Secret of the Highlands," and for many years baffled the ingenuity of geologists, though you may be sure many and arduous attempts were made to solve the problem. Within comparatively recent years the puzzle has been in a great measure cleared up, and the country carefully mapped. It was only by persistent study, sheer hard work, untiring industry, and careful attention to minute detail that this was accomplished. The names of those who took part in this great work are well known, and it is unnecessary for me to attempt to assign individual merit where all have shone conspicuously. They have made for themselves a monument more enduring than brass.

It was the desire to study this interesting district that took me northwards in the summer of 1895 to spend a nine days' holiday, all too short for the purpose, in going over a portion of the country now so well mapped out, and especially that part which has been affected by earth movements. Fig. 1 is a sketch-map of the part visited. To get there, the usual course is to take train by the Highland Railway *viâ* Inverness to Lairg, and there to take a place in the mail-cart, which goes daily from that place to Lochinver on the west coast. The distance from Lairg to Aultnacallagach is about twenty-five miles. In the first part of the drive the country is fairly

wooded and interesting, but after six miles or so are passed we

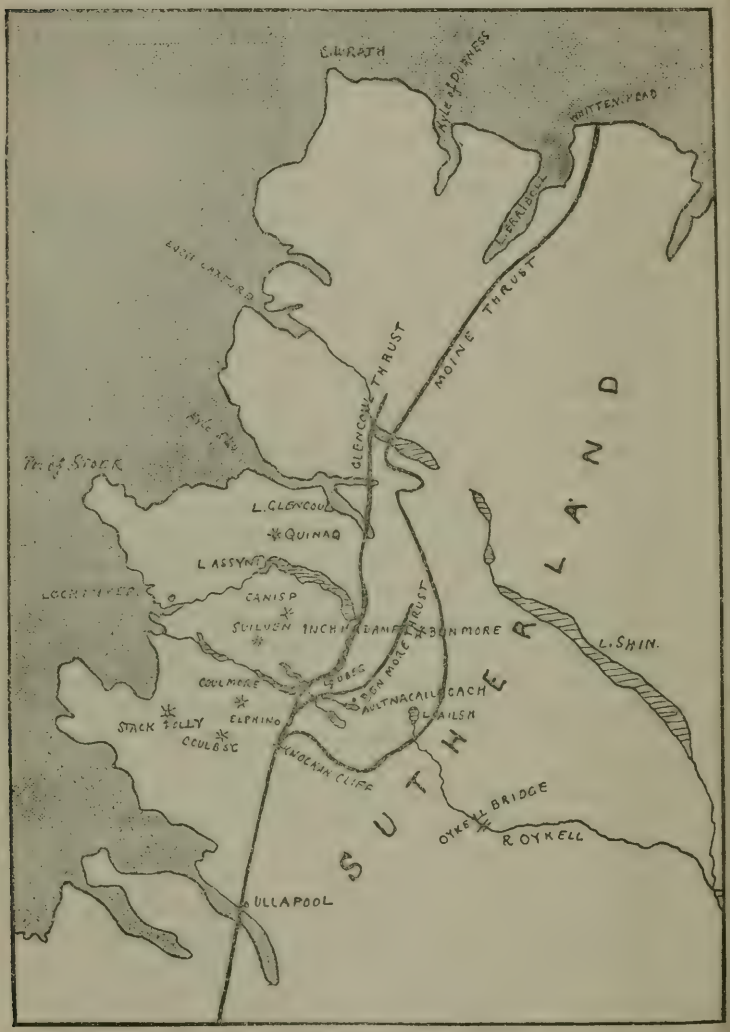


Fig. 1.—*Sketch-map of District.*

get out on to the open moorland, a dreary heath-covered waste

with little to break the monotony. The underlying rocks of the whole of this district consist of plicated and drawn out schistose rocks (Plate XIV. 1), the geological age of which still remains undetermined. At Oykell Bridge, where there is an inn for the accommodation of salmon-fishers, we cross the Oykell river, a swiftly flowing stream, which has eaten for itself a channel in these same rocks. They are well exposed on its banks. In process of time Aultnacallagach is reached. It is neither a town nor a village, but consists of an inn with a wooden annex, stables, a few sheds, and perhaps two or three cottages. The accommodation is good and the fare excellent. Situated close to the margin of Loch Borrolan, with the highway only between, and the great mass of Cnoc-an-Sroine rising behind, the name Aultnacallagach means the burn of the deceiver. I found it to be a great place for trout-fishing, and several gentlemen were staying at the hotel for that express purpose. The sport is excellent, as there are about five lochs connected with the hotel. When we became acquainted, we had many disputes regarding the merits of fishing on the one hand and the study of geology on the other as a means of spending a holiday. I was in a very small minority, but stuck to my guns with determination, and endeavoured to show that I had the advantage, 1st, financially, and 2nd, in the enduring results when the holiday was finished.

One great advantage of Aultnacallagach is the long daylight in summer. It has a few drawbacks, however. The weather, which I found to be exceedingly capricious, limited my excursions considerably. Then another and formidable foe appeared in the form of the light and airy midge, also in the more cumbrous but not much more venomous clegg. I had not reckoned with these interesting parties when I laid my plans, and suffered severely in consequence. However, one of my fishing friends had a bottle of a compound the name of which spelt death to any midge that had the hardihood to absorb the least particle of it into his system. This compound is to be freely rubbed over the skin, and it will entirely prevent midges biting at all. I don't know much about insects personally,—I am afraid my energies have been rather exerted to compass their destruction than to study their anatomy. I was assured, however, by my friend that the usual tactics of the

insect in question were as follows: The midge first finds a man, and, after expressing his delight, he settles on his victim, but he does not bite straight away; with a circumspection far beyond his years, he gives a lick first. "Taste and try before you buy" is his motto. I was assured that, after this preliminary test had been applied, if there was no liniment as a protection, the next act on the part of the midge was the prompt insertion of a set of fangs, rendered doubly sharp by a healthy appetite; and the unhappy tourist had to carry the marks of the onslaught some few days before they disappeared. I gladly took advantage of the remedy, and had much cause to be thankful, for in many places one could positively feel the clouds of insects pass like cobwebs over the face when walking.

We shall now look at the geology of the district broadly (fig. 1). To the west, for the most part, lie the rolling plains of the archæan gneiss, the most ancient rock of which we have any record. Upon this, as we move eastwards, we find the Torridon sandstone, lying in patches, and rising into many separate, rather conical, and high mountains, such as Quinag, Canisp, Suilven, Coulmore, Coulbeg, and Stack Polly. These mountains, from their peculiar position and shape, have a remarkable appearance, particularly Suilven and Canisp, which can be well seen in the vicinity of Aultnacallagach. There they have stood through countless ages, weather-beaten and scarred, the hoary sentinels of that rock-bound coast. Still going eastwards, we come to a series of rocks whose outcrop is sinuous, but the strike runs in a direction from N.N.E. to S.S.W. They consist, first, of a band of quartzites, then the fucoid beds; above these the serpulite grits; and then, above all, a considerable thickness of limestones. All these beds dip below the surface, at a low angle to the east. Just as we come upon the line of these rocks we find, on still going eastward, that they are very much broken up, scattered, and misplaced—indeed to such an extent that we find the archæan gneiss, undoubtedly the oldest rock of all, in many places overlying the much younger limestones; and many other curious inversions have taken place. This confusion in the rocks has been caused by great disturbances and a powerful thrusting movement from the east towards the west. It is as if the strata had been first

broken up by a powerful upheaval and then pushed together like a pack of cards. The outcrops of three main lines of thrust, the maximum thrust planes, have been traced, the truncated edges of which are shown by the three black lines on the map. The lowest one is named the Glencoul thrust, as it is extremely well developed on the banks of Loch Glencoul. The next in order is the Ben More thrust, and is well displayed in the vicinity of Ben More of Assynt. The third thrust plane is called the Moine thrust, because it brings the Moine schists which lie to the east on to the top of the limestones in the Durness district. This thrust plane is well developed at the Knockan Cliff, a little to the south of the village of Elphin, and can be traced all the way from Whitten Head in the north to beyond Ullapool. You will observe that at the Knockan Cliff the three great thrust planes appear to coalesce.

Besides these three great maximum thrust planes there are others of less extent; for when the great movements took place the friction along the sole of the thrust caused the rocks more nearly concerned to break up and fold over one another, producing a complicated series of major and minor thrusts. To the east of the outcrop of the last great thrust plane lie the Moine schists over many miles of country. To explain the matter more fully, I have prepared the following diagrams (fig. 2, *A*, *B*, *C*, *D*), in which we shall trace roughly the building up of the geological series in this district. Fig. 2, *A* takes us back to the time when the gneiss was the only rock in the place: here we see a section of it. It is usually supposed to consist of a great mass of eruptive rocks of a more or less basic type. These have been foliated by powerful mechanical movements within the mass, which was afterwards invaded by numerous dykes of molten matter and again subjected to great shearing and crushing movements. Here we see it at the surface, the sea and atmospheric influences together reducing it to a plane of denudation. This rock, where it appears at the surface, now produces a typical scenery. It forms rolling tracts of hummocky rock, mostly low-lying, as in Barra, but sometimes rising as high as 600 or 700 feet, as at Lochinver. The surface exposed by the old gneiss now is probably little different from that left by the old plane of

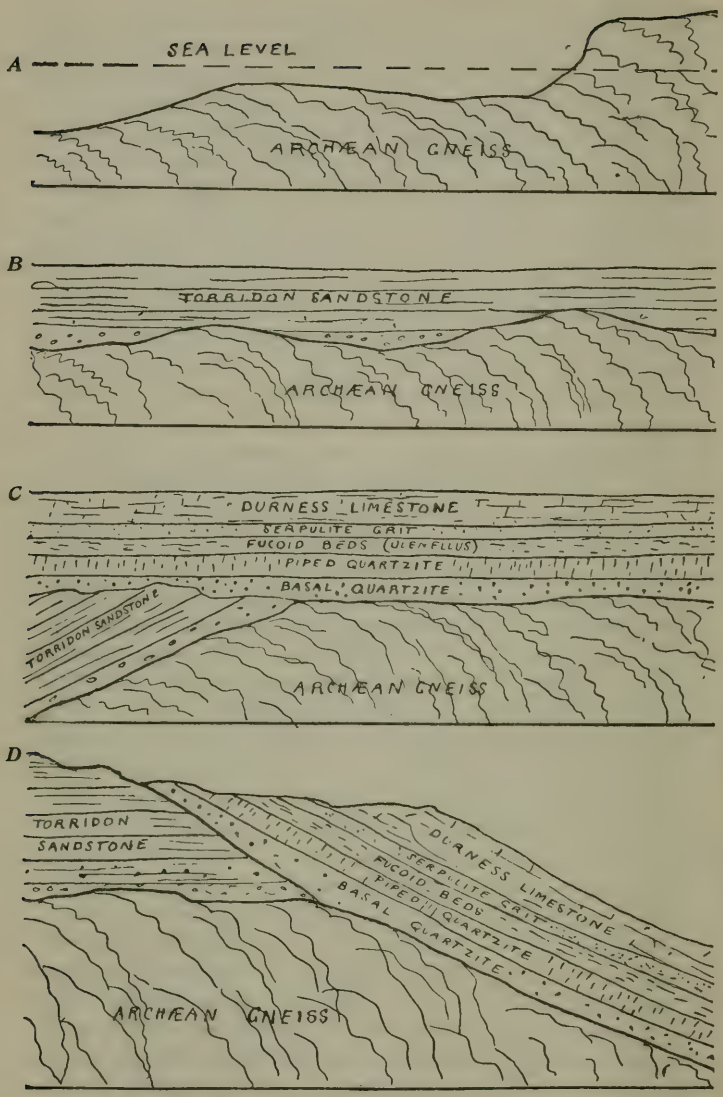


Fig. 2.—*Building up of Geological Series.*

denudation previously referred to, the smooth rounded appearance it now has being impressed upon it by severe glaciation in the Ice period. Where the rock has been exposed to recent prolonged denudation it breaks up into wild crags, as can be seen on the west coast line. Geikie describes gneiss as a schistose aggregate of orthoclase, quartz, and mica, with bands of hornblende schist, actinolite schist, mica schist, &c., and varying in texture from a fine-grained rock up to a coarse crystalline mass. Plate XIV. 2 gives a hand specimen, showing but little sign of foliation. A banded specimen is shown in Plate XV. 1, the dark bands being composed of hornblende or some allied mineral.

The second diagram (fig. 2, *B*) shows the levelled platform of gneiss being gradually submerged, and being covered, as it sinks, with a series of rocks composed of conglomerates and fine sandstones, in layers, and of great thickness, some thousands of feet. These are the Torridon sandstones. From their general appearance they must have been accumulated at a fairly rapid rate, as broken and not much weathered crystals of felspar are frequent. They probably represent an extensive lacustrine deposit. No distinct fossils have yet been found. The sandstones contain many pebbles derived from the gneiss itself, and also many of quartzite, &c. Plate XV. 2 is a specimen obtained from the base of the series on the shore of Loch-an-Fada, on the slopes of Suilven. After these sandstones had obtained their full thickness the land rose again above the level of the water, was bent into gentle folds so that the sandstones were tilted at low angles to the horizontal, and the whole mass was subjected to an enormously long period of denudation, during which, over wide areas, the sandstones were completely removed from the underlying gneiss. Subsidence again took place, and we see, as in the diagram fig. 2, *C*, the tilted and denuded ends of the Torridon sandstones, and the exposed gneiss being overlaid by a great series of rocks, which lie unconformably along the upturned edges of the tilted sandstones. The internal evidence afforded by this fresh series of rocks points to the conclusion that the subsidence was more rapid this time, and carried to a greater depth. The first layer, basal quartzite, is composed of a rough quartz conglomerate (Plate XIV. 3), 200 to 300 feet thick. Above this

is another layer, 200 to 300 feet thick, composed largely of fine white quartzite, so white and pure that it looks like loaf-sugar, and has had the term "saccharoidal" applied to it. In many parts it has a pink or reddish colour. In this series occurs the famous piped quartzite (Plate XIV. 4, 5), the pipes being composed of a quartzite somewhat harder than the matrix. They are supposed to mark former worm-burrows in the rocks, as they were being deposited in the soft state at the bottom of the sea. These markings are very abundant, and are a characteristic feature of the quartzites. Plate XIV. 6 shows a "pipe" in longitudinal section. Above the layer of piped quartzites appear a series called the fucoid beds, 40 to 50 feet in thickness—so called from certain peculiar markings which the earlier geologists took for sea-weeds. These marks are now understood to represent the flattened castings of the various worms that swarmed at that period (Plate XV. 3).

The careful examination of these beds, which are composed of calcareous shales and sandstones, with bands of rusty dolomite, has afforded evidence which establishes with a fair degree of certainty the true geological position of these rocks. Remains of trilobites have been found, and of one especially, termed Olenellus, which is particularly characteristic of rocks of Lower Cambrian age—that is to say, about as ancient as the lowest sedimentary rocks in Wales, and long supposed to be the very oldest. You will see the importance of this discovery: it stamps these series of rocks, beginning with the basal quartzites, as being of Lower Cambrian age (fig. 2, *C*); and you will have observed that these rocks lie unconformably on the edges of the Torridon sandstones; and when you regard the enormous interval between the time the Torridon sandstones were laid down and the time when the quartzites were commenced, you may be able to form some slight conception of the venerable antiquity of these sandstones. In fact, as far as I am aware, they represent the *oldest* water-laid rock, of which we have certain knowledge, in the world.

Above the fucoid beds we come to the band called the serpulite grit, thirty feet or so in thickness, which marks a shallowing for the time being of the sea where it was deposited. It is composed of massive grit, and in many parts the remains

of serpulites are found—*i.e.*, the little calcareous cases of a small species of worm (Plate XVII. 1). You may examine this rock over wide areas and find nothing to speak of in the way of serpulites, but in some places it is crowded with them. This specimen, which I secured on the road between Aultnacallagach and Inchnadamff, close to a small loch called Loch Awe, you see is crowded with the little fossils, and looks almost like a piece of ripe stilton cheese. I happened to come across a portion of this rock in a burn called Allt-an-Uamh, where it had been invaded by a dyke of basic igneous rock. Contact metamorphism had taken place, and the grit, which is here free from serpulites, was fused into a kind of bluish glass. Above the serpulite grits (fig. 2, *C*) come a series of limestones, probably laid in deep sea water, 200 to 400 feet thick. Various fossils have been found in this series, but only at Durness. Formerly considered to be of Lower Silurian age, but now regarded as Cambrian, most of the beds are traversed by worm-casts in such a way that nearly every particle must have passed through the intestines of worms. It is seen in great thickness in the great limestone plateau at Inchnadamff. A few scattered cottages and the hotel comprise the little hamlet which is picturesquely situated at the southern extremity of Loch Assynt. The great thickness of the limestone here is due to the piling up of the strata due to overthrusts. Now referring to fig. 2 *D* again, we see that the land had been again tilted, and in such a way as to bring the Torridon sandstones back to their original level position, while all the overlying beds now dip away to the east at a low angle. That is roughly the position that they occupy now; but towards the east, as before mentioned, great dislocations, upheavals, and thrusts have taken place, and the broken-up mass has been pushed forward from east to west and piled up in lines, as I showed you before, marked by the outcrop of the three principal thrust planes—the Glencoul, the Ben More, and the Moine. The next diagram will make this clear (fig. 3). This diagram gives a section from Quinag east by Achumore, Glasven, Ben Uidhe, and head of Glen Beg, covering a distance of about seven miles. There are two of the great thrust planes shown here—that of Glencoul at the foot of Glasven, and of

Ben More at the head of Glen Beg. We can see in this section how the long band of quartzites lying on the archæan gneiss, which in its normal position should be continued underground, dipping to the east, has been brought up to the surface, and with it great masses of the gneiss. The figure plainly shows how the whole upheaved mass has been thrust forward along definite thrust planes, till the quartzites and limestones to the west have been completely overwhelmed, and we find the anomaly in the field of the older rocks superimposed on those of a much later date geologically. This magnificent section can be well seen at Inchnadamff, and gives to the eye the impression of a great range of mountains which has been brought bodily forward. I believe these great disturbances are supposed to have taken place about the time that the volcanoes of the Lower Old Red Sandstone period were pouring out their lavas, which are to be seen so largely

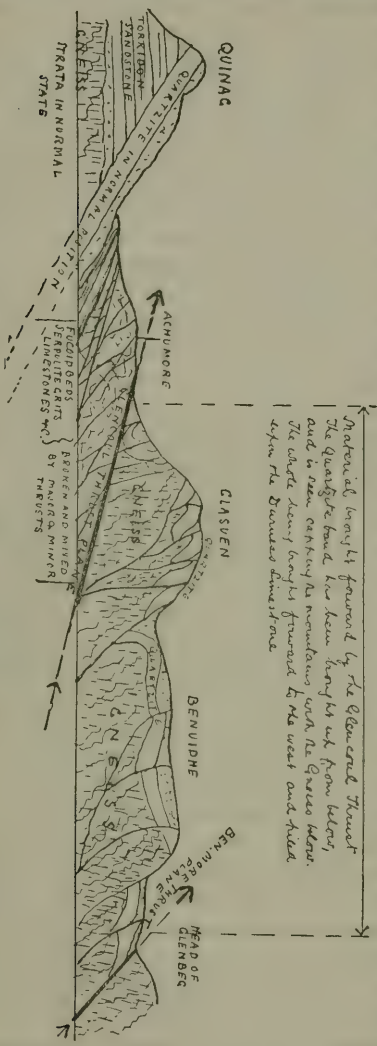


Fig. 3.—*Section from Quinag to Glen Beg.*

represented in the Ochil Hills and in the Pentlands near here. When we look at the magnitude of these great earth movements, we can well understand that the rocks in the immediate vicinity of the thrust planes themselves must have been much altered in their structure by the grinding and crushing process to which they have been subjected. Such is indeed the case, but in the limits of these short notes I do not intend to enter into particulars of change of mineral character, but merely to show you a few of the specimens of various kinds that I obtained from under the three great thrust planes.

Quite close to Aultnacallagach a considerable patch of igneous rock occurs which bears the name of Borrolanite (Plate XVI. 2). It has been much sheared by movements between the Ben More thrust and the Moine thrust. You will easily observe the pulled-out appearance of the white crystals of felspar. On the shores of Loch Cama, about three miles west of Aultnacallagach, we can see the quartzites much affected by the Glencoul thrust (Plate XV. 5). This specimen is much slickensided, and the mass of it so broken up that a slight tap with the hammer would suffice to smash it in pieces. Turning now to the S.W., we pursue our way through the little village of Elphin for an additional three and a half miles till we arrive at the famous Knockan Cliff, where the Moine thrust is so well displayed. Here, immediately under the Moine schists, are the crushed and torn limestones turned almost into a kind of marble by the treatment they have undergone (Plate XVI. 1). You will observe in this specimen the peculiar brecciated appearance suggestive of crushing and grinding. Here is another specimen of limestone (Plate XV. 4) from the same locality. It is weathered on the surface, and shows in rather a striking way two separate lines of movement to which it has been subjected.

On the way back to Aultnacallagach we shall turn nearly a mile out of our way on the road towards Inchnadamff to visit the Ledbeg marble. This is a case of contact metamorphism. The limestones have, by the intense heat of the large intrusive mass of igneous rock which forms the bulk of the hill Cnoc-an-Sroine, been converted into marble of

singular purity and whiteness—the well-known Ledbeg marble (Plate XVI. 3).

To the east of Aultnacallagach, say about three miles, is a little loch called Loch Ailsh. It lies in a valley just under the Moine thrust plane, and in its vicinity the action of the great thrust on the limestones can be well studied. There you see them sticking up out of the ground like flagstones, sheared and drawn out till they are quite fissile, like shales, and subjected to such intense pressure that in many parts they are converted into fine white marble (Flaser marble) (Plate XVI. 4). You can see in this specimen how the marble tends to split along certain planes. Plate XV. 6 is another specimen of sheared limestone from the same place. Another rock there is in this place, evidently a limestone at one time, into which had been intruded a dyke of ultra-basic igneous rock. This rock had been much serpentinised, and when the thrust took place, limestone and dyke became inextricably mixed, the limestone being changed into white marble, the serpentine retaining its green colour, and the whole having somewhat the appearance of a pot of white paint into which a little green pigment had been stirred, but yet not enough to mix it properly (Plate XVI. 5, 6).

I have just one more specimen to show you: it is a piece of the crumpled schist from the Moine thrust at the same spot (Plate XVII. 2). This concludes these few notes on a district of great interest, and I trust, though they have been of necessity rather rambling and diffuse, they have been sufficient to show that any one with a geological turn can spend as much time as he has to spare, with profit, in the places spoken of. He will also bring home more luggage than he started with. His boots will probably be down at heel and pretty well used up, but his brains will be brightened and his experience considerably enlarged.

On account of the death of her Majesty Queen Victoria on the 22nd January 1901, the meeting of the Society called for the 23rd January was postponed until the 6th February,

PLATE XIV.—A GEOLOGICAL TRIP.

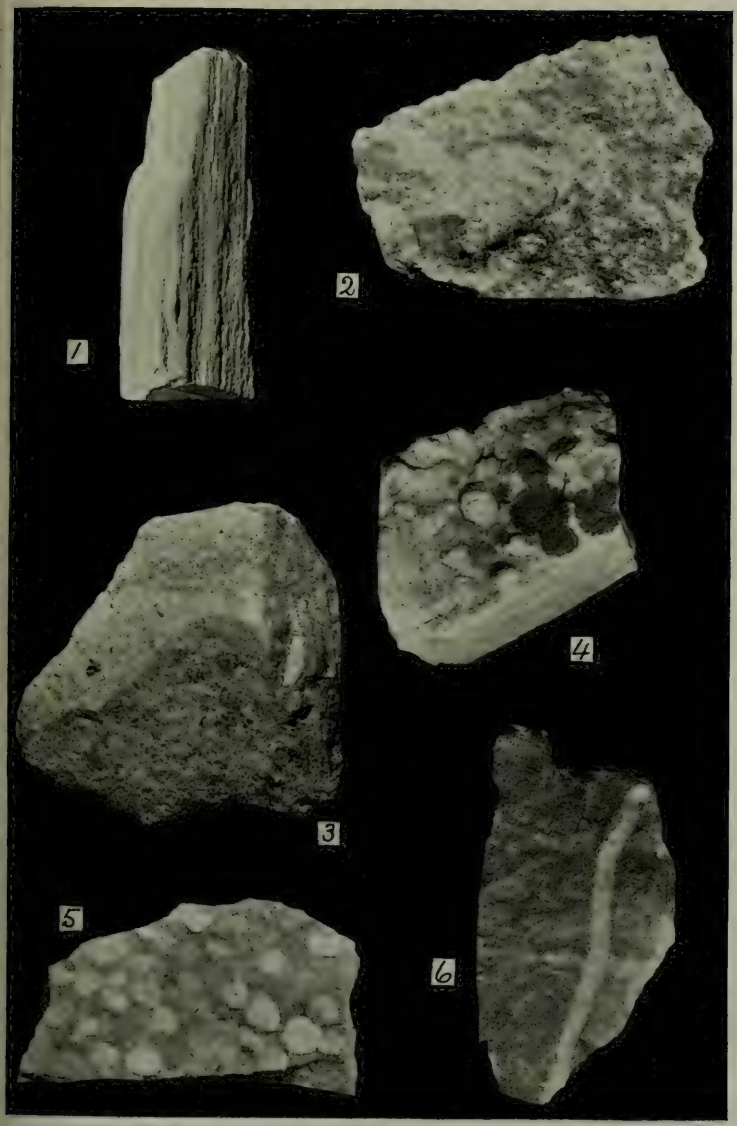
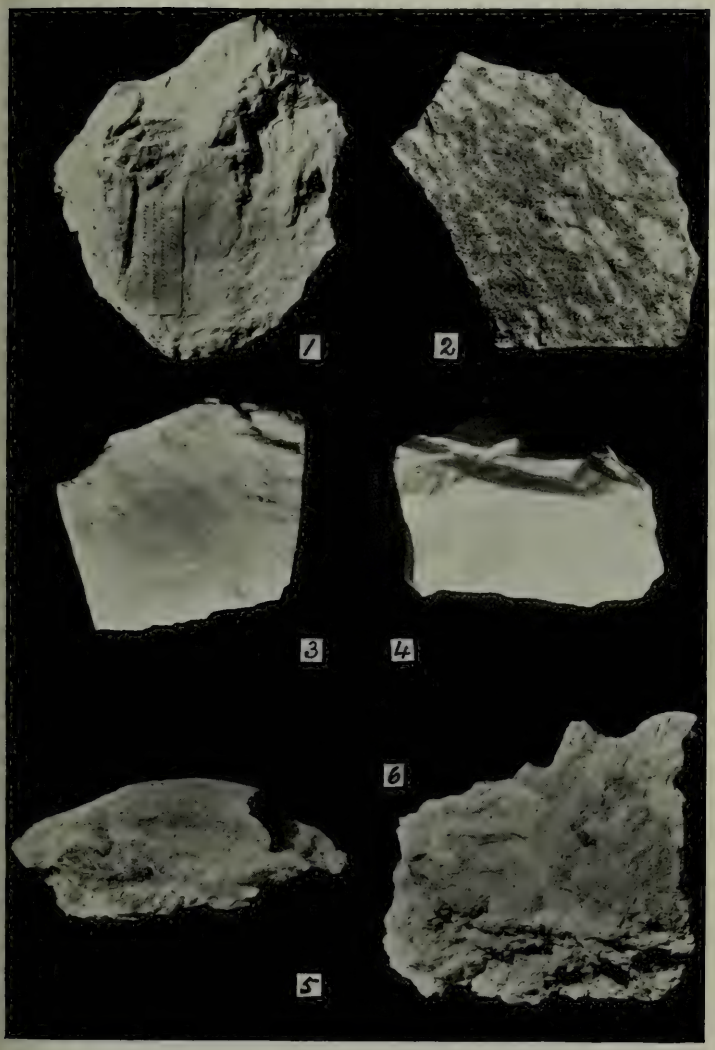


PLATE XVI.—A GEOLOGICAL TRIP.



when the above paper by Mr T. C. Day was read. At the same meeting Mr A. Murray contributed a paper on the Plane-tree; and Mr Charles P. Hobkirk, F.L.S., a corresponding member of the Society, submitted a communication as to the finding of a moss new to the British flora—viz., *Tortula cernua* (Hueb.), Lindb. This latest addition to our British mosses was found by Mr George Webster, of York, at the end of September 1900, in the West Riding of Yorkshire, in small quantity only, on the magnesian limestone near Aberford. It was stated that "now that attention has been called to it, . . . it may be detected by some of our active bryologists in other districts of Great Britain; but as it ripens its fruit in summer, it could hardly be recognised during the winter and spring months."

VII.—*MUSHROOM-CULTURE.*

By Mr JOHN PATON,

Manager, Scottish Mushroom Company, Limited,
Scotland Street Station, Edinburgh.

(*Read Feb. 27, 1901.*)

When I was asked to give a paper on mushroom-culture, I willingly consented, if the Society would accept one dealing chiefly with its commercial aspect. My friend Mr Malthouse will follow me with a paper of a strictly scientific nature on the same subject, and will be able, I have no doubt, to give us some valuable information. In dealing with my own theme,—that of mushroom-culture,—I shall confine my remarks to the *Agaricus campestris*, that being the only mushroom which is cultivated in this country. There are many other kinds which are pleasant to eat, some of them holding a higher place in the estimation of epicures, but as a universally appreciated mushroom the true meadow mushroom bears the palm. I am not aware that the effort has ever been made to cultivate any

other variety, the *Agaricus campestris* being the kind most desired. It is rather a curious fact that in Rome what we call toadstools are freely eaten, and the meadow mushroom is held in abhorrence. Nothing can convey the hatred of one Italian towards another more than by expressing a wish that he may die of a *pratiolo* (meadow mushroom).

It is unnecessary to enter into any detailed account of the many kinds of mushrooms. No doubt you are well aware that many so-called poisonous ones are really quite harmless, but, owing to popular ignorance, are left to waste instead of being utilised as an article of food. Still, it is hard to understand the reasons which influenced the authorities at Rome to issue a command that all meadow mushrooms should be thrown into the Tiber.[1] It is true that at Rome there is a plentiful supply of *Agaricus Cæsareus,* certainly the most delicious of all mushrooms, but even that does not justify the severe condemnation of *A. campestris.*

With such diverse opinions we do not intend to intermeddle at present, but will proceed to give a plain account of our mode of cultivating the mushroom from a commercial point of view. One of the first considerations is the kind of place proper to grow them. In the tunnel at Scotland Street we consider that we have an ideal place. It realises effectually all the conditions required: 1stly, evenness of temperature; 2ndly, humidity; and 3rdly, absence of light. This last element may be disputed as not absolutely required, but experience convinces us that it is a great assistance to the growth of mushrooms. Without these three essentials only a qualified amount of success need be looked for.

In order that mushroom-growing be successful from a money point of view, it is further necessary that a command of a steady supply of manure be assured. This can only be done by being contiguous to a large town. To attempt growing mushrooms at a distance from a large town would so increase the cost of the material by extra haulage and cartage, that it would

[1] "The stale funguses of the preceding day, as well as those that are mouldy, bruised, filled with maggots, or dangerous, together with any specimens of the common mushroom detected in the baskets, shall be thrown into the Tiber."—From the Rules of the *Inspettore dei Funghi* at Rome.

hardly compensate any one to attempt it. In such a place as Edinburgh, and with such a ready access to the Scotland Street tunnel by rail, we can always command a large supply of manure, and so the initial cost is much lightened. In the works there all the manure is taken down by rail to the sheds at Warriston. It is then unloaded and put through a course of turning. First, the long straw is all taken out, and the manure allowed to lie for a day or two. It is then again very carefully turned over, and this operation is repeated three or four times, as required, in order to allow the extreme heat to escape. When the heat is sufficiently reduced the manure is then loaded into trucks, and taken up the tunnel by the engine to the place where the beds are to be made. It is then unloaded, and the making of the beds is at once proceeded with. To do this different growers adopt different methods. In our case we have a mould the exact size of the bed, open at the top, into which the manure is thrown and pressed down hard. When the mould is full it is lifted off, and the bed is then seen to be made. We make our beds 12 feet long by $2\frac{1}{2}$ feet high and 3 feet broad at base, tapering upwards so that at the top each bed is only about 18 inches broad. The beds are laid transversely in the tunnel. When in full operation we have 800 beds, giving a surface measurement of about $1\frac{3}{5}$ acres. The tunnel is 1200 yards long, about 21 feet high, and 24 feet broad.

After the bed has been made by the mould it is left for a few days in order to allow it to gradually lower its temperature, for if the bed were spawned immediately after being made, the heat would burn the spawn and render it useless. The scientific mode of determining when the bed is ready for the spawn is by using a thermometer, when the heat should be about 90°. But for all practical purposes the right temperature can be decided by inserting a stick into the bed, allowing it to lie for a minute, and then withdrawing it and feeling the heat by the hand. The spawn is then broken up into the proper sizes, and inserted after a hole has been dibbled in the bed.

The bed is now ready for soiling, a duty which has to be very carefully done. We find it advisable to procure the

very best soil, which in a district such as this is not a difficult matter. Before using it we have it thoroughly broken up and disintegrated, so as to be free from lumps and all foreign matter. It is then carefully put on by hand and a coating of about 2½ inches applied. The bed is now completed and awaits developments.

I need hardly refer here to the common idea that mushrooms grow up in a night. This idea is erroneous, as under the most favourable circumstances they take from a month to six weeks to mature. The heat of the manure begins to work on the spawn, and gradually the mycelium, which is seen as a white, streaky matter in the spawn when first placed on the beds, begins to soften, and appears by-and-by as a thick viscous substance, which creeps all over the beds under the soil, and in course of time finds its way up through the covering of earth, by an enormous latent force bursting the soil, which is very firmly packed. Small dots, not larger than a pin-point, then appear, and from that time onward very rapid progress is made. Daily a great difference is seen, until in about a fortnight—sometimes only a week—mushrooms ready for the market are obtained.

It is not a necessity to the grower that he should have a knowledge of the life-history of the mushroom. What the spawn is botanists hardly know yet. We can see the spores through the microscope, but cannot tell their history. Sufficient for us to know where to procure good spawn, and experience soon teaches us how to get the best results from it.

It is a peculiar fact that, although the mushroom throws off innumerable spores, yet commercially they are not adopted as the foundation in making spawn. The spawn as used by makers is found in mill-tracks, riding-schools, in pastures—in fact, wherever horse-manure is found in a dry state; and in its midst there is found an article which is converted into a very valuable property. A small piece of virgin spawn is worth a large sum of money. When the spawn is found the manufacturer takes a very small quantity of it and mixes it thoroughly in a mass of horse- and cow-dung and road-scrapings. When it is thus distributed over the whole mass

it is formed into bricks. If the spawn is of good quality these bricks are quite sufficient to supply the beds with seed sufficient for the usual life of a bed, and will produce a large crop of mushrooms. It is very important that one should be able to judge one's spawn, as very inferior stuff is often put on the market, with the result that failure is writ large. Moreover, mushrooms will not grow—I am speaking in a commercial sense—in a dry locality. There have been many instances in our own neighbourhood of practical gardeners being tempted to grow them owing to our success and a market having been created for them, but their efforts have been comparatively futile.

As some of you are aware, we have had to suffer the presence of a blight, which might have discouraged many. For some years we have been contending against it, groping in the dark both as to its cause and its remedy. At present we have the promise of a cure. Able experts have been devoting a great deal of time to its investigation, and Mr Malthouse will tell you the result of his labours. Our success as mushroom growers naturally attracted the attention of all interested in the subject, both botanically and otherwise. When we began business fourteen years ago, the mushroom trade depended largely on French importations, and found an easy market. At the present time it would be as difficult to find French mushrooms on the market as it was to find English ones at that time. A comparison of any sample of French production with our ordinary crop will easily explain the reason. Our output is large, but we have a good market for all we produce. We have created a local traffic which is as steady as potatoes; and but for the blight which has done us so much harm, we would no doubt have had "a guid conceit o' oorsels."

It may be as well to say here—unless I am encroaching on Mr Malthouse's preserves—that the blight is not in any way caused by the conditions under which we grow mushrooms. If that had been so, we would have been compelled to retire beaten. We are satisfied that the blight has been introduced into the tunnel from the outside, and, having found a favourable resting-place, it is difficult to remove it.

VIII.—*A MUSHROOM DISEASE.*

By Mr G. T. MALTHOUSE.

(*Read Feb. 27, 1901.*)

I was asked last summer to examine the mushroom beds in Scotland Street Tunnel, Edinburgh, as they were attacked by a "blight." From the appearance of the mushrooms I felt convinced that the "blight" was due to the attacks of a fungus, and subsequent investigations have proved that this idea was correct. Mr Paton informed me that the disease first made its appearance in 1893, and since then it has spread throughout the whole tunnel, the loss caused by it being enormous. A year or two ago the Scottish Mushroom Company commenced to grow crops in Law Tunnel, Dundee, but in a very short time the disease broke out in that place also, and it was recently closed for a time. The rapidity with which the fungus spread in such congenial surroundings was so alarming that the advice of experts was sought on every hand, and several recommendations for disinfecting the tunnel were made, but none have proved effectual up to the present time.

The appearance of the disease in Law Tunnel, Dundee, is a point of great interest, for it illustrates in a very striking way how easily fungoid diseases like the one under notice can be spread. It is quite evident that the disease was carried to Dundee from Edinburgh by workmen who had been employed in Scotland Street Tunnel, and who took tools with them from Edinburgh. The tools and boots of the workmen would carry sufficient spores to give the fungus a good hold in the new tunnel as soon as operations commenced there.

I have, as yet, been unable to work out the complete life-history of the fungus, and therefore only propose to describe the form in which it appears on the diseased mushrooms, and then give an account of the experiments made with fungicides with a view to stamping it out. The appearance of a bed of mushrooms attacked by this disease is very striking. Instead of the symmetrical form exhibited by sound specimens (fig. 1) diseased ones present many curious malformations (figs. 2-10). These malformations may be divided into three types:—

1. Mushrooms in which the stalk and cap are fully developed, but are twisted and distorted, often appearing as if trodden upon. Fig. 3 is from a photograph of a clump of six mushrooms, and illustrates this type. In this type the stalk often splits open, and remains for a time after the cap is completely decayed (see fig. 4).
2. In the second type the stalk and cap develop rather feebly at first, and growth soon ceases in the cap, but the stalk develops further and becomes considerably swollen, as in fig. 5.
3. In the third type the mushrooms are completely hypertrophied, there being no trace of stalk and cap, the mushrooms resembling round whitish balls, as shown in figs. 6 and 7.

Although I have indicated three principal types of malformed mushrooms, there are a great many intermediate stages, as reference to figs. 8, 9, and 10 will show. The first and second types are combined in the clump shown in fig. 8. At the top is a mushroom belonging to type one, while all the others fall under the second category. Again, in fig. 9 the second and third types are represented on the left and right of the illustration. In fig. 10 there is a combination of all the forms. At the back one or two mushrooms of type one occur, the remainder of the mass coming into the third group, while in the foreground are some belonging to the second type.

In addition to being malformed, all the diseased mushrooms in the bed are covered with a felt-like coat which is at first white in colour, and which changes in a week or ten days to a dirty white or greyish hue (see fig. 9). Ultimately the whole mushroom becomes black and rots away. A very pungent odour is evident near beds containing many diseased specimens. The spawn when diseased has a very different appearance to healthy spawn. Fig. 11 is from a photograph of a patch of healthy spawn, and it has a characteristic thread-like appearance, preserving a sharp outline; but in fig. 12, which is diseased, the outline is not so sharp, the spawn being covered with the felt-like coat that is seen on the diseased mushrooms. Healthy spawn also forms a dense net-

work of filaments, whereas when diseased the branches are much fewer in number.

When the beds begin to produce mushrooms there is no sign of disease, the crop being apparently healthy, and continuing so for a period of from two to three weeks, but examination of the spawn reveals the presence of the fungus, and within a month distorted mushrooms begin to grow. The first of the diseased specimens are all of the first type, but as time passes a few may be seen here and there in which development of the cap has commenced, and then growth has been arrested, the result being a stout, fully-formed stalk terminated by a small cap. Later in the history of the bed the last stage appears, and the mushrooms show no trace of differentiation into stalk and cap, but resemble clumps of puff-balls. It must be noted, however, that when a bed is completely overrun with disease apparently healthy mushrooms develop here and there. The gradual transition from the fully developed but diseased type to the completely hypertrophied condition seems to indicate the struggle that is going on in the bed between the mushroom mycelium and that of the fungus. It seems as if the vigour of the mushroom spawn in the earlier period of the existence of the bed allows the mushrooms to outstrip the disease for a week or two, but that, owing to the gradual lowering of the temperature of the bed, and the slightly diminished food-supply, the vigour of the spawn is not so great as at first, and it is more susceptible to the attacks of the fungus. The result is that perfect mushrooms become fewer, the disease spreads in those that are developing, it ultimately obtains the mastery, and the mushroom spawn is entirely killed out.[1]

Sections were made from mycelium, stalk and cap of diseased specimens, and examined either unstained or stained with bismarck brown or Loeffler's blue. When examined under the microscope thick hyphæ with dense contents could be seen running through the tissue of the mushroom. These were usually more numerous in the stalk than in the cap, and with the blue or brown stain used they assumed a darker hue than the surrounding tissue (fig. 13). The

[1] Spawn from badly diseased beds failed to develop on sterilised stable manure, while healthy spawn from test-beds at Bangholm Nursery developed freely.

hyphæ in sections taken from the thicker parts of the mycelium were invariably thicker than were the hyphæ in the stalk or cap of the mushroom (see fig. 14). On making sections at the outside of the mushroom the hyphæ could be seen growing out. When they reach the surface they assume a different form. The filaments (fig. 15*a*) are almost erect, more delicate than the hyphæ in the tissue of the mushroom, and produce from two to seven whorls of branches, all of which taper off gradually to a point, each bearing at the end a bud (conidiospore) (fig. 15*b*). The conidia are unicellular, and vary in size, the smallest being $4 \times 1{\cdot}50\mu$, while the largest are $7 \times 2{\cdot}75\mu$.

I have previously stated that the beds produced apparently sound mushrooms. These, on examination, were found to contain a few hyphæ of the fungus, and I therefore conclude that such mushrooms were formed from an exceptionally vigorous portion of mycelium, and although attacked by the disease they had outstripped it.

The fungus is evidently a *Verticillium* allied to *V. agaricinum*, Corda. . *V. agaricinum* has whorls of branches similar to the plant under notice, but these branches produce secondary whorls, a condition I have not observed in the species from the tunnel. Verticillium[1] is a form of the genus Hypomyces, and as I am at present growing the Verticillium under various conditions in the hope of obtaining the Hypomyces stage, I refrain from expressing an opinion as to the exact species. A disease due to a similar parasite has appeared on mushroom beds in England,[2] Austria,[3] France,[4] and Germany.[5] Cooke found a *Mycogone* along with the *Verticillium*, the former being the chlamydospore and the latter the conidial stage. To this he gave the name (under reservation) of *M. alba*. Stapf found the *Verticillium* alone in the Vienna specimens. This

[1] De Bary, Comparative Morphology of the Fungi, Mycetozoa and Bacteria, (trans. H. E. F. Garnsey), p. 245.

[2] Cooke in Gard. Chron., 3rd series, vol. v., 1889, p. 434.

[3] Stapf in K. K. Zool.-Bot. Gesells. in Wien., Bd. xxxix., 1889 ; Abh., p. 617.

[4] Costantin et Dufour, Rev. gen. de botanique, tome iv., 1892, pp. 401, 462, 549 ; Comptes Rendus de l'Acad. des sci., tome cxiv., 1892, p. 498 ; Bull. de la soc. bot. de France, tome xxxix., 1892, p. 143 ; Prillieux, Bull. de la soc. bot. de France, tome xxxix., 1892, p. 146.

[5] Magnus, Bot. Centralblatt, Bd. xxxiv., 1888, p. 394.

is similar to the Edinburgh plant. In diseased specimens from the Paris beds, Costantin and Dufour, and also Prillieux, found both *Mycogone* and *Verticillium*, the former having pinkish chlamydospores. This they referred to *M. rosea*, Link. Magnus established a new species from the Berlin specimens, *Hypomyces perniciosus.* In the few months I have had this species under observation it has shown considerable variation when grown in different media, and I am inclined to think that our plant may possibly be the same as that described by other writers, and that the production of the conidial stage (*Verticillium*) only is due to the very favourable conditions under which the mushrooms are grown, and which are also well suited to the rapid development of the parasite. It is possible that starvation or other unfavourable conditions may induce the formation of chlamydospores.

It was quite evident that the tunnel was swarming with the spores of the fungus, and that as new beds were made spores from the diseased mushrooms were carried to them. I made several tests of the condition of the atmosphere by exposing Petri capsules containing gelatine and brewer's wort or rice paste coloured with cochineal, and always had a plentiful crop of Verticillium in a few days. Samples of soil were shaken up with brewer's wort and allowed to settle, and from these sub-cultures were made in two days. The fungus invariably developed from all the soil cultures. I also took samples of the drip-water from the tunnel walls and made cultures in wort. Although growth was not so rapid owing to the smaller number of spores, they were present in almost all the samples taken.

After I had ascertained the exact nature of the disease, my attention was turned to the finding out of some substance that could be used to disinfect the tunnel and destroy the spores remaining therein. Costantin and Dufour [1] used lysol, thymol, boric acid, copper sulphate, iron sulphate, &c., and from their experiments they conclude that a 2 per cent solution of lysol is the most effective, and the next in value is thymol $2\frac{1}{2}$ per cent, followed by copper sulphate 2 per cent. As spraying seemed to be the best means to employ in disinfecting the tunnel, I decided to experiment with such substances as

[1] Rev. gen. de botanique, tome v., 1893, p. 497 *et seq.*

could be applied in liquid form. Accordingly I decided to make trials with (1) corrosive sublimate and (2) copper sulphate + carbonate solutions. The corrosive sublimate was made up of the following strengths: $\frac{1}{1000}$, $\frac{1}{2500}$, $\frac{1}{5000}$. The second liquid was made up of 5 lb. copper sulphate, 4 lb. copper carbonate in a gallon of water, the precipitate being dissolved by the addition of ammonia; this mixture being diluted to 100 gallons. The following experiments were made:—

I.

Sixty tubes containing brewer's wort were sterilised; of these fifty were sown with spores (each tube contained about 30 c.c. of wort), and were treated as follows:—

	No. of tubes.	Fungicide.	Strength.	Result.
a	10	Corrosive sublimate	$\frac{1}{1000}$	No growth.
b	10	" "	$\frac{1}{2500}$	"
c	10	" "	$\frac{1}{5000}$	Growth in four tubes.
d	10	Copper sulphate, Copper carbonate and ammonia	...	No growth.

Ten tubes not infected remained sterile, while ten sown with spores, and not treated with the fungicides, showed growth of Verticillium in every case.

II.

Fifty tubes of brewer's wort were infected with spores, ten being kept uninfected. Eight days later, when growth was vigorous, they were treated as in experiment I.

	No. of tubes.	Fungicide.	Strength.	Result.
a	10	Corrosive sublimate	$\frac{1}{1000}$	Growth arrested.
b	10	" "	$\frac{1}{2500}$	" " in eight tubes.
c	10	" "	$\frac{1}{5000}$	" " in one tube.
d	10	Copper sulphate, Copper carbonate and ammonia	...	Growth arrested.

The ten tubes untreated showed luxuriant growth after ten days.

It was quite evident that the fine mycelial threads growing on the top of the wort retained their vitality through the presence of a thin film of air, the amount of disinfectant introduced being too small to drive it out and submerge the threads, yet, at the same time, it was possible that any conidia formed might be killed. I accordingly made sub-cultures from the tubes in which growth appeared to be arrested in experiment II. This was done as follows: The tubes were well shaken, to wash off as many conidia as possible, and a few drops of the liquid were transferred to sterile tubes. The results were as follows:—

Sub-cultures from II.*a* showed no growth in three weeks.
" " II.*b* " " "
" " II.*c* showed growth in one tube.
" " II.*d* no growth.

The above experiments proved the efficacy of the copper solution and also the corrosive sublimate, when applied at a strength of $\frac{1}{1000}$ or $\frac{1}{2500}$, as a means of destroying the spores. The Scottish Mushroom Company have decided to use corrosive sublimate for disinfecting the tunnel, and preparations are being made for spraying the whole place with it.

My thanks are due to the President of the Society, Drs Davies, J. Taylor Grant, and Mr G. T. West, for valuable suggestions made and assistance rendered during the time the investigations were in progress.

NOTE, *May* 1901.—Since this paper was read the tunnel has been sprayed three times with corrosive sublimate, the strength of the solutions used in the three sprayings being $\frac{1}{1300}$, $\frac{1}{1000}$, and $\frac{1}{500}$ respectively. When the spraying was completed tests were made in various parts of the tunnel.

1. Sterilized plates were exposed for periods of one, six, and twenty-four hours, and out of thirty plates only two showed any sign of growth in seven days. These were exposed at the mouth of the tunnel, and developed numerous bacteria as well as blue mould.
2. Thirty samples of soil were selected, some from the surface, and others at various depths down to 12 inches. These were treated in the same manner as

PLATE XVIII.—A MUSHROOM DISEASE.

c *a* *b*

FIG. 1.

FIG. 2.

PLATE XIX.—A MUSHROOM DISEASE.

FIG. 3.

FIG. 4.

FIG. 5.

PLATE XXI.—A MUSHROOM DISEASE.

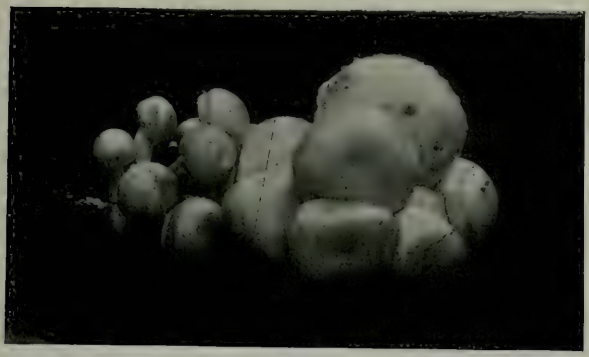


FIG. 9.

FIG. 10.

FIG. 11.

soil which gave abundant growth of the fungus before the spraying, and there was no sign of the disease.

3. I also examined the drip-water in the tunnel, and it proved to be quite free also.

The results obtained from these tests lead to the conclusion that the disease is stamped out, and that if proper precautions are taken it will not reappear.

DESCRIPTIONS OF FIGURES.

Plate XVIII., *Fig.* 1. A collection of healthy mushrooms, comprising the three stages known to the trade as (*a*) buttons, (*b*) cups, and (*c*) flats :—

(*a*) Very young mushrooms—in the centre.

(*b*) Specimens in which the gills are exposed—on the right.

(*c*) Fully developed specimens having a flat cap—on the left.

Fig. 2. Part of a bed of diseased mushrooms in Scotland Street tunnel. There were no healthy specimens on this bed.

Plate XIX., *Fig.* 3. Malformed mushrooms belonging to the first type. Stalk and cap fully developed, but stalk twisted and split open.

Fig. 4. Other examples of first type. Cap almost lost, stalk split open.

Fig. 5. Second type mushrooms, in which development of cap is arrested but stalk is normal.

Plate XX., *Fig.* 6. } These are all of the third type, there being no
" " *Fig.* 7. } trace of differentiation into stalk and cap.

Fig. 8. At the back is one example of the first type, while at the front are two specimens of the second class.

Plate XXI., *Fig.* 9. On the left are a few weak mushrooms, some of which belong to the second class; others apparently sound, but all containing the disease. On the right side of the clump are eight forms of the third type.

Fig. 10. At the back of the clump are a few fully developed but distorted examples. In the front are a few of the second class, the remainder belonging to the third type.

Fig. 11. A patch of healthy spawn. Outline sharp. Branches numerous.

Plate XXII., *Fig.* 12. A patch of diseased spawn. Outline indistinct. Branches fewer in number.

Fig. 13. Photomicrograph of section of stalk of diseased mushroom with hyphæ of *Verticillium* running through the tissue. × 150.

Fig. 14. Photomicrograph of section of mycelium of mushroom infested with hyphæ of *Verticillium.* × 100.

Fig. 15*a*. Conidial filaments of *Verticillium* with developing conidia. × 325.

Fig. 15*b*. Conidia of *Verticillium.* × 325.

IX.—*ORTHOCHROMATIC PHOTOGRAPHY.*

By Mr T. CUTHBERT DAY.

(*Read March 27, 1901.*)

The word "orthochromatic," as applied to photography, is liable to some misapprehension. It means, in its strictest sense, the reproduction of an object in its true colours by means of photography; but it has now come to be understood as the correct rendering of an object in monochrome by photography, so that the luminosity values of the different colours are correctly reproduced in monochromatic tones. To produce photographs in natural colours is an extremely difficult operation, which is now distinguished by the name of Trichromatic photography, and requires a person with considerable skill and experience in order to produce anything like a presentable result. Orthochromatic photography, on the other hand, as dealt with in this paper, is a comparatively easy process, full of interest, and when taken up intelligently by any one accustomed to the use of dry plates, it is capable of affording very pleasing results with little extra trouble, and will be found by all who once study it to possess an attraction quite its own. It is my intention, to-night, to show what can be done in this way, —first giving, as briefly as may be, the why and wherefore of the process.

In order to clearly understand our subject, it will be necessary to refer shortly to a few facts with regard to that mysterious agent, Light. The observed phenomena respecting light can be fairly well explained by assuming, in the first place, that all space, even that occupied by solid and liquid bodies, is permeated by a subtle something to which we give the name of Ether. Certain manifestations of force, such as intense chemical action, as we find it in the sun, are capable of setting up vibrations in the ether which are propagated in all directions. The vibrations, when intercepted by appropriate substances, can be made to yield energy in the form of heat, light, electricity, and chemical

action. The light we receive from the sun is called white. Its passage through clear space is invisible, the presence of the vibrations producing it only becoming sensible to the eye when they either penetrate it directly or are reflected from some surface on which they fall. Tyndall, in order to demonstrate the invisibility of light rays traversing transparent media such as air, allowed a pencil of light to pass through a box, the interior of which was blackened. The path of the light was easily seen, being clearly marked out by the small particles of dust which were illuminated in its track. He then took a lighted spirit-lamp, which burns with a smokeless flame, and applied the flame to the stream of light passing through the dark box. The particles of dust in and around the flame were at once consumed, and the light, having nothing to reflect it, disappeared from the heated portion, the effect produced being the appearance as of thick black smoke arising from the smokeless flame.

When a ray of light passes from a rarer to a denser medium, it becomes refracted or bent from its original course. In passing through a denser medium such as glass, if the sides of the glass are parallel, the ray on emerging from the other side is bent back again to a course parallel to its original direction and otherwise suffers no change. If the sides of the glass are not parallel, as in the prism, then we see that the ray of light, on leaving the second surface, is bent still more from its original course than at the first surface, and pursues an entirely different direction. If this refracted ray be now intercepted by a white screen, we shall see, not a spot of white light, but a somewhat lengthened coloured band—an old but beautiful experiment, showing that white light is made up of rays which give to the eye different colours according to their refrangibility (fig. 1); the least refrangible giving us the sensation of red, and, as the refrangibility increases, passing through orange to yellow, yellow-green to green and blue, indigo, and finally violet. Experiment has shown that the red rays have a longer wave-length, and the violet a shorter, the wave-length gradually decreasing from the red to the violet. Besides those rays that are rendered visible to the eye there are others beyond the visible limits of the spectrum. The infra-

red rays beyond the red end manifest themselves by the production of heat, and the invisible rays beyond the violet are evident by their powerful chemical influence. If our ray of sunlight be admitted through a narrow slit parallel with the length of the prism and be examined with a small telescope, narrow dark bands are seen to cross the spectrum at stated intervals, showing gaps as it were in the continuity of the light. These are the Frauenhofer lines. Their position

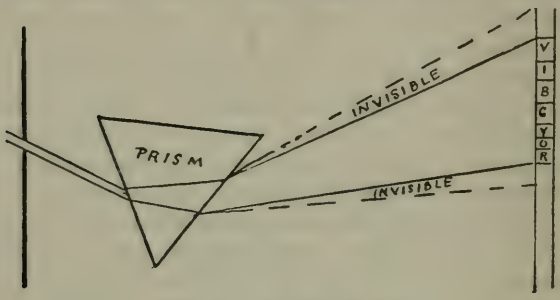


Fig. 1.—*The Solar Spectrum.*

in the spectrum is fixed, and they can be used as reference marks. In the absence of actual colour we shall use these lines as our landmarks.

It is with the chemical power of the various rays of the spectrum that we have to do this evening. Chemists soon discovered that the salts of silver, under favourable conditions, were strongly affected by light. The iodide, bromide, and chloride of silver are the salts usually employed in the manufacture of photographic plates. Freshly precipitated silver chloride is white, but if it be exposed for some time to ordinary diffused light, it soon becomes dark in colour, and finally turns quite black—the chloride being decomposed, and the silver separating as a black powder.

It is worthy of careful note here that the intensity of the action of light on the haloid salts of silver depends greatly on circumstances. Some substance must be present to absorb the liberated chlorine, bromine, or iodine, such as nitrate of silver, as in a wet plate, or some organic substance, as in the dry plate of to-day. If these substances are not

present the action of light becomes comparatively slight—so that you will observe that these haloid salts of silver really need a *sensitiser* for white light. This is worthy of particular notice, because we shall presently see that another sensitiser applied to these salts has a further effect in making them sensible to light rays in a yet greater degree.

Now, when light acts on a photographic plate the silver salts contained in the film are modified, but the effect is not visible to the eye. Certain chemicals, however, when applied to the plate, cause a separation of silver from the portions affected by light, the amount of deposit depending upon the intensity of the illumination. Here is a plate which has been exposed in the camera to a picture of a white cross on a black ground. You see it appears to have been unaffected. Here is a duplicate plate which has been exposed to the same subject and developed and fixed. The part affected by light is now clearly seen, and you will observe that the white cross is represented by a black deposit. The white light from the cross has affected the silver salt in the film, and the developer has caused the silver to separate as a black deposit. This is a negative. The next slide shows a print from the same in the usual way.

Now we must return to the spectrum. Having seen by the foregoing simple experiment that ordinary white light affects the photographic film, we may now inquire which of the various colours that go to make up white light have the most powerful effect. This diagram (fig. 2) is designed

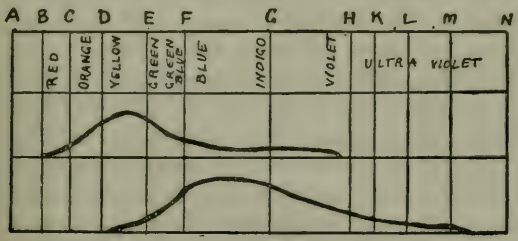


Fig. 2.—*Colour Effects in Photography.*

to give us the information we require. Here we see the spectrum drawn with its various colours in their proper

proportions in the visible part, and also produced at each end to show the extent of the invisible rays—*i.e.*, the infra-red and the ultra-violet. (The lines marked A, B, C, D, E, F, G, H are the Frauenhofer lines.) The upper curve represents the intensity of luminosity at any part of the visible spectrum. It is highest, as we see, in the yellow, and falls away rapidly at either side till it becomes quite faint in the blue, indigo, and violet, and also in the extreme red. Now, in order to represent these colours in monochrome, say as in an ordinary wash drawing, the bright yellow must be nearly white; the orange as a grey turning to darkish grey in the bright red and nearly black in the deepest red; the greens from light grey to darkish grey in the blue to dark grey, nearly black, in the indigo and violet. You will observe that it is impossible to represent difference in *colour tint* in monochrome, and that it is only the difference in *luminosity* that can be so represented. For instance, a dark blue and a dark red, though so different in colour, could only be translated, each of them, into a dark grey. A light green and an orange of the same degree of luminosity could not be represented otherwise than by the same light grey tint in a wash drawing. From all this we can easily infer that if a photographic plate is to give us a proper rendering in monochrome of the colours of the objects photographed, the amount of deposit of silver in the film would be correctly represented by a curve which coincides with that of the luminosity of the spectrum. But what do we find on actual trial? This lower curve gives the answer. It shows the amount of deposit on the photographic film caused by the different coloured rays to which it has been exposed. There is practically no deposit under the yellow, the orange, and the red rays, so that these colours, especially the yellow and orange, which constitute the brightest part of the spectrum, are photographically represented as blacks. When we look at the other end of the spectrum we find under the very much less luminous rays, such as the blue, indigo, and violet, the plate has been powerfully affected, and the deposit very dense—so much so that these colours, as is well known, are generally represented as white by photography. In addition to this, we see that even beyond the visible limit of the spectrum there are rays that can

affect the photographic film to a very considerable extent. Here is a photograph taken on an Imperial special-rapid plate of the spectrum of a Welsbach light (Plate XXIII. 1). You will see how closely it corresponds to the diagram just shown. The deposit does not extend beyond line F, where it abruptly terminates. The continuation beyond the visible violet rays is well seen. Now we can understand how it is that when a lady has her photograph taken, if she is wearing a nice blue blouse with white spots upon it, the whole garment shows as white, and the pleasing contrast which existed in the original is lost in the portrait. So again, a vase containing yellow daffodils and bluebells will show the bright yellow flowers as nearly black and the blue as nearly white in the photograph. Everybody knows how unsatisfactorily blue eyes are represented in portraits. From these instances we can see that although in many things we can rely upon the photographic plate to give us pretty nearly absolute truth, yet when we come to bright colours in the subject there is a great falling off.

The outcome of the experiment of photographing the spectrum shows us that for the correct rendering of *pure* colours the ordinary photographic plate is practically useless. How is it, then, that we are able, as a rule, to obtain so many beautiful photographs in the ordinary way—photographs in which, as a rule, there is little that appears amiss? The reason is plain. In nature pure colours are rare, and from every object which we see there is so much of white light reflected, that all the colours being more or less mixed with it, they affect the photographic plate in some degree; but whenever a particular colour approaches purity, like the yellows, reds, or blues, for instance, then we are able to observe that in a photograph they are far from correctly rendered.

Means have at length been found by which the colour defect in the photographic plate has been in a measure overcome. In considering the effect of the spectrum on an ordinary photographic plate, we saw in the slide shown that the yellow and red rays produced practically no effect. But as we find in the spectrum that heat rays pervade all parts, though the great mass of them are found in the red and infra-red portion, and as we also find with regard to the visible rays that they too

are found in the greater portion of the spectrum, though most apparent in the yellow space and close by—may it not also be that, in the case of the chemical rays, they, too, are found everywhere, even in the yellow and red, though much more energetic in the blue and violet? In order to test this an ordinary plate might be exposed to the spectrum, but the precaution taken that the blue and allied rays should be cut out by means of a piece of yellow glass, or a solution of chromate of potassium. Here is a plate (Plate XXIII. 2, Imperial special-rapid) that has been so exposed, and you see with what result. There is now a deposit even as far as the red, though in degree it is faint. To obtain this an exceedingly long exposure was necessary—one hour and forty minutes—and if the blue rays had not been cut out the plate would have been spoiled by halation and fogging caused by reflected blue light in that long time. This experiment shows that some approach to correct representation of colour luminosity may be obtained even with an ordinary plate by the artifice of interposing a properly coloured light filter, though for practical purposes it is quite useless, owing to the inordinate length of exposure required. If this faint sensitiveness of silver salts to the red, yellow, and green rays could be much increased, then orthochromatic photography would be a possibility; for, by using a plate so sensitised, and cutting off the two active blues by suitable light-filters, the deposit on the plate could be made more nearly to follow the luminosity values of the different parts of the spectrum.

In 1873, by a happy chance, some (collodion) bromide dry plates, prepared by Colonel Stuart-Wortley of England, and stained with some yellow substance, came into the hands of a man of observation. This was Dr H. W. Vogel of Berlin. He noticed that these plates gave a more correct rendering of green and yellow colours than any he had seen. He did not find this sensitiveness to yellow and green in the collodion bromide plates prepared by himself, and so judged there must be something in Colonel Stuart-Wortley's plates that was causing the difference. To test this he washed one of the plates in alcohol and so removed the yellow stain, and he found that after this treatment the plate was no longer as sensitive to yellow and green as before. The result of this experiment

induced Dr Vogel to study the effects of various dyes in increasing the sensibility of the silver salts to the more luminous rays of the spectrum; and so the first step in orthochromatic photography was taken. Vogel in that same year (1873) announced that if bromide of silver be dyed with certain yellow and red dyes, its normal sensitiveness to the yellow and green rays of the spectrum is thereby much increased. The work was taken up with energy and success by many eminent scientists, as Eder, Abney, Carey-Lea, Becquerel, and Waterhouse. During the time of these investigations the gelatine bromide dry plates were introduced, and photographers everywhere were so absorbed by this new discovery that the beginnings of orthochromatic photography were almost forgotten. After a while, however, the effects of certain dyes were tried with much success on these new plates. In 1882-83 Tailfer & Clayton of Paris patented plates sensitised with eosin. J. B. Edwards & Co., in 1884, introduced their isochromatic plates, and many others followed in quick succession. In America Carbutt, Ives, Forbes, and Weustner produced isochromatic plates. In France the Brothers Lumière of Lyons have recently introduced a series of colour sensitive plates selectively sensitised for various parts of the spectrum. Special mention should be made of the orthochromatic system introduced by Messrs Cadett & Neal in connection with their lightning spectrum plate.

The true action of the different dyes employed in increasing the sensitiveness of the silver salts is not well understood. A combination appears to take place between the silver salt and the dye, but whether it is chemical or molecular only is not, I believe, determined even yet. The dyes themselves belong to the more complicated benzene derivatives—eosin yellow, the potassium salt of tetra-bromo-fluorescin, $C_{20}H_6Br_4O_5K_2$; eosin blue; the sodium salt of tetra-eiodo-fluorescin, $C_{20}H_6I_4O_5Na_2$; erythrosin; the potassium salt of tetra-iodo-fluorescin, $C_{20}H_6I_4O_5K_2$, and cyanin, $C_{28}H_{25}N_2I$, which is one of the best sensitisers for the orange and red rays. Malachite green, together with naphthalene blue, are used as sensitisers for red, yellow, and green rays.

There are two ways of using these dyes. The first is to add the solution of the dye to the emulsion before the plate is

coated: this is the method usually followed by manufacturers. The second way of applying the dye is by soaking ordinary dry plates in the dye solution with certain precautions. This process may be practised with success by amateurs, but I do not purpose going into it to-night. This diagram (fig. 3) shows by curves the effect of two of these dyes on the colour sensitiveness of a plate—*a*, as exhibited on an ordinary plate;

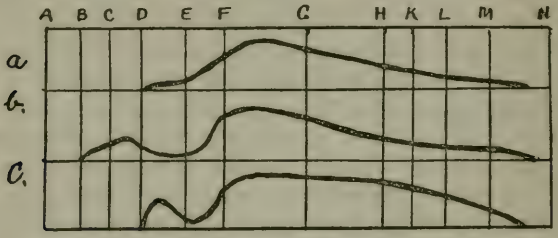


Fig. 3.—*Effect of Dyes in Photography.*

b, the effect of cyanin; and *c*, the increase of sensitiveness due to the use of erythrosin. I will now show you a series of photographs of the spectrum, taken by myself on various brands of orthochromatic plates without the intervention of any light-filter to modify their actual sensitiveness. The spectrum employed was that derived from a Welsbach gas-light C burner. The light was passed through a small direct-vision spectroscope, kindly lent to me by my friend Mr Stenhouse. The spectroscope was fixed in front of the camera, taking the place of the lens, the spectrum being focussed on the screen and means taken that every plate should register exactly in the same position. Foundation datum marks were obtained from the sodium line D, and the potassium line K_2, which was got by photography. The other lines were then obtained by comparison with a spectrum chart. I thought it best to take the Frauenhofer lines in this way rather than to attempt colouring the slides. The plates tested were—Ilford chromatic (Plate XXIII. 3), Edwards' isochromatic (Plate XXIII. 4), Lumière A (Plate XXIII. 5), Lumière B (Plate XXIII. 6), Lumière C (Plate XXIII. 7), and Cadett spectrum (Plate XXIII. 8). You will notice the tendency to an insensitive gap in these plates between the

lines E, F—*i.e.*, about the region of the green rays. This is hardly at all apparent in the Cadett spectrum plate, which certainly shows a wonderful evenness in the deposit, and is really a remarkably fine plate. Though, according to these experiments, two of the Lumière plates appear to push a little farther into the red than the Cadett, still the deposit on the Cadett plate in this region, if not quite so far, is much more dense. It is quite plain that in all cases the blue colours still have a predominant effect on the plates, and that there is a want, more or less, of sensitiveness in the green. We can well see that in order to get correct, or fairly correct, results with these plates, the blue rays must be cut out to a great extent.

If we are to get correct results with any of these plates, we must so arrange matters that the deposit in the yellow part of the spectrum is most dense, and much lighter in the blue and violet. We must, as it were, push back the summit of the curve, which still lies in the blue, back to the D line of the spectrum in the yellow. We can do no more with the dyes: resort must now be had to an artifice, the same as we employed in the case of the ordinary dry plate—a properly coloured light-filter must be interposed in the path of the rays, of such a tint that the red, orange, yellow, and green rays may pass through unimpaired in strength, while the blue, indigo, and violet are nearly cut out. The upper curve in fig. 4 shows the effect of

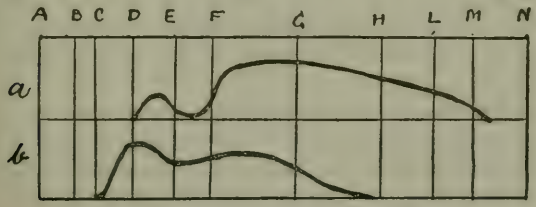


Fig. 4.—*Effect of Light-filter in Photography.*

a, Plate treated with eosin. *b*, Plate treated with yellow screen.

an eosin-dyed plate on the action of the spectrum; the lower curve, the action on the same plate when a yellow screen is interposed. The summit of the curve is pushed back into the yellow, while the blues are much reduced in intensity. It will

be observed that with the yellow screen the curve is actually higher in the yellow, and extends farther into the red. This is owing to the longer exposure, which gives these colours more time to affect the film. You will remember that we got something like this effect even with an ordinary plate, but in the case before us the exposure was very much less in duration, owing to the plate having been orthochromatised with eosin. Here is a photograph of the spectrum on a Cadett spectrum plate which has been exposed to the spectrum, a yellow glass being interposed. The glass was not quite of the right tint, as we can see that the blue about the A line might have been reduced a little more with advantage (Plate XXIII. 9).

We are now in a position to apply the principles which we have established as regards orthochromatic photography. It will be obvious that its most useful application is in the reproduction of objects more or less definitely coloured. For this work a good brand of plates is essential. Those prepared by Lumière Brothers of Lyons, and marked A, B, and C, are excellent. The Cadett spectrum plate is a remarkably good plate, and has also the valuable quality of rapidity—I judge, about four times that of the Lumière plates. The Ilford chromatic is a good plate for ordinary work, but slow. The Edwards plate gives very good results. Rapidity in an orthochromatic plate, especially for outdoor work, is of the utmost value, because the use of the tinted light-filters prolongs the exposure. With a good rapid plate and a lens that works well at open apertures, the difficulty of longer exposure can be fairly overcome.

Tinted ray-filters are necessary if good results are desired. These can be purchased of various intensities, made out of optically worked glass, for a reasonable price. The prevailing tint is yellowish. I strongly recommend using the filters advocated by the makers of the plates; they are usually specially prepared to suit the various brands. Cadett & Neal are particular in calling attention to their light-filters, and though I have not yet used them I intend doing so. Much judgment is required as to what grade of ray-filter shall be used. Suppose we wished to take a landscape with a blue sky having many light white clouds drifting. In an ordinary

way the sky would be so much over-exposed that the beautiful clouds would be entirely lost; but if an isochromatic plate be used with a very light tinted ray-filter, the blue of the sky will be sufficiently held back for the clouds to make a fair impression on the plate. As a rule, the more colour in the subject the deeper the tint required in the ray-filter. In working by gaslight, as in taking microscopic photographs, the ray-filter is seldom required, because the light is already yellow, and if a ray-filter is used it need be only of medium tint. All these artifices will soon occur to those who practise orthochromatic photography for a little while and carefully examine their results. The length of exposure must be found by practice, and it is difficult to give directions. But with the use of an exposure meter "mixed with brains" very few failures need be feared. Light-filters can easily be home made, but I do not recommend them, for this reason: it is not easy to get the two surfaces perfectly flat and parallel, and unless this is the case distortion, if only in a small degree, must result, and it would be a pity to interfere in any way with the beautiful working of the excellent modern lenses now in the hand of the photographer. The light-filters can be placed either in front of the lens or at the back. Personally I prefer the front position, and have my ray-filters cut in circular shape, mounted in cardboard, and of such a size that they slip easily into the hood of the lens, where they are secured by a light spring made of wire. Where the lens has no hood they can be made in the form of a cap to fit in front.

We have now all that is required for the work, and it only remains to remark in this connection that the development of orthochromatic plates needs some care. It must be borne in mind that they are sensitive to rays which do not affect the ordinary plate. It will not do to develop them in the full light of the dark-room lamp, or it will soon be found that they have a decided tendency to fog. Even in putting the plates into the dark slide, it is best to let no direct light of any kind reach them. In my own practice, when developing, I use just enough light to see that the developer is properly flowed over the plate, and immediately withdraw the dish so that no light of any kind can reach it. To watch the appearance of the image the tray is brought to the light for exam-

ination, but no nearer than absolutely necessary. Do not take the plate out of the dish, and on no account hold it up to the light to look through it. The time required for correct development can be easily judged by practice, and by working with a small clock in the dark room. The density can be fairly judged by turning the plate over and looking at the back when the time is nearly up. All white light must be carefully excluded, even after the plate is put into the fixing bath.

In photographing coloured pictures it is a good thing to have a strip of paper half black and half white, say at the foot of the subject. It will be found a great help in development to enable one to judge the correct density for the whites if there should happen to be none in the subject. Two photographs are shown in Plate XXIV. of Gilbey & Hermann's advertisement card for their coloured poster inks. The card was highly coloured. No. 1 is a photograph taken on an ordinary Paget xxx plate, and No. 2 one taken on a Cadett spectrum plate, through a yellow ray-filter. These two illustrations are a study in the photography of colour, and in many parts the one is the actual reverse of the other.

[Many slides were exhibited of photographs of coloured subjects, such as flower-studies, &c., taken with ordinary plates, and also with orthochromatic plates, in order to show the advantage in using the latter.]

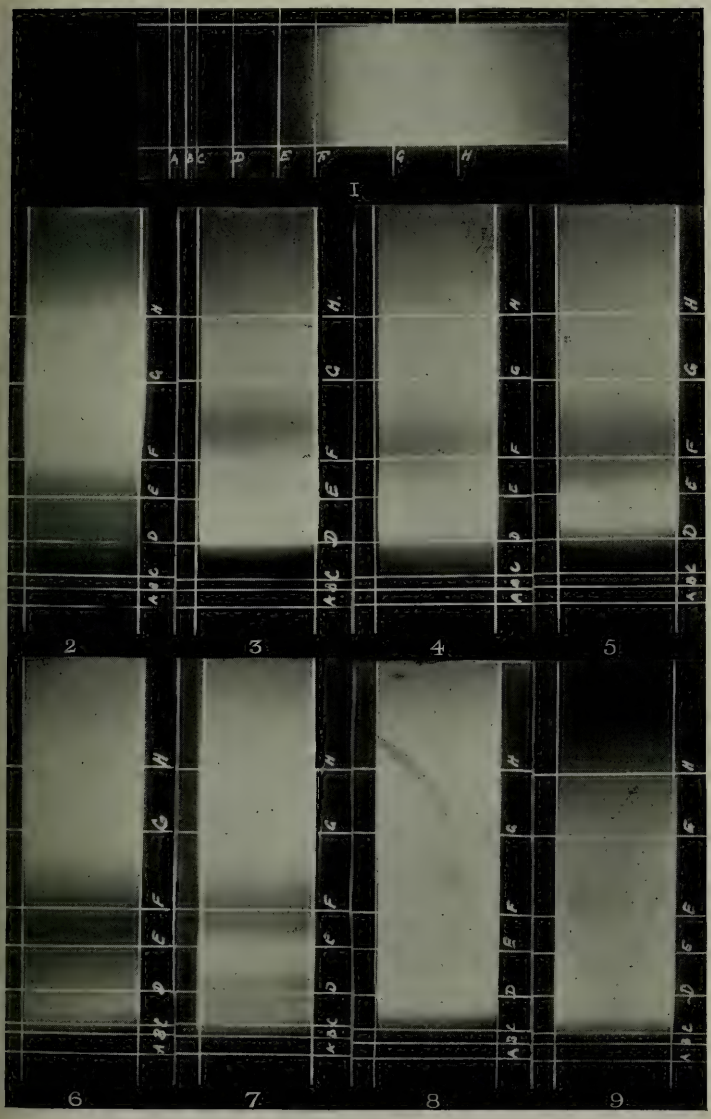
X.—*NOTES ON THE FLORA OF THE SHORES OF THE FIRTH OF FORTH.*

By Mr MARK KING, Honorary Member.

(*Read April 24, 1901.*)

The flora of Edinburgh and its vicinity has engaged a good deal of my attention during a number of years, although latterly I have confined my observations to the banks of the Forth from high-water mark to about a score of paces

PLATE XXIII.—ORTHOCHROMATIC PHOTOGRAPHY.



beyond. With that end in view I have made various excursions between North Berwick and Bo'ness on the south side of the estuary, and between Elie and North Queensferry on the north side. It may be as well to state at the outset that I have no new or rare species to note. Yet it seems to me that the absence or abundance of common forms in a locality is interesting, in so far as that has relation to the distribution of species, with their altitude and area. The flora of the Forth, in my opinion, belongs to a very ancient period in the physical structure of our country. There is probably little or no difference as regards the plants now found on both shores and those present before the estuary ploughed its way up the land. Similarly, to take as an example that narrow strip of sea, the Strait of Gibraltar, which separates the continents of Europe and Africa, European forms are found on the opposite or African shore.

In order to be more precise, I shall now refer to the locality and duration of a few typical species. Black mustard (*Sinapis nigra*, L.) flowers and fruits abundantly on Inchkeith, and also on the Leith shore. Last summer I saw a specimen growing on waste ground near Leith gasworks, a short distance from the spot where I had gathered it eighteen years previously. Another Inchkeith plant that is abundant on the south side of the island is the Scottish lovage (*Ligusticum scoticum*, L.) Additional habitats are Inchcolm and the opposite rocky shore near Aberdour, where it has been apparently long established. Stray specimens may also be found on the south shore between Longniddry and Cockenzie. A specimen that I brought from Inchkeith in 1883 and planted in my garden has produced seed every season since then. The spread of the species is slow, the progeny growing near the parent. Last year a seedling came up twenty yards distant from the parent —the plant I now exhibit. The henbane (*Hyoscyamus niger*, L.) is abundant on one or two spots on Inchkeith, and I have also gathered specimens on Leith sands and at Granton. The sea tree-mallow (*Lavatera arborea*, L.) was at one time plentiful on the Bass Rock. The celebrated botanist John Ray (1628-1688), during his travels through Great Britain,

noticed this plant growing on the Bass. Dr Walker, Professor of Natural History in the University of Edinburgh, says that he found it "in great plenty" more than a hundred years after Ray's time. The rue (*Thalictrum minus*, L.) is abundant at Caroline Park, and also at North Queensferry and Dysart. The common gooseberry (*Ribes Grossularia*, L.) grows on the sandy coast at Buckhaven and also at Bo'ness, sparingly, but producing fruit in abundance. My idea is that this species may be taken as a true native of North Britain. The bloody crane's-bill (*Geranium sanguineum*, L.) grows plentifully among the sand near Aberlady, illuminating a bare place with its purple and crimson corolla. The dove's-foot crane's-bill (*G. molle*, L.) and the stinking crane's-bill (*G. Robertianum*, L.) are common on both sides of the Firth. The stork's-bill (*Erodium cicutarium*, Sm.) is plentiful where it does occur. I came on a large plot of it opposite Fidra, most of the plants with white flowers. At a short distance from the same place I saw various plants of the local oyster-plant (*Mertensia maritima*, Don), but the foliage was scanty, from the browsing of the rabbits by which the place is overrun. The viper's bugloss (*Echium vulgare*, L.) is growing on the shore at Fisherrow Links, and also at North Queensferry. The tuberous comfrey (*Symphytum tuberosum*, L.) grows on a damp spot near Cramond: this form has not been recorded for the north side of the Firth. The creeping toad-flax (*Linaria repens*, Ait.) I noticed several years in succession growing among *débris* at high-water mark between Morrison's Haven and Prestonpans. This is the only station for this form that I noticed on the margin of the Forth. The ivy-leaved toad-flax (*Linaria Cymbalaria*, Mill) grows on a wall near Dysart, and is plentiful on the railway embankment east from Burntisland. There is a small patch on a wall near Cramond. The wild teasel (*Dipsacus sylvestris*, L.) is found at East Wemyss and Dysart, but it is not a common plant anywhere on the banks of the Forth. The devil's-bit scabious (*Scabiosa succisa*, L.) is found near North Queensferry.

I shall now notice shortly a few additional species. The sea starwort (*Aster Tripolium*, L.) is interesting as the only British form of the genus: it is plentiful on the Aberlady

shore, also at Morrison's Haven, growing in similar abundance. It is not again found until near South Queensferry. Then it appears at Bo'ness, and on the opposite shore at Kincardine. The common scurvy grass (*Cochlearia officinalis*, L.) is very common on both sides of the Forth: it is particularly abundant at South Queensferry, North Queensferry, and Morrison's Haven: from the last only a few scattered specimens are seen on to the mouth of the Esk. Then scarcely another plant will be found until reaching the grassy bank at North Leith old churchyard, where it grows abundantly.

Among the grasses found on both shores of the Firth may be mentioned the creeping couch-grass (*Triticum repens*, L.), the meadow soft-grass (*Holcus lanatus*, L.), the wall barley (*Hordeum murinum*, L.), and the barren brome-grass (*Bromus sterilis*, L.) Amongst the twenty reputed species and varieties of Atriplex, several are found on the shores of the Forth. It may be well to notice here the important part played by various plants as agents of reconstruction. Of this class there are several species plentiful here and there on the margin of the Forth, such as the whitlow-grass, the dyer's rocket, the rest-harrow, Trifolium arvense, Astragalus hypoglottis, and Epilobium obscurum (plentiful at Bo'ness).

In conclusion, on traversing the shores of the Forth from North Berwick upwards, the observer will note the absence of shrubs or trees near its margin. From North Berwick to opposite Fidra the ground is partially level: after that there is no vegetation to be met with for some distance—only huge mounds of sand, made up of thousands of tons. Near the Longniddry shore arborescent vegetation again begins to appear, weather-bitten and scant of foliage, making evident the force of the gales which blow across the German Ocean. Not far distant, and near to the water's edge, the elder grows luxuriantly—a hint to proprietors that this is an excellent shrub to plant in exposed situations. After the elder comes the whin and the bramble; while the sea-buckthorn grows luxuriantly a little beyond South Queensferry. On the north shore arborescent forms begin a little lower down.

XI.—*FERN VARIETIES.*

By Mr S. ARCHIBALD, Tomatin, Inverness,
Corresponding Member.

(*Read April 24, 1901.*)

In 1882 I contributed a paper on this subject,[1] in which I described briefly the circumstances which led me to search for varieties, and the district — a tolerably good one for the purpose—in which I was then located. About twenty more or less distinct varieties were exhibited and described. Since then I have added a few to my collection, and extended my knowledge of the distribution of some of the others, and now have the pleasure of placing these before you.

But first of all, one correction must be made in the list of those previously sent. The fern there called Lastrea dilatata, var. Brownii, proved on closer inspection to be an attenuated form of its near ally, Lastrea spinulosa, that form being the result of its habitat—in a hedge on the face of a low retaining stone dyke. All the other varieties were, to the best of my knowledge, correctly named.

The first variety I will notice is a very pretty form of the graceful little Bladder Fern (*Cystopteris fragilis*), the points of the fronds being bi-, tri-, or multi-fid. It was found on the banks of the Carity, near Kirriemuir in Forfarshire, and the character is quite permanent, as I have had the plants in pot for over a dozen years, and the fronds exhibited are last year's growth. The next specimen is from the famous Den of Airlie. It is a variety of Polystichum aculeatum, in which the pinnules are narrow, distant, acute, and pointing forwards, the upper pinnules next the rachis being much larger than the others.

Last summer I noted some small plants of Blechnum boreale at the roadside near this place, in which most of the fronds were bifid. (There were only barren fronds on the plants.)

In my collection of 1882 there was a very distinct variety

[1] See 'Transactions,' vol. i. pp. 78-80, "List of a Few Ferns and Fern-Varieties collected chiefly in the Parish of Kilmalcolm, Renfrewshire, 1881-82."

of Athyrium filix-fœmina named denticulatum, having, as its name implies, long sharp teeth at the end of each pinnule. Here is what seems to be an allied variety, named uncum, but with shorter, claw-shaped teeth. Both varieties are small, but they differ in this—uncum is of normal outline, whereas denticulatum is very broad in the middle compared with its length, and narrows upwards very abruptly to the point, with a concave curve. Both were found near Kilmalcolm in Renfrewshire. In the same district the larger forms of Athyrium grow in profusion, and in great variety of form in the way that the pinnules are divided and subdivided,—from the normal bipinnate form, through tripinnatum and decompositum, to Arranense, a large lax variety, with fronds eighteen inches or more across, and each pinna resembling a complete miniature frond, narrowing downwards from the middle to the rachis. Var. rhœticum was also frequent. In it the edges of the pinnules are recurved, giving them a curious narrow or shrivelled appearance. Tripinnatum and rhœticum are frequent over the country, and so is a red-stalked variety similar to one in the Botanic Garden from Killarney.

Lastrea filix-mas, var. paleacea-crispa, is frequent. It is a large-growing variety, distinguished from the normal type by its very robust appearance, upright habit, dark-green and thick leathery foliage, the pinnæ and pinnules being crowded and crisped or waved. Of Lastrea filix-mas the vars. incisa and Borreri are frequent, and producta is quite common. In Borreri the chief character is the large lobe at the base of each pinnule, which is narrow in the upper part. In incisa the pinnules are narrow and distant. Producta is a very large variety, immensely developed in all its parts; pinnæ and pinnules not distant, often close; pinnules with large teeth, and the ones next the rachis often much longer than the others.

To those who may not have given much study to Fern varieties, the foregoing notes and the specimens submitted may help to show that, even in our cold northern clime, there is a wide field open in this department. Of course most of the extraordinary varieties and monstrosities are confined to the southern and warmer parts of our island. But Scotland can claim to have produced at least *one* wonderful and very beautiful variety, the var. Victoriæ of Athyrium filix-fœmina,

in which each pinna is divided at a short distance from the rachis, one branch growing upwards at an angle of about 45°, the other downwards at about the same angle, the branches crossing each other and forming a lattice. If Scotland has produced *that one,* what may not be in store for the diligent searcher!

XII.—*RECENT OBSERVATIONS IN NATURAL HISTORY.*

By Mr TOM SPEEDY.

(*Read April 24, 1901.*)

Stalking a Seal.

Many of you will have read recently in the newspapers a description of the scenery which is now opened up by the Mallaig Railway. Irrespective of its wild and picturesque nature, this district has attractions to many from its being associated with memories of Prince Charlie and the Rebellion of '45. Jacobites will here find classic ground; while lovers of nature will revel amid an ever-varying panorama of mountain and lake scenery, unsurpassed by anything to be witnessed in the fjords of Norway. It is not, however, the natural beauty, nor yet the historical associations, of the district that I desire at present to bring under your notice, but an observation in natural history showing the intelligence animals often display in noting the disturbed movements of other wild creatures, though themselves unaware of the source of the danger, and the consequent defeat of the intruder who threatens to destroy them.

Being retained by several of the proprietors of the ground intersected by the Mallaig Railway, with the view of giving evidence in their behalf at a reference, I spent a few days last summer in the district. Residing in the Kinloch Aylort Hotel, I received that motherly hospitality from Mrs Macnab with which all who stay under her roof are familiar. Sunday

seemed abnormally long, there being no church in the district save a Roman Catholic chapel, the waves of the Reformation never having reached that locality. Taking a walk along the shores of Loch Aylort, I observed a number of seals, and having admired a beautiful sofa blanket of sealskin in the hotel, I resolved to make an early start the following morning with the endeavour to secure a seal. Having arranged with Mr Head's keeper to meet me at the boat-house at 4 A.M., he was there punctually, his rifle with him. It was a beautiful morning, and as we rowed down the placid lake amid the wild mountain scenery, I thought that anything more picturesque could scarcely be conceived. It was broad daylight, and as the boat silently glided on, no sounds were heard but those of nature—chiefly the screaming of seafowl. Carefully scanning the rocks with the telescope, I was for long disappointed in getting sight of a seal. After rowing several miles, the keeper's eyes proved better than mine, he knowing where to look for them, and he asked for the glass. His English was not very good, but he quickly ejaculated "big fellow." He then rowed on as before. After getting behind an island we pulled ashore, and the wind being right, we started to stalk the seal. There was little difficulty in stalking, and we soon got behind a knoll, from the top of which we would be within a hundred yards of the object of our pursuit. I examined the rifle and saw it was a Mauser, but unfortunately the bullets were solid ones, which necessitated hitting the head or neck, otherwise he would be certain to struggle into the deep, and, though perhaps mortally wounded, would, as far I was concerned, be lost for ever. Crawling cautiously to the top of the hill, I first noticed a pair of what I took to be immature tufted ducks sporting themselves in a small bay. Paying no attention to them, however, we crawled a yard or two farther, and looked down on the seal at a distance of between seventy and eighty yards. He was, as the keeper had said, a "big fellow," and as we knew he had no suspicion of danger, we waited for a time to watch his movements. He lay like a log of wood on a bed of seaweed which covered the rock, and periodically moved his head from side to side. I was in the act of shifting into a position in which to get a lean, in order, as I thought, to put the bullet through his head, when the

two ducks referred to took wing and flew across the water. They uttered no sound, but had a Boer "Long Tom" been fired it could not have better demonstrated to the seal, "The Philistines be upon thee, Samson!" The tide had receded a short distance from where he lay, and his violent struggles to reach the water were most amusing. The ducks had seen us, and thought it prudent to shift their quarters; but doubtless there exists a species of wireless telegraphy among those denizens of Loch Aylort, with the result already mentioned. As he struggled towards the water I could have put several bullets into his huge body, but as his head was mostly away from me, and his erratic movements made it difficult to hit such a small target, I refrained from firing. I fully expected, after he found himself safe in the water, that he would put up his head and afford a shot, but he evidently knew there was real danger about, and never did so.

Perhaps you will think I was disappointed. In my younger days I would have been; and not only so, but the chances are that the seal would have escaped with a Mauser bullet through his body, to pine and die amid the caverns of the deep. As it was, I received an object-lesson as to how human ingenuity may be baffled by the watchful instincts of wild animals, and I returned homewards with a light heart. If I had not succeeded in bagging a seal, I at any rate found a splendid appetite for breakfast, and highly appreciated my morning sail amid the beauties of nature.

A wide-awake Fox.

It was in a hunting district in Berwickshire. I was spending a week-end with a friend. Taking a saunter after breakfast, I witnessed a fox enter a ploughed field and search about for a place to rest in for the day. Why he was so late afoot is difficult of explanation, unless he had been disturbed elsewhere. He appeared to have some difficulty in getting a resting-place congenial to his taste, as he shifted again and again, but eventually settled down in a furrow. To "catch a weasel asleep" is to defy human ingenuity, and yet a friend in Fealer forest thus once caught a fox and carried it home in his game-bag. The idea, therefore, immediately struck me

that I might try my luck in catching a fox asleep. Waiting for a considerable time till I thought he might be indulging in an unconscious snooze, I started on my somewhat difficult enterprise. I had no intention of capturing him, but, prompted by curiosity, I was anxious to see if I could get near enough to do so if I desired. Approaching by a side wind in order to avoid going straight up the furrow in which he was lying, but taking care to keep sufficiently leeward to avoid him detecting my presence by scent, I stealthily approached him. Walking perfectly upright, I could see his back, the top of his head, and his ears distinctly, but his eyes were beneath the line of vision. If his eyes were closed I felt almost certain that I would get near him, though that I would get sufficiently near to catch him—had I wished to do so—was problematical. When within eighty yards, I observed that a couple of peweets would be a barrier to my success. They were not exactly in the way, but too near it to allow me to pass without taking wing. Halting for a while in the hope that the birds would move a little or become aware that they were not threatened with danger, I saw with chagrin that they had no intention of leaving, but, with their heads up, kept eyeing me in a most suspicious manner. Standing motionless, I could not help reflecting on the words of that great observer of nature who wrote—

> "Thou green-crested lapwing, thy screaming forbear."

Moving a step or two, the birds took wing, but, alas! they did not forbear to scream. "Peweet" seemed scarcely to have emanated from the throat of one of the birds, when in the twinkling of an eye reynard was galloping up the furrow at racecourse speed. I am certain that he never saw me, or he would not have been so scared. Deer, as is well known, are much more frightened when they scent than when they see the danger. Reynard understood by the scream of the birds that he was in proximity to an enemy. His mind must have been made up what to do when he lay down, as he took no time to look round or consider. To me the scream of the bird and the bound of the fox appeared to be simultaneous.

I have—now many years ago—seen a fox lying in a grass field. The late Earl of Wemyss's pack had drawn all the

covers blank and started for home. Passing within fifty yards of the animal to make certain that it was a fox and not a hare, I pretended not to see him. Had I stopped and looked, doubtless he would have bolted. I ran to the top of the Tweed bank and halloed. A number of people on Norham Bridge halloed also, and in a few minutes the entire field cantered back. Hurriedly telling his lordship the exact spot where reynard was lying, I hastened to a point of vantage to see the sport. The fox, doubtless, saw the approaching horsemen and hounds, but, evidently in the hope of being passed unperceived, he lay still till the pack was within five yards of him. This to my mind demonstrates that, like deer, the fox is much more frightened by an invisible than by a visible enemy.

Grouse sitting on Trees.

Recently, while driving in a moorland district in Kirkcudbrightshire, I observed birds sitting on two willow-trees in close juxtaposition by the roadside. On getting near, I saw they were a pair of grouse, the cock sitting on the one tree and the hen on the other, both being about twenty feet from the ground. This may not be very uncommon, but it is only the second time in my experience that I have witnessed it. On the other occasion I was shooting in Berwickshire; and on a small bit of moor at Max Mill, a detached part of the Ladykirk estate, a covey of grouse was espied. Standing behind a knoll, five birds were driven past me, and I shot a brace. The remaining three flew only a short distance, and then settled on a thorn-tree.

Rooks deserting a Rookery.

The tenacity with which rooks adhere for generations to nesting in particular trees has long occupied the attention of naturalists. Before the imposition of the gun tax every village had its "sportsmen" who annually sallied forth for "a day at the craws." Despite the persecution to which rooks are subjected, they year after year build their nests in the same trees, or at least in the same plantation. In many country districts it is believed that by ceasing to shoot them they will

desert the trees, but the fact of them breeding in towns, as in Blacket Place in Edinburgh, demonstrates this to be a fallacy.

At the same time, they are gradually leaving the rookery at The Inch, where they have bred in large numbers for very long, though they have not been shot for ten years. This year only one nest was built, and that was commenced on the 15th of April, and has since been deserted after completion.

A Peculiarity of the Magpie.

The magpie is an interesting bird, and in very considerable numbers breeds around Edinburgh. While a good many make their nests at Craigmillar, I generally destroy most of them, as I should be sorry to see them increase in numbers. They are merciless tyrants among the nests of other birds, robbing the eggs and devouring the young.

It is a well-known fact that the magpie, like many other predatory birds, does not appear to mourn for long the loss of a mate. I have repeatedly shot one off her eggs, and within a few days a second one shared the same fate. There appears to be a registry for unmarried magpies somewhere, as no sooner is one shot than within a day or two another mate is secured, and domestic arrangements go on as before.

Last year a pair of magpies nested in a tree in the wood at the back of the garden at The Inch. When the process of hatching was commenced I had the bird disturbed and shot as she flew off from the nest. Early the following morning a number appeared, and a great deal of hilarious chattering around the nest indicated to my mind that, in "piet" language, a wedding was going on. The hilarity was brought to a sudden termination by a shot from the centre of a holly bush, when they quickly dispersed, minus one which fell to the ground. This continued in the early mornings for a week, when no fewer than six magpies were destroyed.

Growth of Roots in a Sewer Drain.

A drain at The Inch having been choked, we had it lifted in order to ascertain the nature of the interruption and have it rectified. The contractor who laid the drain had scamped

it, the flanges not being properly caulked and cemented. The result was that the roots of a chestnut-tree which grew near had found their way into the pipes and ran along in a most remarkable manner. The exact distance the roots extended in the pipes was unfortunately not measured, but it is safe to put it at over a dozen yards. So effectually had they filled the drain that some of the pipes could not be removed without breaking them, when there was revealed a cylindrical mass of matted roots, showing in a perfect manner the formation of the flanges of the pipe. It would have been interesting to have had the entire length taken out intact, but as the labourers were anxious to save the pipes, the roots were cut asunder at every three feet. So solid had they become that even a three-feet length was a considerable weight, resembling pretty closely a "divot" without the green grass on the outside. One would have liked to ascertain how far the roots would have travelled along the drain had they been allowed to remain. Personally I am of opinion they would have grown a long distance. Thinking it might be interesting, I have brought the "tail end" of the growth for exhibition here to-night. I am aware that in narrating this case I am reiterating a simple statement of a well-authenticated fact, but though the fact is well known, it is seldom that an illustration is brought under the notice of others than contractors and their labourers.

XIII.—*NOTES OF EXPERIMENTS ON THE GROWTH OF YEAST IN SOLUTIONS OF ARSENIOUS OXIDE OF VARIOUS STRENGTHS.*

By Mr W. C. CRAWFORD, F.R.S.E., and Dr A. E. DAVIES.

(*Read April 24, 1901.*)

At the meeting of the British Association last year, after Major Ross had given a lecture on Mosquitoes and Malaria, in which he traced the life-history of the hæmamœba from man through the tissues of its other host, the mosquito, and back again to

man, one of the audience asked naïvely what effect the parasite had on the mosquito? There was a little laugh when Major Ross answered that he had not studied that point. It was, notwithstanding, a very philosophical question.

Much has appeared lately in the newspapers about the poisoning of beer-drinkers by arsenic contained in the beer, but hardly any one asks the far more significant question, What effect has a poison like arsenic on a simple growing cell like yeast? It is one of a number of questions of extreme biological interest, as we shall presently show. For field naturalists—that is, people who occupy themselves with nature studies—there is no way of advancing these studies like trying to grow organisms in new and definite conditions. Bonnier took plants of the plain far up the Alps or the Pyrenees and planted them in a garden there, and they assumed an alpine form. A Jerusalem artichoke, for example, ceased to have a tall stem, its leaves became crowded together and hairy, and lay close to the ground. Nägeli grew hawk-weeds—of all plants those in which species are most difficult to distinguish. He had 2500 in the Botanic Gardens at Munich. He studied them for thirteen years to see if changes arising from culture were permanent, and he got negative results. Maupas grew rotifers at definite temperatures, and found how at a higher temperature numbers of male eggs were produced, like drones amongst bees.

In order to test the effect of arsenious oxide on the growth of yeast, it was necessary to ascertain the amount of glucose converted into alcohol in solutions of definite strength and containing known quantities of arsenious oxide. For this purpose the following solutions were prepared: (1) a solution of commercial glucose containing 125 grammes in one litre of water, this strength being such that 80 c.c. of the solution mixed with 20 c.c. of water gave a 10 per cent solution of glucose; (2) ten solutions of arsenious oxide of such strengths that 20 c.c. added to 80 c.c. of water would yield solutions containing the following proportions of arsenious oxide: (A) 1 in 500; (B) 1 in 1000; (C) 1 in 2500; (D) 1 in 5000; (E) 1 in 10,000; (F) 1 in 20,000; (G) 1 in 30,000; (H) 1 in 40,000; (I) 1 in 50,000; and (K) 1 in 60,000.

The mode of conducting the experiments had next to be

settled. Several processes by which the rate of growth of the yeast, or, in other words, the conversion of the glucose into alcohol and carbon dioxide, could be ascertained were available, —as the periodical direct determination of alcohol or carbon dioxide formed, or the diminution of the amount of glucose in the various solutions, due to its gradual conversion into these substances; or, again, by measuring the pressure of the evolved carbon dioxide, as adopted by Schultz and others. After full consideration, we concluded that there were objections to all these methods, and that for our purpose the simplest and most accurate process would be to ascertain, by weighing, the actual amount of carbon dioxide evolved from day to day.

With this object twelve flasks, each having a capacity of about 200 c.c., were taken and so fitted that the carbon dioxide produced by the fermentation was allowed to escape freely after passing through strong sulphuric acid to retain moisture, the entrance and final exit tubes of the apparatus being protected by tubes containing potassium hydrate and calcium chloride, to prevent absorption of moisture, &c., from the atmosphere. The flasks were numbered 1 and 2 and A, B, C, D, E, F, G, H, I, and K. Into each flask 80 c.c. of the solution of glucose were introduced. Nos. 1 and 2 each received in addition 20 c.c. of water, and to each of the others was added 20 c.c. of arsenical solution, so as to give proportions of arsenious oxide ranging from 1 in 500 to 1 in 60,000, as already indicated. To No. 2 and A, B, C, D, E, F, G, H, I, and K was added 20 c.c. of brewer's yeast, No. 1 being left without. The flasks were then very carefully weighed, the potassium and calcium tubes being, of course, previously removed. The weighing was repeated daily at (with one exception) the same hour until the conclusion of the experiment, the loss of weight representing the amount of carbon dioxide evolved, and indirectly, of course, the amount of glucose converted by the process of fermentation into alcohol and carbon dioxide and the rate of growth of the yeast, from which the effect of the arsenious oxide in retarding or accelerating growth can be at once seen.

We do not publish our weighings and calculations in detail: we have represented them in curves, which show our results at a glance. Plate XXV. is to compare the CO_2 given off by

yeast in a solution of glucose alone, and in similar solutions of glucose containing weak, medium, and strong doses of arsenious oxide. The quantity of CO_2 given off is shown by the ordinate, and the time is indicated along the abscissa. Similarly, in Plate XXVI. a curve is given for each flask. Plate XXVII. shows at the end of each day the action in the different flasks.

Now, as to the things to be noted from our experiments, we would mention several. It is too early to draw conclusions.

1. It must strike every one that a simple organism—an organism consisting of a single cell like yeast—can live in a very strong arsenical solution, while a minute dose would poison a man. The beer which poisoned those who drank it at Manchester contained 1·4 grains per gallon—*i.e.*, 1 in 50,000. Some of the poisoned drank more than a gallon per day, others did not take more than a pint.[1] If we consider 2 or 3 grains as a certainly fatal dose for man, and a man weighs, say, 200 lb., $\frac{1}{500000}$ of his weight is a poisonous dose. If we consider yeast to be roughly of the same specific gravity as water,—and in one of our experiments we used a solution of 1 in 500, so that yeast can live in $\frac{1}{500}$ of its weight of arsenic, that is a thousand times as much as a man,—that was to be expected. In the complex tissues of the higher animals drugs affect certain cells or tissues more than they do others. That is the case with arsenic, and we believe we are right in saying that it is the basis of medicine.

2. Some curious and exceedingly interesting experiments were made a dozen years ago by Hugo Schultz on simple animal and vegetable cells by treating them with exceedingly dilute solutions of virulent poisons. The experiments are recorded in Pflüger's 'Archiv' for 1888. Schultz used corrosive sublimate, iodine, formic acid, arsenious oxide, chromic acid, and some other reagents, and he found the activity of the organism at once increased. He measured the quantity of carbon dioxide given off by manometers of simple construction, and he made readings after the addition of the poison every two hours, if we remember correctly. The advantage of using his method is that results are easily read off.

Reaction to a stimulus—an irritation—is the most character-

[1] 'Nature,' 4th April 1901.

istic property of living matter. Let us take a simple example of what is meant. Tight boots increase corns. The boot presses on the foot: Nature resents the injury, and directs a company of cells to place a patch of leather on the irritated part. Similarly, the yeast-cells are stimulated by the poison, which is sufficiently weak to irritate and not to poison them, and increased action goes on.

Our results were read at too long intervals to show this; but one of the curves (Plate XXVI., at end of fourth day), the one of 1 in 50,000, has a curious fall after a prominence. The fall we take to be due to the exhaustion after the effort to get rid of the poison. It is interesting to note how unexpected results record themselves mechanically in a curve.

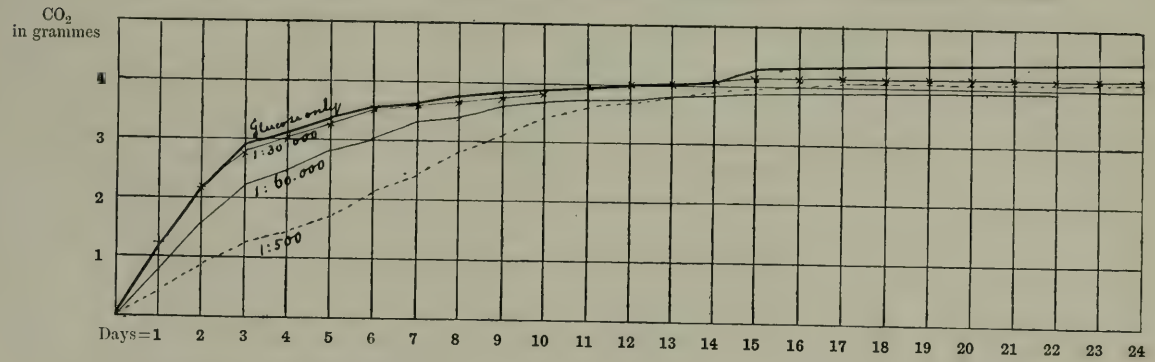
Since Hugo Schultz a number of other observers have made analogous observations. Effront in 1894 or later found picric acid, salicylic acid, and formaldehyde, besides hydrofluoric acid, to have a stimulating action. Other observers found that carbon dioxide made the protoplasmic movements in *Elodea* more rapid. There are, lastly, a number of very suggestive researches on the etherification of cells, such as spirogyra or seeds. We need hardly mention the effect of tea or tobacco or alcohol in man.

3. At present the most striking, the most inexplicable, result of our experiments is the almost insignificant effect of what we have called moderate quantities of arsenious oxide on the vital activity of yeast—quantities of 1 in 20,000 or 30,000 or 40,000 of water (Plate XXV.) No doubt a probable answer will occur to some. It is well known that yeast as used by brewers, in this country at all events, is a mixture of organisms. It is also known that some kinds of fermentation are produced by two organisms acting together—a symbiosis like a green alga and a fungus in a lichen. The ginger-beer plant is such a symbiotic union, and kephir is obtained from milk by the mutual action of a butyric acid bacterium and a yeast. The arsenious oxide may be more injurious to some organisms in common brewer's yeast than it is to others; but this is not the place to enter into such a discussion, even if we were qualified to do so. Judging from the present trend of speculation on these matters, it is very likely to

PLATE XXV.—GROWTH OF YEAST.

GROWTH OF YEAST MEASURED BY O_2 GIVEN OFF IN SOLUTIONS OF GLUCOSE.

(1) ALONE; (2) WEAK, (3) MEDIUM, (4) STRONG, SOLUTIONS OF ARSENIOUS OXIDE ADDED TO GLUCOSE.



Glucose only 10% sol.

—x—x—x—x— " $+As_4O_6$ 1 in 30,000.

Glucose $+As_4O_6$ 1 in 60,000.

" " 1 in 500.

10 grammes of commercial Glucose were used in each flask.

CO_2 GIVEN OFF BY YEAST GROWN IN GLUCOSE (10%) + As_4O_6 OF DIFFERENT STRENGTHS.

TIME VARIABLE, As_4O_6 CONSTANT.

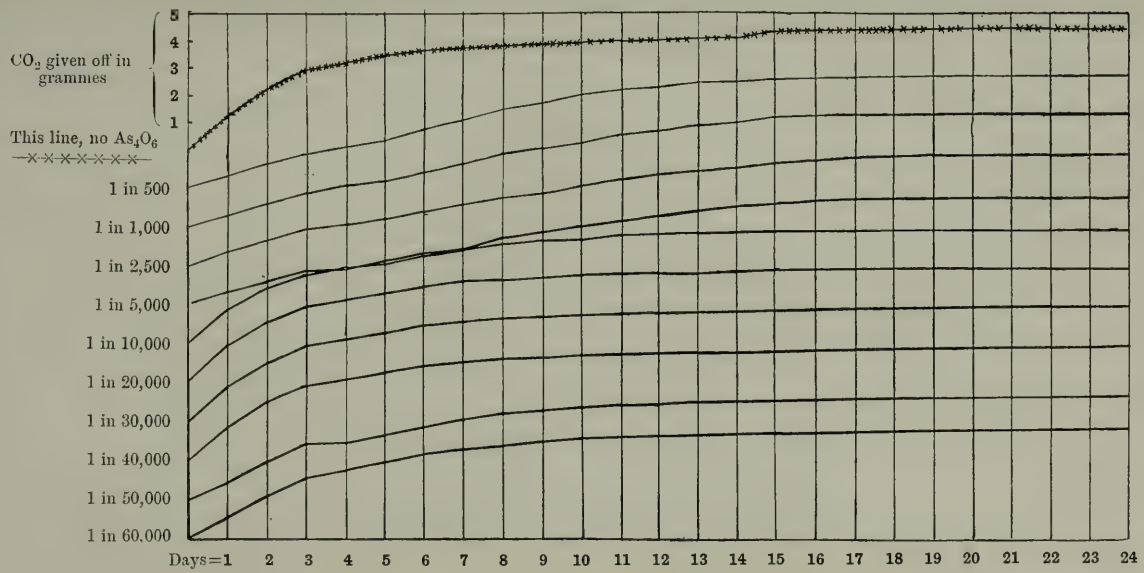


PLATE XXVI.—GROWTH OF YEAST.

suggest itself, although its satisfactory proof would be a much more difficult matter.

We have made these investigations from a purely biological point of view. When one begins an investigation of this kind, many other problems arise out of it. We may have gone over ground which has been already traversed by brewers' chemists: it would be surprising if it had not been. We have, however, not met with any such investigations. We propose to take up some other aspects of the question in other series of experiments.

CAMPING IN THE HAUNTS OF THE VENUS' FLY-TRAP.

By Dr J. M. MACFARLANE, Honorary Member.

(*June 24, 1901.*)

A special meeting of the Society was held on the evening of June 24, when Dr J. M. Macfarlane, a former member of the Society, now Professor of Botany in the University of Pennsylvania, Philadelphia, U.S.A., delivered a lecture on "Camping in the Haunts of the Venus' Fly-trap." A large number of the members and their friends were present to welcome Dr Macfarlane, after an absence of ten years, and to listen to the interesting address he gave. In the absence of the President in Switzerland, Mr A. B. Steele, Vice-President, occupied the chair, and spoke of the good work Dr Macfarlane had done when a member of the Society, more especially in the microscopical section, and of the pleasure it gave the members to meet him again. Dr Macfarlane then proceeded with his lecture, which was illustrated by a large number of beautiful lantern slides.

In imagination the lecturer and his audience journeyed in early April from Philadelphia to Wilmington, North Carolina, 500 miles south, remarking on the wonderful changes experi-

enced by the way as regards climate and vegetation,—frost being on the ground and slight showers of snow in the air on starting, while an almost tropical heat with floral luxuriance greeted their arrival. It was explained that a waggon drawn by two mules was generally hired for these camping expeditions, —a tent being included in the baggage, and a cook added to the party. It was thus an easy matter to live in the forests for weeks, shifting the scene of operations frequently. Wilmington, though only some twelve hours' railway journey from Philadelphia, was characterised as a typical Southern city, with its large coloured population living in frame-houses quite apart from the whites, its broad streets lined with rows of trees, and its handsome public buildings in the business quarter. In the slides attention was drawn to the evergreen or live oak (*Quercus virens*), which was the tree commonly found on each side of the wide thoroughfares at Wilmington. On this tree a fern akin to the British common polypody lives and thrives. Another growth also found frequently on this oak is the native mistletoe, which thus differs from the European form, that is seldom seen on oaks in Britain. So serious are the ravages of this parasitic plant in the Southern States, that unless it is cleared off the trees they frequently succumb.

Arrived at the camping-ground,—a beautiful spot named the Mill Pond,—a feature which at once attracted attention in the lantern slides was the presence of the so-called Florida moss (*Tillandsia usneoides*), hanging in long waving festoons from the branches of the swamp cypress (*Taxodium distichum*). The strange, weird effect of these festoons, as they were swayed with the breeze, was graphically described. Several views of the cypresses were shown, in which the trees were either dead or dying—smothered by the growth of the Florida moss. This epiphytic plant is now being largely used for stuffing mattresses and for other purposes. Though so like the lichen *Usnea*, it is in reality a flowering-plant, belonging to the natural order of the Bromeliaceæ, to which the pine-apple also belongs.

Before passing from the swamp cypress, several views were shown on the screen of the remarkable aërial roots by which this tree is often surrounded. Growing as it usually does in

wet ground, where there is little oxygen supply, these surface roots are an effort made by the tree to procure from the atmosphere what it cannot sufficiently extract from the soil—namely, oxygen. The appearance presented by these trees with surface growths, two or three feet high, around them, was fantastic in the extreme.

Another tree which claimed notice was the long-leaved or southern pine (*Pinus palustris* or *P. australis*). In itself a magnificent tree, attaining a height of from 60 to 70 feet, it is valuable as furnishing large quantities of what are known as "naval supplies"—namely, tar, pitch, resin, and turpentine. The method of extracting the resin by tapping or "slashing" the trees was minutely described; and the destruction of the tree by forest-fires was deplored.

The presence of large numbers of the trumpet plant (*Sarracenia flava*) in this district was next dwelt upon, the pond banks and swamps being often bordered by this curious insectivorous form, only to be seen in Botanic Gardens and a few private establishments in Britain. As regards this plant, the lecturer said that when the type botanic garden in connection with the university at Philadelphia was being formed, a number of Sarracenias were procured from their native habitat and planted in the garden. The result was that they were so abundantly visited by moths and other insects of the district, that at the end of the season the pitchers were found stuffed with their dead bodies, while the plants themselves perished. When another lot of Sarracenias was procured, the precaution was taken to plug the pitchers after planting.

The camping-ground was next shifted to Silver Lake, some eight miles farther south. Of the insectivorous plants, three species of butterworts were here found—namely, *Pinguicula lutea*, *P. pumila*, and *P. clatior*. But the great feature of this locality was the Venus' fly-trap (*Dionæa muscipula*). It occurs in such numbers that from thirty to forty plants may be counted in a sod a few inches square. In fact, so abundant is it that there is little fear of its becoming exterminated through the scientific ardour of botanists, the chief danger being from forest-fires, which often cause great havoc. To adequately describe this plant, which might be termed, the lecturer said, the most wonderful plant in the world, would require a

volume. Much had already been done in order to elucidate its physiological structure.[1] The lecturer said he would only mention two of its curious characteristics—namely, its response to stimuli, that corresponds to muscular action in animals; and, in connection with that phenomenon, the evidence which the plant gives of possessing memory response. A concise account of the observations on these points was then given, when it was stated that, in order to cause the lobes of the leaf to fold over, either two hairs must be touched or one hair must be touched twice. If the interval between successive stimuli was too great, no response followed, the leaf seeming to retain sharply the memory of the first stimulus for about 140 seconds only. When the stimuli continue to act at proper intervals, say by an insect, the leaf becomes firmly interlocked on its halves, and a secretion which is acid to litmus paper pours over the insect. This secretion, analogous to the peptic juice of the human stomach, soon digests away the soft parts of the insect. Want of time only, the lecturer added in closing, prevented him from pursuing this interesting theme further.

Dr Macfarlane's address was followed throughout with the closest attention, and at its close, on the motion of Mr Symington Grieve, a very hearty vote of thanks was accorded the lecturer.

REPORT OF THE MICROSCOPICAL SECTION.

By Mr JAMES RUSSELL, Convener.

The members of the section decided to follow up during this session their studies of the previous session, and to devote their attention to the consideration of some of the smaller Crustacea. The sub-class chosen was the Entomostraca. The name is derived from two Greek words—ἔντομον, an insect, and ὄστρακον, a shell, and thus signifies "insects in shells." Prof. Thomas Rupert Jones, F.R.S., thus defines the

[1] For a notice of Dr Macfarlane's investigations on Dionæa see 'Transactions,' vol. iii. p. 62, "Recent Work by Dr J. M. Macfarlane," by Dr Watson.

Entomostraca: "Animal aquatic, covered with a shell or carapace of a horny consistency, formed of one or more pieces, in some genera resembling a cuirass or buckler, and in others a bivalve shell, which completely or in great part envelops the body and limbs of the animal."

The text-book followed was Baird's 'Natural History of the British Entomostraca,' and one species was studied under microscopical dissection from each of the following genera, and in the order stated—viz., Apus, Argulus, Daphnia, Cypris, Cyclops, Canthocamptus, and Diaptomus.

Apus.—The genus Apus belongs to the Apodidæ, a family of the large legion of the Branchiopoda, or branchial-footed animals. The species which engaged attention was the *Apus cancriformis*, Schaeffer, a comparatively large crustacean inhabiting stagnant waters. The length of this species, inclusive of the tail appendages, is about an inch and a half. The head and thorax are covered by a carapace in the form of a shield, with a deep indentation at the posterior end. It is of a tough flexible nature, and is composed of three layers. The outer layer is chitinous, of a light-brown colour, and very transparent; the median layer is spongy, of a bluish-grey colour; while the innermost is composed of an extremely thin, transparent membrane. The carapace externally is convex, rising to a central longitudinal ridge. In the median layer on each side of this longitudinal ridge are three or four well-marked lines running obliquely in an arched form, thus following the contour of the outer edge of the carapace. Each of these lines is reflexed or bent back upon itself, thus forming a series of loops, the one inside the other, like a nest of test-tubes. The older writers regarded these as blood-vessels; they are now called the shell glands. They are very clearly seen by the naked eye if the carapace be removed and laid upon its back. From the anterior part of this median layer spring the muscles which actuate the mandibles. These mandibles are very powerful, being upwards of one-tenth of an inch in length, and each armed with eight strong teeth.

The outer layer of the carapace covers the whole of the tergal aspect of the head, and, extending over the snout, turns backward on the ventral aspect, and forms the covering of a membrane which extends to the mouth, and from which the

upper labrum springs. The antennæ spring from the edge of this membrane, one on each side of the labrum.

The Apus has two compound eyes, situate on the tergal aspect of the head. They are of a cuneiform shape, and are composed of several separate crystallines of a bluish-black colour. They appear like a bramble-berry cut in two longitudinally. They are covered by the outer layer of the carapace, which, as mentioned above, extends over the head, but at the parts covering the eyes this layer loses its brownish colour and is quite clear.

The mouth is on the ventral aspect of the body, and is partially covered by the large upper lip or labrum mentioned above. The most prominent organs of the mouth are the mandibles, which have been already referred to, and the first pair of jaws (there are two pairs), consisting of two plates strongly ciliated and toothed. As the food of the Apus consists of the smaller entomostraca, these ciliated plates may be looked upon as strainers.

The feet are very numerous, packed closely together, and extend from the mouth downwards along each side of the body, decreasing in size. The first pair of feet are situate immediately behind the mouth, and are for the purpose of locomotion; the others serve the purpose of respiration, and are called branchial feet. The general character of these branchial feet is a stem from which spring many finger-like appendages, strongly ciliated, a triangular plate finely ciliated, and another of an oval shape. As they descend the body these feet become modified, until at last they are merely rudimentary. The tenth branchial foot, however, deserves attention: it is modified so as to form a kind of ovarian pouch or capsule, and consists of two circular plates—the triangular and oval plates above mentioned modified to a circular form—the one a little smaller than the other, bound together at one edge by a strong muscle, forming a hinge-like joint, enabling the smaller to be closed upon the larger like the lid of a capsule. In this capsule are contained the eggs, small dark-brown specks. In the one examined there were seven eggs. By a little delicate manipulation the two plates can be separated, the smaller being folded back upon its hinge, thus enabling the internal structure to be examined.

From the caudal extremity of the Apus are given off two long appendages composed of a great number of articulations. Indeed, the outstanding feature of the creature is the immense number of its articulations. "Latreille says that we may safely take them to be not less than two millions!" It is needless to add that we did not attempt to verify this statement.

The Apus has not been found in Britain for many years,—not since before Baird's time,—but it occurs in various places in Europe.

Argulus.—The Argulus, which next claimed attention, is a parasite of various fresh-water fishes, being found upon the stickleback, carp, roach, and some others. The name of the order, Siphonostoma, in which it is placed by Dr Baird, is founded upon the peculiar siphon-like tube with which the mouth is furnished to enable the creatures to suck the juices of the hosts upon which they live; while the name of the tribe, Peltocephala, is founded upon the shield-like covering of the head.

Compared with the Apus, the Argulus is a small crustacean. It is of an oval form, measuring about one-fourth of an inch in length. The body is covered by a carapace which in the tergal aspect stops near the commencement of the thorax, but in the lateral aspects is prolonged for a considerable distance. This carapace is very transparent, and, like that of the Apus, is composed of three layers. In the median layer of the lateral portions is seen a system of opaque tubes, arising from a single branch which springs from the stomach. They seem to fulfil the same purpose as the shell glands in the Apus. The two eyes are situate in the anterior part of the tergal aspect of the head, and are sunk in the thickness of the shell. They appear like two small dark spots, and are areolar.

The apparatus of the mouth is somewhat complex, the most prominent part being the siphon or sucking-tube, on which the name of the order is founded. This sucking-tube is enclosed in a sheath which is a prolongation of the lip. The antennæ are situate one on each side of this tube, but are completely covered, when viewed from the tergal aspect, by the carapace.

But besides the appendages just referred to, there are what Dr Baird describes as the second and third foot-jaws, the

anterior pair of which are of a very peculiar construction. This pair is so modified that each foot-jaw forms a short hollow cylinder fitted at the extremity with a horizontal rim, furnished round the margin with strong setæ. Attached to the inside of these cylinders are seen four strong muscles, by which they are actuated. These cylinders, with their rims and strong setæ, act like suckers, and enable the animal to fasten itself securely to its host.

There are four pairs of swimming feet by which the Argulus can move about in the water when it is not attached to a fish. These feet serve also for the purpose of respiration, and are fringed with beautiful plumose setæ.

Unlike the Apus, the Argulus has no external ovisac, but in a gravid female the eggs may be seen in the cavity of the thorax, between the two lateral prolongations of the carapace. The abdomen is by some described under the name of the tail. It consists of a bilobed plate, in the bifurcation of which is situate the anus.

The other Entomostraca studied were of much smaller size. We shall take them in their order.

Daphnia.—The Daphnia is one of the genera belonging to the family Daphniadæ, and of the order Cladocera, so called from their antennæ resembling somewhat the branched horns of a stag. The species studied was the *Daphnia pulex*, or water-flea. This name appears to have been given to it on account of its form somewhat resembling the parasite in question, and also from its jumping motions through the water. *Daphnia pulex* is sometimes common in ponds and ditches of standing water. During its life the creature moults very frequently, this moulting taking place every ten days or a fortnight, according to the warmth of the weather. Viewed externally, the Daphnia appears to consist of two very distinct parts—the head, which carries the eyes, antennæ, and the apparatus of the mouth; and the thorax and abdomen, which bear the branchial legs, and are covered by a very transparent shell. The head is also covered with a shell of somewhat harder consistency than that which covers the thorax and abdomen. The prolongation forward of this covering of the head forms a point somewhat resembling the beak of a bird. Beneath this beak are the superior antennæ, consisting of a

few short setæ; while the inferior antennæ, which spring from the sides of the head, are large and much branched, each branch being finely plumose.

The Daphnia belongs to the class of what are called Monoculi, or one-eyed animals. The eye is compound, consisting of about twenty separate crystalline lenses, and has a slightly rotatory motion, actuated by two sets of powerful muscles. This motion is very well seen if the animal is examined by a low power of the microscope in a live-box. In this position, owing to the transparency of the shell, the motions of the branchial plates can also be well seen. In female Daphnia the ovaries are, according to Baird, situated along the sides of the abdomen; and, in moderately young individuals, their position may be made out by the small, round, pellucid globules they contain. At the back of the shell, and behind the ovaries, is the brood-pouch into which the eggs are discharged from the ovaries, and where the young Daphnia may be observed in different stages of development. These eggs are sometimes spoken of as summer eggs, and a considerable number of them may occasionally be found in the brood-pouch at one time. But eggs of another kind, called ephippial eggs,—also known as winter eggs and as resting eggs,—may under certain conditions be produced. The number of ephippial eggs produced by Daphnia is usually two. They appear, when nearly developed, as dark-brownish objects at the back of the shell. The part of the shell in which these eggs are enclosed becomes thickened, and is by-and-by thrown off with the enclosed eggs, floating or sinking amongst the mud till conditions favourable for the development of the eggs occur.

Cypris.—The Cypris is one of the genera into which the family of the Cypridæ is divided. It belongs to the order Ostracoda, of the legion Lophyropoda. The species studied was the *Cypris tristriata*, Baird, now *Cypris virens* (Jurine). It is one of the Monoculi, or one-eyed animals. The eye is not compound—that is, there are no traces of separate crystallines.

The whole body of the Cypris is enclosed in an oval shell like that of a small mussel, the two halves of which are attached to each other by a strong ligament which acts like a

hinge, thus allowing the shell to be opened and shut at the will of the creature. The shell is thickly studded over by small dots, which on close examination by a high power of the microscope appear as protuberances crowned by a minute hair. The shell is very brittle, and seems to be covered by some substance which repels the water: it may be that the protuberances in question are of use in this respect.

The mouth is situate on the under surface of the anterior lobe of the body, and consists of a superior and inferior lip, a pair of mandibles bearing each a palpus, and two pairs of jaws. The mandible is a powerful organ for such a minute animal: it consists of two parts — the mandible proper, terminated at one end by a sharp point and at the other by four or five pretty strong teeth; and the palpus, which springs from about the middle of the mandible proper, and consists of three joints and several setæ. The use of these palpi is understood to be to cause a current in the water for the purpose of carrying its food to the mouth of the animal. There are two pairs of antennæ: the superior pair, springing from the head immediately below the eye, are branched and beautifully plumose.

Cypris is more or less common in ponds and ditches of fresh water where the water is stagnant but not putrid.

Cyclops.—The Cyclops is classed under the Cyclopidæ, one of the families of the order Copepoda or oar-footed animals. It is also a one-eyed animal, and is found in fresh water, in ponds, lakes, &c. The species studied was the *Cyclops quadricornis.*

The Cyclops is a pretty little creature, about the one-tenth of an inch in length, including the appendages of the tail. Viewed externally, it appears to be divided into two distinct parts—the thorax and abdomen. The thorax is divided into four segments, of which the anterior is equal in size to the remaining three: the abdomen is divided into six segments, but in the female the second and third are so united as to appear but one. The shell of the various segments of the thorax is open on the ventral aspect of the animal, to give passage to the feet, the organs of the mouth, and the antennæ. The single eye is situate in the anterior part of the first segment of the thorax, between the superior antennæ. These

antennæ are of considerable size, comprised of numerous articulations, and are covered with setæ. The inferior antennæ are much smaller.

There are five pairs of feet, which spring from the thorax —a pair from each of the segments; the fifth pair is small, and almost rudimentary. The first four thoracic pairs are alike. Each foot consists of two branches, springing from a common base: each branch has three articulations, and is provided with numerous plumose setæ. Arising from the root of the base of each foot is a long, finely plumose seta. These two setæ incline inwards towards each other, and nearly, if not altogether, meet. The tail consists of two pieces, each terminated by four finely plumose setæ. The plumose setæ of the tail and thoracic feet are extremely pretty objects when seen under the microscope.

The shell of the thorax is so transparent that with a good light the eggs may be seen in the ovaries: these ovaries are situated in the middle line, and give off an oviduct on each side of the thorax. There are two ovisacs, one on each side of the first segment of the abdomen, and attached to it by a slender tube. These ovisacs may frequently be seen. They are of various colours, and seem each to contain about thirty eggs.

Canthocamptus.—The Canthocamptus is a genus belonging to the same order as the Cyclops. The generic name is derived from the long flexible spines of the tail. The species studied was the *Canthocamptus minutus* of Baird, an inhabitant of fresh-water ponds and ditches.

The shell consists of ten segments, gradually decreasing in size towards the tail, but the thorax and abdomen are not distinctly separated as in the Cyclops. The body between the fourth and fifth articulations is very flexible, so that the hinder part can be turned up at right angles to the anterior part.

The antennæ, compared with those of the Cyclops, are comparatively short, and are furnished with setæ; but, on the other hand, the feet are much longer than those of the Cyclops, and are beautifully plumose. In those which were dissected the striated muscles were clearly seen under the microscope.

The Canthocamptus has only one ovisac, which is attached to the first segment of the abdomen, and usually contains a large number of eggs. From the caudal extremity there issue two very long flexible spines with serrated edges, and it is from these appendages that the generic name is derived.

Diaptomus.—The last genus studied was the Diaptomus, one of the genera included by Baird in the family Diaptomidæ, but now removed to the family Centropogidæ, and belonging, like the two preceding genera, to the order Copepoda. The species chosen was the *Diaptomus castor.*

The Diaptomus is a one-eyed animal, the large single eye being situate at the anterior extremity of the first segment of the body. The shell consists altogether of ten segments, of which five belong to the cephalo-thoracic portion and five to the abdomen. The antennæ are very large, their length being equal to that of the body; they are divided into a great number of articulations, and are furnished with strong setæ.

There are five pairs of legs: the first four pairs much resemble the corresponding pairs of the Cyclops, but are much longer. Each of these legs consists of two branches springing from a common base, and each branch of the second, third, and fourth pairs of legs consists of three articulations furnished with very fine plumose setæ. The terminal setæ of the branches are very long, and form a beautiful microscopic object. The fifth pair of legs is somewhat differently formed. The tail consists of two parts, each terminated by five setæ finely plumose. In a specimen which was steeped for some hours in liquor potassæ the outer covering was removed, and the skeleton was laid bare, showing in a beautiful manner the antennæ, legs, and tail. The female has one ovisac of a comparatively large size attached to the abdomen, containing a large number of eggs.

The Diaptomus is a very pretty creature, and its movements through the water, especially when it is disturbed, are rapid in the extreme. Its generic name seems to be founded upon this rapidity of motion, being derived from the two Greek words signifying "through" and "to fly," as if it seemed to fly through the water. The words of Jurine in this respect may be quoted: "Son port est élégant; sa manière de s'élancer dans la liquide est noble et hardie; ses mouvements

sont libres et faciles; tout enfin annonce chez lui une supériorité qui caractérise la grandeur de l'espèce à laquelle il appartient."

The foregoing remarks upon some of the organisms studied during the session are necessarily limited by the space at my disposal. In conclusion, it may not be amiss to state the medium which was found most suitable for mounting the more delicate parts for examination under the microscope. After trying several media, it was found that the following gave excellent results, allowing the fine plumose setæ to be clearly seen: Glycerine, 1 part; alcohol, 1 part; distilled water, 2 parts. Gold size should be used for making the cells and for sealing them after the cover-glass has been put on, and when dry a coat or two of good asphalt cement should be added.

My best thanks are due to Mr T. Scott, F.L.S., Naturalist to the Scottish Fishery Board, and an Honorary Member of the Society, for revising the classification in the above Report.

In Memoriam: *MARK KING (1828–1901).*

By Mr JOHN LINDSAY.

At the concluding winter-evening meeting of the Society for the present session, on April 24, a paper was read by one of our honorary members, Mr Mark King, on "The Flora of the Shores of the Firth of Forth." In submitting his communication, the writer said that he had hoped to make it more worthy of the subject, but that he found his years of threescore and thirteen were not equal to the task. This paper, which is now published in our 'Transactions,'[1] is a valuable contribution to a large and important subject, and betokens much labour and careful observation, conjoined with botanical skill, on the part of the writer. Shortly after this communication was made to

[1] See *ante*, p. 202 *et seq.*

the Society, the members were startled by the announcement that the writer of it had died suddenly, on the 9th of May. His tall, straight figure, and striking individuality, are still fresh in our memories, and we can hardly yet realise that he has gone from our midst.

Mark King was born at Lilliesleaf, Roxburghshire, on December 28, 1828. He was the eldest of five sons, all of whom left their rural home early in life—as is still the custom with village youths, often to be afterwards widely scattered. Two of these brothers are now in positions of influence in Vancouver, British Columbia, while a third is pushing his fortunes in South Africa. Mark chose the occupation of a gardener, no doubt from his love of flowers, and served his apprenticeship in the Earl of Minto's gardens at Minto House, Hawick. On leaving this place as a young journeyman, he proceeded to Yorkshire, where two or three years were passed; and he then returned to Scotland, spending some time at Stanwell Nurseries, Leith, under his lifelong friend Mr Hugh Fraser, now an honorary member of this Society. Having a great desire to learn something of chemistry, Mr King seized the opportunity of becoming an assistant in the chemical works of the late Anthony Laird, at Magdalene Bridge, Musselburgh. This, however, cut him off too much from his botanical studies, and it was soon given up. In 1865 he became gardener to the late William Kinghorn, Esq., of The Grove, Bonnington, Leith, in whose service, and that of his successor, he remained until he retired on a pension a few years ago. Here much of his leisure was devoted to the pursuit of field botany, and many miles were often walked on a Saturday afternoon to collect some botanical rarities, which would be planted in a special part of his garden, to be tenderly watched and cared for. One of his favourite hobbies was the observation of "weeds" which had found their way into gardens, fields, or nurseries from foreign countries, or to the ballast-heaps of our shores. With these he had an intimate and wide acquaintance. On two different occasions during the past session he exhibited to the Society wild-flowers gathered on the South African veldt. These were collected by his youngest brother, Robert, during hours of enforced waiting with the hospital train, of which he was the engine-driver, and sent on to the plant-loving

brother at home. Strange to say, when, last May, Robert returned to this country on a short furlough, after eighteen years' absence, the first news he heard was the announcement of his eldest brother's death.

So far back as March 1884 Mr King contributed his first paper to the Society, on "Some American Plants worth Notice." This was followed in February 1885 by "Notes on the Genus Lamium," and by "Veronicas in the Neighbourhood of Edinburgh" in January 1886. In January 1891 he read a very interesting paper on "Plant Multiplication," and in December 1895 another on "Poisonous Plants." This last paper was very favourably noticed in the 'Gardeners' Chronicle' and in 'Nature' on its publication in the 'Transactions' of our Society. He was also a member of the Scottish Horticultural Association, and contributed to its 'Proceedings.' He was a man of sterling probity, well read in many subjects, and greatly esteemed by all who knew him.

EXHIBITS IN NATURAL HISTORY.

At the winter-evening meetings during the past Session a number of interesting objects in Natural History were shown by members of the Society. The following were amongst the number: The President, Mr W. C. Crawford, exhibited a pure culture of fresh-water algæ made by Professor Chodat, Geneva; also specimens of gold-bearing quartz from the Transvaal, and a sample of *pioggie di sangue* or blood rain from Naples, which last was also shown from Dumfriesshire by Dr Watson. The Secretary exhibited a nest of the weaver-bird from Assam, while Miss Mitchell showed a nest of the humming-bird from Jamaica. A yellow-coloured mavis, captured in Dalmeny Park, was shown by Mr C. Campbell, as also skins of a pied variety of mole from the same locality. Mr G. A. Harrison exhibited a nest of the trap-door spider, and Mr Adams a death's-head hawk-moth caught at Dunfermline. A small collection of fungi was shown by Mr Calder, and a

number of wild plants, insects, and fruits from South Africa by Mr King. Miss Edith M. H. Gray exhibited a cone from an Araucaria imbricata grown at Hollybush, Ayrshire. A large number of microscopic slides were also shown by members throughout the session.

NATURE STUDY FROM THE POINT OF VIEW OF THE FIELD NATURALIST.

By Mr W. C. CRAWFORD, F.R.S.E., President.

(*Read Oct. 23, 1901.*)

Three years ago you elected me your President: I can hardly believe it was three years ago, the time seems so short. I have greatly valued the honour: it has given me very much pleasure to preside over a society where goodwill and kindness uniformly prevail, and where many kindred spirits meet together. And now in retiring for the third and last time,—for we, the office-bearers, retire every year, and you have re-elected me twice,—I should like to talk to you on a subject to promote which is the chief aim of this and of similar societies—and of these societies there are a great many, not only in this kingdom but in other countries. The subject is Nature Study.

A witty Frenchman, I think it was, once said, "There are no such things as facts—there are only points of view"; and in discussing human affairs, where the facts are multitudinous and confusing, the point of view may be as important as the facts themselves. Is not every theory a point of view? And so the field naturalist from his point of view should be able to see clearly the significance and the trend of nature study.

Nature study is greatly talked about at present: it is being introduced into schools,—and it is no easy matter to introduce radical changes into national institutions. I do not intend to say much about that aspect of the matter. Several of our

members with far more knowledge and experience than I have are incomparably better qualified to speak of nature study in schools, and the practical difficulties to be overcome before it can be successfully taught there. What I am going to say will apply to young people both at school and in their homes; and home influences, to my mind, are the most important part of all true education, because they have the greatest influence on conduct.

It has always seemed to me that the defects or failures of school education were largely due to the fact that the British parent has no clear idea of what he wants when he sends his children to school. "You shall educate me," says Emerson, "not as you will, but as I will." What the aim of education should be is one of the most difficult things to determine. The aim of nature study is to bring us into sympathetic touch with our surroundings. The nature student uses books as guides to nature, like so many Baedeker's or Murray's handbooks, to direct him to what is most worth notice, and to tell him how to reach the best points of view in the shortest time. Nature study is the beginning of what receives later the name of original research. Nature study and research are pervaded by the same spirit. We cannot all be discoverers of new truths and publish our results, and it is well for our fellows that we cannot; but we can all learn to some extent the habit of getting at the facts for ourselves, of thinking for ourselves. Those of us who have spent happy *semesters* at German universities know what an amount of research goes on there, and still there is less originality about it than we might at first be inclined to believe. Students get a great deal of direction and advice from their professor or privat-docent, so that it is really the training in how to investigate for oneself that is the most valuable part of the higher education in Germany; and this is just advanced nature study. The nature student, or for that matter the field naturalist, follows the same path which the race has pursued through the ages in acquiring scientific knowledge. His mental attitude resembles that of the early astronomers on the plains of Chaldea: considering that they depended simply on their own observation, they seem to have known a great deal; and like them the nature student gains higher standpoints, and so

widens his intellectual horizon. Nature study accustoms us to look at things in the solid, and not in diagrammatic form as they are sketched for us by others. In nature study the acquiring of numberless facts is not aimed at so much as the cultivation of the power of observing facts within our immediate experience, and of building conclusions on that solid ground.

There are two ways of teaching, just as there are two ways of building houses. We may begin at the bottom,—that has been the way the race has all but universally followed to shelter itself from wind and rain; or we may begin at the top, if a well-devised, sufficiently rigid framework is prepared beforehand. In America they do that: they construct a sort of Eiffel Tower, put a roof over it, and then build downward. Some of us here, I daresay, made our early acquaintance with the Latin tongue through a venerable grammar written in Latin; and many of us were supposed to know a good deal about aorists and perfects before we knew a couple of hundred words of Greek. That was on the Eiffel Tower system; and, as in the immense majority of cases the metallic framework was never filled in, there remains in after life a mental structure as valueless as so much old iron and old bricks.

To continue my illustration from the study of languages: if we begin to learn a language new to us as a child does,—as, for example, is done in the so-called Gouin system,—we learn a great many words linked in natural associations, and we connect a word with an action, and so the action leaves its trace on the brain, and this becomes deeper and deeper by repetition. Naturally to get good results, whether in nature study or in the study of languages, our course must be arranged systematically, progressively, logically, to economise time.

The psychological basis of nature study is inquisitiveness. It is natural for every child to be inquisitive, and to wish to find out the reasons of things around it. Systematic, carefully thought-out nature study—the so-called heuristic[1] method—is an attempt to gratify intelligently this curiosity,

[1] From the exclamation of Archimedes when he discovered the specific density of gold, "Heureka," "I have found it!" The word has been adopted by the Education Department.

and to exercise and develop the rudimentary faculties of research. The teacher directs the natural impulses, and tries to make them automatic so as to build up character, very much as the gardener prunes and trains the tree that it may bear good fruit. There is fine insight in what Shakespeare wrote :—

> "Yet nature is made better by no mean,
> But nature makes that mean : so, over that art,
> Which you say adds to nature, is an art
> That nature makes. . . .
> . . . This is an art
> Which does mend nature,—change it rather, but
> The art itself is nature."
>
> —"The Winter's Tale," iv. 3.

"*Feed* the young growing human being," says Professor James, our present Gifford lecturer, "feed him with the sort of experience for which from year to year he shows a natural craving, and he will develop in adult life a sounder sort of mental tissue, even though he may be 'wasting' a great deal of his growing time in the eyes of those for whom the only channels are books and verbally communicated information."[1] Sir John Gorst, in his address as president of the section of Education of the British Association, made some remarks worth remembering, coming as they do from so great an authority on educational affairs. "If children in village schools," he said, "spent less of their early youth in learning mechanically to read, write, and cipher, and more in searching hedgerows and ditch-bottoms for flowers, insects, and other natural objects, their intelligence would be developed by active research, and they would better learn to read, write, and cipher."

Nature study has been made to play an insignificant part in our educational system, because the results cannot be mechanically determined by an examiner,—they cannot be readily quantified and paid for according to the method long in vogue. The same difficulties were felt long before the age of examinations and the compulsory teaching of the three R's. Our spiritual guides in the National Church tried to introduce soul-sifting machines, known as confessions

[1] 'Talks to Teachers,' by Professor James, p. 148.

and catechisms: it saved so much trouble to put a question and get the stereotyped correct answer; and it was hard work indeed to teach in the concrete. There is some hope for improvements in the future, when an earnest attempt is being made to discontinue a system in which, to quote again from Sir John Gorst, "the children were not really educated at all—they were only prepared for examinations." Systems of national education, like human institutions generally, became in course of time hindrances to progress from their want of elasticity. They are like the crustacean exoskeleton: while it strengthens and protects the organism within, it must frequently be cast off, and the process is painful and dangerous; still it is unavoidable, if the living organism is to retain its vigour and grow. All social systems must undergo ecdysis, for the institution was made for man, and not man for the institution.

I have referred to payment by results, which is happily now likely to become a thing of the past, and I had fondly hoped that nature study was a territory still unexploited by the examiner, a region where the educational prospector had not marked off his claim. Of that I have lately had doubts—for habits, individual or social, are hard to eradicate. I attended a lecture or two of a recent course given by well-known scientific men to schoolmasters, to show how nature study might be taught. What I heard disappointed me, because it was academical and bookish in form. I had expected a shore walk, a basketful of the common objects, and demonstrations from the living things: perhaps that was quite impracticable. Instead of it we had a number of magic-lantern slides, not taken from nature but from well-known book-illustrations, some of which had done duty for a couple of generations. Now man is a very imitative animal, and one may imagine the pedagogic audience repeating the lessons they had themselves received after being diluted to suit juvenile digestion; and the magic-lantern and the book illustrations will doubtless reappear in the primary or secondary school. Not only so, but this course of lectures ended, I heard, with the usual written examination to ascertain how far the schoolboy of mature life had imbibed the instruction imparted to him. If this is also to be repeated in the schools, it makes one

earnestly wish that nature study had been left untilled ground.

The *Here* and the *Now* are the categoricals of nature study. It is Thoreau who says that every hill may be an Olympus, where the gods may be seen by those who train their eyes to see them; and you may remember the story of the old Greek philosopher, which impressed both Aristotle and Lessing. Heraclitus was visited by some friends when he was warming himself in a stable, and they hesitated to enter. "Come in," he said, "for here also are the gods." To illustrate what I mean, suppose we want to show an example of a synergid we need not exhibit a picture of the umbrella-like alga found in the Bay of Naples, and by no means common there, when we can gather *Vaucheria* or *Bryopsis* in handfuls not far from our own doors. If we wish to illustrate the movement of leaves, it would be well to avoid a tropical *Desmodium* as an example for the lantern screen (although it is given in many German text-books, and so finds its way into ours), so long as similar phenomena may be seen in wood-sorrel or clover.

There is another reason for teaching nature study in schools, besides that of attaining a higher educational ideal. Purely intellectual reasons are rarely if ever enough to bring about great reforms: some economic or social need must be present to give impetus to the movement; and social and economic causes are at work to promote nature study. These have been recognised in America, where the people are more ready to adopt new ideas than they are in the old country. For some time there has been in America, as there has been in Europe, an extensive migration of country people into the larger towns. The population is increasing much more rapidly in the cities than in the country. In fact, the recent American census shows a decrease in population in some of the rural districts. The Americans have set themselves in a very far-seeing way to endeavour to increase the attractiveness of the country by teaching the boys and girls—who will soon be themselves citizens, and ere long parents of a new generation—to see some of the beauties and interests of country life. In several States leaflets and pamphlets have been carefully prepared for the use of public-school teachers to help them to present to their pupils nature study

in an interesting way. A number of these lie on the table. I showed some of these tracts to a young lady, a member of this Society, who has studied very thoroughly Kindergarten methods, and her criticism of them struck me as particularly to the point. She said they were got up far too evidently to coach the teacher. This applies to English as well as American nature study tracts. The aim of the movement is most praiseworthy, but, it must be confessed, by no means easy to accomplish, because teachers in public schools on both sides of the Atlantic are already an overworked body, and teaching nature study above all things must be sympathetic and not mechanical, and for that a certain amount of leisure is essential.

Here I should mention an article which appeared in Appleton's 'Popular Science Monthly' for February 1898, which showed that a good deal was being done in the way of what I might call economic nature study. I shall quote a few sentences from the article. "In 1890 there were nearly 8000 school gardens—gardens for practical instruction in rearing trees, vegetables, and fruits—in Austria." "In France gardening is practically taught in 28,000 primary and elementary schools, each of which has a garden attached to it, and is under the care of a master capable of imparting a practical knowledge of horticulture." Similar arrangements exist in Sweden. "Still more significant is the establishment of many school gardens in Southern Russia." Out of 500 schools in one province, about one-half have school gardens of fully an acre each, and this movement has widely spread over Central Russia.[1]

To sum up what I have already said: nature study—or, to use the new word, the heuristic method—is the phylogenetic method; it is the path the race has pursued in advancing from palæolithic times to the present, from ignorance

[1] It is curious to note what a change in men's views of education has taken place in little more than a century. Dr Samuel Johnson thought education as needful for the "embellishments of life." "The truth is," he says, "that knowledge of external nature and the sciences which that knowledge requires are not the great or the frequent business of the human kind" ("Life of Milton"). In very much the same spirit Rousseau wrote: "Le pauvre n'a pas besoin d'éducation,"—he means of books; "celle de son état est forcée; il n'en sauroit avoir d'autre" ('Émile,' i.)

to knowledge. It cultivates the habit of finding out things for ourselves: it is therefore the true ontogenetic method—the course to pursue for individual development. It is of great economic importance to make the country more attractive and prevent its depopulation. The difficulties which stand in the way of its introduction are the want of teachers, themselves trained in the heuristic method; the want of time in school hours; and, chiefly, the results cannot readily be summed up for payment by examination.

And now I must go on to speak of the subject as it concerns us mature men and women, and chiefly the real although almost unconscious devotees to nature study—the field naturalists. Most of us have unfortunately not had the advantage of good sympathetic direction in our nature studies in early youth, and much of our education might, I daresay, have been with advantage replaced by nature study: it would have saved us giving brain-room to a good deal of intellectual lumber.

It is often noticed that people who spend much of their time in reading are not observant; and our school education, which is mostly taken up by book study, leads to a like result. Some years ago a friend of mine and I were staying in a west coast village. It was a lovely summer afternoon an hour or so before sunset, when we saw a most interesting meteorological phenomenon. It was a mock sun of great brilliancy. The phenomenon lasted a good half hour, and impressed us exceedingly. One sees such things figured in books on the arctic regions, but I had never seen a parhelion before, nor have I seen one since, in this country. It was Sunday: the hour for evening service approached, and a hundred or two of people walked along the road to church. The sun was at the back of some on one road and on the right of others on another road, and somewhat hidden by a plantation, so that it was not straight before them. What struck us greatly was that none of the passers-by seemed to notice the phenomenon at all, except a few to whom we pointed it out. I asked several neighbours next day if they had seen the mock sun: not one of them had done so, and some greatly regretted that they had not. I have known people—educated people—who lived within two or three hundred yards of rocks on which were magnificent ice-groovings, and although they had passed these rocks every day

for a generation they had never noticed the ice-markings. Examples might be multiplied indefinitely. When the British Association was in Edinburgh last, I heard the late Professor Fitzgerald make some remarks which were so pithy that I have not forgotten them yet. He said that the study of Greek literature had made very little impression on us as a nation, because the thoughts were conveyed in an almost unknown language; while Hebrew literature had had an enormous influence on us, because the Bible had been translated into the vernacular. Nature study is the vernacular of the race, by the use of which it has made all its great discoveries; and when we prefer secondhand knowledge to nature study, we allow our powers of observation to become atrophied. We are much more impressed by observations made by ourselves than things we read about. The fact observed is like a scene in the sunlight; the other is like a photograph which, however accurate, wants life and colour. Let me give an illustration or two from my own experience. Many years ago I visited Yellowstone Park, and amidst the many wonders of that region of geysers was one which made a great impression on me. It was to see the water in the geyser basins of a beautiful blue-green colour, from the living algæ it contained. The water was boiling—that is, it had a temperature of about 180° Fahr., which is the boiling-point at the elevation where we were. I could not believe that it was possible for protoplasm to live at that temperature, and my first impulse was to doubt that these delicate organisms were alive at all. Many years after, at a meeting of the Royal Society, I was delighted to hear Lord Kelvin express his wonder at finding similar organisms in the hot springs of Banff, in Canada. His inference was that living algæ might exist on the earth when it was much hotter than it is, and supply the atmosphere with oxygen. Later, I found other cases of simple organisms living in most unexpected places,—for example, a mould growing in dilute sulphuric acid; from which it may be concluded that the physical basis of life has powers of adapting itself to conditions as yet not dreamt of in our philosophy.

But Yellowstone is in a far country, and not many of us wander thither. Let me take another illustration of the impressiveness of seeing things for oneself, and this from our

native country, the interest of which, for the field naturalist at least, is inexhaustible. Some years ago, in company with a geological party, I visited Mull. Naturally the Ardtun leaf-beds were the chief object of attraction. We went to them and dug out from underneath the sheets of basalt pieces of leaves of dicotyledonous plants, some of them resembling plane-tree leaves. The leaves are in considerable quantities: they have been blown, possibly by autumnnal winds, into some lake or stream, and have been there covered over by showers of volcanic ashes, and afterwards by enormous sheets of basalt from a neighbouring volcano. Like Pompeii and Herculaneum, they have been preserved through the ages, only unlike the old Italian towns they have had mountains of basalt—a Hebridean Pelion and Ossa—piled over them. Since these tender leaves grew, the fiord of Loch Scriddan and the valley of Glen More have been excavated through the sheets of volcanic rock; all the valleys of the West Highlands, in fact, have been formed. The sight was very impressive, because it gave us some idea how long the Highland valleys had existed, and, judged by geological time, it was not so long ago after all. It was since plane-trees and cinnamon-trees existed, almost the same as those living now; and these perishing trees have more enduring forms than the solid rocks on which they grew.

Another point to be noticed is that living, growing, developing objects are the most suggestive. Suppose we take this time an example or two from living things which we cultivate,—for a field naturalist can come into touch with nature best of all by growing things—by becoming for the time the developed gardener or shepherd. There are few things we may obtain more suggestions from, particularly about human society, than from domestic bees. I have kept bees for a very long time—not for their honey, but because a hive seems to throw much light on many and profound social problems. In my young days—it was before frame hives came into general use—we kept our bees in "skeps," and we often killed them in order to get the honey. It was the most foolish thing a beekeeper could do. I do not speak of its cruelty. The best, the most active of the bee colonies were killed off, because their hives contained the most honey, and the more backward—the inferior

—hives were preserved. It was an ideal way to deteriorate the race. In principle it resembles the human plan of settling international differences by war. You remember the average height of the French people was lowered by an inch after the Napoleonic wars. Another problem about the bee community is the number of drones maintained in the hive. In a large good hive there are some 20,000 bees and some 500 drones, whereas a dozen or two would seem to be enough: this means that the working members of the community have to pay 6d. per £ of income-tax—in many cases much more—to keep up the idle classes,—the leisured classes. There must be some reason for this. May I suggest a probable explanation? The drones, whether from their leisure or celibacy, are the gifted members of the hive. The workers are sacrificed to work, and die early. The queen is wholly given to reproduction, and has the brain of an imbecile; while the drones are the best endowed with organs of sense and with brains,—I mean, their nervous system is the most developed. The drones may therefore be a means of keeping up the intelligence of the race, and for this the workers submit to the income-tax I have mentioned. I know that I am treading on dangerous ground, and that this is not the time to discuss such a problem, nor to suggest a solution not according to current Weismannian views. Beekeeping, however, means having a garden, and that is a luxury beyond the reach of many urban field naturalists. A great many interesting cultivations, however, may be made in an inverted bell-jar. In summer I had a boat lying on the shore in which there happened to be a good deal of rain water. On going to empty it, I found scores of the aquatic larvæ of some gnat or mosquito floating on the surface, and others swimming rapidly through the water by sudden contortions,—you know what I mean. I gathered a lot into a tube and tumbled them into an aquarium: there was nothing in that. I have done the same thing before—we have many of us done it again and again, just as we plant out our geraniums or sow our annuals every year: we want to enjoy seeing them as often as we can. In that small glass vessel the whole drama of insect life was performed. The curtain rises and shows us on

the stage the active young larvæ almost as transparent as glass. Three or four scenes of moulting succeed, then there is the great transformation scene of pupation, and lastly the emergence of the winged insect into a new element. The changes which have taken place in the organism before our eyes have been enormous—changes of the external organs, a sort of liquefaction and reconstruction of the internal, waste nitrogenous matter thrown off at each moulting—a curious way of obtaining and getting rid of our clothes; and the great problems of heredity presented in an entirely new light. Whether we give a biological or a poetical interpretation to many things in metamorphosis—and the phenomena admit of both—we could not be spectators at a drama fuller of meaning than that of the life-history of a gnat. You remember Browning's

> "Fancy which turned a fear,
> Because the membraned wings,
> So wonderful, so wide,
> So sun-suffused, were things
> Like soul, and nought beside."
>
> —"Fifine at the Fair."

The want of a garden is no reason why we cannot still play the *rôle* of the developed, metamorphosed gardener. We can grow numbers of algæ in a tumbler of water, and obtain from them a working model of the origin and evolution of sex. Numberless other illustrations will occur to you. I know it will be said we have no time in this busy age for such studies. I would reply that we live in the richest empire the world has ever seen, and there is a great deal of leisure if we use it well. Laveleye, the economist, has a fine paragraph, which I copied out of one of his books ('Luxury') a long time ago. Laveleye says, "When our rational wants are satisfied, what we need is not to create a superfluity for the satisfaction of spurious needs, but to employ our leisure in cultivating our minds, enjoying the society of our fellows, and fostering our love of the beautiful. The higher a man rises in culture and knowledge, the less he cares for fine clothes and sumptuous fare." This is only another version of Wordsworth's ideal—"plain living and high thinking."

If nature study formed a part of education, and if our

education did what all true education should do, organise habits of conduct, it would go far to work out Laveleye's ideal. There are few things more depressing in our social life than to observe how men spend their leisure. Look at the way our trades holidays are largely spent. Take a trip in a steamer on the Clyde during the Glasgow Fair Holidays, and you will see thousands of hard-working, respectable men and women who, when they have a few days' freedom from toil, do not know what to do with themselves. It is much the same in all our great cities. "What use will humanity make of its leisure?" asks Maeterlinck ('The Kingdom of Matter'). "On its employment may be said to depend the whole destiny of man, and were it not well that his counsellors should begin to teach him to use such leisure as he has in a nobler and worthier fashion? It is the way in which hours of freedom are spent that determines as much as war or as labour the moral worth of a nation. It raises or lowers, it replenishes or exhausts. At present we find in these great cities of ours that three days' idleness will fill the hospitals with victims whom weeks or months of toil had left unscathed." I have quoted this passage—which seems to me entirely true—from the distinguished Belgian writer to show that the evil is international.

It is not our working classes alone who do not spend their leisure well: look at the literary trash the average English traveller brings into a railway carriage to while away an hour. I was once in the desert of Arizona, and there I met an American artist. He had spent a long time in contact with the Red Indians, and, like many men in such places, he enjoyed intensely a talk with a stranger. He dilated on the Red Indian's ideal of life, and on that of the white American, preferring much that of the Red Indian. In tone it was exactly like a conversation with a Red Indian chief given by Lotze ('Microcosmus,' ii. 240). "Ah, my brother," said the chieftain to his white guest, "thou wilt never know the happiness of both thinking of nothing and of doing nothing; this, next to sleep, is the most enchanting of all things. Thus we were before our birth, and thus we shall be after death. . . . Your people are like a fountain flowing from the rock,—they never rest. When they have finished reaping

one field, they begin to plough another; and as if the day were not enough, I have seen them working by moonlight," and so on. And the great philosopher of Göttingen adds, "This is not the language of stupidity. On the contrary, if it were presented to us in Greek verse, we should admire in Latin commentaries the fineness with which it derides the perversity of the white men, of whom so many, in their haste to get forward, lose all remembrance of their goal."

It is the Hindoo habit to give some time every day to tranquillity and meditation; and it was Aristotle who said, "All work to which men submit is for the purpose of having leisure"; and it seems to me that a man can have no greater material blessing than leisure and the power to use it well. From the invention of machines and the use of steam power every man in this country may be said to have the power of five or six men placed at his disposal, yet labour for the majority of men is not less incessant. One should hope that in the future labour will become less imperious, and that the concomitant leisure will make for human culture. If we take the power of using leisure well as the measure of culture, we may have grave doubts that we are making much progress in that direction. Russell Lowell once expressed badly—which he did not often do—a thought at bottom right: he said, "A university is a place where nothing useful is taught." That may have a painful ring of truth about it to us old students, in a sense that was not intended. What Lowell intended to convey was, that a university was a place for obtaining a liberal education, and a liberal education is not an education in bread-and-butter making; it is essentially an education in disinterestedness. That seems to be the ideal towards which the higher education should continually approach: it is to be feared that it is not doing so at present. Culture for its own sake is what we need, and the method of nature study should be for many a convenient path towards it.

Much more might be said about nature study as culture. Man is the terminal link of a long chain of organic forms. Since these plane-tree leaves of which I have already spoken grew in Mull, the mammalian brain has increased enormously in size. Will this brain development go on? Will existing man develop into higher forms to whom we shall appear like

cave men? We can hardly doubt it. And man is the only animal which can alter by foresight the destiny of his race. Karl Pearson ('The Chances of Death') gives us good ground for believing that human society is recruited chiefly from its inferior members. That is a depressing thought. By taking counsel together could we not do something to improve that immortal part of us which has been called posterity? That would be the ideal imperialism—to create a better race.

There is only one other thing I would say here. We all at some period of our lives, when sorrow comes and when misfortune overtakes us,—we all need solace and sympathy; and the love of nature—an outcome of nature study—will do much to help us in these hours of gloom.

I did not read over what I had written until I had reached this point, and when I did do so I felt a good deal disappointed. I had tried to explain much that all real field naturalists know sub-consciously—"The impulse of the vernal woods,"—

> "Or to what uses shall we put
> The wild-weed flower that simply blows;
> And is there any moral hid
> Within the bosom of the rose?"

I have not escaped the influence of the spirit of the time, and I fear I have tried unintentionally to measure spiritual things by the common standards of commercial value, and with the usual disappointing results.

And now I must conclude by making a few remarks about some matters which more particularly concern this Society. Two or three years ago the Society began to offer an annual prize for the encouragement of the study of local natural history. It is an experiment, and whether it will accomplish its object remains to be seen. The intention was to encourage our members to nature study by taking up some small field of it—for example, fresh-water algæ, water-fleas, lichens, minute life in fissures, and so on. The subject is changed from year to year. It is to be hoped that our members who undertake these special studies will by their co-operation do much to help other members in nature study. If we and similar societies could get a number of our members to become specialists

to some extent, field excursions would promote culture much more than they do. A field naturalist excursion is not merely a pleasant country ramble, an interesting gossip wound up with a sociable and refreshing tea. These may be concomitants: the essential is to get some new impressions—a few fresh ideas about natural things; and there are few walks through the woods, or along the shore, or on the mountains from which the receptive field naturalist does not bring home some new thoughts—particularly if the company be small and of kindred spirits. Unless these natural history prizes lead to co-operation such as I have indicated, they will be a failure. They are a minute form of endowment of research of which we hear so much at present. Research to discover new truths cannot be overestimated, and yet it has a dark side—the search for endowment. That evil we need not fear. This leads me to say a word about original work in societies like this. In such societies really original work plays a very subordinate *rôle*, and if we look at our 'Transactions' I do not think that this society compares unfavourably with its neighbours. In Edinburgh, several old and chartered societies exist. The Royal Physical, for example, virtually a natural history society, was established long ago in the *ancien régime*, when Linnæus and Buffon were still alive. The Botanical Society took its rise also in the *ancien régime* of botanical science, when botanists still studied nature out of doors, and before laboratory methods and stains had banished from among us the spirit of nature study. Then there is the Geological Society, the youngest of the three, and the one which has apparently best fulfilled the promises of its youth in cultivating nature study the most: possibly that is due to its being less academic than the others. In a city where such societies exist, naturally and properly any original papers will be attracted to them. Besides, we do not desire in any way to be a competitor with these societies. If I mistake not, we had our origin in a desire not to compete with them, but to supplement them,—to do what they could not well undertake. This Society was originally a field club: it had no winter meetings; it was intended to make the work of the older societies more practical, to make excursions, and so bring the members of these societies more into living touch with the things which they talked about at their winter

meetings. It was essentially a club for nature study, and that I believe to be our chief function still.

The originality which we and societies like us should cultivate is the habit of reasoning from ultimate facts. We want to read the book of nature for ourselves, and are not satisfied with any commentary thereon. "What is originality?" said Emerson. "It is being one's self, and reporting accurately what we see and are." The originality which we students of nature seek is not so much to write original papers for our 'Transactions,'—there are far too many of such publications; and a society, like a nation, may be the happiest which has no history: the originality for us is the habit of getting new ideas from natural things, and letting these sink like rain on thirsty ground, or rather scattering them like seed on the fertile soil of our sub-conscious selves,—our subliminal consciousness,—where they will in time bear a plentiful harvest.

In this Society we have a microscopical section, and I must say a few words about it. The section, as you know, meets once a fortnight in winter—not in a public room, but at the house of the convener of the section. Out of a Society of two hundred members, we are not likely to have more than a score or so of regular attenders at the microscopical section. Should the number increase, we may need to change our quarters. At present we can all find places in the dining-room—I was going to say round the hospitable board—of the convener of the section. Similarly, after our excursions in summer there is an informal meeting at the house of another of our members, to name some of the things we have found, and to discuss any points connected with them which may arise. This way of meeting at the houses of some of our members, if they are so kind as to have us, is admirable. These members have very serviceable libraries of books on natural history and microscopy, which can be referred to; they have microscopes and other instruments at hand to aid us should they be wanted,—and that is very much better in every way than to meet in a public room with a bare table and a score of chairs. Besides, these meetings show a most praiseworthy spirit of enthusiasm and co-operation.

As to the subjects studied at the microscopical section, it has been our custom to take up a group of plants or animals

alternately. We had, for example, Algæ one winter and Crustacea another. The section has resolved, and I think wisely, this winter to take the memoirs on "Typical British Marine Plants and Animals" issued by the Liverpool Marine Biology Committee, taking one memoir after another, having demonstrations, and making microscopical sections. The aim of the section is to help each other to use the microscope with skill, so as to increase our knowledge of natural things,—to extend, in short, our mental horizon. I would emphasise the word *use*. It would be a waste of time for us to try to follow recent elaborate researches on the cell, but we can all have glimpses, and very impressive glimpses, into nature's workshop. We do not expect to see centrosomes or to follow their mystic dances, but we can all see for ourselves the movements of living protoplasm in Tradescantia. It is quite easy to fertilise Echini in spring and follow the early stages of the building up of an animal, and by the not undue use of the scientific imagination we can understand that fertilisation is intimately connected with osmosis or electrolysis. Then occasionally we may be able to show to each other an example to illustrate some spirit-stirring new discovery, such as double fertilisation in plants. In a word, our aim is to use the microscope rather as an instrument of culture than one of research, and there is no instrument which serves that end better than a microscope.

I am glad the number of our members keeps up, for we never canvass for recruits,—we employ no commercial travellers. We know a little—a very little—of the wonderful universe into which it has been our privilege to be born; we want to know more of it, and we should like others to know more of it too.

The undertone which runs through this address may be well summed up in a few lines from Russell Lowell, with which I shall conclude:—

> "For a cap and bells our lives we pay,
> Bubbles we buy with a whole soul's tasking;
> 'Tis heaven alone that is given away,
> 'Tis only God may be had for the asking.
> No price is set on the lavish summer;
> June may be had by the poorest comer."
>
> —"The Vision of Sir Launfal."

At the close of the above address Mr Hewat, who during its delivery had occupied the chair as senior Vice-President, conveyed to Mr Crawford the sincere thanks of the Society, not only for his able address, to which they had listened with great enjoyment, but also for his three years' service as President. Mr Crawford's services to the Society had been ungrudgingly rendered, and the members owed him a deep debt of gratitude for the numerous and varied ways in which he had sought to promote its welfare. The vote of thanks to Mr Crawford was carried with acclamation.

A large number of books and pamphlets on Nature Study, several of them from America, were shown by Mr Crawford in illustration of his address, and these were examined with interest by the members of the Society before they separated. For the benefit of teachers and others who take an interest in the subject of Nature Study, Mr Crawford's List of these publications is here appended :—

A SHORT LIST OF BOOKS AND TRACTS ON NATURE STUDY.

(*Restricted to those of which I have personal knowledge.*)

1. Books for Field Naturalists.

Of these there are not many modern and really good ; nearly all relate to insects. The following three are admirable :—

'The Natural History of Aquatic Insects,' by Prof. L. C. Miall. London: Macmillan & Co. 1895. 6s.

'La Vie des Abeilles,' par Maurice Maeterlinck. Paris: Charpentier. 1901. 3 frs. 50 c. English translation, by A. Sutro. London: Allen, Ruskin House. 1901. 5s. net.

'Alternating Generations. A Biological Study of Oak Galls and Gall Flies,' by Dr Hermann Adler. Translated by Straton. Clarendon Press, 1894. 10s. 6d. net.

To these may be added a book which has been much admired in Germany—

'Spaziergänge eines Naturforschers,' von Prof. William Marshall. 2nd ed. Leipzig, 1890. Bound, 10 marks net.

For a long time new works have been greatly wanted to take the place of Gosse's charming books, 'A Year at the Sea-shore' (1877), and others; or Lewes's 'Seaside Studies' (1860); or Quatrefages' 'Rambles of a Naturalist,' published in 'La Revue des Deux Mondes' about fifty years ago (Eng. trans., 1857). (Now quite antiquated.)

"Memoirs on Typical British Marine Plants and Animals," published by the Liverpool Marine Biology Committee. London: Williams & Norgate. 1899, &c. Energetic field naturalists will find splendid materials for study in these memoirs. 1s. to 2s. each.

'Life by the Sea-shore. An Introduction to Natural History,' by Dr Marion Newbigin (London: Sonnenschein, 1901), will be most useful. 3s. 6d. net.

'Commom Objects of the Sea-shore,' and others, by J. G. Wood, although very cheap and very popular, has done yeoman service to generations of beginners. London: Routledge. 1s.; coloured, 3s. 6d.

'Ponds and Ditches,' by M. C. Cooke (London: S.P.C.K., 2s. 6d.), is good. It is chiefly about microscopic objects.

'Life in Ponds and Streams,' by Furneau. London: Longmans. 6s. net.

Some well-written books on our commonest plants from the biological point of view are wanted, most of all popular books founded on such works as Wiesner's 'Biologie der Pflanzen' (Wien, 1889), or Costantin's 'Les Végétaux et les Milieux Cosmiques' (Paris, 1898), and making use of our common wild flowers as illustrations.

'Romance of Wild Flowers,' a companion to the 'British Flora,' by Edward Step, is good. London: Warne. 1901. 6s.

The following are good American books, all very well illustrated:—

'Insect Life,' by J. H. Comstock, Professor of Entomology in Cornell University. New York: Appleton. 1901. $1.50.

'Life-Histories of American Insects,' by C. M. Weed, Professor of Zoology and Entomology, New Hampshire College of Agriculture. New York: Macmillan & Co. 1897. $1.50.

'Tenants of an Old Farm. Leaves from the Notebook of a Naturalist,' by Dr H. C. M'Cook. New York: Fords, Howard, & Co. $1.50.

Also—

'Directions for Collecting Insects,' by Riley, Smithsonian Institute, Washington, D.C. *Free.*

'Talks Afield,' by L. H. Bailley. New York: Macmillan & Co. $1 (and other works by the same author).

'Wild Animals I have Known' (with 200 drawings), and 'Lives of the Hunted, containing a True Account of the Doings of Five Quadrupeds and Three Birds' (with 200 drawings), by E. Seton-Thompson, Naturalist to the Government of Manitoba. London: Nutt. 1901. Each 6s.

Both of these are beautifully got up books, well suited for school prizes.

'The Amateur Aquarist,' by Mark Samuel, Columbia College, N.Y. New York: The Baker and Taylor Co. 1894. $1.

Some interesting plants for aquaria are sold by H. Henkel, Kunstgärtner, Darmstadt, Germany.

A great number of seeds and plants of scientific interest, not readily obtained in this country, may be got at very moderate prices from Haage u. Schmidt, Handelsgärtner, Erfurt, Germany.

2. For the Instruction of the Young.

'Nature Study and the Child,' by C. B. Scott, Instructor in Nature Study, State Normal School, Oswego, N.Y. London: Isbister. 1901. 6s.

'Outdoor Studies. A Reading Book of Nature Studies,' by J. G. Needham. New York: American Book Co. 40 cents.

'Nature Study in Elementary Schools.' A Manual for Teachers, by Dr Lucy L. W. Wilson. New York: Macmillan & Co. 1900. 90 cents.

'Handbook of Nature Study,' by D. Lange. New York: Macmillan & Co. $1.

'Art out of Doors,' by Mrs Van Rensselaer. New York: Scribner & Sons. $1.50.

'A Course of Nature Study for use in the Public Schools,' by Louise Miller. (Bulletin 63, Pennsylvania Department of Agriculture.) *Free.*

This is an excellent pamphlet. A more extended and advanced course is being prepared for teachers.

'Nature Study Reference Library.' A list of books on Nature Study. (Bulletin 64, Pennsylvania Department of Agriculture.') *Free.*

'Leaflets on Nature Study.' Purdue University, Lafayette, Indiana. 1898. *Free.*

'Pennsylvania State College Correspondence Courses in Nature Study.' By G. C. Watson. State College Centre Co., Pa. *Free.*

'Nature Study Leaflets (numerous), published by Cornell University, Ithaca, N.Y. *Free.*

'Nature Knowledge.' Teachers' Leaflets, published by the Agricultural Education Committee, 10 Queen Ann's Gate, Westminster, London, S.W. 1d. each.

'Heuristic Method of Teaching.' Education Department. Printed for H.M. Stationery Office. 3d.

3. Spirit-stirring Books.

Thoreau: Selections from, by Salt. Eversley Series. London: Macmilllan & Co. 5s.

Wordsworth: Selections from, by Matthew Arnold. Golden Treasury. Macmillan & Co. 2s. 6d. net.

'Obermann,' par de Senancour. Paris: Charpentier. 3 frs. 50 c.

'The Friendship of Nature,' by Mabel O. Wright. New York: Macmillan & Co. 50 cents.

To these might be added such books as—

'The Naturalist in La Plata,' 1892; and 'Idle Days in Patagonia,' by W. H. Hudson. London, 1893.

'Studies of Wild Life and Scenes in Many Lands,' by Brehm. Trans. by Mrs Thomson. London: Blackie & Son. 1895. 5s. (reduced).

'Animals at Work and Play,' by Cornish. London: Seeley. 2nd ed., 1897. 6s.

And many other works of naturalist-travellers.

PRIZE COLLECTION OF FRESH-WATER CRUSTACEA.

The President, at the close of his valedictory address, referred in general terms to the prize which had been offered for the best collection of fresh-water crustacea. He then read the report of the adjudicator recommending that the prize be awarded to the collection bearing the motto "Perseverance." On opening the sealed envelope bearing this motto, it was found that the collection had been made by Dr and Miss Sprague. After the form of the prize has been decided upon, it will be presented at one of the meetings of the Society.

The following is the list of crustacea collected, with a note thereon by the adjudicator:—

LIST OF FRESH-WATER CRUSTACEA

COLLECTED IN MID-LOTHIAN IN THE YEARS 1900 AND 1901, AND MOUNTED AS MICROSCOPIC OBJECTS BY DR AND MISS SPRAGUE; AND FOR WHICH THE SOCIETY'S PRIZE, VALUE £5, WAS AWARDED ON 23RD OCTOBER 1901.

(*The numbers refer to the slides.*)

AMPHIPODA.

Gammarus.

1, G. pulex, Penn.

Cobbinshaw Reservoir, June 22, 1900. Very common. Has been met with most plentifully in running water.

ISOPODA.

Asellus.

2, A. aquaticus, Linn.

Marchfield Pond, July 7, 1900. Very common.

COPEPODA.

Diaptomus.

3, 4, 5, D. gracilis, G. O. Sars.

Ravelston Quarry, Aug. 2, 1900. Bavelaw Burn, June 28, 1900. The colour of this creature was bluish, and the ends, but not the tips, of the antennæ red. This species is common in clear water, and where it occurs is often very plentiful, especially in sunny weather. It varies considerably in size and colour.

Cyclops.

6, 7, C. strenuus, Fischer.

Marchfield Pond, June 17, 1900. Very common. Easily recognised by the long and divergent stylets of the furca and short tail-bristles.

8, C. bicuspidatus, Claus.

Quarry in Corstorphine Wood, Jan. 13, 1901. Common. Most easily recognised from the shape of the receptacle (*receptaculum seminis*), and by the numerous minute dots on the furca and other parts. Schmeil calls them cup-shaped depressions.

9, C. languidus, G. O. Sars.

Pond near Tynehead, March 30, 1901. Uncommon. Seems to prefer high ground. Best recognised by the 16-jointed antennæ.

10, C. vernalis, Fischer.

Pond on west side of Bonaly golf-course, Jan. 2, 1901. Common. Requires some care to distinguish it from C. bicuspidatus or a small C. viridis. Most readily distinguished by the fifth foot and the form of the receptacle.

11, C. bisetosus, Rehberg.

Pond on House-of-Hill Farm, Aug. 21, 1900. Uncommon. Sometimes almost undistinguishable from C. bicuspidatus except by its smaller size.

12, C. viridis, Jurine.

Granton Quarry, July 14, 1900. Very common. Distinguished by its very large size and the form of the fifth foot.

13, C. fuscus, Jurine.

Ravelston Cottage Quarry, May 21, 1900. Common. Easily recognised by its dark indigo colour, especially in the furca, and by the serrate membrane attached to the last joint of the antennæ.

14, C. albidus, Jurine.

Ravelston Cottage Quarry, June 27, 1901. Very common. Distinguished by the dark furca, the dark joints (2nd, 3rd, 9th, and 10th) of the antennæ, and the 5th foot (which, however, is the same as in C. fuscus). There is a conspicuous membrane, which is not serrate, attached to the last joint of the antennæ.

15, C. serrulatus, Fischer.

Granton Quarry, July 26, 1900. Very common everywhere. Varies greatly in size and colour. Most easily recognised by the serration on the outer margin of the furca, and by the widely divergent egg-bags (ovisacs).

16, 17, C. affinis, G. O. Sars.

Elf Loch, June 30, 1900. Ponds in Penicuik Grounds, Aug. 25, 1900. Uncommon. Never lies straight under a cover-glass, but always twists its tail round.

18, C. nanus, G. O. Sars.

Auchencorth Moss, April 9, 1901. Uncommon. Seems to prefer high ground. Best recognised by the 11-jointed antennæ, the form of the receptacle, and of the 5th foot. It is easy, however, to mistake the form of the latter, as the uppermost spine appears at first sight to spring from the 5th thoracic segment. We are not aware of any published figure of this animal.

19, 20, C. fimbriatus, Fischer.

Pond, House-of-Hill Farm, Aug. 27, 1900. Pond near Carswell, May 18, 1901. Common. Most easily distinguished by the short very plumose antennæ. Only a few specimens were ever obtained by us at one fishing.

21, C. phaleratus, G. O. Sars.

Marl pit, Davidson's Mains, June 7, 1900. Common. Much compressed from back to front. We have observed that it is in the habit of crawling out of the water if the slope of the vessel in which it is placed is not too great. The distinctive features are the very short 10-jointed antennæ and closely adpressed egg-bags. Only a few specimens were found in any single catch.

22, *C. æquoreus*, Fischer.

Rock pool on Cramond Island, July 6, 1901. *This is a brackish-water species, of which we obtained many specimens in the only brackish-water pool we visited. We know of no other such pool in Mid-Lothian.*

Harpacticus.

23, 24, *H. fulvus*, Fischer.

Rock pool on Cramond Island, July 6, 1901. *The pool was swarming with the species.*

Canthocamptus.

25, 26, C. staphylinus, Jurine.

Elf Loch, Sept. 15, 1900. Granton Quarry, Nov. 3, 1900. Very common.

27, *C. northumbricus*, Brady.

Edinburgh, Jan. 6, 1901. *Never found by us except on this occasion, when we got two specimens.*

28, C. pygmæus, G. O. Sars (Attheyella cryptorum, Brady).

Marfield Loch, April 9, 1901. Uncommon. Easily recognised by the tail-bristles and the 5th foot.

Ostracoda.

Cypria.

29, C. ophthalmica, Jurine.

St Margaret's Loch, Aug. 18, 1900. Common. Easily recognised by the very compressed reniform valves. An unusually transparent species. Conspicuously punctate.

Cyclocypris.

30, C. serena, Koch.

Lower Elf Loch, Nov. 24, 1900. Very common. Recognised chiefly by its small size.

Cypris.

31, C. fuscata, Jurine.

Elf Loch, Jan. 26, 1901. Uncommon. Distinguished from C. incongruens by the reticulation on the shell, the duller brown colour, the absence of the crenate border on the anterior margin of the right valve, and by the slenderer caudal rami.

32, C. incongruens, Ramdohr.

Pond, House-of-Hill Farm, Aug. 21, 1900. Common. Has no reticulation on the shell; is of a bright brown colour; has crenate border on anterior margin of right valve.

33, C. virens, Jurine.

Marchfield Pond, July 7, 1900. Very common. Generally of a decided green colour.

34, C. obliqua, Brady.

Craigleith Quarry, Feb. 2, 1901. Rare. Only one specimen found. In general appearance resembles C. fuscata, but the brown colouring is in places tinged with green. There is no reticulation, and the caudal rami are different.

Ilyocypris.

35, I. biplicata, Koch.

Elf Loch, Sept. 15, 1900. Rare. Easily recognised by the general shape and the well-marked punctation of the shell. Light brown colour.

Herpetocypris.

36, H. reptans, Baird.

Marl pit, Davidson's Mains, June 5, 1900. Very common.

Cypridopsis.

37, C. aculeata, Lilljeborg.

Cramond Island, July 6, 1901. As regards frequency, see remark to Cyclops æquoreus. One specimen, however, was got from a pond at Westbrook, Balerno, on Jan. 19, 1901.

Pionocypris.

38, P. vidua, Müller.

Granton Quarry, July 26, 1900. Very common. Easily recognised by its inflated ovoid form and by the three black bands on the white shell.

Candona.

39, C. candida, Müller.

Low pond, Penicuik, Dec. 1, 1900. Very common, but does not leave the bottom of the pond.

Cladocera.

Diaphanosoma.

40, D. brachyurum, Liévin.

Marfield Loch, Sept. 21, 1901. Rare. All the specimens found were males.

Ceriodaphnia.

41, C. reticulata, Jurine.

Elf Loch, Sept. 15, 1900. Bright pink. Easily distinguished from the other species in our collection by the teeth on the under surface of the terminal claw.

42, C. scitula, Herrick (?).

High pond, Penicuik, Sept. 7, 1901. Uncommon. Distinguished from the foregoing by the absence of teeth on the terminal claw, and from C. quadrangula by its larger size, more strongly marked reticulation, the form of the antennules and of the post-abdomen. We found one male. It had a bluish shell.

43, C. quadrangula, Müller.

Duddingston Loch, June 21, 1901. Uncommon. There are small dots, perhaps very short bristles, within the meshes of the reticulations.

Scapholeberis.

44, S. mucronata, Müller.

Ravelston Cottage Quarry, July 17, 1900. Uncommon, but found in large numbers where it occurs.

Simocephalus.

45, S. vetulus, Müller.

Ravelston Cottage Quarry, June 13, 1900. Very common. Seems to thrive best where the water is not too clear.

Daphnia.

46, D. pulex, De Geer.

Marl Pit, Davidson's Mains, June 2, 1900. Very common. Seems to thrive best where the water is not too clear.

47, D. lacustris, G. O. Sars.

Hurley Cove, Penicuik, Dec. 1, 1900. Common. Met with in large sheets of clear water.

48, D. galeata, G. O. Sars.

Granton Quarry, Sept. 1, 1900. Uncommon. The young form is easily recognised by the helmet-shaped head; the mature form by its protuberant forehead.

49, 50, D. hamata, Brady.

Granton Quarry, Sept. 1, 1900. Rare. All our specimens are young, and have three or four teeth on the shoulder.

Bosmina.

51, 52, B. longirostris, Müller.

Ravelston Quarry, Aug. 2, 1900. Cobbinshaw Reservoir, June 22, 1900. Uncommon, but occurs in large numbers when it is found. Prefers clear water.

Macrothrix.

53, M. laticornis, Jurine.

Pond in Queen's Park, June 16, 1900. Rare. Found only one specimen; this was in a mixed gathering taken from Duddingston, Dunsappie, and St Margaret's lochs. Easily recognised by the post-abdomen and by the anterior antennæ.

Acantholeberis.

54, A. curvirostris, Müller.

Marfield Loch, Sept. 21, 1901. Rare. We have found it in no other locality.

Ilyocryptus.

55, I. sordidus, Liévin.

Elf Loch, Jan. 26, 1901. Uncommon. Easily recognised by its bright red colour.

Graptoleberis.

56, G. testudinarius, Fischer.

Elf Loch, Aug. 9, 1901. Rare. Easily recognised by the general form, well-marked reticulation, and the three or four teeth at the lower back corner of the shell.

Eurycercus.

57, E. lamellatus, Müller.

Duddingston Loch, Aug. 18, 1900. Rare.

Alona.

58, A. guttata, G. O. Sars.

Elf Loch, June 1, 1901. Rare. Best recognised by the form of the post-abdomen. The small spots on the shell, from which the specific name is taken, are not always well marked.

59, A. tenuicaudis, G. O. Sars.

Duddingston Loch, Aug. 18, 1900. Rare.

60, A. quadrangularis, Müller.

Duddingston Loch, June 21, 1901. Common.

61, A. affinis, Leydig.

North Esk Reservoir, May 18, 1901. Common.

Alonella.

62, A. rostrata, Koch.

Cobbinshaw Reservoir, Aug. 13, 1900. Rare. We have found only one specimen.

63, A. exigua, Lilljeborg.

Marfield Loch, April 9, 1901. Rare. Easily recognised by the single conspicuous tooth at the lower back corner of the shell.

64, A. nana, Baird.

Marfield Loch, April 9, 1901. Rare. Appears to like high ground.

Acroperus.

65, 66, A. harpæ, Baird.

Granton Quarry, July 26, 1900. Very common in summer.

Alonopsis.

67, 68, A. elongata, G. O. Sars.

Marfield Loch, May 25, 1901. Rare.

Pleuroxus.

69, 70, P. trigonellus, Müller.

Marchfield Pond, June 21, 1901. Uncommon.

Peracantha.

71, P. truncata, Baird.

High pond, Penicuik, Sept. 7, 1901. Rare. Found only on one occasion.

Chydorus.

72, C. sphæricus.

Very common. During eighteen months the males were only observed in one gathering made on 31st May 1901 at House-of-Hill pond.

Note.—Nos. 22, 23, and 24 are excluded as being obtained from brackish water. No. 27 was excluded from this list as having been collected from a pond not available to other competitors: it has, however, been recorded from Duddingston Loch by Mr Thomas Scott, F.L.S.

Note on the foregoing List.

By Mr Thomas Scott, F.L.S.

The specimens are carefully and very neatly mounted, and a few of the characters which serve to distinguish the species are in general fairly well shown. But it would have added to the value of the collection had there been separate preparations of at least a few of the more important appendages, as it is only in this way that the specific characters of many of the species, especially of the Copepoda, can be correctly exhibited.

The list will form an interesting addition to the literature on the crustacean fauna of the county of Mid-Lothian. The discovery of such species as *Cyclops nanus, Macrothrix laticornis,* and *Alonella rostrata* is of much interest, and is an indication that further research may lead to further discoveries.

No. 18, *Cyclops nanus,* was added to the British fauna by the writer of this note in 1899, but not figured by him (see 17th Annual Report of the Fishery Board for Scotland, pp. 172-182). *C. languidus* was also, about the same time, added by him to the Scottish fauna.

No. 40. This species has frequently been referred to *Diaphanosoma brachyurum,* Liévin; but Lilljeborg, in his recently published work, places it doubtfully under *Diaphanosoma Leuchtenbergianum,* Fischer. Should it turn out to be really identical with Fischer's species, Baird's name, being the older, will have to be restored: in that case the name would be *Diaphanosoma Wingii,* Baird.

No. 42. This looks very like *C. rotunda,* G. O. Sars.

Nos. 47 and 48. Prof. Lilljeborg, in his great work lately published, ascribes both these species to *Daphnia hyalina,* Leydig. But these so-called species of Daphnia are so exceedingly liable to variation, that only a lengthened study of them can enable one to come to anything like a satisfactory decision about them. In these circumstances I give Lilljeborg's finding, without venturing an opinion as to whether it is right or wrong.

Nos. 49 and 50. I have scarcely any doubt that these are immature specimens of No. 48. The crest on the back of Daphnia is not of much value as a specific character.

ANNUAL BUSINESS MEETING.

After the valedictory address of the President had been delivered (*ante*, p. 234) and the prize for the collection of fresh-water crustacea awarded (*ante*, p. 254), the Annual Reports were submitted to the Society. The Secretary made the following statement:—

During the winter session 1900-1901 six evening meetings (exclusive of twelve meetings of the Microscopical Section) have been held. On the evening of 24th June 1901 a special meeting was held, when a lecture was delivered by Dr J. M. Macfarlane, Professor of Botany at the University of Pennsylvania, Philadelphia. Dr Macfarlane is now one of our Honorary members, and when he was resident in Edinburgh a number of years ago he was a very valuable member of the Society.

For the summer session twenty meetings were arranged. The season was very favourable for our excursions, but notwithstanding this, the attendances have been a little disappointing. There was an aggregate of 335, or an average of about 17 at each meeting, which is somewhat below the figure of last year.

The membership of the Society continues about the same figure as last year. 19 members resigned, and 23 new members were admitted. Three or four names will have to be removed from the Register for failure to pay subscriptions.

During the year we have lost by death one of our hon. members—Mr Mark King—who was so well known to the Society.

Mr Russell, Convener of the Microscopical Section, held at his house meetings for the study of the Entomostraca. These were duly notified in the billets. The subject of study for this season is the Ascidian and Codium, based on the Liverpool Memoirs, and Mr Russell has again kindly offered the use of his house for these meetings.

The preparation for the Microscopical Section entails considerable labour and expense on the part of two or three of our members; the only reward they seek is that more may become interested in the section, and avail themselves of the opportunity for microscopical study which it affords.

The general prosperity of the Society has been maintained, and it is hoped that at the end of the new session it will show an advance.

Attention was then drawn to the printed balance-sheet, showing the income and expenditure of the Society for the past year. From this it was seen that the finances of the Society were still in a flourishing condition, the balance, after paying all accounts for the year, standing at £49, 18s. 11d.

The election of Office-bearers was next proceeded with. The following is the complete list, the members whose names

are printed in italics being those elected to fill up vacancies: President—*Arch. Hewat, F.F.A.;* Vice-Presidents—A. B. Steele, Jas. Russell, *David Gloag;* Secretary—W. Williamson; Treasurer—G. Cleland; Editor of 'Transactions'—J. Lindsay; Auditors—R. C. Millar, C.A., and J. T. Mack; and the following Councillors: Dr Davies, Wm. Forgan, A. Murray, A. R. Calder, Jas. Fraser, Major Grahame, Miss I. Elliot, Mrs Maxwell, *Robert Watson, Miss Sprague, Miss E. A. Townsend,* and *Allan A. Pinkerton.*

Mr Crawford now vacated the chair in favour of Mr Hewat, who was received with applause. In a few well-chosen remarks, Mr Hewat thanked the Society for the honour done him in unanimously calling him to this important position, and promised to do all in his power to promote the welfare and success of the Society. After some formal business the meeting closed.

LIST OF PAST PRESIDENTS.

Dr Robt. Brown (*deceased*),	1869.	Mr John Walcot,	1879–1882.
Mr R. Scot Skirving (*deceased*),	1869–1874.	Mr A. B. Herbert,	1882–1885.
Mr Wm. Gorrie (*deceased*),	1874–1877.	Mr Symington Grieve,	1885–1888.
Rev. R. F. Colvin (*deceased*),	1877–1879.	Dr William Watson,	1888–1891.
		Dr Sprague,	1891–1895.
		Dr Davies,	1895–1898.

OFFICE-BEARERS, 1900-1901.

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W. C. Crawford, F.R.S.E.

Vice-Presidents.

A. Hewat, F.F.A. | A. B. Steele. | J. Russell.

Council.

T. Laidlaw.
C. Campbell.
Miss Oxley.
Dr Watson.
Dr Davies.
W. Forgan.
A. Murray.
A. R. Calder.
James Fraser.
Major Grahame.
Miss I. Elliot.
Mrs Maxwell.

Editor of 'Transactions.'

John Lindsay.

Secretary.

W. Williamson.

Treasurer.

George Cleland.

Auditors.

R. C. Millar, C.A.; J. T. Mack.

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Henderson, Prof. John R., M.B., C.M., The College, Madras.
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Macfarlane, Prof. J. M., University of Pennsylvania, Philadelphia, U.S.A.
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Walcot, John, Craiglockhart Hydropathic, Slateford.

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Hobkirk, Charles P., 9 Parish Ghyll Road, Ilkley, Yorks.
Hossack, B. H., Craigie Field, Kirkwall.

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(As at October 15, 1901.)

Adams, James, Comely Park, Dunfermline.
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10 Bonnar, William, 8 Spence Street.
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Brotherston, Mrs G. M., 16 Comiston Drive.
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Bryden, Miss, Linksfield, Aberlady.
Bryden, Mrs, Linksfield, Aberlady.
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20 Butchard, J. W., 10 Inverleith Gardens.
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Campbell, Bruce, British Linen Company Bank, St Andrew Square.
Campbell, Charles, North British and Mercantile Insurance Company, 64 Princes Street.
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Carter, Albert, Selville Cottage, Portobello.
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Clapperton, Mrs W., Stamford Hall, Gullane.
30 Clarke, William Eagle, 35 Braid Rd.
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Cowan, Alex., Woodslee, Penicuik.
Cowan, Charles Wm., Valleyfield, Penicuik.
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Crawford, Francis Chalmers, 19 Royal Terrace.
Crawford, Miss Jane C., 1 Lockharton Gardens, Colinton Road.
Crawford, Mrs, 1 Lockharton Gardens, Colinton Road.
40 Crawford, W. C., 1 Lockharton Gardens, Colinton Road—*President.*
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Davies, Dr, Tweedbank, West Savile Road.
Day, T. C., 36 Hillside Crescent.
Denson, E., 83 Comiston Road.
Deuchar, Mrs, Harlaw, Hope Terrace.
Dewar, John F., Hamilton Lodge, Joppa.
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Dowell, Miss, 13 Palmerston Place.
50 Dowell, Mrs, 13 Palmerston Place.
Duncan, James Patrick, 3 Cobden Road.
Durham, Frederick W., 2 Argyle Crescent, Portobello.
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Edward, John, 99 Newbigging, Musselburgh.
Elliot, Andrew, 3 Palmerston Road.
Elliot, Miss E., 39 Colinton Road.
Elliot, Miss I., 39 Colinton Road.
Ewart, James, 1 Dundas Street.
Fairley, Captain J. H., 58 Colinton Road.
60 Farquharson, John K., 100 Thirlestane Road.
Fish, D. S., Royal Botanic Garden.
Forgan, John, S.S.C., 20 George St.

Forgan, William, 3 Warriston Crescent.
Forrest, John L., 8 Glengyle Terrace.
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Gartshore, Miss Murray, Ravelston House, Blackhall.
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Gibson, Mrs, 4 Colinton Road.
Gloag, David, 9 Barnton Terrace.
70 Goodchild, J. G., 2 Dalhousie Ter.
Grahame, Major G., 2 St Bernard's Crescent.
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Grieve, Sommerville, 21 Queen's Crescent.
Grieve, Symington, 11 Lauder Road.
Grieve, Mrs Symington, 11 Lauder Road.
Hamilton, G. R., 14 Caledonian Road.
Hawkins, Wm., 33 Comely Bank Place.
Harrison, H. J., 10 Cluny Place.
Harvie-Brown, J. A., Dunipace, Larbert.
80 Heggie, John, 149 Warrender Park Road.
Hetherton, Miss M., 13 Sciennes Road.
Hewat, Arch., 13 Eton Terrace.
Huie, Miss Lily, Hollywood, Colinton Road.
Humphries, John, Easter Duddingston Lodge.
Hunter, John, 1 Straiton Place, Portobello.
Hutton, Mrs, 27 Gardner's Cres.
Jamieson, J. H., 54 Bruntsfield Gardens.
Johnson, W. H., Tweed Villa, Relugas Road.
Johnson, John, Royal Botanic Garden.
90 Johnston, J. A., 7 Annandale St.
Kerr, Thomas, 15 Gilmour Road.
Kilgour, Thos. W., 22 Nile Grove.
Laidlaw, Thomas J., 2 Oxford St.
Laing, Rev. G., 17 Buckingham Ter.
Law, Mrs, 41 Heriot Row.
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Lindsay, John, 43 James St., Pilrig —*Editor of 'Transactions.'*
Lindsay, William, 18 South St Andrew Street.
Macadam, Prof. W. Ivison, Slioch, Lady Road, Craigmillar Park.
100 Macdonald, J. J., Commercial Bank, Comrie.
M'Donald, J., 9 Brunstane Gardens, Joppa.
MacDougall, R. Stewart, M.A., D.Sc., Royal Botanic Garden.
M'Gillivray, Wm., 4 Rothesay Pl.
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CONTENTS.

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I.—*TEA: ITS CULTIVATION, AND PREPARATION FOR THE MARKET.*

By Mr WM. WILLIAMSON, Secretary.

(*Read Nov. 27, 1901.*)

Some time ago the home-coming of a gentleman connected with tea-planting in Assam suggested to me that some interesting information might be obtained regarding the tea-plant, so as to form the subject of a communication at one of our evening meetings. The gentleman to whom I refer is Mr T. M. Elliot, who has been in Assam for a number of years. When the subject was mentioned to him, he very cordially agreed to give what help he could, and this he has done by giving me a considerable amount of information of a practical nature. With the exception of the theine and tannin and the Chinese and Kangra Valley tea, all the exhibits have come from India specially for our use, and have been furnished by Mr Elliot, as well as the specimens of manufactured tea, which he obtained from the London market for us. Without the aid he has so freely and courteously given, I would not have undertaken to make the communication.

The subject can be conveniently divided into four sections, of which the first deals with the cultivation of the tea plant and the manufacture of the commercial article. The second deals with the insect and other pests which attack the tea plant, and against which the planter has to contend. The third section relates to the extent of the tea industry, both in

regard to India and the other tea-producing countries. This information, as well as some interesting statements dealing with the consumption of tea, I obtained from a Report on Tea Culture in Assam for 1900, and a Return made to the House of Commons in August 1900. Both of these documents were courteously placed at my disposal by the Commercial Intelligence Branch of the Board of Trade in London. In the fourth section is a brief narrative of the discovery of tea and its subsequent developments. For this I have drawn on some literature I had access to.

When the tea plant is cultivated with a view to its commercial use, it is grown in tracts of well-cultivated land. These are termed gardens, and vary in size from two or three hundred to two thousand acres. Most of the Assam tea is grown in the valleys, rich soil and a hot moist atmosphere being necessary for its full development. When the Government gave land to the early planters on condition of their clearing it and sowing it in tea, the seed was sown so indiscriminately that plants were sometimes very scattered and sometimes very crowded. Experience has taught that plants for their wellbeing require a certain amount of free space, and they are now planted at regular intervals of about four to four and a half feet apart.

Although the tea plant in its uncultivated state attains the dimensions of a tree, in its cultivated state it is a bush no higher than about 2½ feet, and is kept pruned down to that size for convenience in plucking. It is three years old before the leaf is plucked for manufacture, and full bearing of leaf does not take place till the bush is six to eight years old. From about the middle of December the work of pruning is done, and this is commenced practically as soon as the bushes have stopped throwing out new shoots. The purpose of pruning is to promote the growth of young shoots, and to do it so that there will be as large a yield as possible. The lighter pruning is done by women, the heavier by men, who also do the hoeing and other heavy work connected with the cultivation.

With the advent of the rainy season in March, the bushes begin to throw out shoots. The top part of the shoot only is plucked, and includes the bud and one or two of the young

leaves. The plucking of these shoots goes on once a week for nine months of the year—viz., from the middle of March to the middle of December. This work, being light, is done by women, who can pluck about 24 lb. of leaf in a day, representing about 6 lb. of the manufactured article. The plucked leaf is gathered together in baskets, and kept as much as possible in the shade to prevent deterioration. After being weighed it is passed on to the withering house, and the process of manufacture commences.

To facilitate withering, the leaves are spread out in thin layers on platforms in open sheds. When properly withered, which may take from twelve to sixteen hours, according to its condition when brought in from the garden, and also to the state of the weather, the leaf is still green but very soft and pliable. Leaf which has not been left long enough to wither yields a poor quality of tea. Left too long, it becomes dry and brittle, breaking up during the rolling process, and also yielding an inferior quality of tea. From the withering sheds the leaves are taken to the tea house to be rolled. The purpose of rolling is to give a twist to the leaf and also to break the leaf cells. When the cells are broken the sap exudes, and by the continued rolling it is spread all over the surface of the leaf. The rolled leaves are then taken to the fermenting house—a dark cool place—and spread out thinly to ferment, or oxidise as the process is also called.

During the fermentation, which may take about three hours, the leaves have changed from a green to a copper colour, and have possibly lost some of the twist given by the first rolling process. To remedy this, the leaves are again taken to the tea house and rolled for a quarter of an hour. The rolled tea is then taken to the firing machinery, where it undergoes two operations. In the first operation, the tea is dried over a current of hot air for about half an hour. This completely arrests the process of fermentation, and all the moisture is driven off. When the first firing is completed, the rough tea, as it is now called, is taken away to be sorted by a rotary sieve driven by machinery. The different grades are known as broken orange or broken Pekoe, composed chiefly of tips and youngest leaves—Pekoe, young leaves and very little tip—Pekoe souchong, and broken tea, from coarser leaves, &c.

There is no arbitrary rule for naming teas, each garden having its own standards. The different grades of tea are then fired for the second time. This operation is of short duration, and is intended to drive off any moisture which may have been absorbed during sorting.

The manufacturing processes are now concluded, and the tea is packed up in boxes for shipment to the London market.

The second section of this communication refers to the pests of the tea plant. These are numerous, and are dealt with at some length in the report by Dr Watt published at the Government printing-office at Calcutta in 1898.[1] The subject is too large to be dealt with here, so we shall confine our attention to those pests of which we have specimens.

Red spider (*Tetranychus bioculatus*, Wood Mason).—The red spiders are very small insects, living together in colonies on the leaves. The red spider, or tea-mite as it is also called, injures the leaves by sucking out the sap. As a result the leaves take on a bronzed appearance, and eventually fall off. The vitality of the bush is reduced, and the yield of tea correspondingly affected.

Mosquito (*Helopeltis theivora*, Waterhouse).—This insect inserts its proboscis through the epidermis of the leaf or shoot and sucks the juice. A pale brown spot, from $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter, with a darkened rim and a spot in the centre, marks the area of depredation. In time the colour deepens and becomes dried up and blackened. The mosquito pays its attention to the very young leaves and buds, the ones specially wanted by the planter for manufacture. If the mosquito is too abundant, the leaf crop is seriously affected, and the yield of tea much diminished.

Orange beetle (*Diapromorpha melanopus*, Lacord).—This is a small orange-coloured beetle with hard pitted wing-cases. It is a grass-eater by nature, but has taken to tea plants. Orange beetles, like the mosquitoes, confine their attention to the portion of the tea plant most desired by the planter. They scrape away the green stem of a shoot fit for plucking,

[1] The Pests and Blights of the Tea Plant, being a Report of Investigations conducted in Assam, and to some extent also in Kangra, by George Watt, M.B., C.M., C.I.E. Calcutta: 1898.

below the Pekoe or Souchong leaves, and eat perhaps half-way in or more. In a day or so the shoot has withered and fallen off. This insect is sometimes confounded with the lady-bird, which is quite distinct. The colours are different; the elytra of the ladybird are smooth; and it is carnivorous, while the orange beetle is a vegetable eater. The chief food of the ladybird is the black aphis found on the leaves.

Caterpillars and Cocoons.—The caterpillars eat the leaves and bark, but can be easily caught and destroyed before much harm is done. One of the specimens seems to be the faggot worm, and the other the bag worm. The faggot worm nips off short lengths of twigs and fastens these parallel to one another. In Assam these cases average from 1½ to 3 inches long and ½ to 1 inch diameter. The entrance to the case is closed by a little lid hinged at the top. The bag worm makes its case of one or two leaves fixed down for their whole length to the case. It has no lid such as the faggot worm has.

Thread blight (*Stilbum nanum*, Massee).—In the early part of the season this blight can be seen on the lower part of the stem. The name is very descriptive—a soft white woolly thread lightly attached to the bark. Generally the thread is to be seen on the branches. On the young twigs it forms slight thickenings at the joints, from which offshoots go to the leaves. On reaching the leaf, the fungus follows the course of the midrib, from which it develops a soft felted layer, covering the whole of the under side of the leaf. The leaves fade and gradually become brown, slowly bending over till they touch the stem. They then gradually drop off, and as the thread forces its way to the buds, the vitality of the twig is slowly but surely extinguished.

From a Return to the House of Commons (Aug. 1900) relating to tea and coffee, some interesting information relative to our third section—viz., the extent of the tea industry—can be obtained. Only four countries produce tea on a large scale. These are China, Japan, British India, and Ceylon. Their exports were in 1899, China 217,467,000 lb.; British India, 159,806,000 lb.; Ceylon, 129,662,000 lb.; and Japan for 1898 (no figures being given for 1899), 61,532,000 lb. China shows a very considerable decrease in the amount of

its exports, though it is still the largest exporter: the other three countries show a considerable increase, that in the case of Ceylon being rather remarkable. In 1884 its exports only amounted to 2,393,000 lb.; now they are nearly 130,000,000 lb. The other places producing tea are Java, which in 1898 exported 12,000,000 lb., and in 1899, 12,800,000 lb.; and Natal, which in 1899 had an estimated yield of 1,000,000 lb. Each year since shows an estimated increase of 300,000 lb., and it is expected that before long Natal will produce all the tea required in South Africa.

A small quantity of tea is produced in the Caucasian provinces of Russia, and also in the United States. From the report of the U.S. Secretary of Agriculture for 1900 I learn that, under the auspices of the Department of Agriculture, experiments have been conducted at Summerville, South Carolina, with the view of ascertaining if the cultivation of tea in the United States was practicable. An important factor is the labour question, but this has been so far met by employing negro children. At the gardens, schools are established, and there the children, in addition to an ordinary school education, are taught the work of a tea garden. The Americans are satisfied that they can grow tea, such crops as they have raised being disposed of at a fair profit. A company with a capital of $50,000 is being organised to grow tea when a situation having the necessary soil and climatic conditions is secured. Special attention is to be given to pure green tea, to which, according to the report referred to, British planters are turning their attention, as they are beginning to recognise their inability to bring Americans to use black instead of green tea. The economical use of machinery for plucking, &c., is receiving the careful consideration of the Department.

Most of the Indian and Ceylon teas are sent to the United Kingdom. The bulk of the Chinese tea goes to Russia, though some is sent to America, where also most of the Japanese production is sent.

The *per capita* consumption of tea is interesting, and I give it so far as I have figures relating to the year 1899: United Kingdom, 5·98 lb.; German Empire, 0·11 lb.; Holland, 1·39 lb.; France, 0·05 lb.; United States, 0·96 lb. (a decrease from 1·55 lb. in 1897, a tax of 10 cents per lb. having been im-

posed in June 1898); Australasia, 7·70 lb. (partly estimated); Dominion of Canada, 4·72 lb. The latest figure for Russia is 0·82 lb. in 1898. Of the *per capita* consumption in this country, approximately 3 lb. are Indian tea, 2 lb. Ceylon tea, and the remainder is foreign—principally Chinese.

The United Kingdom is the centre of the tea industry, in the year 1899 no less an amount than 289 million pounds being imported, the declared value being over 10½ millions sterling. Of that large amount 86 per cent came from British possessions, the small balance from foreign countries. This is somewhat remarkable when one considers that 65 per cent of the tea imported in 1884 was of foreign origin, and only 35 per cent the produce of British possessions.

The official report on tea-growing in Assam for 1900 showed that there were 804 tea gardens, embracing an area of 1,059,624 acres. Of that large tract 337,327 acres were under tea cultivation. Over 97 per cent of the area under tea is in the hands of Europeans, while less than 3 per cent is owned by the natives of India. More than half a million of people find employment in cultivating tea in Assam—nearly 470,000 of that number being permanently and 35,000 temporarily employed. 500 million lb. of uncured leaf were plucked, yielding 141,118,644 lb. of the manufactured article. The amount exported was 107,241,760 lb., and the yield per acre averaged 468 lb.

I have referred to a moist atmosphere being necessary to the tea plant. The following figures, taken from the Report on Tea Culture in Assam for the year 1900, will convey some idea of the rainfall:—

Station.	Average for the previous five years.	1899.	1900.
Silchar . . .	110·85	138·17	108·06
Sylhet . . .	140·73	179·78	125·87
Dhubri . . .	97·77	99·03	83·44
Gauhati . . .	68·96	78·12	52·61
Tezpur . . .	68·74	84·61	67·18
Nowgong . . .	66·19	101·83	59·03
Sibsagar . . .	100·81	94·58	89·45
Dibrugarh . . .	118·12	124·35	86·01

To show what such a heavy rainfall really means, our City Astronomer has kindly allowed me the use of the figures

showing the monthly and annual rainfall recorded at the Calton Hill for the last four years:—

	1898.	1899.	1900.	1901.
January . .	0·680	3·531	2·423	1·240
February .	0·910	1·359	2·638	0·965
March . .	1·195	1·746	0·948	1·420
April . .	1·747	2·208	1·352	0·985
May . .	1·881	3·825	1·030	2·040
June . .	1·375	1·000	1·880	1·525
July . .	1·192	3·755	2·968	0·205
August . .	3·174	0·565	5·109	3·811
September .	1·825	2·508	1·795	0·876
October . .	3·458	2·178	3·885	1·488
November .	3·394	2·382	5·088	2·635
December .	1·450	1·803	3·518	2·410
Totals .	22·281	26·858	32·634	19·600

We now come to our fourth and last section—viz., the discovery of tea and its subsequent developments. At what time tea and its well-known properties were discovered no one can with any certainty say. It appears to have been known to the Chinese from very remote times. They do not claim it as a native plant, as they assert it came originally from somewhere in the West. During the early part of the nineteenth century it was found that tea was indigenous to Assam, and not to China. In its wild state it becomes a tree of goodly proportions, living on the best soil under the influence of abundant heat and moisture. In China the tea tree becomes dwarfed into a bush, owing to its being planted on hilly land, the best land being devoted to rice cultivation, and under circumstances which do not conduce to promote a luxuriant tree growth. One Chinese author states that general attention was not directed to tea bushes till the third century, during the Han dynasty, and that from that time it was only used medicinally until the beginning of the sixth century, when it came into general use as a daily beverage. During the Tang dynasty, which lasted from the early part of the seventh century to the beginning of the tenth century, the Chinese exchequer was enriched by means of a tax levied on tea; and in the Sung dynasty which followed, a larger tax was imposed. At some time towards the end of the sixteenth century tea appears to have been brought to Europe, but precise information is lacking. During the seventeenth century

the East India Company began the importation by bringing home a few thousand pounds weight of tea, which sold at very large prices. In the next century the importation of tea had increased to some millions of pounds weight, with a very considerable reduction in the price—a price which would at the present day be considered absolutely prohibitive.

As the specimens now exhibited have come from Assam, and the methods of cultivation and manufacture just described are those practised in Assam, we shall consider specially the origin of the industry in India. About the end of the eighteenth century some captains of the East India Company brought tea plants from Canton to Calcutta. These were planted in some gardens, and grew well, notwithstanding the local ignorance of their necessities for successful culture. Some little time after reports were prepared for the Company, dealing with the cultivation in India of new crops, and one of them was tea. Nothing, however, was done in the matter. The Company had a monopoly of tea, and consequently did not feel under the necessity of embarking in the cultivation and manufacture of tea in India. When renewing their charter in 1833, they found that they had lost their tea monopoly. To remedy matters, they at once commenced experimental gardens with a view to cultivating tea in India of which they would have control. The Chinese planters grow their tea on hillsides, and it was thought that was the proper thing for India also. Experience demonstrated that it would not do. The heavy rain floods washed away the soil from the roots and undid the work of planting. To obviate this, terraces were formed, and in some parts of India under tea these are still to be found. While the experiments were being carried out, a report got into circulation that tea was indigenous to Assam, and not to China as was generally supposed. Various stories got abroad attributing the discovery to different people. A careful sifting followed, when it was found that the honour belonged to a Mr Robert Bruce, and this the Government confirmed by giving him a reward. Mr Bruce had occasion to visit Assam in 1823, and when there his botanical researches resulted in the discovery of the tea tree growing wild near Rungpore. At that time Rungpore was the capital of Assam, which was not a part of the British

Empire. Since then it has been incorporated with British India, the chief town being Gaohati. Before leaving Assam Mr Bruce entered into an agreement with one of the native chiefs for the supply of a number of tea plants. In the following year Mr Bruce's brother visited the chief, and under the agreement obtained a quantity of tea seed and a considerable number of plants. These were put into gardens, but nothing seems to have been done till ten years later, when the question was raised as to the plant being indigenous. When this was decided, an attempt was made to ascertain the conditions which tended to make successful cultivation. In reporting, the investigating committee expressed the opinion that the native tree had, through lack of proper cultivation, grown rank, and therefore deteriorated, and they recommended the introduction of the Chinese variety. This took place about 1835, and led to the production of new varieties. Mr Robert Bruce had not been idle, however, for during the years intervening since his first discovery of the native tree he had been travelling all over the country, finding new places where the tea was growing wild, and by the year 1840 he had discovered considerably over one hundred tea tracts.

About the year 1850 the Government gave up the experimental stations, and tea cultivation, which had become an established industry, passed into the hands of individuals and corporations.

II.—*THE TEETH OF FISHES CONTRASTED WITH THOSE OF OTHER ORDERS.*

By Mr W. H. MENMUIR, L.D.S., R.C.S.E.

(*Read Nov. 27, 1901.*)

The teeth serve a variety of purposes, the principal being to cut and masticate food; to combat, as in the tiger and pig; and for carrying, as in the elephant. There are two kinds: (1) Hard calcified, as human, and (2) horny, as in the sword-fish.

The human tooth is formed of three constituents—enamel, dentine, and cementum. The enamel covers the crown, the dentine forms the body, and the cementum envelops the roots. Teeth are developed by a dipping down of the oral epithelium from the surface of the jaw. There are four methods of attachment: (1) Fibrous membrane, as in sharks and rays. The teeth are here attached to fibrous membrane, and have no connection with the cartilaginous jaw. (2) Hinge, as in pike and hake. (3) Anchylosis, where there is membrane between tooth and bone, as is very well seen in the section of tooth and portion of the jaw of a python now exhibited, showing the marked difference in character between the bone of attachment and the rest of the bone. (4) Implantation in bony sockets, as in most mammals. There is here a special development of bone around the tooth, called alveolar border. This grows up with the tooth and disappears when it goes away. There is a membrane between tooth and bone.

Fishes are divided into four classes: the principal, from the point of view of teeth, are—(1) Teleostei; (2) Elasmobranchi. The Teleostei are best known to us. They possess a bony skeleton, and the mouth is crowded with teeth, pharynx as well as jaws. In the pike the teeth are inclined backwards, and are larger in some places than others. In the Elasmobranchi, or sharks and rays, the skeleton is formed of cartilage. The teeth are numerous, and are attached to fibrous membrane. The horny teeth of the saw-fish are dermal spines, are socketed—which is uncommon among fish—and grow from persistent pulps.

In the Batrachia the teeth are not so numerous as in fish. Toads are edentulous. The frog has a single row of teeth in the upper jaw, and the lower jaw, which has no teeth, passes inside the upper. The Chelonia—tortoises and turtles—have no teeth, the margin of the jaws being sheathed in horny cases.

Saurian Reptiles—lizards. In some cases these have small, rounded, conical teeth, and in others long and pointed. The teeth are anchylosed to the bone by bone of attachment. The succession of teeth is constant. They come from the inside of the bases of the old teeth, and pass to the front.

Ophidian Reptiles—true serpents, the ribs being the means of locomotion. There are two groups—non-poisonous and poisonous. (1) Non-poisonous Snakes. These have one row of teeth in the lower and two in the upper jaw. In the upper they are distributed on the jaw bone, palatine and pterygoid bones. The teeth are recurved, and are anchylosed to the bone. The teeth during their development have a horizontal instead of a vertical position, and are thus protected from displacement, as happens in other creatures. They have no canals in their teeth for ejecting poisonous saliva. (2) Poison Snakes—Puff-adders, rattlesnake, vipers, &c. The maxillary bone carries no teeth behind the poison-fang. This is a splendid example of the doctrine of adaptive modification, where in the course of generations the other teeth which we see in the non-poisonous snakes have disappeared by the development of the poison-fang.

Crocodilia. In this order the teeth are implanted in sockets: they are conical and sharp, while one or two are larger than the others.

Birds. In the present age birds have no teeth, but from excavations in different parts of the world fossil remains have been discovered proving that some of the birds of the past were possessed of true teeth.

We now come to the mammals, and, as far as can be gathered from fossil remains, the typical dental formula was—

incisors $\frac{3}{3}$; *canines* $\frac{1}{1}$; *premolars* $\frac{4}{4}$; *molars* $\frac{3}{3}$

Edentata—sloths, armadillos, and ant-eaters. In these the teeth are of simple form, grow from persistent pulps, and do not differ much from one another in appearance. Most of them have no incisor teeth.

In Cetacea we have two groups—toothed whales or Odontoceti, and the whalebone whales or Mysticoceti. The dolphin has very numerous slender teeth, which interdigitate with one another. They are fastened on cartilage, and could be pulled out *en masse.* The pilot whale or Grindhval of the Faroe islanders, which attains a length of twenty feet, is often caught in the North of Scotland. The teeth are fewer than in the dolphin, and have an edge-to-edge bite. In the sperm whale the teeth are numerous in the lower jaw, but are stunted

in the upper, where they remain buried in the dense gum. In the narwhal two teeth alone persist in the upper. In the female these are rudimentary; in the male, one tusk, in some rare instances both tusks, continue to grow from a persistent pulp. The tusk is quite straight, and is marked by spiral grooves, winding from left to right. Where both teeth have been developed, the spiral grooves wind in the same direction. Whalebone whales have no teeth, but in their place they have baleen plates placed transversely to the axis of the mouth, but not at right angles to it. The plates are fringed, and as the whale takes large mouthfuls of water containing minute marine creatures, these are caught by the baleen plates, while the water is expelled.

Cheiroptera, or bats. The bats possess wings, and are divided into two groups—namely, insectivorous and frugivorous. Insectivorous bats have the following dental formula—

$$i.\ \tfrac{2}{3};\ c.\ \tfrac{1}{1};\ p.m.\ \tfrac{3}{3};\ m.\ \tfrac{3}{3}$$

Blood-sucking vampires (Desmodus) have teeth specially adapted for their blood-sucking habits.

Rodentia. The animals of this order are pretty well scattered over the world. They have long chisel-shaped incisors, which grow from persistent pulps. In hares and rabbits there is an extra pair of incisors, which grow behind the large ones.

Proboscidea. In this group the incisors grow from persistent pulps. The molars are massive teeth, and are made up of plates held together with cementum. The tusks represent the principal ivory of commerce, and, on account of their elasticity, are largely used in the manufacture of billiard-balls. This elasticity is due to the small size of the dentinal tubes, and to the frequent bends which these make, giving to ivory the peculiar engine-turning pattern that distinguishes it from bone. In the elephant there is no vertical succession of teeth, as one finds in most mammals, but they come from behind and travel forwards as the front ones drop out.

Ungulata, or hoofed mammals. These are divided into Perissodactyle or odd-toed, and Artiodactyle or even-toed. The Perissodactyle comprise the horse, tapir, palæotherium, and rhinoceros. The dentition of the horse is—

$$i.\ \tfrac{3}{3};\ c.\ \tfrac{1}{1};\ p.m.\ \tfrac{4}{4};\ m.\ \tfrac{3}{3}$$

The first premolar is rudimentary. The incisors are peculiar on account of a folding in of the enamel in the centre, forming the well-known pit or mark by which a horse's age can be reckoned with certainty up to a certain time. The pit or mark is situated near the middle of the cutting edge of the teeth. It is shallow, and by the constant rubbing of the upper and lower teeth together, it is obliterated in the two centrals at 6, in the laterals at 7, and on the next from 8 to 10 years. If a horse is fed on soft food, the mark will not be rubbed out so soon as if it had been reared on hard food. When the horse is about 10 years old a groove commences to show at the gum margin of the outermost incisor, and as the teeth are being constantly pushed from their sockets to make up for the attrition, the groove lengthens as well as the tooth, and when it has reached the middle of the crown the horse is 14, and by the time the cutting edge is reached the horse is reckoned 21. The thickness of the incisors also varies, by which means one can get a fair idea of a horse's age.

The incisors of the pig are peculiar, on account of their being widely separated at their bases. The molars are adorned with rounded conical cusps called the Bunodont pattern.

In the hippopotamus the dental formula is—

$$i.\ \tfrac{2}{2};\ c.\ \tfrac{1}{1};\ p.m.\ \tfrac{4}{4};\ m.\ \tfrac{3}{3}$$

The incisors are long and tapering, while the canines are enormous teeth, and are used by the animals for uprooting aquatic plants on which they feed. The ivory is of dense substance, and is used for the manufacture of small objects.

The principal feature in the dentition of the carnivora is the very small incisors and powerful canines, with the premolars narrow and pointed, and as a rule rudimentary molars. The fourth upper premolar is called a carnossial tooth, and the first molar in the lower.

We now come to the aquatic carnivora, or seals and walruses. The Otariidæ, or Sea Lions, are the seals from which sealskin is procured. Their teeth are like the cetacean, not differing much from one another in any part of the mouth. The Phoca Grœnlandica is the seal commonly met with round our coasts. The walrus has enormous upper canines. Its dental formula is—

$$i.\ \tfrac{1}{0};\ c.\ \tfrac{1}{1};\ p.m.\ \tfrac{3}{3}$$

Lastly, we come to the primates, an order which embraces monkeys, the lemurs, and man. The true monkeys are divided into two great groups—the old world monkeys and the new world monkeys. The new world monkeys are called Platyrrhine or wide-nosed monkeys. Their dental formula is—

$$i.\ \tfrac{2}{2};\ c.\ \tfrac{1}{1};\ p.m.\ \tfrac{3}{3};\ m.\ \tfrac{3}{3} = 36$$

The old world or Catarhine monkeys have a dental formula the same as man. The dentition of the orang approaches very nearly to that of man. The canines are longer, while the difference in the premolars and molars is of a trifling nature.

III.—*THE BIRDS OF BALLINLUIG, BLAIR ATHOLL, AND FOSSOWAY.*

By Mr BRUCE CAMPBELL.

(*Read Dec. 18, 1901.*)

The following notes were made chiefly during my annual holiday—those referring to Ballinluig being made during the last eight years or so, in June, July, August, and September, with an occasional week-end visit at the May bank-holiday. My notes from Blair Atholl were made only at week-end visits at the May bank-holiday during the last two years; while those referring to Fossoway were made in July and the beginning of August of this year (1901). On week-end visits I was always accompanied by my esteemed friend T. G. Laidlaw of this Society. My practice in going to a locality is to carry a copy of Howard Saunders' List of British Birds in my pocket, and tick off each species as it is observed, marking any particulars that may be deemed necessary.

(1) Ballinluig.

I may mention a few notes of our journey to Ballinluig, as sometimes a good deal can be seen even from the window of an express train. Starting from Edinburgh, there is not

much to be observed until we cross the river Almond, where we generally catch a glimpse of a moor-hen disporting itself in the slimy-like fluid of that river. MacGillivray, in his classic work, gives an account of a journey from Edinburgh to Cromarty during the month of March, and it may not be out of place to give an extract from it here:—

> At Queensferry, where we crossed the Forth, over whose placid waters gleamed from afar the white ridge of the Southern Grampians, were seen flocks of common and black-headed gulls, with a few individuals of the great black-backed species, and some ducks too distant to be distinguished. Between this place and Kinross were observed numbers of the more common small birds, partridges, and two pheasants feeding in a ploughed field, and a male hen-harrier, the flight of which afforded a most interesting sight. First it came skimming over a field almost close to the ground, then gliding along a hawthorn-hedge, now on one side then on the other, turned abruptly to follow another hedge, never flying higher than three or four yards, and lastly passed over a large ploughed field and disappeared. It was eight when we entered Perth, and the journey by Dunkeld and Blair into the Central Grampians having been performed under night, little could be seen, although it was clear moonlight, excepting woods and plantations in the lower tracks, and in the higher, hills covered with heath, of which the dark colour contrasted with the patches of snow that remained unmelted, with bare valleys in which not a hut was to be seen for several miles.

The gulls, ducks, &c., may still be seen, but it would be a treat nowadays to see a hen-harrier.

There is not much of interest to be noted until Loch Leven is reached. It was during one of our week-end excursions that Mr Laidlaw and I saw the pintail ducks there. These birds had not been recorded as breeding in Scotland previously, and we thought it would be interesting to follow the subject up. Not having time at our disposal, we placed the matter in the hands of Mr Wm. Evans, who gives a full account of the nesting of the pintail on Loch Leven in the 'Annals of Scottish Natural History' for July 1898.

We have reason to believe that these birds were somewhat harassed during the nesting-time for the next year or two, but last year they were strictly protected, with the result that as many as sixteen were seen at one time by a friend of mine last summer.

After passing Perth, the valley of the Tay becomes interesting. We generally see common terns, swallows, house

and sand martins skimming about. Game seems to grow more plentiful, and as we approach Ballinluig the oyster-catcher becomes very abundant. The local name for this bird is "Tooleet," from its cry. During the month of June one can hear the cry of the tooleet at any hour of the day or night.

Having reached Ballinluig, I shall give an account of the district, with a few notes on the birds observed there. The district lies at the junction of the Tay and Tummel rivers, eight miles north from Dunkeld, and four south from Pitlochry. It is in the parish of Logierait, associated with the escape of Rob Roy from the Duke of Atholl. Some of the prisoners taken at Prestonpans in '45 were sent to prison here. The woods, somewhat dense, are well suited for bird life, and roe-deer are plentiful in them. The trees are chiefly larch, Scots fir, and oak. Larch is especially fine, and of considerable value to the proprietor. The oak used to be felled and the bark peeled off for use in tanning, but this does not seem to have paid—at least, the practice has been abandoned during recent years. There is abundance of moorland all round the district. My notes were made within a radius of three or four miles around Ballinluig.

The following does not pretend to be a complete list of the birds of the district, and is simply a record of what came under my own observation. The list of birds comprises 95 kinds, some—such as the jay and capercailzie—not being met with in many parts of Scotland. The capercailzie flourishes here because the woods are admirably suited for it, both as regards habits and food. Taymouth Castle, the place of its reintroduction in 1837-38, is only a few miles off. The jay continues to hold its own in spite of all manner of persecution from game-preservers. It is said to be a notorious egg-stealer, and consequently pays the penalty. I have had eggs pointed out to me by a keeper who said he knew they had been sucked by a jay from the neat hole made in the egg by that bird. I have seen family parties of jays feeding on insects on oak trees, also on maggots on a dead rabbit. The jay is a match for the wasp, and I was told by a keeper that he had shot one in the act of killing wasps. In fact, he fired the shot out of his house, setting fire to the window-

curtain in doing so. I have seen more than a dozen jays nailed to a keeper's rail, most of them having been recently killed.

The following is the list of birds :—

Missel thrush.
Song "
Blackbird.
Ring-ouzel.
Wheatear.
Whinchat.
Stonechat.
Redstart.
Robin.
Hedge-sparrow.
Whitethroat.
Garden warbler.
Blackcap.
Sedge warbler.
Chiff-chaff (June '93).
Willow warbler.
Wood wren.
Golden-crested wren.
Long-tailed tit.
Great "
Blue "
Cole "
Marsh " (June '93).
Dipper.
Wren.
Pied wagtail.
Grey "
Tree pipit.
Meadow pipit.
Spotted flycatcher.
Swallow.
House-martin.
Sand-martin.
Tree-creeper.
Greenfinch.
Goldfinch (July '95).
Siskin.
House-sparrow.
Chaffinch.
Linnet.
Lesser redpoll.
Twite.
Bullfinch.
Crossbill (August '94).
Corn bunting.
Yellow "
Reed "
Starling.
Jay.
Jackdaw.
Raven.
Carrion crow.
Hooded "
Rook.
Skylark.
Swift.
Kingfisher (June '93).
Cuckoo.
Barn owl.
Long-eared owl.
Tawny owl.
Buzzard.
Sparrow-hawk.
Merlin.
Kestrel.
Common heron.
Sheldrake.
Mallard.
Teal.
Goosander (May '97).
Wood-pigeon.
Stock-dove.
Capercailzie.
Black grouse.
Red "
Pheasant.
Partridge.
Corncrake.
Moor-hen.
Coot.
Ringed plover.
Golden "
Lapwing.
Oyster-catcher.
Woodcock.
Sandpiper.
Redshank.
Curlew.
Common tern.
Black-headed gull.
Common "
Lesser black-backed gull.
Guillemot (Sept. '99).
Puffin.
Little grebe.

(2) Blair Atholl.

Leaving Ballinluig, we proceed to Blair Atholl, a distance of eleven miles or so. The scenery now becomes more Highland. Passing Pitlochry with its hydropathics, we are soon running through the historical Pass of Killiecrankie. To see the pass properly, one must walk through it. The chief object of interest at Blair Atholl is, of course, the castle, the residence of the Duke of Atholl. Claverhouse is said to be buried in the old churchyard near the castle. The Falls of Bruar, immortalised by Burns, are well worth seeing. MacGillivray gives a most interesting account of spending a

night among the hills here. Scrope, in his 'Deer-Stalking,' also tells many curious stories about the district and the characters he met with when residing in it. We were shown a rock in the Tilt where a celebrated chieftain, the Mackintosh, held his court, and every time he did so a man was hung. This gave rise to the saying in the district, when any important event takes place, "It's not every day the Mackintosh holds his court."

The Atholl Gathering, held in September, is well worth seeing. The Duke has an armed retinue of two or three hundred of his men, who meet at the castle and march to a field close at hand, where Highland games of all kinds are engaged in, prizes being given by the ducal family. The public are admitted to the park, and the sports are always well attended.

The list of birds comprises 62 species, as follows:—

Missel thrush.
Song "
Fieldfare.
Blackbird.
Wheatear.
Redstart.
Redbreast.
Willow wren.
Hedge-sparrow.
Dipper.
Long-tailed tit.
Great "
Cole "
Blue "
Wren.
Pied wagtail.
Grey "
Tree pipit.
Meadow pipit.
Swallow.
House-martin.
Greenfinch.
House-sparrow.
Chaffinch.
Twite.
Yellow bunting.
Starling.
Jay (one in 1900).
Jackdaw.
Carrion crow.
Hooded "
Rook.
Skylark.
Swift.
Cuckoo.
Sparrow-hawk.
Common heron.
Mallard.
Teal.
Widgeon.
Pochard.
Tufted duck.
Ring-dove.
Capercailzie.
Black grouse.
Red "
Pheasant.
Partridge.
Moor-hen.
Coot.
Golden plover.
Lapwing.
Oyster-catcher.
Snipe.
Sandpiper.
Redshank.
Curlew.
Common tern.
Black-headed gull.
Common "
Lesser black-backed gull.
Little grebe.

(3) Fossoway.

We now proceed to Fossoway, or the "Crook of Devon," so named because the village is situated at the bend of the river Devon. The name is said to signify "haunt of the deer." I may say, however, that I did not see any of these graceful animals during my visit to the district. Fossoway is situated partly in Kinross-shire and partly in Perthshire, the village

being about eight miles from Kinross. The ancient castles of Aldie and Tullibole deserve a visit. Mercer, the laird of Aldie, joined Prince Charlie at the rebellion of '45, and was slain at the battle of Culloden. Aldie is now the property of Lord Lansdowne.

The Devon is a pretty river, the water being very clear, and trout are plentiful, but are not easily caught. Burns visited this locality, and composed the well-known song, "How pleasant the banks of the clear winding Devon." Rumbling Bridge and the Falls of the Devon are familiar tourist haunts.

I was informed that there were capercailzie in the large fir wood near the village, but I was not successful in seeing any. The list of birds comprises 57 species. It is somewhat short, but July is the worst month for making observations about bird life, and last July was so very warm that a little walking "went a long way." My notes were made chiefly within a mile or two around Fossoway. The following are the birds observed:—

Missel thrush.	Meadow pipit.	Kingfisher.
Song "	Spotted flycatcher.	Cuckoo.
Blackbird.	Swallow.	Tawny owl.
Whinchat.	House-martin.	Common heron.
Redbreast.	Sand-martin.	Mallard.
Whitethroat.	Greenfinch.	Wood-pigeon.
Golden-crested wren.	House-sparrow.	Pheasant.
Willow wren.	Chaffinch.	Partridge.
Wood "	Linnet.	Moor-hen.
Hedge-sparrow.	Lesser redpoll.	Lapwing.
Dipper.	Corn bunting.	Oyster-catcher.
Long-tailed tit.	Yellow "	Woodcock.
Great "	Reed "	Sandpiper.
Cole "	Starling.	Redshank.
Blue "	Jackdaw.	Curlew.
Wren.	Carrion crow.	Tern.
Tree-creeper.	Rook.	Black-headed gull.
Pied wagtail.	Skylark.	Common "
Grey "	Swift.	Herring "

[In illustration of the above paper, a large number of slides of birds' nests, from photographs taken by Mr Bruce Campbell, were shown on the screen. Four of these photographs are here reproduced.]

PLATE XXVIII.—BIRDS OF BALLINLUIG, &c.

NEST OF REDSHANK.

NEST OF MOOR-HEN IN REEDS.

IV.—*THE SQUIRREL.*

By Mr TOM SPEEDY.

(*Read Dec. 18, 1901.*)

It is now considerably over forty years since I made the discovery for myself that squirrels nested and reared their young like birds in the trees. I was sitting on a wooden fence, a very short distance from the toll-house at the end of the bridge which crosses the Tweed near the village of Norham. My attention was attracted by a peculiar purring noise, and on looking up, I saw a squirrel on a branch about 15 feet over my head. I further observed what looked like a bunch of dried leaves out on the branch some distance from the trunk. Concluding that it was the nest of a bird, the desire to discover what kind of nest it was quickly took possession of me. The tree was an elm, and as the trunk for a considerable distance up was branchless, to climb it was impossible. The following day I again repaired to the spot, and again saw a squirrel on the tree, yet it never dawned on me that the bunch of leaves would be a squirrel's nest. Divulging my secret to a school companion, he seemed as anxious as I was to ascertain what bird the nest belonged to. We threw stones, but could see no bird fly from it. We, however, hit on a plan by which we hoped to be able to scale the tree. A ladder was stolen from a farm-steading half a mile distant, and by placing it against the trunk I found that the branches could be reached. I at once ascended, and soon got out on the branch which contained the coveted nest. I then found, however, that it would be difficult to reach the nest, as the branch bent beneath my weight. Taunted by my companion below with being "feared," I endeavoured to proceed, but, losing my balance, I fell from the branch, though I hung for some seconds by my hands. My struggles caused such a vibration on the branch that two young squirrels, in attempting to escape from the nest, fell to the ground, and almost simultaneously I dropped also. I landed on my feet, but fell heavily, and was considerably bruised. However, to be half

killed was a trifle, since the two young squirrels were secured. I am ashamed to confess that in the exuberance of our delight we forgot to return the farmer's ladder, but it came to his ears who had taken it, and for a long time after we gave him a wide berth.

After such a long vista of years I would not care to state exactly the size of the pets, but it is safe to say that they were about half grown. In our ignorance of squirrel life I fear they did not receive the treatment due to such tiny creatures. We took one each, and I hurried home with my prize. My companion's died the following day, probably having been injured by falling from the nest. I had mine confined in a box among some hay, and fed him with small pieces of bread soaked in milk. He soon became very tame, and allowed me to handle him, and would run up my sleeve, come out at my breast, and nestle on my shoulder. For a time he seemed to thrive, and I became much attached to such an interesting pet. I got hazel nuts, but always had to crack them for him. I am now under the impression that it was lack of his mother's milk and nursing that wrecked his health, as he succumbed before he was even full grown. I should therefore advise any one attempting to rear a squirrel to try and get it as young as possible and have it suckled by a domestic cat. I have had setter puppies reared by a cat, and have seen a kitten, a rabbit, and a squirrel, all suckled by puss at the same time. At present I could show you a white kitten nursed by a Scotch terrier.

Never can I forget the death-scene of my pet squirrel. For a day or two he had refused all food, and before leaving for school in the morning I saw by the rapid heaving of his breast that something serious was the matter. On my return in the afternoon he was still alive, but very prostrate. I lifted him out of his box and held him in my hands near the fire. Once with his large, black, intelligent eyes he looked right into mine as if imploring for something, but what of course I could not understand. He seemed pleased to lie in my hands, but he scarcely ever moved, and within half an hour I felt his heart cease to beat. Though I was at the time, I am not now, ashamed to confess that I ran into a spruce wood and cried as if my heart would break. No act, however, could restore to life this gentle creature that had

suffered from misguided affection, in the course of a most unsatisfactory, and I now confess inconsiderate, experiment. Alas! how many pets share a similar fate. I buried it in the wood, and to this day could point out the spot.

The nest of the squirrel is generally found on a branch where smaller ones shoot out. It is made of twigs, dried grass, and leaves bound together with the inner bark of the lime-tree. Great care is displayed, and this is necessary, in order that it may resist a violent gale. The nest is made on the principle of Jenny Wren's, with which we are all so familiar. So carefully is it knit together that it is never soaked by heavy rains, and here the squirrel brings forth its young and spends much of its time during the inclemency of winter. Sometimes the nest is formed in a cavity of a large branch, where they gnaw out any rotten parts prior to forming the nest. In the end of May last a dead tree was cut down in the policies of Moredun, and on falling to the ground it was discovered by the woodman that a squirrel's nest was in the cavity of a decayed branch. Five young squirrels nearly half-grown were in the nest, but one of them was dead. The woodman gave the four to the boys of a farmer close by, but here again they became the victims of misguided affection, warm milk from the cow (which is much too strong) being given them without stint.

Squirrels love warmth, and I am of opinion that they only leave their nests in stormy weather when compelled by hunger. They bring forth their young early in May, and, as far as I am able to judge from dissection in the spring months, their period of gestation, like the rat and the weasel, is six weeks. As far as I know, they generally breed only once a year, but I do not wish to dogmatise on this point, as I understand that in the south of England they bring forth their young much earlier than May.

Among my early recollections was a story in my schoolbook entitled "The Use of Squirrels to the British Navy." A gentleman in Monmouthshire observed a squirrel burying acorns in the ground, and arrived at the conclusion that the animals would fail to find them all again, with the result that the acorns would spring up and eventually grow into giant oaks suitable for shipbuilding purposes. The writer's con-

clusion was a little astray, as the oak requires the growth of centuries to mature it, and, as is well known, it has long since been superseded by iron in building our modern men-of-war. But he was accurate enough in his remarks regarding squirrels forgetting where to find their hidden treasures. I have again and again observed the stupidity of squirrels in this respect. I have seen them carrying walnuts a considerable distance from the trees, and burying them in a garden by scraping holes and covering them with soil. I have also seen them hunting most actively and scraping here and there for their hidden food, and, what is surprising, very frequently without success. I was for long under the impression that squirrels, like field mice, invariably laid up stores in quantity, but this has seldom come under my observation, though I have often seen single hazel nuts, walnuts, and chestnuts unearthed when digging was being prosecuted in flower-beds. That the long-tailed field mouse has a granary of stores laid up for winter is familiar to every one. I have often followed squirrels' tracks when there was a sprinkling of snow on the ground, but in few cases found a store. I was, however, fortunate in finding one this morning. Taking up the track at a large lime-tree on the avenue at The Inch, on which there is a nest, I followed the trail round behind the stables and found a number of places where he had been scraping. Searching diligently, I came upon a store of haws and acorns (Spanish oak), which I carefully picked up to exhibit here to-night. They were covered only by dead leaves.

I was recently interested in watching a squirrel pulling chestnuts from a tree in Kingston Grange Park. I had of course to keep a respectful distance, but observed that it pulled them off with its feet, when the nuts dropped to the ground. It would then run down, pick one up and run off with it, crossing the park, a distance of over a hundred yards, to a place where the density of the foliage prevented grass from growing underneath. Here it made a little scrape, pushed the nut as far underneath the leaves and soil as it could with its nose, gave three or four scrapes with each fore paw to cover it, and was off again. During one of the journeys with a nut I got nearer the chestnut tree with a view to observing accurately how it removed them. On its return

it quickly observed me, ran up into the cleft of a branch, and watched suspiciously for several minutes. Picking up a bit of stick, I began working with it on the walk, and gradually went farther away from the chestnut tree. The squirrel evidently made up its mind that I was a gardener and had no intention of interfering with it, as it again commenced operations. Here I discovered how largely this animal is endowed with the instinct of self-preservation, as it discontinued crossing the field, but ran round nearly double the distance on the top of the wall that surrounds the park. There is a row of trees inside the wall, and prudence dictated that it was safer to keep near them than to cross the open field.

Strange as it may seem, the tame squirrel now exhibited will not eat chestnuts, but this may be accounted for by its getting a superabundance of food more congenial to its taste. It might be otherwise during a protracted storm. It must also be kept in mind that some seasons beech nuts and acorns can be gathered in large quantities, while in others scarcely any can be got. Not being able to find beech nuts and acorns hereabouts this season, and knowing from the recollections of my boyhood that a great many grow in the historic park of Ladykirk, in Berwickshire, I wrote and asked the gardener to send me some. He replied, "There is not such a thing to be seen this year; last year they could be gathered in barrow loads."

The usual food of squirrels is fruit, nuts, acorns, fungi, the cones of pine, which they pull to pieces segment by segment in order to get out the seed, and—must it be confessed?—the shoots of young trees. They seem to be fond of gooseberries, but these are not carried away. Their *modus operandi* is to select a berry they can reach from the ground, make a hole in the side and scoop the heart out with their paws, leaving the skin hanging on the bush. Where squirrels are numerous hazel nuts are frequently cleaned up before they are fit for pulling. Cherries are also a great temptation for squirrels. I was once much amused by seeing a gardener at Ladykirk determined to protect a beautiful crop of cherries which were growing against the garden wall. He had them covered by hanging a herring-net over them double, and with an evident

feeling of self-satisfaction said that "not even a sparrow could get in." *Sciurus vulgaris* was, however, too many for him, as, like the rat, he soon cut holes in the net to suit himself, and the cherries rapidly disappeared. I was sent for with my gun to shoot the depredator. While showing me a place to conceal myself among some bushes, the gardener was sent for by his mistress. Sitting quiet, the squirrel soon made its appearance on the top of the wall, when I fired and killed it. It is to this day, however, a moot point whether the squirrel or his murderer was the greater robber of the cherries, as, having shot the thief, I saw no reason why, in the gardener's absence, I should not help myself.

Large quantities of fungi are devoured by squirrels. When grouse-driving at Millden in Forfarshire in September last, I observed one miles away from any trees. At the termination of a drive far up the side of Mount Battock, and when sending my retriever to "seek dead," he made a point at something in the heather. I knew by his manner that it was not a grouse, and on going forward he pounced on something which jumped up, and which I at first took to be a stoat. In an instant it was seized by the dog and killed. I saw it was a squirrel, but too late to save it. I had it put in the panniers, and could not help reflecting on a squirrel being so far from wood. What, I wondered, could it be doing there? This fact is at variance with many writers, who state that squirrels do not stray far from trees. Instances are, however, recorded that they do. At lunch time I dissected it, and found its stomach packed full of fungi, which possibly had attracted it so far up among the treeless mountains. Another theory suggested itself to my mind. As squirrels are suffering much persecution for destroying the forest trees in the valley of the Dee, and as Mount Battock constitutes the watershed between the counties of Aberdeen and Forfar, might it not be impelled by natural instinct to leave the persecuted district and seek for more congenial quarters in the valley of the North Esk?

I have in snow followed the tracks of an otter—which is generally believed never to stray far from water—over the mountain ridge which constitutes the watershed and county march between Perthshire and Inverness-shire. Rats are also known to travel long distances, and I do not think the theory

is far fetched that squirrels might flee from persecution in the valley of the Dee across the mountains to Glenesk.

In the woods at The Burn, near Gannochy Bridge, I have been much interested in watching squirrels carrying pieces of fungi, large quantities growing there. I am ashamed to confess that I have never as yet accompanied any of the "fungus forays" of this Society, and am ignorant of the species which are poisonous and those which are edible. In the mushrooming excursions of my boyhood I was taught to gather only those in the open fields, as the ones growing underneath trees were characterised as "puddock stools," and consequently poisonous. As stated, I have never made a study of them, but long since discovered that squirrels and deer seem to revel in devouring them, especially the red, and, to the uninitiated, poisonous-looking ones.

Squirrels often devour the haws of the thorn and the berries of the yew. After a fall of snow last year, I came on the track of one which I followed till it disappeared beneath a large Irish yew. Retiring to some distance in order to watch his movements, I had an excellent opportunity of observing how differently squirrels and sparrows feed in concert. The bush was thickly studded with red berries, on which the squirrel was feeding, and it was interesting to watch how dexterously he seized one, and split it up the middle in order to get out the kernel. This in turn he split up, devouring the inside, but allowing the shell with the outside of the berry to fall to the ground. Directly the squirrel let any fragments drop, half-a-dozen sparrows flew down and picked them up. I have also known them do much mischief by gnawing off the tops of horse-radish. They do not even stick at a turnip. A few years ago, when partridge-shooting with a party in Lauderdale, in Berwickshire, and while sitting at lunch on the roadside, we observed a peculiar animal running towards us on the road. We could not make out what it was until it came close to us, when we discovered it was a squirrel with a turnip in its mouth nearly the size of a man's clenched fist. When quite near, one of the dogs moved, and it quickly dropped the turnip and scuttled through the hedge.

Do squirrels eat eggs? This has for some time been a controverted question. For long I was disinclined to believe

it, but having one sent me which my friend Mr Paterson, of Rutherford, shot in the act of eating out of a blackbird's nest, I dissected it, and found the yellow of the yolks and bits of the blue shell in the stomach. Why they do so, or whether it is habitual or exceptional, I am not inclined to express an opinion.

The squirrel is such a beautiful, nimble, active, and industrious little creature, with its large black eyes sparkling with intelligence, that I cannot help regarding it as the embodiment of gentleness and innocence. That it is, however, destructive in the garden and the forest, is a truism that cannot be gainsaid. Squirrels have always been special favourites of mine, and even when in my teens—the bloodthirsty age—I shot them with reluctance, despite stern instructions to kill them down for their depredations in the garden and in the woods. Such was the destruction done by squirrels in the pine woods in Strathspey a number of years ago, that an organised raid was made against them, and a very large number were killed in one day. As already indicated, the extensive pine forests in the valley of the Dee in Aberdeenshire have suffered severely by a plague of squirrels. The damage done is incalculable, by their peeling the bark in great splashes, generally from within six inches to a foot from the top of growing fir trees, and feeding on the under bark. On examining a lot of timber in the pine forests of Glentana, there was scarcely a tree on which there were not several bare pieces, some of which were two feet in length and half round the tree. Five or six bare pieces, as described, on one tree was quite common. This completely ruins the timber, as it gets black from the exudation of resin and exposure to the weather, and eventually decays or is broken over by the wind. There is scarcely a tree in the extensive forests referred to without such blemishes, and, as already mentioned, the damage done is very great. Even to a superficial observer the work of squirrels is apparent where these animals exist. Under the trees the ground is littered with cones pulled to pieces, thin spales of wood which the squirrels have discarded, and the young shoots cut off from the tops of the branches of various firs. It is my opinion that they eat the soft wood of the latest year's growth. To such an extent has the mischief

done by squirrels grown in Aberdeenshire, that in a letter I have just received from a well-known proprietor and member of Parliament, he says: "Squirrels are a perfect curse to tree-growing districts, and we in Aberdeenshire have suffered most seriously from their operations. They only came into the county about forty years ago, but since then they have been so active that hardly a wood has been spared, and we proprietors have lost many thousands of pounds. Their *modus operandi* is well known. They cut away a ring of bark, not far from the tree top, which then withers and becomes so brittle as to be easily broken off by the wind or snow, and after that the growth of the tree is checked, it becomes stunted, and when cut will practically be found to be 'piped' and much deteriorated in quality. Even if the top is not snapped off, the circulation of the sap is checked by the ringing of the bark, and healthy growth ceases."

Even in old-timbered parks such as The Inch, Kingston Grange, and Edmonstone, squirrels do much mischief. I have observed in the early spring (when there is a sprinkling of snow it is more apparent) the ground littered with buds beneath the fine old planes, the centre of the buds being eaten out by squirrels. Later in the spring, when the horse-chestnut has made young shoots of from three to six inches in length, they seem to take a pride in the quantity of shoots they can nip off. They hollow out the pith, leaving the shoot hanging by a strip of bark, which in a day or two dries up, giving the tree the appearance of having been blasted by a severe spring frost or withering east wind.

That squirrels have become a nuisance must appear manifest, much as I regret the fact. With the exception of the domestic cat, they have practically no enemies but man. The gardener's cat at The Inch killed a squirrel the other day. In deciduous forests they can be shot down, as when stripped of leaves "squirlie" cannot well conceal himself, and once seen there is no chance of escape from a gun. It is otherwise in a dense pine forest, the difficulty there being to see them. The best time to destroy them is in the spring when the tree sap begins to rise.

It is a law of nature that where animals which have a tendency to increase rapidly abound, checks are generally

found by way of counterbalance. Man, however, sometimes presumes to be wiser than the framer of natural law, and interferes with Nature, with the most ruinous results. Rabbits, as is well known, were introduced into Australia and New Zealand, and quickly increased to such an extent that agriculturists were practically ruined.

I am not prepared to state whether squirrels are, or are not, indigenous to Scotland. It is on record that they have been imported from Russia and Norway to this country as pets, and, speaking from my own experience, many pets escape. About 1772 the then Duke of Buccleuch kept squirrels in a miniature zoological garden at Dalkeith Park, from which a number got access to the woods of the park, where they increased with amazing rapidity. It is now close on forty years since the late Tom Inglis, who was so long at Dalkeith Park gate, informed me that he came to Dalkeith in 1825, and a year or two after that time he procured several nests of squirrels and sent them to Minto, where he had previously been, and also to a friend at The Haining, near Selkirk, where they quickly spread in all directions. Again, in 1844, the then Lord Lovat introduced them to Beaufort Castle in Strathglass, about ten miles north of Inverness. I am informed by Mr Donald Grant of Grantown, who, as factor on several estates, and from long association in Speyside, is entitled to respect, that when Lord Lovat was conveying the squirrels north by coach, and when changing horses at the inn near Alvie, the cage fell off the top of the coach and several of the prisoners escaped to the Rothiemurchus pine forest. Mr Grant did not actually see the animals escape, but his memory carries him back to that time, so that its accuracy need not be doubted. I remember being told when a young lad that squirrels had been introduced into Ladykirk, in Berwickshire, but as this was only hearsay, perhaps too much credence cannot be placed on it. The fact, however, remains that squirrels were introduced to Dalkeith, in Mid-Lothian; Minto, in Roxburghshire; The Haining, in Selkirkshire; Dunkeld, in Perthshire; Beaufort, in Inverness-shire; Castlemilk, in Dumfriesshire; and Barskimming, in Ayrshire. It is therefore conceivable that proprietors would like to see such beautiful and interesting creatures gambolling in their parks, and would purchase a few for in-

troduction. In those days facilities for disseminating information of this kind were not so common as now, and the chances are that squirrels were introduced to many places, though the fact was never put on record.

In writing on the squirrel, it is with the deepest regret that I cannot characterise this beautiful animal to be as innocent as he is interesting. That he has become a destructive pest has already been pointed out, and to such an extent has he been persecuted that 1000 and 1200 have been killed in one year, and in seventeen years 14,123 squirrels were killed in the plantations on Cawdor estate, in Nairnshire, alone. Notwithstanding the war of extermination—1s. per tail being paid on some estates in Strathspey—they continue to do much damage, and, strange to say, they show a partiality for planted trees as against natural. So long as cones are plentiful, they will not attack the bark. They begin their ravages about the end of April and continue their work of destruction until fungi or toadstools grow, when they cease to feed on bark. As already indicated, they ramble far from woods in search of fungi.

Mr W. J. Stillman, in his charming little book on his two pet squirrels "Billy and Hans," asserts that squirrels do practically no harm, and in support of his contention quotes from a letter of "an intelligent Scotch gamekeeper, Mr James Mutch." The letter states, "There are a great many of them here. . . . I have never seen a squirrel eating or destroying the young shoots of forest trees, and there are thousands of young trees here, Scotch fir or pine, the kind they are blamed for destroying, and I am safe to say that I could not point out one tree damaged by a squirrel." Unfortunately he does not mention from what estate Mr Mutch writes. I know gamekeepers in every part of Scotland, and have never heard of James Mutch. If I can find out his address, I shall make a point of going to see him, and will be only too glad if he can convert me to his views.

The squirrel is frequently found infested with vermin, and my experience of once putting one in my pocket is anything but pleasant. I am not sufficiently skilled in entomology to describe the kind of flea, but, as far as I can judge, it closely resembles the domestic flea, which, as we are all aware, is

armed with powers to disturb the peace of the king. Every creature has a plague in the shape of a parasite, some creatures have several, and it seems strange that Nature should have arranged it so.

At the meeting of Dec. 18, 1901, Dr Watson delivered a short address on Common Fungi; and on the evening of Jan. 22, 1902, made some further remarks on the same subject, with the help of lantern diagrams.

V.—*THE SQUIRREL AS A PET.*

By Dr W. AITCHISON ROBERTSON.

(*Read Jan. 22, 1902.*)

I must first apologise for troubling you with a subject which you had so recently before you as last meeting. Imperative absence in the South of England prevented me, however, from being with you on that occasion, else you had been spared the present communication. I have been able to ascertain the views of Mr Speedy only from the notice which appeared in the 'Scotsman' and from what my friends have told me. From what I gather, however, I think Mr Speedy views the squirrel as an enemy, and one would hardly take the opinion of such regarding his foe as a trustworthy estimate. I should think that the views of one who did not regard them as enemies to be exterminated would convey a more just estimate than the views of one who was inimically inclined towards them. It was stated that squirrels were "stupid creatures." Doubtless this is correct if one takes for comparison a city financier, or even a first class *chef*. But I deny entirely that the squirrel is, compared with other animals, stupid. The very reverse is true. Timid and nervous to a degree he certainly is, but to apply the term "stupid" to him is absurd. I have in my time kept many pets and watched the habits of many animals, and I can assert,

with positive assurance, that no animal (not even excluding man's companion, the dog) that I know of possesses higher mental qualities than the squirrel. Mr Speedy cites as evidence the fact that he has frequently seen them searching for buried nuts and not being able to find them. Nothing is so easy as to draw an erroneous conclusion from observations, and I feel sure that this has occurred here. I also have often watched squirrels hiding nuts, and noted with pleasure the clever way in which the tiny hands were used to cover them up (the term "paw," I think, should be applied only to those animals who do not use the digits as a hand). But I have also just as often seen the squirrel come to examine his hiding-place to see if his hoard were still safe, or else to find which nut was most mature or which tickled his sense of smell the most. I have seen one go from place to place sniffing, and at last unearth one which doubtless seemed most to his taste. The tame squirrel exhibits similar preferences, rejecting one and grasping another nut, both of which seemed equally good. This is an example of how observers differ in the interpretation of observations. In this case, mine is certainly correct.

Well, I have kept squirrels for four years, and ought surely to be able to speak with some degree of authority regarding their habits. No other pet that I know of will give one so much pleasure as the squirrel. Its constant vivacity, keen sense of fun, and interesting ways, render it an object of Natural History well worth the attention of every kindly disposed person. I must premise, however, that in order to make a *tame* squirrel, you must get one almost from the nest. Unless you do so you will never be able to make a real pet of him—he will always remain somewhat wild, and hardly to be depended upon. The free use of his teeth comes too readily to him to be altogether pleasant for the owner. Besides, the cruelty of taking an animal which has had the free run of a forest and confining him even to a house is too great to be thought of. Though you may give him a cage to exercise in, with a sleeping-box attached, on no account ought he to be confined in one. To an animal of so active a nature a cage is a positive torture, and no matter how well you attend to him in the way of food, he will soon languish and

die. He must have the free run of the room at least, and when you have had him for some time you may allow him to accompany you out of doors. There is no fear of him running away from you; he regards you as his protector, and will always run to you for safety. When brought up with dogs or cats he lives in perfect harmony with them, and their play is often most amusing. My present squirrel allows the cats to pat or lick him with perfect unconcern. He knows that he will receive no injury from them.

Squirrels are proverbially fond of play, and will nibble, worry, and kick at one's hand like any frolicsome kitten. Hide-and-seek round a chair or round one's back affords him a never-ending joy. Most human-like are the habits our present squirrel has of yawning and stretching his arms. When tired he cannot restrain his yawns, and invariably on awakening he yawns. Bread, biscuits, lettuce, fruit, cake, and of course nuts of all kinds, form his articles of diet; and I am sorry to say that he is not an abstainer, for he is inordinately fond of mild table or lager beer.

I deny entirely that the squirrel destroys the eggs of wild birds. This is asserted by some writers as a fact. The squirrel is an absolute vegetarian, and never tastes animal food even in the shape of the contents of an egg. He is a much more strict disciplinarian than our human vegetarians who eke out their restricted dietary by the addition of milk and eggs. Mr Speedy cited the case of a squirrel being shot while sitting on a blackbird's nest, and in whose stomach eggs with parts of the shell were found, and took this as a proof that the squirrel eats eggs. I fancy, even if he did eat egg, that one blackbird's egg would prove an ample meal for a squirrel, and so I cannot think that the plural number was really meant here. I am inclined to think that the yellow matter which was present in this unfortunate squirrel's stomach was not of eggy origin. The matter which they frequently vomit up is yellow in colour, and is due to the oily yellow matter in the nuts and kernels which they consume. Even in the remote chance that this squirrel did partake of an egg, an isolated case such as this would not prove that it was the custom of squirrels to eat eggs. A hungry animal may eat anything, as shipwrecked mariners have been known to eat their fellows or even shoe-

leather. One would never, however, argue from such data that sailors lived usually on human flesh or enjoyed a meal of leather.

I believe the explanation of the above incident to be as follows. Every animal, including vegetarian animals, requires a certain amount of mineral matter to keep himself in health. It is very probable that the squirrel in question found himself deficient in some such respect, and thought rightly that the egg-shell would supply his needs. To take an extreme illustration, I would hardly suppose that any one would go the length of saying that a tame squirrel of mine lives on lime plaster, though this might be found in his stomach at intervals, and the cornice of my dining-room bears very evident traces of his efforts to obtain mineral matter. Nor would any one conclude that the squirrel ate bones, though at rare intervals he might find traces of dried bones in his intestinal contents and due to his search for lime salts. The fact is that nuts, acorns, &c., do not contain a sufficient amount of lime to replace that constantly destroyed in his skeleton, and perforce he has to get an additional supply in a more direct way, as from fragments of chalk, plaster, or very rarely egg-shells. The ridiculous statement which we find in certain books that the squirrel kills and eats young birds and mice in their nests is so alien to their natural habits, that I only mention it to show how imperfectly the habits of this little animal have been studied.

To return to our pets. We have never taught our present squirrel any special tricks—there was no need, he is so full of trickiness himself. Several of his actions show remarkable reasoning power. If, while he is eating a nut, you offer him another, instead of refusing it he runs off to hide the one he was eating and returns to take the second. He found out that the proper way to remove the lid from a biscuit-box was to prise it up with his teeth on each side alternately. He soon discovered that if he merely drove it up on one side it jammed. Dish-covers he also disposes of by pushing them upwards, and then throws them over. He is a most inquisitive little fellow, and tears off the paper from every parcel to see what it contains. This habit he has taught our kitten, and now we have only to lay a parcel down for it to be unpacked by either of them. At meal-time he invariably makes his appearance, and having appropriated some article of

food, as a lump of sugar or a crust of bread, he seats himself either on one's shoulders or wrists to eat it. Having eaten as much as he feels inclined to, he shoves the remainder down one's neck between the collar and the skin, and pushes it well down with his hands. This proceeding is not altogether a pleasant one, especially when the choice morsel happens to be a piece of moist pastry or a strawberry. When he wishes some special article of food he nibbles gently at one's finger until it is given to him, and will refuse every other kind but that one on which he has set his heart. He is exceedingly fond of our society (although very shy of strangers), and waits for our return on some chair near the door ready to jump on us when we enter, when he greets us with many happy little noises and gambols around us. When any of the cats disturb him when he is sleeping,—and this they often do when they want him to come out for a game, by tapping on his box,—he puts his head out and grumbles, and scolds as energetically as any stair-head randy. Finding this of no avail, he appeals to us with beseeching eyes, and the cause of the disturbance having been forcibly removed he returns to bed.

Squirrels have a most retentive memory, and our present pet immediately recognises us even after an absence of five weeks.

By far the gravest accusation which is brought against squirrels is, that they cause an immense destruction to woods and forests. Mr Speedy states that the damage done to pine woods by squirrels is very great. On some estates in Strathspey, he adds, 1s. per tail has been given; and as many as 1000 to 1200 have been killed on one estate in Nairnshire in one year. This question ought to allow of a positive answer. Are trees better developed or do they furnish better wood in forests which are practically free from squirrels (for I grieve to say that in many districts the little animal has been practically exterminated) as compared with the trees in forests where squirrels abound? My own observation alone allows me to state that no appreciable damage is done to trees by squirrels, and this is reinforced by the answers to questions put to landed proprietors and estate owners. Many of these have told me that neither they nor their keepers would have been aware of the presence of squirrels in their woods unless

the little animals had demonstrated their existence visually. On the other hand, let it be granted that the squirrel eats the growing tips of young branches (which I entirely deny)—might not this be very desirable? We know what happens if a forest tree be neglected in not being pruned. It grows up a long, bare, straggling specimen. The duty of the forester is to prune it so that it throws out strong lateral branches. Might not the squirrel be Nature's forester—removing the growing ends and so giving origin to lateral offsets? Nature required foresters long before man thought of taking up such duties. If we consider pine trees, we can easily see that the removal of the tip of the axial stem would be fatal to the usefulness of the tree for timber. The desire of the forester is to make the pine tree grow tall, straight and undivided. I have already quoted authorities to show, however, that any destruction which squirrels may cause to pine trees is insignificant. Vast tracts in Norway and Sweden are covered by the pine (*Pinus sylvestris*) and the spruce (*P. Abies*), and yet in spite of immense numbers of squirrels these trees grow to a height and girth never seen in this country. The squirrel, even when he does eat buds, nibbles the young leaves, but does not bite the tip off. The accusation brought against him that the enormous number of young pine-shoots which are found lying on the ground after high winds are due to his work is unfounded. The pine beetle (*Hylurgus piniperda*) tunnelling in the pine-shoots is the insect at fault, as the late Miss Ormerod clearly showed. Again, Mr Stillman has had experience in his own woodland to prove that when food of any kind and water is provided for them, the squirrels harm nothing. In the large parks in American cities—New York, Richmond, Philadelphia, Baltimore—the American grey squirrel is acclimatised and grows very familiar,—so much so, that to people with whom they become acquainted they will come to be fed, and search for their food in the pockets of the friend they recognise. Nothing prevents this charming sight from being common in the English parks but the want of protection of the little creature.

Of course, some folks will not be convinced, or if convinced remain of the same opinion still, but to me it seems that the consensus of opinion is quite opposed to the popular belief

that the squirrel is destructive to forests. I would earnestly ask our landed proprietors to become convinced of the fact of the non-destructiveness of the little animal for themselves, and to rely on their own observation, and not on the too often mistaken opinions of their servants. Were this so, we should soon have a proper protection afforded to this delightful little friend. Especially should this doctrine be preached in our own land of Scotland, where ignorant prejudice is already in too many districts exterminating the squirrel. Trap and gun have already cleared many a wood of them. In England, where more enlightened ideas take root sooner, on many estates the squirrel is protected, and forests and glades are rendered still more enchanting by the presence of the little "shadow-tail" (*Sciurus*).

I have made this communication in the hope that it will to a certain extent nullify the statements made by Mr Speedy. From the respect with which any statements made by that gentleman are received, I fear that gamekeepers and foresters may redouble their energy against my little friends, and I trust that I may be able to lessen the severity of this crusade against them, and so even in this feeble way repay a debt of gratitude which I and mine shall for ever owe to the tiny folk for the many delightful hours which they have afforded us.

Several lantern slides were exhibited in illustration of the foregoing. Four of these are reproduced here, and show our squirrel either feeding himself or at play.

VI.—*THE DAISY AND THE DANDELION.*

By Dr WM. WATSON.

(*Read Jan. 22, 1902.*)

Both the daisy and the dandelion belong to a family of plants called the Compositæ. The chief peculiarities of the Compositæ are that the anthers cohere, and that a number of small flowers grow together on a head. In other respects all Com-

PLATE XXX.—THE SQUIRREL AS A PET.

HELPING HIMSELF

AT PLAY.

PLATE XXX.A.—THE SQUIRREL AS A PET.

GETTING AT A NUT.

RIVAL ATTRACTIONS.

positæ are not alike. In some all the florets are of the same shape. They may either be all tubular or all ligulate. Others have two kinds of florets on the same head. Sometimes these florets are of the same colour, sometimes they differ in colour as well as in shape. We have thus four groups—1st, All florets alike, and all tubular; 2nd, All alike, and all ligulate; 3rd, Florets of two kinds, but of the same colour; 4th, Florets of two kinds, and of two colours. The dandelion belongs to the second group; the daisy to the fourth or highest. There are two ways of treating any problem in Biology or Sociology. One is, to investigate for yourself; the other is, to take down your Darwin and read what the great teacher has said on the subject. Both are good, but as a mental discipline it is perhaps better to study the subject unaided, and when you have come to definite conclusions, to see by consulting Darwin's works whether your conclusions are correct or otherwise.

Can the plants we have selected give us any information as to how we ought to act? This may seem a fanciful way of gaining information, but analogies can be found. When we observe an eclipse we generally look at the sun through smoked glass, but we can look at it reflected from a basin of water. So we can look at human life directly, or view it indirectly reflected from the mirror of the life of the lower animals or of plants. In the first place, I may say that what man is to the lower animals the Compositæ are to other flowers: this applies specially to the higher section of them. Like man, they have succeeded in the struggle for existence by being social and by division of labour. They are eurythermal, or able to live in almost any climate, like man; not stenothermal, or restricted to a few climates, like monkeys. The analogue to monkeys is the Dipsacus family, which are gregarious in family groups, but have not developed division of labour, and their anthers do not combine. Still lower are the Caprifoils and Valerians, which have no common involucre nor combined anthers. They are like a herd of oxen, or a flock of sheep, to which you may at any time add one animal or remove one, and it still remains a herd or flock. Not so in human beings. The group is a definite one, bound together by kindred, and by a common language represented in Com-

positæ by the involucre. In monkeys we have the tie of relationship, but not of common language. To investigate the relative value of these two bonds is the object of my paper.

Looking round Britain, as we see it in 1902, we must observe that the restricted group is everywhere the family—a man, woman, and children, living in one house. It may be a palace or a hut, but in each case there is a home—the property of the group. The house is the great family institution, just as fire is the great tribal institution and clothes the great individualist. Man was originally a naked savage. He became mainly socialist, individualist, or domestic according as he first developed and mainly cultivated a fire, clothes, or a hut. In India we have large aggregates. A family often does not break up for three or four generations. Cousins in the male line live together with their respective wives and children, and cook at a common fire. This is called in books a patriarchal family, but in my sense of the words it is not a family, but a small tribe, for the common fire is the centre, not the hut—but the fire represents Socialism, just as the hut represents the family instincts. The most socialistic races known are the savages of Australia. They have huts and fires, but no clothes. In Britain we have preserved perfectly the monogamic family, represented in Compositæ by the corolla, and the national organisation represented by the involucre. We have lost the tribal organisation, represented in the Compositæ by the palea of the receptacle, but the daisy and the dandelion have also lost these palea.

In the present day the Socialists wish to destroy the family in the interests of the nation. The palace is to be made less palatial, the hovel to be made more beautiful. In other words, the ray florets are to be shortened and the colour taken out of them, while the disk florets are to be lengthened and their colour deepened. A man is to be forced by law to leave his earnings not to his children, but to the State. Children are to be educated, not by their parents, but by the State. The daisy is to be turned into a dandelion, all the florets are to be of one colour, and the supposed advantage is, that in the dandelion all the florets resemble in shape the ray florets of the daisy. Of course we are all in part Socialists.

(1) Improving the dwellings of the poor is Socialism. (2) Leaving money to build a hospital is Socialism. (3) Free education is Socialism. (4) An Established Church is Socialism. But while admitting the merits of Socialism, we must not forget the rights of individualism and of the family. It is right to entertain our neighbour with food, cooked at the tribal fire, but we must not neglect to repair the hut that shelters our wives and children; or to keep in good order the clothes which enable us to face the blast and work in the fields far from the hut and the fire. All those inside the involucre should be dear to us, but still dearer those inside the same corolla. The only precedent of a great State practising modified Socialism is Sparta, where the boys were brought up together by the State, and money was scarcely used. But Sparta was not purely social, for Sparta was strictly monogamic. Of the two great philosophers of antiquity, Plato was a Socialist, a follower of Marx; Aristotle, a Darwinian, or a Spencerian. Plato went further than Sparta. He recommended that men and women, as well as children and property, should be sacrificed to the supposed exigencies of the State. But Platonism has never been adopted by mammals, far less by men. It is too late in the world's history. The Hymenoptera are Socialists, of the Fabian Society type, but their nervous system is ventral, not dorsal, their eyes compound, not simple, and they have antennæ—organs denied to us. No animal with a dorsal nervous system ever has been or can be a pure Socialist. To become pure Socialists, we would have to retrace our steps—to lose our dorsal nervous system, and even our notochord, and after getting down to be a chordate Amphioxus, or a hemichordate Balanoglossus, then start afresh, on our upward road, as Arthropods. Even when we got rid of our backbone, what kind of insects are we to rise to be? Besides the Hymenopterous Socialists, the bees, there are also Neuropterous Socialists, the white ants. It would be a terrible thing if, after going such a long road in hopes of becoming four-winged, many-eyed bees, we found ourselves blind, wingless, white ants—where the children toil and a few fortunate adults idle: something like the Manchester factory system upheld by John Bright and abolished by Lord Ashley.

To return to our botanical metaphor, we are the daisies of the human race. As already said, we have retained our corollas and our involucres, though we have lost our palea. We must accept our position. The ray flowers must help the disk flowers, but not give up their ligulate shape nor their attractive colours, for if they did they would be injuring, not benefiting, the flowers of the disk. Above all, let them not listen to the Fabian Society, and vainly seek to be dandelions. I believe that, on the whole, the daisy is more beautiful than the dandelion; but whether it be the case or not, we are daisies, and must make the best of it. As the Latin has it, *Spartam nactus es, hanc exorna.* In English, "You are a daisy"—to my present audience I may add "Flowers of the ray, do your duty as such."

In addressing the members of this Society as daisies, I am presuming they are of Teutonic extraction. The Celts are different. They are more inclined to Socialism, and therefore in character they somewhat approach the dandelion. It is a favourite flower of the Celts. In the Autumn Part of Professor Geddes's book, 'The Evergreen,' there is a beautiful story by Fiona Macleod in which she calls the dandelion the flower of St Bridget, so that it is a sacred plant to the Gael. Its seeds with abundant pappus soon leave the parent plant, reminding us of the custom of fosterage so characteristic of Celtic nations. We Lowlanders all love the daisy sung by our national poet,

> "Wee, modest, crimson-tippèd flow'r.'

The true Lowlander thinks the daisy the sweetest plant in the whole world; but with inveterate national prejudice we dislike the Celtic dandelion, and, not content with forcing the Highland crofters to emigrate to America, we root out from our garden-plots the lovely flower of St Bridget. It is too gay for us. But the Highlander loves gay colours, variegated tartans, Socialism, and its emblem the dandelion.

VII.—*NOTES ON THE ENTOMOSTRACA OF MID-LOTHIAN.*

By Dr T. B. SPRAGUE and Miss B. SPRAGUE.

(*Read Feb. 26, 1902.*)

Our principal object in this paper is to give the Society some account of the work done in connection with the recent competition for the prize offered by the Society for the best collection of freshwater crustacea from Mid-Lothian; and we are not without hope that we may thus induce other members to take up the same interesting study. We shall touch briefly on the three divisions of the entomostraca, noting some of their habits and characteristics; and shall then explain our methods of collecting and preserving; and finally, describe some of the localities visited, and some of the more striking species obtained. Only two out of the sixty species we found are large enough to be examined without the help of a microscope. These two are the *Asellus aquaticus* or "water woodlouse", a creature resembling the common woodlouse or "slater", to which it is nearly related; and the *Gammarus pulex* or "freshwater shrimp", which is almost identical in appearance with the familiar sandhopper. The remaining 58 species are all included under the general term "entomostraca", and fall into three divisions,—the Copepoda, Ostracoda, and Cladocera. It may be worth while to note what these names mean: "Copepoda" means literally "oar-feet", and refers to the fact that all the species in this division use their feet in swimming. "Ostracoda" means "having the form of a shell"; all the ostracods resemble more or less closely tiny bivalve shells; when the creature is at rest, the whole of the limbs—antennas and legs—can be tucked inside the shell, leaving nothing exposed. "Cladocera" means "branch-horned," and denotes those entomostraca which have a two-branched antenna instead of a simple one.

Taking the copepods first, we find that they are all more or less shrimplike in appearance, the body being composed of a number of segments protected by as many distinct rings of

chitinous covering which, although widely different from the shell of a mollusc, may still be popularly called shell. These rings are united by a strong pliable membrane. The creatures are extremely active, swimming in a quick succession of jerks or darts, produced by vigorous strokes of the antennas and feet. Some of them, as the *Cyclops*, keep a fairly straight line when swimming; others, as the *Canthocamptus*, move alternately to right and left. It is often possible to recognize from the method of swimming to what genus, or at least what family, a specimen belongs; and in some cases even the species itself can be recognized by its peculiar method of progression. This is the case with *Cyclops phaleratus;* being a very flattened species, it is able to preserve its balance easily and to crawl on the surface of the mud, or on the sides of the vessel in which it is placed. We have frequently taken specimens of *C. phaleratus* from a gathering, and put them temporarily in a few drops of water in a watch-glass, meaning to examine them later on. After leaving them ten minutes or so, and returning, it has been quite a common experience to find that one or two have crawled right out of the watch-glass, and are wandering on the underside of it, or on the table.

The copepods generally swim with the ventral surface downwards, but we have often seen some species of *Cyclops* swimming, so to say, wrong way up—with the dorsal surface downwards.

The *Cyclops* is peculiarly liable to parasites, both animal and vegetable; we have often seen brilliant green specimens, which owed their colour to the presence of numbers of minute unicellular algas growing on them; and others we have seen swimming about surrounded by a white cloudy-looking mass, which under the microscope proves to be sometimes hundreds of bell animalcules. On the *Canthocamptus* there may generally be found a few specimens of a small animal parasite —an infusorian living in a delicate hyaline cup. These so-called parasites do not prey on their host, but merely attach themselves to its shell and reap the advantage of being constantly carried about to fresh food-supplies; but when present in large numbers they must cause it serious inconvenience.

Turning to the ostracods, it seems hard at first sight to ascertain anything more than the mere outline and colour of

any specimen. The shell is usually so opaque, and the body and limbs so completely enclosed in it, that little or nothing of the internal structure can be seen. The opacity of the shell also renders it difficult to see the characteristic external markings, which are present in many species; but this may be done by careful adjustment of the light. We have, first, the so-called "lucid spots", which are really the points of attachment of certain muscles; the shape and number of these spots in each species is fairly constant and distinctive. Secondly, there is also in some species a well developed pattern on the shell. By putting a specimen into a solution of caustic potash we render the shell semi-transparent, and can see the general shape of the limbs; but this process effaces the shell-markings, and should therefore only be done after they have been observed.

It is extremely difficult to dissect the ostracods, and after a few experiments we gave up the attempt. In order, therefore, to identify our species, we had to pay careful attention to the size, colour, and outlines of the shell. If we were given a specimen of either *Cypris fuscata* or *C. incongruens*, and asked to say which of the two it was, we should find it difficult to decide the point at first sight; but if we were to draw the outline accurately with the help of the camera lucida, that alone would be sufficient to settle the question. *Cypris incongruens* narrows very slightly towards the front, and *C. fuscata* towards the back; and, so far as we have observed, this small difference is always to be relied on.

We chanced, while still quite inexperienced as regards the ostracods, to get a number of *Cypris virens* and *C. incongruens*, both young and old, in a single collection; and since the very young *Cypris virens* differs considerably in outline from the adult, and the half-grown forms of *C. virens* and *C. incongruens* are somewhat alike, we could not tell for some time how many species we really had—whether 1, 2, or 3.

Being so well protected by their shells, and their habit of concealing themselves in mud, the ostracods do not need to have their powers of locomotion well developed. Some of them are very active, but all the species we know are quite easy to catch at once with a dipper, whereas you may require to chase a copepod patiently for a minute or two before

capturing it. A large number of them crawl at the bottom of ponds, and cannot swim at all. They have all a steady, even method of progression, quite unlike the jerky movements of a copepod.

The cladocerans we found particularly interesting. They are very varied, and often present most elaborate and beautiful developments, especially in the antennas and the postabdomen. They swim with a slow, jerky motion, rising slightly in the water at the commencement of each stroke, and sinking at its close. Many of them maintain an upright position, with the head uppermost; and this, of course, makes it much more difficult for them to progress quickly. This is very noticeable in the daphnids; the lynceids, which swim with the head depressed and on the same level as the body, move much more rapidly.

The body of a cladoceran is enclosed in one large shell, which is open on the ventral and posterior margins. The head is protected by a shelly covering, firmly united to the rest of the shell; the line of junction can often be traced, and in some species, after a specimen has been dead any length of time, the two portions of shell become entirely separated. The "legs" are used for breathing; and the organs used in swimming are the antennas and postabdomen.

Habits.

As a rule, the freshwater entomostraca are fond of sunlight, and we have generally made our best catches on bright days. It has happened to us more than once, that after finding Ravelston Quarry literally swarming with *Diaptomus gracilis* and *Bosmina longirostris* on a bright day, we have returned a few days later in dull cold weather and been unable to find half a dozen specimens of either. The quarry is deep, and in dull weather the creatures presumably retreat to the deep water. Many species, including the two just mentioned, prefer clear water; others, as certain of the daphnids, and many of the ostracods, seem to thrive best in muddy water.

The copepods and ostracods may be found all the year round; but many of the cladocerans appear to die off in the winter.

In all the copepods the egg-clusters are external: *Diaptomus* has only one, carried on the ventral surface of the abdomen; while *Cyclops* has two attached laterally, one on each side. We have made several observations on the rate of reproduction in *Cyclops strenuus*, by isolating two or three mature females and keeping them for some weeks. We found that about four days elapse between the formation of the egg-clusters and the hatching of the eggs. Two days after a brood is hatched, another pair of egg-clusters is formed, the whole process thus requiring only six days for its completion. About thirty young ones are hatched in each brood. We tried several times to rear the young ones, in order to observe the moulting processes, but without much success. The longest time we succeeded in keeping a young one alive was twenty-nine days; in that length of time it had developed one fresh pair of limbs, and had, we think, moulted once. Our experiments were made in very cold weather, and we did not know what food to provide. At first we used to leave the mother *Cyclops* with the young ones after the latter were hatched; but it seemed to us that the young ones disappeared uncommonly quickly under these conditions, and we have a strong suspicion that the mother *Cyclops* fed on them in default of its proper food.

The number of eggs in one brood varies greatly in the different species and genera of the copepods, but in all cases the eggs seem to be produced and hatched in rapid succession.

Of reproduction in the ostracods we can say nothing; comparatively little is known of the subject as yet, and in many instances only the female of a species has been observed.

When we come to the cladocerans we find two methods of reproduction. The summer eggs are carried about within the shell of the parent until hatched. The number of eggs in one brood varies according to the species, such species as *Chydorus sphæricus* or *Bosmina longirostris* having generally two to four, while certain *Daphnias* and *Polyphemus pediculus* may have as many as twenty. The winter eggs are only one or two in number, and are contained in a case called the ephippium, which forms at the back of the shell. In the autumn the ephippial females appear in large numbers; after a while the ephippium falls off without injuring the creature, and floats on

the surface of the water, and the eggs are hatched in the following spring. We have occasionally found the water at the edge of a pond thickly covered with these floating ephippiums. *Daphnias* generally seem to die off in the winter, though we have on a few occasions found swarms of them even then. Baird, writing of the South of England, says that in a mild season they may be found all through the winter.

In studying these little crustaceans we are confronted with the same perplexing question that arises with regard to higher organisms—"What constitutes a species?" To take the daphnias as an example, Brady recognizes as distinct species *D. lacustris* and *D. galeata*, while Lilljeborg includes both these forms under the name *D. hyalina*. Writing in 1898, Brady says, "Professor G. O. Sars now reckons as mere varieties of *D. longispina* no fewer than eleven forms which had been previously described by himself or other authors as distinct species."

In the days before the theories of evolution and natural selection were familiar to students, the origin of this multiplicity of closely related forms must have been extremely puzzling; but we now know the daphnia to be a very variable organism, which responds readily to changes in its environment; and we believe that the various forms met with in different localities are all modifications of one or two original species, slowly diverging more and more from each other, as each is gradually acted upon by its own peculiar surroundings.

We are also in a position nowadays to conjecture with some degree of probability the significance of the peculiar characters found in certain young forms, since we know that in every young creature the life-history of its ancestors is more or less clearly indicated. Take, for example, the pointed head commonly found in young specimens of *D. galeata*; this is a peculiarity characteristic of the adult *Hyalodaphnia cucullata* and certain other northern species, believed to be of pelagic origin; and suggests that the ancestors of *D. galeata* lived for generations under conditions similar to those now prevailing in the present home of those northern species. (These remarks apply to *D. galeata, Sars*, as described by Brady in "Natural History Transactions of Northumberland, Durham, and New-

castle-on-Tyne,' vol. xiii., Part 2., which is the form we ourselves have found. *D. galeata, Sars,* as described by Lilljeborg in his 'Cladocera Sueciæ,' seems to differ considerably from the British form, inasmuch as the *adult* (summer form) is helmeted.)

The variation that occurs with regard to the eye and eyespot is also suggestive. The presence or absence of one or the other, and their size and position both relative and actual, are taken as constituting generic characters. With regard to the three families, *Bosminidæ, Macrothricidæ,* and *Lynceidæ,* as described in Norman and Brady's monograph, we find that in *Bosmina* there is a large eye, but no eyespot; while in *Monospilus* the eyespot is present, but there is no compound eye. In other genera both eye and eyespot vary much in size and position; in *Drepanothrix* the eyespot is large and quadrangular; in *Lathonura* it is a mere speck; in some of the *Lynceidæ* it is larger than the compound eye. Coming to the family *Daphnidæ* we find that the eyespot is present in *Ceriodaphnia, Scapholeberis,* and *Simocephalus,* and absent in *Moina;* and that in *Daphnia* it is generally, but not invariably, present. How is this variation to be explained? It seems probable that a now functionless eyespot may be the degenerate representative of a former simple eye, which at some stage in the creature's history became superfluous and is now disappearing. This would account for its complete disappearance in some cases, and its insignificance in others; and if it is no longer useful to the creature, and therefore no longer subject to the action of natural selection, we can understand that it might in the process of degeneration assume the variety of forms now existing.

Collecting.

Our method of collecting entomostraca is as follows: we have a stick about eight feet long, which can be unscrewed into two parts for convenience in carrying. To one end is fastened a wire hoop, which may be from six to twelve inches across, and on to which is sewn a fine muslin net. This tapers gradually towards the lower end, which, instead of being sewn up, is fastened round the mouth of a small wide-necked bottle. Many collectors use the muslin net by itself,

but it is convenient to have a bottle attached, so as to see from time to time what kind of material is being brought up. We sweep the net slowly through the water, passing it repeatedly through any weeds, so as to catch the creatures sheltering and feeding among them. Care should be taken also to scrape gently along the surface of the mud, since there are a number of species that cannot swim, but can only crawl; and these of course are always found at the bottom. We generally collect from the surface of the water as well; in fact, our aim is to collect from every variety of locality in a pond—from deep water and shallow, from mud and from weed. We have usually confined our operations to fishing from the bank, but have occasionally collected also from a boat; and in large sheets of water this is necessary, since there are certain deep-water species which do not come near the banks. We empty the contents of the small bottle at intervals into a glass jar, in which they are carried home. Then they are turned out into a wide shallow white dish—a photographic developing-dish answers the purpose admirably—and after the mud has settled and the water cleared, it is comparatively easy to distinguish the various species by the naked eye.

There are certain species found in Mid-Lothian which we have been peculiarly unsuccessful in obtaining; and it appears from what we have lately read in a paper of Mr Scourfield's, that some of these can only be found by a special method. He says, "I usually put wet mosses into a jar with water, and after beating them up vigorously with a fork or some such implement, take out most of the pieces of moss and await results. In a short time a number of Harpacticids . . . are almost sure to be seen swimming about. . . . This method of washing damp mosses . . . has yielded two species not found in any other way, namely, *Alona rustica* and *Moraria anderson-smithi*."

Mounting.

When we want to preserve specimens for mounting or any other purpose, we put them in a 4 per cent solution of formalin, in specimen tubes of the smallest size obtainable—1½ inches by ⅓ of an inch. These tubes are numbered and a list kept

containing the name of the species, with locality and date of collection. When we began mounting our specimens, we tried balsam and Farrant's solution, but we found Grübler's glycerine jelly to be more satisfactory. In the case of thick specimens, such as Eurycercus, we used vulcanite ringcells, in order to obtain sufficient depth of jelly; but these, we found, are liable to leak after a time. For our thinner specimens we adopted the plan of building up a cell of the proper depth with gold size, and we are told that this method succeeds perfectly well with deeper cells.

Some of our small difficulties were overcome only by repeated experiments. First, we found that the jelly became cold, and set too quickly, before we could get the proper number of specimens placed in the cell. This was obviated by heating the slides beforehand. Then there was some difficulty in placing the cover-slip on the jelly; either the jelly would run halfway across the cover-slip and then stick, or else bubbles would find their way in. This was easily remedied by putting some of the liquid jelly on the cover-slip before placing the latter on the slide. One of our most serious troubles was, that a few of our specimens were too delicate to be put direct into glycerine jelly; and unfortunately we had no means of telling beforehand which were the delicate ones. Several times we have, as we thought, made some almost perfect slides, and put them away to dry; and on examining them later, found that the specimens were grotesquely distorted and sometimes almost unrecognizable. It took us some time to find out what had happened; but at last we came to the conclusion that the failure was due to osmosis—*i.e.*, that the juices of the body ran out at a greater rate than they could be replaced by the jelly, and that the latter was too strong a medium. We then put fresh specimens into G.W.A. (a mixture of one part glycerine, two of water, and three of alcohol). This plan was very successful, except for some of our most fragile creatures; these had to be left for days in a much diluted solution, and were then transferred by degrees to a stronger and stronger one.

We had a curious experience with regard to *Diaptomus gracilis.* We had a large number of specimens preserved, from several different localities; some of these had died a natural

death through having been kept too long in unsuitable conditions, and after being placed in formalin they were still beautifully displayed, with the antennas fully extended; whereas all those that we have killed with formalin curl up, and the antennas droop towards the body and lose their fine outlines. Rather to our surprise we found that the former were much the easier to mount. They appear to be little more than skeleton shells, into which the G.W.A. found ready admission; while in the other case it did not so easily replace the juices of the body.

One or two of the Cladocera were very troublesome to draw. We generally put our specimens in a few drops of water on the slide, and place a cover-slip gently on the top. But if a slip is put on a *Chydorus*, for instance, no matter how carefully, the pliable shell becomes more or less distorted; whereas, if *no* slip is put on, the creature turns round and round on the slide until it is tired, when it is likely enough that the water has evaporated, and the outlines therefore become obscured. The live-box is of some assistance, but not much; and our best drawings of *Chydorus* were made from specimens which we left uncovered on a slide, and watched patiently until they lay still. All our drawings are made with the help of the camera lucida.

Localities.

Altogether about forty localities in Mid-Lothian were visited by us.

The pond to which we have done most justice is the Elf Loch, on the Braids. We obtained from it twenty-three species, but this by no means exhausts its possibilities, as Mr Scott and Mr Lindsay obtained from it thirty-two species during their investigations in 1896, '97, and '98. We visited the loch in all seasons: once we went there on a winter afternoon when the hills were covered with snow, and on reaching the pond we found it frozen two inches thick. We broke a hole in the ice, and having fished as well as circumstances permitted we were well rewarded by finding in our catch some specimens of *Ilyocryptus sordidus*, a bottom species, which we had not previously obtained. The only species we have added to Mr Scott's list for the Elf Loch is *Cypris gibba*. We

found it there only on one occasion, and have not seen it elsewhere.

In an old quarry near Granton, into which warm water is discharged from the ink works, we found numbers of *Daphnia galeata*, and also a young form which corresponds exactly to Brady's *Daphnia hamata*. The terminal claw of the post-abdomen in *hamata* is furnished with several strong teeth, which are absent in *D. galeata*. Such a difference is commonly held to be sufficient to constitute a species, and Mr Scott tells us that the so-called *Daphnia hamata* is almost certainly a young form of *D. pulex*. We hope to make some observations on the subject this summer.

We have found the large old quarry in Ravelston a good collecting ground, and our thanks are due to Miss Murray Gartshore, who has kindly given us permission to collect there as often as we like. The crustacean fauna of the quarry differs from that of most localities in the neighbourhood, by far the most abundant species being *Diaptomus gracilis* and *Bosmina longirostris*. The water in the quarry is deep and very clear.

From Craigleith Quarry we obtained a solitary specimen of *Cypris obliqua*, a species which we have not found elsewhere. When we first fished in the quarry, some three or four years ago, we found hardly anything, except the larvas of some aquatic insect; but lately we have obtained ten species of crustaceans, and we suppose the water is becoming gradually populated.

Duddingston, as might be expected, considering the extent of water, and the age of the loch, has given us a greater number of species than any other locality. We obtained twenty-seven in our four visits; but Mr Scott, in his report to the Fishery Board on Scottish Inland Waters, gives a list of forty-three species from Duddingston. Four of our species, *Cyclops affinis*, *Ilyocryptus sordidus*, *Alona guttata*, and *Alona affinis*, are not included in Mr Scott's list. Duddingston is the only place in Mid-Lothian where we have found *Eurycercus lamellatus* and *Alona tenuicaudis*; and our only locality besides the Elf Loch for *Ilyocryptus sordidus* and *Alona guttata*.

The old bed of the Almond, near Turnhouse, has given us some good catches; we have found there fifteen species in all.

The three ponds in Penicuik grounds—the High Pond, Low Pond, and Hurley Cove—are all good places. The High Pond is our only locality for a certain *Ceriodaphnia*, whether *C. rotunda*, Strauss, or *C. scitula*, Herrick, we have not yet been able to determine. It is also the only pond in Mid-Lothian where we found *Peracantha truncata*.

In Hurley Cove we have found great numbers of *Daphnia lacustris*. We obtained specimens of this species on 1st December 1900, but on visiting the pond on 16th March 1901, we found none. This species also occurs in large quantities in Granton Reservoir (where we have also found *Volvox*).

The Marlpit, Davidson's Mains, is another good fishing-ground: from it may almost always be obtained *Cyclops phaleratus*, which is by some writers considered a rare species; we have come across it in five localities.

As an example of an unexpected find in a frequently examined pond, we may mention *Pleuroxus trigonellus*, of which we found several specimens last June in our very small pond at Marchfield.

Marfield Loch is one of the most interesting pieces of water that we have visited. It is presumably of great age, and has quite an unusual fauna, since of the fifteen species we obtained from it, four (*Diaphanosoma brachyurum*, *Acantholeberis curvirostris*, *Alonella exigua*, and *Alonopsis elongata*) we found nowhere else, and four more in only one other locality. The character of the surrounding country has no doubt much to do with this; we have observed a somewhat similar fauna in ponds in the Trossachs, and the English Lake District, where there is the same mossy, swampy kind of ground.

The old quarry in the grounds of Ravelston Cottage deserves mention, since it contains *Ceriodaphnia quadrangula* and *Scapholeberis mucronata*, which are not of frequent occurrence in Mid-Lothian.

The only piece of brackish water we had an opportunity of collecting from was a tiny rockpool on Cramond Island. We found it swarming with *Harpacticus fulvus*, and there were also many specimens of *Cypridopsis aculeata* and *Cyclops æquoreus*.

In the very small pond at House o' Hill Farm may always

be found *Cyclops bisetosus*, a species which is far from common in Mid-Lothian.

From Cobbinshaw Reservoir we obtained quantities of *Scapholeberis mucronata* and *Bosmina longirostris;* and, in addition, our only specimen of *Alonella rostrata.*

Species.

Diaptomus gracilis is the only species of the family *Centropagidæ* that we have met with in Mid-Lothian; it is a slender, beautiful creature, with extremely long antennas exceeding the entire length of the body. It is in the habit of resting upright and motionless in the water, with its antennas outspread; but the instant it is approached with the dipper, it darts off with unexpected rapidity. It seems to be the most agile of all our sixty species. It varies greatly both in size and colour: many of our largest specimens were a dark yellow brown; the smaller ones are often bluish and very transparent, with a distinct tinge of red in the antennas; while the male is sometimes bright red throughout.

We succeeded in finding in Mid-Lothian fourteen out of the eighteen Scottish species of Cyclops. Two of them, *Cyclops languidus* and *C. nanus,* have not as yet been reported from many localities in Scotland; and the latter was recorded from Scotland for the first time as recently as 1899, by Mr Scott. But from what we have seen in Mid-Lothian and elsewhere, we are under the impression that it may often be found in pools in mossy ground.

Cyclops serrulatus is the commonest species of the genus; and as might be expected, is very variable, especially in size and colour. It is easily recognized by the divergent, pointed egg-clusters, and by the long and slender stylets with their serrate margins.

Cyclops phaleratus is a showy species, often coloured bright red and blue. It may be recognized at a glance by the dark egg-clusters, which are parallel and lie unusually close to each other; and by its already mentioned habit of crawling along at the edge of the water, or even out of it.

With regard to *Canthocamptus staphylinus* it is interesting to notice that the fifth foot, which in the *Copepods* may generally

be relied on as a constant character, often varies. We have found specimens with one, two, and three small spines respectively, on the inner side of the second joint. This is a very common species; like others of the same genus, it is in the habit of concealing itself among algas and moss; but, unlike them, it is easily dislodged

The little ostracod *Cypridopsis aculeata* is mentioned by Brady as a species which prefers brackish water, and he notes its occurrence in eight localities, seven of which are slightly brackish, while the eighth is loaded with salts of lime. Our own specimens were all obtained from brackish water, with the exception of one, which we found in a pond on a stream near Balerno.

Diaphanosoma brachyurum has a peculiar interest for us: in the autumn of 1900 we discovered, in a mixed collection from the three ponds in Penicuik grounds, the fragment of a creature with which we were not familiar, and which, judging from the antenna, we thought was most likely *Diaphanosoma.* We returned to the ponds several times, hoping to find a complete specimen, but were never successful. About a fortnight before the close of the competition, the number of our species had risen to fifty-nine, and we were very anxious to make it up, if possible, to sixty. We accordingly took a fishing from Marfield Loch, as having the most uncommon fauna of all our fishing-grounds; and we were rewarded by finding several specimens of *Diaphanosoma brachyurum*, the very creature we were most eager to obtain. Curiously enough, all the specimens were males.

In the same collection we found some splendid specimens of *Acantholeberis curvirostris.* This is a very handsome creature, brightly coloured, and with elaborately adorned antennas and postabdomen. It is a fragile thing, and owing to our unfamiliarity with it, and the short time at our disposal after finding it, we did not graduate it carefully enough into the glycerine jelly, so that our specimens are unfortunately completely spoilt.

Ceriodaphnia is a genus with which we have only recently become familiar; we recorded three species in our list, *C. reticulata*, *C. scitula* (?), and *C. quadrangula*, but are almost certain that we have a fourth. Several of the species resemble

each other closely in general outline, and can only be distinguished by slight differences in the anterior antenna, &c.

Scapholeberis mucronata we have found in only three localities, but each time in considerable numbers. It is a curious-looking little creature, very dark brown or almost black, with greenish eggs, and antennas tinged with pink.

Simocephalus vetulus is one of the commonest of the cladocerans, and may be obtained all the year round. It often occurs in large numbers, especially in muddy water.

Daphnia pulex has the same apparent preference for muddy water; there must be many thousands in the small pond at Drylaw, where we have seen them swimming about in shoals. We found an immense number one January evening in a pond at Lasswade. They are often coloured bright red, and when present in large numbers give a distinct reddish tinge to the water.

Ilyocryptus sordidus is a most curious creature. To begin with, it is so sluggish in its movements, and so thickly covered with fragments of muddy vegetation, that it would be hard to distinguish in a catch, but for its brilliant red colour. Being unable to swim, it drags itself about the bottom of the pond by means of its strong antennas. The postabdomen is large, and furnished with numerous delicate spines and a surprisingly long pair of setæ. There are on the shell four or five irregularly concentric curves, apparently the margins of different layers of shell, each bordered with a fringe of sharp curved spines. It is very hard to get a good view of Ilyocryptus; we spent about an hour one morning trying to clean one by squirting it in and out of a dipper in clean water, squirting water at it, and trying to clear off its accumulation of dirt with a needle and brush. The last named method seems to be the most efficacious. The spines at the front of the shell, and those at the back, are different in structure.

Graptoleberis testudinaria is one of the prettiest things in our collection, having the shell covered with a delicate tortoise-shell pattern, from which the specific name is taken. It would probably be undistinguishable to the naked eye from some of the Alonas, but that its mode of swimming at once betrays it. It is hard to say exactly what the difference is, but if one sees

fifty or sixty creatures all swimming in an identical way, and one or two others among them swimming in a slightly different way, the latter catch the eye at once. So much so, that we have frequently taken up in the dipper some creature which was swimming in an unusual way, and found that it was merely a common species which had either lost its tail or was hindered in its movements by a swarm of parasites.

Eurycercus lamellatus is a somewhat ungainly looking creature, but excites admiration by the wonderful saw with which the postabdomen is furnished. In a large specimen there may be as many as one hundred teeth in the saw, gradually increasing in size towards the large terminal claw.

The various species of *Alona* are occasionally difficult to distinguish; we have sometimes, for instance, found ourselves unable to decide whether a certain specimen was *affinis* or *quadrangularis:* the typical *A. affinis* has a distinct tuft of hairs just below the terminal claw, and the typical *A. quadrangularis* has none; but when we find a specimen with one or two small hairs, it becomes difficult to say to which species it should be referred.

Alonella nana is the smallest of all our species; it is, as Brady remarks, easily distinguished from other lynceids by having the shell striated in the reverse direction.

Acroperus harpæ is a very common species; numbers may often be seen floating on the surface of the water. It seems that they get caught by the surface tension and are unable to free themselves from it. We have often released one from this position and squirted it into the water, and seen it swim off apparently none the worse.

Alonopsis elongata we found in only one locality—Marfield Loch. It is at once distinguished by its long narrow shell and dark brown colour; and also by the small lines of striation running obliquely between the larger lines on the shell.

Peracantha truncata we only found on one occasion, in the High Pond, Penicuik: it has a row of strong curved teeth along the posterior margin of the shell, which gives it a very characteristic appearance. We were surprised at the scarcity of this species in Mid-Lothian, having found it very frequently

PLATE XXXI.—THE ENTOMOSTRACA OF MID-LOTHIAN.

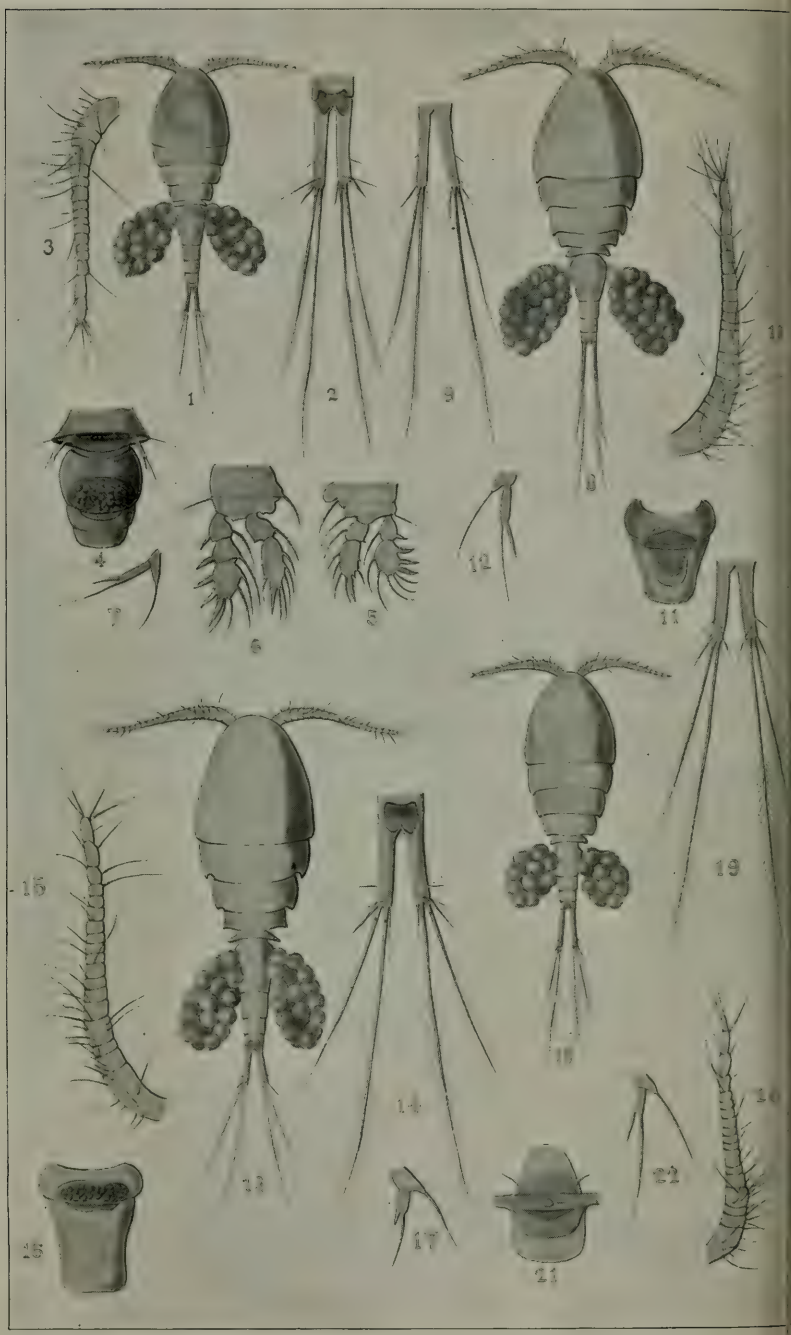


PLATE XXXI.

Cyclops languidus, G. O. Sars.

FIG.

1. Female × 38.
2. Tail × 106.
3. Anterior antenna × 106.
4. Receptaculum × 106.
5. First foot × 106.
6. Second foot × 106.
7. Fifth foot × 212.

Cyclops bicuspidatus, Claus.

8. Female × 38.
9. Tail × 83.
10. Anterior antenna × 106.
11. Receptaculum × 106.
12. Fifth foot × 212.

Cyclops vernalis, Fischer.

13. Female × 38.
14. Tail × 87.
15. Anterior antenna × 106.
16. Receptaculum × 106.
17. Fifth foot × 212.

Cyclops bisetosus, G. O. Sars.

18. Female × 38.
19. Tail × 106.
20. Anterior antenna × 106.
21. Receptaculum × 212.
22. Fifth foot × 212.

PLATE XXXI.A.

Ceriodaphnia affinis, Lilljeborg.

FIG.

1. Ephippial female × 38.
2. Anterior antenna of female × 212.
3. Anterior antenna of male × 212.
4. Postabdomen of female × 106.

Scapholeberis mucronata, Müller.

5. Female × 38.
6. Postabdomen of female × 106.

Cyclops nanus, G. O. Sars.

7. Female × 38.
8. Tail × 106.
9. Anterior antenna × 106.
10. Receptaculum × 212.
11. First foot × 212.
12. Fifth foot × 212.

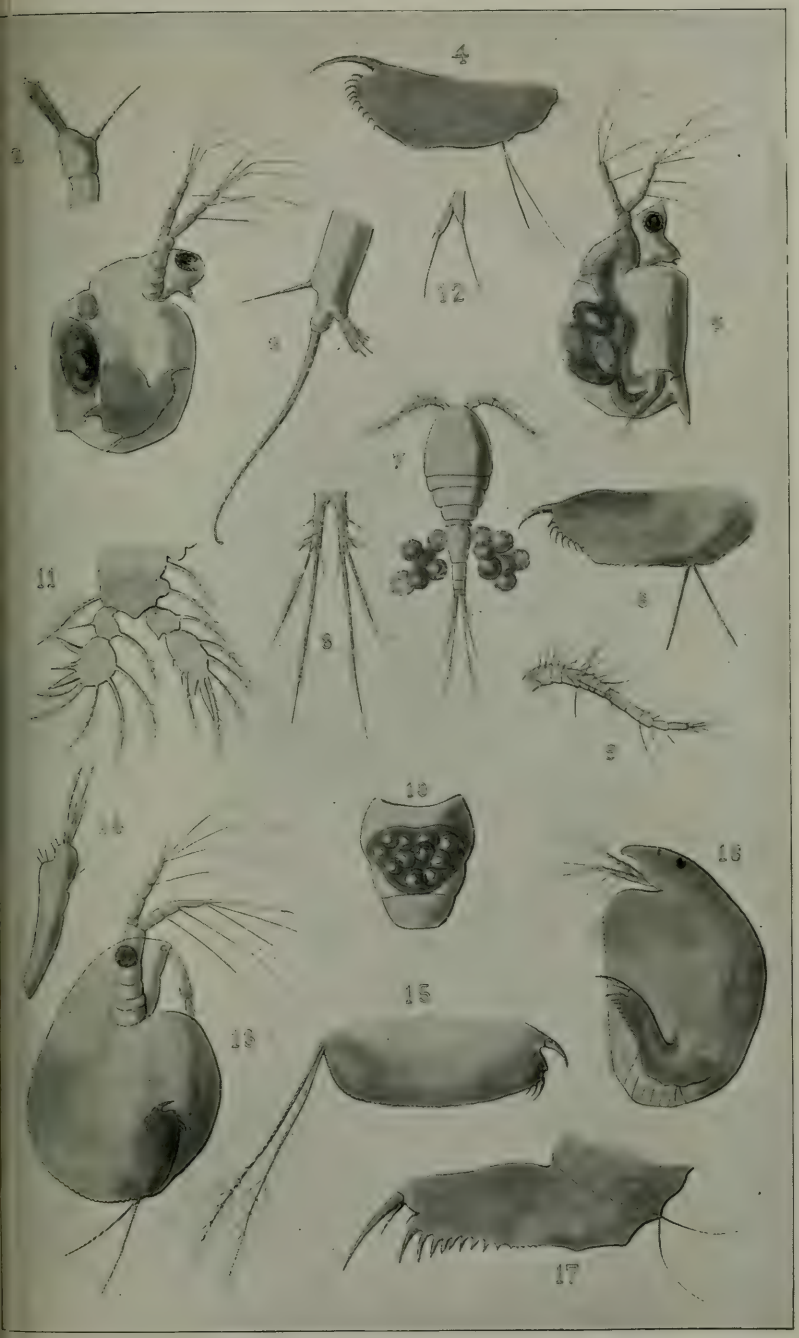
Macrothrix laticornis, Jurine.

13. Female × 87.
14. Anterior antenna of female × 212.
15. Postabdomen of female × 212.

Alona tenuicaudis, G. O. Sars.

16. Female × 87.
17. Postabdomen of female × 212.

PLATE XXXI.A.—THE ENTOMOSTRACA OF MID-LOTHIAN.



in the Trossachs and the English Lakes, and near Bournemouth.

We obtained *Alonella rostrata* on our second visit to Cobbinshaw, on a grey cheerless day, most unfavourable for collecting. We walked right round the large reservoir, fishing at thirty or forty points with little result, catching hardly anything but Gammarus. But on reaching home we looked carefully through the catch, and found this one rare specimen. One thing we have learned by experience is, that however poor a collection appears to be, it is worth while to examine it thoroughly.

Chydorus sphæricus, with which we shall conclude, is by far the commonest cladoceran, and perhaps the commonest of all the entomostraca, in Mid-Lothian, though *Cyclops serrulatus* runs it very close. It varies greatly in size, colour, and even outline. We have observed the males in only one locality, the small pond on House o' Hill farm; and this in spite of the fact that we were on the look-out for them all last summer.

Mr T. Scott desires to say that in the Note on the list of fresh-water crustacea (*ante*, p. 260) No. 42, *Ceriodaphnia scitula*, Herrick, should read, "This looks very like *C. affinis*, Lilljeborg." Nos. 49 and 50, *Daphnia hamata*, Brady, should also read, "These I regard as immature forms of *D. pulex*, No. 46."

(We are indebted to both Mr T. Scott and Mr D. Scourfield for having drawn our attention to *Ceriodaphnia affinis*, Lilljeborg; and having compared my drawings carefully with those of Lilljeborg, I now think that our specimens belong to that species. It seems probable that the name *C. scitula*, Herrick, which we appended to No. 42, is a synonym of *C. affinis*, Lilljeborg.—B. S.)

In conclusion, we have to thank the Society for directing our attention to a most interesting group of creatures, of which previously we knew scarcely anything; and we can very heartily recommend the study of the entomostraca to any member who is at a loss for a special subject to take up.

VIII.—*FORTROSE AND ROSEMARKIE.*

Notes on the Geology, Botany, and Antiquities of the District.

By Mr S. ARCHIBALD, Tomatin, Inverness, Corresponding Member.

(*Read Feb. 26, 1902.*)

The peninsula popularly known as the "Black Isle" lies in a N.E. and S.W. direction between the Cromarty Firth on the north and the Moray, Inverness, and Beauly Firths on the south. It consists of a tableland along the middle, flanked by ridges on each side, about 500 or 600 feet in height. The ridge on the south has a steep slope seawards, which for the most part ends more or less precipitously at or near the water's edge. From near the middle of the south coast a long sandy peninsula, called Chanonry Point, stretches fully a mile and a half out into the firth, forming fine bays on either side; and the ancient burghs of Rosemarkie and Fortrose, which are just about a mile apart, are charmingly situated on the east and west bays respectively. Nearly opposite Chanonry Point, but a little lower down, projects the peninsula on which Fort George is built, and the geological problem of how these two points were formed is an interesting but rather difficult one. There are great cliffs of boulder clay at Rosemarkie, and there is a hill of similar material behind Campbeltown on the opposite side. One writer thinks that in the geological ages there may have been a great barrier wall of this material right across the valley, sending the drainage of the Ness and Beauly basins out some other way, and that after the pressure of water had broken through the barrier, the currents would deposit the rougher materials on the south side, and being deflected and eddying round, would deposit the finer particles on the north side, forming Chanonry Point. While staying at Rosemarkie I noticed a peculiarity in the tide. About fifteen minutes after high water, and when it had gone down a little, there came a succession of large waves, raising it to about its previous mark. This would

no doubt be caused by reflected waves from Fort George Point on the first outward rush of the tide after high water, the whole of the large body of water from the inner firths having to pass through the narrow opening. The navigation of the channel is guided by a lighthouse on the end of Chanonry Point. A well-defined terrace or raised beach, about 100 yards from the present coast-line, extends nearly the whole way along the eastern side of the peninsula.

At, and for a short distance east from, Rosemarkie, there is a fine sandy beach, very suitable for bathing. Beyond this, the beach consists of a very rough rocky floor; and near this commences a line of high, precipitous cliffs, extending to Tarbet Ness, and broken only by the narrow entrance to the Cromarty Firth, with its guardian "sutors." These cliffs, which are of a strong red colour, present a bold and striking appearance as viewed from the water or the opposite shore. They are pierced by a great many caves, singly, and in twos and threes, some of them going right through a projecting point of rock. The entrances to these caves are all about fifteen feet above the present coast-line. In 'The Testimony of the Rocks' Hugh Miller describes the geological features of this rocky coast, and speaks of the clear proofs which these caves afford of the whole coast having been raised since they were formed. And no doubt the "terrace" on Chanonry Point bears witness to the same geological process. Along the foot of the cliffs there are many isolated stacks and pinnacles of rock, in two series, one belonging to the present and the other to the ancient coast-line. Strange in appearance are these latter, many of them being now at some distance from the water's edge, surrounded by sandy dunes, much weathered, and ivy clad, like the "ruins of a world gone by." These cliffs, for some miles at least, are composed chiefly of gneiss, with bands of quartzite varying in colour from white to blood-red; deformed pegmatite, muscovite (white mica), &c. Along the rocky floor are strewn carried boulders of many varieties, including some of a peculiar grained granite, and a block of amphibolite, which, from its appearance, readily attracts notice. Ammonites and other fossils are occasionally found in fragments of rock washed up on the beach from a bed of oolite. At Eathie Burn, seven miles from Rosemarkie, are

the quarries of old red sandstone made famous by the labours of Hugh Miller. There the stone is mostly of a pure grey colour, but along the central plateau sandstone occurs of a deep red colour, as well as grey streaked with red. All along the rocky beach there is considerable scope for the study of marine flora and fauna. Some interesting shells were picked up, as the dwarf dog whelk (*Nassa pygmæa*), plentiful; cowries (*Cypræa europæa*), scarce; and a few conelets (*Bela rufa* and *B. turricula*).

A small stream which enters the sea at Rosemarkie comes down from a very romantic den. It is deep, rocky, and beautifully wooded, and well deserves its name, the "Fairy Glen," presenting, as it does, the most charming scenery in the district. Near the head of the glen there are two pretty waterfalls, the banks and rocks all around being clothed with ferns, mosses, and many others of Flora's treasures. From the high ground on either side of the glen magnificent panoramic views are obtained of land and sea. Opposite Rosemarkie the hill, descending with a rapid slope, ends abruptly in a broad perpendicular cliff of red boulder clay, about 100 feet in height, streaked with horizontal seams of sand, in which a great colony of jackdaws have made their homes. A little way up the glen, on the opposite side of the stream, there is a remarkable assemblage of cliffs and pyramids of the same material, about 200 feet in height, the remains of a vast accumulation of boulder clay, which has been worn and carved into many strange and fantastic forms.[1] These cliffs and pyramids of boulder clay are without doubt the most remarkable geological feature of the district. Evidently Hugh Miller considered them quite unique. In his day they must have presented a very bleak and savage aspect, but their appearance has now been much modified by the growth of trees all around. A splendid view of these cliffs can be obtained from near the high road, which gradually climbs the slope on the opposite side to the central plateau, and on to Cromarty, distant eight miles from Rosemarkie.

The time of my visit to the place (September) was too late in the season to allow of an extensive list of the flora being

[1] A very graphic description of these cliffs will be found in Hugh Miller's 'Cruise of the Betsy.'

compiled, but enough remained, either in flower or in a condition easily identified, to furnish a very interesting list, and to show the vegetation to be not only luxuriant but varied, and that it embraces a considerable number of comparatively rare plants, as the following short list of the more noteworthy ones will show:—

Mertensia maritima (plentiful).
Hyoscyamus niger.
Solidago Virgaurea (great branching spikes three feet high).
Cynoglossum officinale.
Salsola Kali.
Reseda lutea.
Agrimonia Eupatoria.
Eupatorium Cannabinum.
Astragalus Hypoglottis.
Geranium sanguineum.
Plantago maritima.
P. Coronopus.
Cakile maritima.
Artemisia vulgaris.
Trifolium arvense.
Stachys arvensis.
Hypericum quadrangulum.
Vicia sylvatica.
Lysimachia nemorum.
Myosotis palustris, var. strigulosa.
Circæa alpina.
Erodium cicutarium.
Malva rotundifolia.
Parnassia palustris.
Sanicula europæa.
Trientalis europæa.
Goodyera repens.
Myriophyllum spicatum.

Among grasses were noted Bromus asper, Brachypodium sylvaticum, Festuca gigantea, Elymus arenarius, Ammophila arundinacea, Triticum junceum, and Melica uniflora.

Ferns do not seem to be very numerous, either in number of species or number of plants of any one species, except Brackens (*Pteris*). But there are Brackens extraordinary (!), covering great areas, and of immense size. Of others I noted Cystopteris fragilis, Asplenium Trichomanes and A. Ruta-muraria, Polystichum aculeatum, and some fine specimens of the common Lastreas and Athyrium.

Between the line of cliffs and the sea there is in many places a narrow strip densely covered with vegetation, including ash, hazel, bramble, burnet and dog roses, and brackens. Brambles and hazel nuts are in strong evidence, both being ripe in September.

To speak now of the antiquities. Rosemarkie, the modern name of the burgh and of the parish, which also contains the burgh of Fortrose, was originally Rosmarkyn (*ros*, and *maraichin*, the headland of the seamen). The burgh was a place of importance as far back as the beginning of the eighth century, about which time a church is said to have been founded there by St Boniface, an Italian (or according to some an Irish)

monk, and his effigy adorns the "common seal of the burgh of Rosemarkie." Another tradition connects St Moluag of Lismore with the place, and says he was buried there; and further, that the Celtic (commonly called the runic) cross which was found under the flooring of the parish church when it was being rebuilt in 1821 covered the grave of that saint. The cross now stands close to the N.W. corner of the church. It had been broken across, but is now carefully cemented together, and is held in position by an ingenious framework of iron. The dimensions of the cross are: height about 8 feet; breadth, 28 inches at base and 30 inches at top; thickness, 7 inches. It had originally been considerably higher, the top being mutilated. It is closely sculptured all over, mostly in high relief, but, being exposed to the weather, is rapidly becoming defaced. Each face is divided into three panels. The upper panel on the front contains a plain equal-armed cross, surrounded by very intricate interlaced and knotted scrollwork. The middle panel is filled with semi-zoömorphic forms, and the bottom one with circles, &c. On the back the cross—a "stepped" one—is in the middle panel, and is surrounded by a key-pattern. The background of the cross is filled in with fine interlaced work and bosses. The large upper panel on this side seems a very important one, as it contains most of the mystic symbols carved on this and similar crosses, the meaning of which is not yet known. These include the crescent three times repeated (when entire), with the V-shaped rod symbol; double disc symbol with its bosses, and Z-shaped rod symbol connected therewith. Zoömorphic forms and knot-work are introduced on the lower crescent and elsewhere. The two edges are also divided into panels, and filled with interlaced and knotted work, in some cases formed of serpent-like and other creatures. Where these animal and semi-animal forms are introduced, it is done in a very subdued manner, with little of the grotesque. Altogether, this stone seems quite a unique specimen of early Celtic art, testifying alike to the skill and perseverance of the artists in designing and executing such work; and it will be a great pity if such a valuable relic should be allowed to become a plain slab.

In Rosemarkie churchyard there is another sculptured stone —a slab about four feet long and two feet wide. It is sculp-

tured on one side only, and lies face downwards on a grave. The ornamentation consists of key-patterns and spirals. Other three sculptured fragments which have been found there are now in the Edinburgh Museum of Antiquities. In connection with the bosses on some of these sculptured stones, and the cup-shaped markings on others, the thought occurred to me that these may be the same symbol reversed, though of course that would do nothing to explain their meaning.

The next important thing to be noticed is Fortrose Cathedral. In ancient days Fortrose was the "chief seat of ecclesiastics and of literature in the north." The bishopric of Ross was founded about 1124, and the cathedral was built about 200 years later. It was originally of considerable extent, and consisted of choir and nave, with south aisles, eastern lady chapel, western tower, and chapter-house. There now only remain the aisles and chapter-house, but these are carefully preserved. The rest was torn down by Cromwell, and the materials used to assist in the building of his fort at Inverness. The style of architecture is described as "the purest and most elaborate middle-pointed," and enough is left to show that it contained many beautiful features, such as the mouldings of the pillars, the groined roofs of the aisles, and the remains of the tracery in the top of the five-light east window. In two of the arches between the aisles and the body of the building there are the remains of some very fine canopied tombs, one of which at least has been built with the cathedral.

About half-way down Chanonry Point, and just on the top of the "Terrace," there stands the broken shaft of a cross of grey sandstone. It is of a flattened hexagonal shape, about three feet high, and fifteen inches broad. About its own history I could learn nothing, but it is said that one of the last cases of witch-burning in Scotland took place beside it. While on the "Point," it may be noted that a fine golf course has been laid out on it, and as it runs so far out into the firth, forming a natural pier or promenade, it affords a grand opportunity for all in search of sea-air to get the full benefit thereof, without any discomfort or trouble.

On the plateau about half-way between Rosemarkie and Cromarty there is an immense cairn of stones called the "Glas

Cairn," or Grey Cairn. It is about twenty-four yards across and ten feet high, and is said to mark the site of a great battle between the Scots and the Danes. There used to be another cairn near it, called the "Cairn of the Battle," but it has been carted away by farmers to build dykes. Under it were found stone coffins, and weapons of copper (? bronze) and other metals, thus confirming the tradition that a great battle had been fought in the neighbourhood.

In conclusion, I would say that any one, naturalist or otherwise, in search of health or of a pleasant place for a holiday, would find the district I have roughly described a very good one for their purpose.

IX.—*THE FOLK-LORE OF NATURAL HISTORY.*

By Mr CHARLES CAMPBELL.

(*Read March 26, 1902.*)

The stories and superstitions connected with natural history have always had a fascination for me, and the following, gleaned at various times from many sources, will, I venture to hope, not altogether fail to be of interest, although many must necessarily be familiar to you already. For is it not a relief to turn from the sometimes dry-as-dust details of modern scientific inquiry, and to allow the imagination to wander back into times when there were not so many books about nature, and nature itself was more of a book, the pages of which were full of mystery and wonder?

One stormy night some winters ago, as I was going home through the woods, I saw an unusual light some distance from the path. Not a little astonished, I groped my way over to where it was, and found an old oak tree had been blown down, and that its roots were all aglow with a phosphorescent light that some distance off looked decidedly uncanny. On reaching home, I spoke of the unusual sight, and my father said that what I had seen used to be known as spunkie wood: it reminded him of the tales of his boyhood, nigh seventy years ago. And it is back to about that period I would like to go to-night.

The Owl.

The countryman wending his way across some desolate moor on some dark night—

"When winter scowls along our northern sky"—

sees a light flitting across the peat moss: he clutches his stick and hastens his steps, for is not that "spunkie" trying to wile him off his road and drown him in his watery den? What to us is the will o' the wisp flickering amongst the marshes was then directly attributed to the presence of fairies or spunkies. We can easily imagine how, in the long dark winter nights in the lowly Scottish homes of a past generation, the talk would turn on things weird and supernatural, and stories of ghosts and witches would be eagerly listened to, and as firmly believed. In an environment such as this the simplest incidents of natural history came to possess a significance the origin of which cannot always be easily traced. But any one who has been startled by the scream of an owl on a lonely road can readily suppose that it would then be put down to something uncanny. Tannahill, in one of his finest Scottish songs, says—

"The cry o' howlets maks me eerie"—

and the owl has been generally regarded as a bird of ill-omen, and superstitiously considered a messenger of woe. The Romans viewed the owl with detestation and dread. "The owlet's wing" was an ingredient of the cauldron wherein the witches prepared the charm of powerful trouble ("Macbeth," Act IV. sc. i.) Should an owl appear at a birth, it is said to forebode ill-luck to the infant. King Henry VI., addressing Gloster, says—

"The owl shrieked at thy birth,—an evil sign."

When Richard III. is irritated by the ill news showered thick on him, he interrupts the third messenger with—

"Out on ye, owls, nothing but songs of death."

Among the strange occurrences presaging King Duncan's murder is mentioned—

"On Tuesday last,
A falcon, towering in her pride of place,
Was by a mousing owl hawked at and killed."
—"Macbeth," Act II. sc. iv.

Among the many curious legends with reference to this bird we may mention one to which Shakespeare alludes—

> "They say the owl was a baker's daughter."
> —"Hamlet," Act IV. sc. v.

This refers to an eastern tale, too long to quote here, which says a certain baker's daughter was for some wickedness transformed into that bird, and to this day she laments her fate in its mournful hoot.

The Eagle.

The opinion that the eagle possesses the power of gazing undazzled at the sun is of great antiquity. Pliny relates that it exposes its brood to the test as soon as hatched, to prove if they are genuine or not:—

> "Nay, if thou be that princely eagle's bird,
> Show thy descent by gazing 'gainst the sun."
> —"K. Henry VI.," Part III., Act II. sc. i.

> "A lover's eyes will gaze an eagle blind."
> —"Love's Labour's Lost," Act IV. sc. iii.

As a bird of good omen the eagle is often mentioned by Shakespeare—

> "I chose an eagle and did avoid a puttock" (kite).
> —"Cymbeline," Act I. sc. ii.

The great age to which this bird sometimes attains has been remarked on by most writers on ornithology. The Psalmist has beautifully alluded to it when he says of the righteous man, "His youth shall be renewed like the eagle's."

The Hawk.

The sparrow-hawk appears to have been frequently used in falconry in olden times to take the smaller kind of game. In the Accounts of the Lord High Treasurer of Scotland we find the following entry: "16th Sept. 1473. Item given to a man of David Oguilviys of Inch martyn that brocht a spar hawk to the King iij s." A wild hawk

was sometimes tamed by watching it night and day to prevent it sleeping:—

> "You must be watched ere you be made tame, must you?"
>
> —"Troilus and Cressida," Act III. sc. ii.
>
> "I'll watch him tame."
>
> —"Othello," Act III. sc. iii.

The Raven.

Go where you will over the face of the wide world, the well-known hoarse croak of the raven is still to be heard. Through a long course of centuries the raven has been regarded as a foreteller of good or evil, and even to this day there are those who believe the raven's croak predicts a death—

> "The raven himself is hoarse
> That croaks the fatal entrance of Duncan
> Under my battlements."
>
> —"Macbeth," Act I. sc. v.
>
> "O! it comes o'er my memory
> As doth the raven o'er the infected house
> Boding to all."
>
> —"Othello," Act IV. sc. i.

A curious belief is mentioned with regard to the rearing of its young:—

> "Some say that ravens foster forlorn children
> The whilst their own birds famish in their nest."
>
> —"Titus Andronicus," Act II. sc. iii.

It would appear from some passages in the Scriptures that the desertion of their young had not escaped the observation of the inspired writers. It was certainly a belief in olden times that when the raven saw its young ones newly hatched and covered with down, it conceived such an aversion to them that it forsook them and did not return to the nest till a darker plumage had shown itself. And to this belief commentators suppose the Psalmist alludes when he says, "He giveth to the beast his food, and to the young ravens which cry" (Ps. clxvii. 9). "Who provideth for the raven his food? when his young ones cry unto God, they wander for lack of food" (Job xxxviii. 41). An old writer also says that "the raven's young be fed with the dew of heaven all the time they have no black feathers."

With the ancients much superstition prevailed in regard to the crow family generally, and Shakespeare specially mentions three of these as birds of omen—

> "Stones have been known to move, and trees to speak,
> Augurs that understood relations have
> By magot pies, and choughs, and rooks brought forth
> The secret'st man of blood."
>
> —"Macbeth," Act III. sc. iv.

Even at the present day there are still to be found some who profess to augur good or evil from the flight of the magpie or the numbers seen together:—

> "One for sorrow, two for mirth,
> Three for a wedding, four for a birth."

But in my own district we had it—

> "Yin's joy, twa's grief,
> Three's a marriage, four's a death,
> Five is heaven, six is hell,
> Seven's the devil's ain sel'."

The following lines from Tannahill will be familiar:—

> "The craw that biggit in the stackyard thorn,
> Scraight and forsook its nest when she was born;
> Three pyets crossed the kirk when she was christened;
> I've heard it tauld, and trembled when I listened."

The Rook.

As far back as the year 1424 we find an Act passed by the Scots Parliament for the purpose of lessening the number of rooks. When children see crows hastening away in a body they say the schule is skailing; and if they are noticed sitting thickly on trees in the winter time, it is called "a craw's preachin'." When they are seen whirling and hovering round one spot in numbers, old people say it is a craw's weddin'. If they are observed flying high in the air in a flock, and tumbling and diving down, it is considered a sign of wind and rain. An old Scottish saying is, "Ay, but ye're a bonnie pair, as the craw said to his ain twa feet." In Shakespeare we find the quotation—

> "We'll pluck a crow together."
>
> —"Comedy of Errors," Act III. sc. i.

—the meaning of which is perhaps not quite so clear as our

own Doric, "I've a craw tae pluck wi' you, my man." There is a widespread belief that the rooks are very punctual in starting their nest-building, and the following rhyme is wonderfully accurate as regards dates:—

"On the first of March
The craws begin to search;
On the first of April
They are sittin' still;
By the end of May
They're a' flown away,
Croupin' greedy back again
Wi' October's wind and rain."

I do not remember ever seeing the crows building in February, but I have many a time seen them carrying sticks on the 1st of March, and this year was no exception.

The Yellow-hammer.

"Fair plumaged bird, cursed by the causeless hate
Of every schoolboy."
—Graham's 'Birds of Scotland.'

This beautiful little bird is the subject of unaccountable superstition on the part of the peasantry in England and Scotland as well. Its nest therefore receives less mercy than that of almost any other bird. Its somewhat extraordinary appearance, nearly all of one colour, and that an unusual one in birds, is the only imaginable cause of the antipathy with which it is regarded. The yellow-hammer was accounted one of the devil's birds, as instanced in the rhyme—

"Yellow, yellow yorlin',
Drink a drap o' the de'il's bluid
Ilka Monday morning"—

and it was further believed that the devil, crouching in the form of a toad, sat upon the yellow-hammer's eggs and hatched them and fed the young:—

"Quarter puddock, quarter taed,
Half a yellow yourlie."

Jamieson, in his 'Scottish Dictionary,' says: "The superstition of the country has rendered it a very common belief among the illiterate and children that this bird, the yeldring,

somehow or other receives a drop of the devil's blood every May morning." In the 'Proceedings of the Berwickshire Nat. Club,' vol. i. p. 219, we find this account: "Children hang by the neck all the yellow-hammers they can lay hold of. They often take the bare gorbals or unfledged young of this bird and suspend these by a thread tied round the neck to one end of a cross-beam: they then suddenly strike the other end and drive the poor bird into the air. This operation they call 'spangie hewit.'" In my younger days at Cramond school I can remember the same process, only it went by the name of "spring wheasling." In revenge for the treatment which it received, the yellow-hammer was supposed to curse its persecutors in its song of—

> "De'il, de'il tak' ye,
> For me to big a bonnie nest,
> And you to take it frae me;"

or—

> "Whetit te, whetit te, whee,
> Harry my nest and de'il tak' ye."

It is to be hoped, however, that the present generation of school children know nothing of these fine arts of savagery, and that no more

> "The weary yeldrins have to wail
> Their little nestlings torn."
>
> —Tannahill.

The Whitethroat

is another bird whose nest is often found by boys, who seldom scruple to harry it, from a prejudice against the wheatie, on account of their belief that it sucks the eggs of other birds. One of its popular names in Berwickshire is "Jenny cut-throat." The bird, of course, lives entirely on insects and small fruits. An old school conundrum which country boys used to puzzle their town friends with ran thus:—

> "A wheetie and a whitebird,
> A laverock and a lark,
> A blackie and a blackbird,
> How many birds is that?"

In some parts of Scotland the stonechat or stanechacker is exempted from the pains of harrying, in consequence of a

malediction which the bird itself is supposed to be pronouncing :—

> "Stane chack, devil tak',
> They wha harry ma nest
> Will never rest,
> Will meet the pest.
> Deil brak their long back
> Wha my eggs wad tak-tak."

The lark is supposed to have ugly eyes, and there is a reference to this in "Romeo and Juliet," Act III. sc. v. :—

> "Some say the lark and loathèd toad change eyes."

I have given some instances of wanton cruelty to birds on account of superstition. We will now take the other and more pleasing side of the picture, where first we find

The Robin.

> "And thou the bird whom men love best,
> The pious bird with scarlet breast,
> The bird who by some name or other
> All men who know thee call thee brother."

The earliest Scottish poet who mentions the redbreast is Holland, in 'The Howlat,' written about 1453, and, apparently from its familiar disposition, he calls it "the hennis man" or family servant. "The Robins are too muckle about the doors the day for guid weather," is an expression that at one time was common. Boys used to believe that the robins followed them into the woods for the purpose of intimating any danger that might waylay them, and sometimes the belief was so impressed upon them that they would take to their heels if the birds approached too closely. In some districts of the country the robin is looked upon as a hallowed bird, and very few boys will kill one, it being said that if they do, its spirit will some day return and seek the blood of the slayer. The story of the robins in the "Babes of the Wood" is familiar to all, and the popular belief in robins covering dead bodies is very old.

> "No burial this pretty pair of any man receives,
> Till Robin redbreast piously did cover them with leaves."

Isaac Walton, in the 'Compleat Angler' (1653), speaks of the

honest robin that loves mankind both alive and dead. The robin is said in one legend to have been the only bird that ventured near the cross, and that the blood of the Saviour fell on its breast, which has remained red ever since. But there is another bird that a strange but beautiful story connects with the crucifixion:—

"And by all the world forsaken,
Sees He how with zealous care
At the ruthless nail of iron
A little bird is striving there.

Stained with blood and never tiring,
With its beak it doth not cease;
From the cross 'twould free the Saviour,
Its Creator's Son release.

And the Saviour speaks in mildness,—
'Blest be thou of all the good!
Bear, as token of this moment,
Marks of blood and holy rood!'

And that bird is called the crossbill;
Covered all with blood so clear,
In the groves of pine it singeth
Songs, like legends, strange to hear.'
—Longfellow, "The Legend of the Crossbill"
(tr. from the German).

And in connection with things sacred, is it not a strange fancy that makes the poet exclaim—

"The sparrows chirped as if they still were proud
Their race in holy writ should mentioned be"?

The Wren.

In Henderson's 'Folk-lore of the Northern Counties' we find it stated that the wren had a sacred character among our Celtic ancestors. It has for centuries back been always associated with the robin.

"The robin redbreast and the wren
Are God Almighty's cock and hen."

John Webster, writing in 1638, says:—

"Call for the robin redbreast and the wren,
Since in shady groves they hover,
And with leaves and flowers do cover
The friendless bodies of unburied men.

At one time, on St Stephen's day, the common people of the Isle of Man assembled and carried about a wren tied to the branch of a tree, singing a doggerel song called "The hunting of the Wren." This custom is believed to have taken its origin from an effort of the early Christian missionaries to extinguish a reverence for the wren which had been held by the Druids as the king of birds. In Ireland the same custom must have prevailed. In the year 1845 we find a proclamation issued by Richard Dowden, Mayor of Cork, forbidding, on the score of cruelty, the hunting of the wren on St Stephen's day. Whatever may have been the origin of the custom in Ireland, there is no doubt that on St Stephen's day the "wren boys" went about the hedges pelting the unfortunate victim with sticks and stones, and carrying it about when caught on the top of a pole in the midst of ivy or holly, singing some doggerel verses beginning with—

> "The wren, the wren, the king of all the birds,
> St Stephen's day was caught in the furze," &c.

The Swallow.

There is no bird whose appearance is more welcome, and whose departure is watched with greater regret, than the swallow. And it is round this bird we have had some very pretty fancies developed regarding *hibernation* as opposed to *emigration*, but into these I shall not enter. "There is a tradition," says Dr Henderson of Chirnside, "amongst boys of the county, that if a swallow fly betwixt a person's body and his arm that person will lose the power of his arm for ever. It is obvious there can be little danger of such a thing taking place, yet I remember when I was a boy I had a great dread of the swallow when she was skimming past me on her swift pinions." When swallows fly low and sweep close over pools of water, rain may be expected.

> "When swallows fleet soar high and sport in air,
> He told us that the welkin would be fair."

Old writers tell us that when the young swallows are hatched they are blind for some time, and that the parent birds bring to the nest a plant called Chelidonium or swallow-

herb, which has the property of restoring sight. The plant is the well-known Celandine (*Chelidonium majus*). Besides the swallow-herb there is the swallow-stone, to which wonderful properties have been likewise attributed in connection with diseases of the eye. Pliny makes mention of a swallow-stone which, he affirms, is found in the stomach of the swallow. In Brittany and in some English counties the stone is said to be found in the nest of the swallow. Longfellow, in "Evangeline," refers to the legend of the swallow-stone:—

"Oft in the barns they climbed to the populous nests on the rafters,
Seeking with eager eyes that wondrous stone, which the swallow
Brings from the shore of the sea to restore the sight of its fledglings;
Lucky was he who found that stone in the nest of the swallow!"

The Cuckoo.

The cuckoo had its calendar embodied in the following rhyme:—

"In April come he will;
In May he sings all day;
In June he changes tune;
In July away he'll fly;
In August go he must."

But the believers in hibernation had also their jingle:—

"Seven sleepers there be,—
The bat, the bee, the butter-flee,
The cuckoo and the swallow,
The kittywake and the corncraik,
Sleep a' in a little hollow."

The Kingfisher.

It was a firm belief of the ancients that during the time the halcyon or kingfisher was engaged in hatching its eggs the water, in kindness to her, remained so smooth and calm that the mariner might venture on the sea with the happy certainty of not being exposed to storm and tempest. This period was therefore called by Pliny and Aristotle the "halcyon days." It was also supposed that the dead bird stuffed, carefully balanced and suspended by a single thread, would always turn

its beak towards that point of the compass from which the wind blew.

> "But how now stands the wind?
> Into what corner peers my halcyon's bill?"
>
> —Marlowe.

The Lapwing.

> "Far from her nest the lapwing cries away."
>
> —"Comedy of Errors," Act IV. sc. ii.

The dolorous cry of the lapwing, called in Scotland the peeseweep, has attracted the attention of children, and is embodied in one of their rhymes as

> "Peeseweep, peeseweep,
> Harry my nest and gar me greet."

Tannahill, regarding it as a foreboding sign of evil, says,—

> "The peeseweeps scraichin' o'er the spunkie's cairn."

In certain parts of Scotland there is an antipathy to this bird, and it is held as unlucky on account of its having served in persecuting times to point out the retreat of the Covenanters who had sought refuge in the wilds.

> "The lapwing's clamorous whoop attends their flight,
> Pursues their steps where'er the wanderers go,
> Till the shrill scream betrays them to the foe."

Barnacle Geese.

As long ago as the twelfth century we find the story that, somewhere in the Orkney Islands, there grew certain trees that produced at the end of their branches small swelled balls, containing the embryo of a goose suspended by the bill, which when ripe fell off into the sea and took wing. The old woodcuts illustrating this story are very amusing. Boece, the oldest Scottish historian, denies this story, but says they are produced in the form of worms in the substance of old trees or timber floating in the sea; and he gives a circumstantial account of their appearance. In connection with this old superstition, it is a curious fact that, in spite of the many modern scientific and exploring expeditions, the real breeding haunts of the barnacle goose have never been discovered. It,

however, has been known to breed in captivity, and is a somewhat rare winter visitor in the Firth of Forth.

Cormorants.

In connection with another sea bird, the cormorant, it may not be out of place for me to mention that King James I., in 1611, had a regular establishment of these birds for fishing on the river Thames at Westminster. Numerous interesting entries regarding it are found in the Record Office: "To John Wood the sum of £30 in respect of bringing up and training of certain fowls called cormorants and making them fit for the use of fishing." "May 27, 1612.—Payment to the said John Wood for getting cormorants from the north."

Cranes.

A common belief existed at one time that somewhere in the centre of Africa there existed a race of pigmies between whom and the migratory cranes deadly battles were fought. Pliny, in his seventh book, gives some justification for the alleged feud: "In the spring-time the pigmies sally forth in great troops, riding upon goats, searching for and devouring the eggs of the cranes." Recent explorations in Africa have indeed revealed the existence of a certain race of pigmies, but we hear of no account of any such warfare in modern times.

While the Scottish rural class of former days had their curious superstitions as regards birds and beasts, the interpretation of their habits into omens and signs of the weather might well form a separate chapter of study. The knowledge which long-continued observation gives respecting meteorological changes was embodied in verses of the usual simple kind, which were handed down from sire to son with the greatest fidelity, and are even yet quoted by old people. One of the simplest and oftenest heard is that

> "An air' winter's
> A sair winter"—

i.e., a winter early begun is likely to be a severe one. Feb-

ruary appears to be one of the most important months as regards weather predictions, as it seems to have some mysterious influence on the weather that is to follow. Yet throughout the country generally good weather in February is regarded as an unfavourable symptom of what is to come.

"A' the months o' the year
Curse a fair Februar'."

Also—

"February fill the dyke,
Be it black or be it white:
If it be white, the better to like."

"If Candlemas be dry and fair,
The half of the winter's to come and mair;
If Candlemas be wet and foul,
The half o' the winter's gane at Yule."

When the new moon is in such a part of the ecliptic as to appear turned much over on her back, wet weather is expected.

"The bonny moon is on her back—
Mend your shoon and sort your thack."

"About the moon there is a brugh—
The weather will be cauld and rough."

The halo seen round the moon, being a consequence of the humidity of the atmosphere, may well forebode wet weather.

The hills, by their attracting the clouds and precipitating rain, serve as natural barometers all over Scotland. Thus in Roxburghshire they say—

"When Rubislaw puts on his cowl,
The Dunion on his hood,
Then a' the wives of Teviotside
Ken there will be a flood."

It is a popular belief that when the oak comes into leaf before the ash there will be fine weather and an abundant crop. I remember in my school days there was a tradition that if, when the rainbow was seen in the sky, you were to go to the spot where the rainbow rested on the earth and dig down, you would find a pot of gold. The time when that rainbow appears is supposed to aid in foretelling the weather:—

"A rainbow at night is the shepherd's delight:
A rainbow in the morning is the shepherd's warning."

An old writer says, "Where the rainbow toucheth the tree, no caterpillar will hang on the leaves: where the glow-worm creeps in the night, no adder will go in the day."

The Indian story of the rainbow is the most beautiful of all natural history legends. The old squaw, in answering Hiawatha's question as to what the rainbow is, says,—

> "'Tis the heaven of flowers you see there;
> All the wild-flowers of the forest,
> All the lilies of the prairie,
> When on earth they fade and perish,
> Blossom in that heaven above us."

The following simple couplet is prevalent throughout the whole of Scotland, and with slight variations is also common in England—

> "The evening red and morning grey
> Are tokens of a bonnie day."

Of the antiquity of this observation we have it in the Scripture, "When it is evening, ye say, it will be fair weather: for the sky is red" (Matt. xvi. 2).

The future of the weather is often augured from the flight of birds. In some districts there existed at one time a belief that the weather of the day was foretold by the two most conspicuous members of the crow family: if the raven cry first in the morning, it will be rain; if the rook, it will be fair.

> "The corbie says unto the craw,
> Johnnie, fling your plaid awa';
> The craw says unto the corbie,
> Johnnie, fling your plaid about ye."

A homely rhyme addressed to the seagull by children used to be—

> "Seagull, seagull, sit on the sand;
> It's never good weather when you're on land."

The following account of a new weather-prophet appeared in the newspapers recently:—

A sportsman who spent a holiday in Unst, the northmost of the Shetland Islands, went to see the Muckle Flugga Lighthouse, which stands on a rocky islet about a mile from the north point of Unst. The lighthouse keepers told him that for nine years they had a tame rabbit living on the rock beside them. It had three holes on different parts of the islet over

which it roamed at pleasure. The keepers said that when they saw the rabbit going to one particular hole they had learned that they might prepare for a south-west gale.

I have previously mentioned how common was the belief in witches, and it is but natural that we should look for some antidote to their power to do mischief. Hence we have the rhyme,—

> "Rowan tree and red thread
> Mak' the witches tyne their speed."

Among the Highlanders of Scotland the virtue of the rowan tree is in the highest repute even at the present day. The mountain ash is considered by them the most propitious of trees, and in fishing-boats a pin of this wood for fastening the halliard to has been held of indispensable necessity. Sprigs of mountain ash in diseases of cattle, &c., are considered a sovereign remedy.

The peculiar circular growths of fungi which occur sometime in old pasture-land are familiar to all field naturalists. These were called fairy rings, and husbandmen used to avoid with superstitious reverence to till or destroy these circlets of bright green grass, which are believed to be the favourite ball-rooms of the fairies; for, according to the appropriate rhyme,—

> "He wha tills the fairies' green
> Nae luck again shall hae;
> And he wha spills the fairies' ring,
> Betid him want and wae.
> For weirdless days and weary nichts
> Are his till his deein' day."

Whereas by the same authority,—

> "He wha gaes by the fairy ring
> Nae dule nor pine shall see;
> And he wha cleans the fairy ring
> An easy death shall dee."

There are many other topics which I have necessarily left untouched, for I fear I have already trespassed too long on your time, and I feel I have done but faint justice to a subject which, for me at least, has a peculiar fascination, and which a skilful pen would render of more than passing interest. For the range of scientific knowledge is ever

widening, and under its influence in a few short years the simple legends of natural history,—the peculiar heritage of country children,—which have passed from generation on to generation, will gradually fade out of memory. It was only last summer that, listening to some children playing among themselves, I heard one being scolded for having killed a red spider, or "red sodger"—for in their innocence they believed that its slaughter would be followed by a "sunny shower." And who would like altogether to see such simple stories die out. Do we not rather like to picture the times such as are described by Longfellow in "Evangeline," when the old notary in amusing the children told—

> "How on Christmas Eve the oxen talked in the stable,
> And how the fever was cured by a spider shut up in a nut-shell,
> And of the marvellous power of the four-leaved clover and horse-shoe."

X.—*NOTES ON SOME FOREIGN BIRDS I HAVE KEPT.*

By Mr G. M. BROTHERSTON.

(*Read March 26, 1902.*)

I wish to-night to exhibit several foreign birds which I have kept, and to make a few remarks or notes on them. The first bird to which I will draw your attention is the Pekin robin (*Liothrix luteus*). It is called by dealers the Sun-bird, Lesser Pekin nightingale, or Japanese nightingale. The German name is "Sonnenvogel." This bird is a little larger than a cole tit. The back is olive brown, changing to an olive-yellowish tint at the head, and to greyish brown at the sides. The throat and breast are dark; each wing-feather is edged with bright deep orange colour. The female is very similar to the male, and only to be distinguished by the orange tints being a shade less deep and a trifle less spread over the breast. China, Japan, and the Himalayas are the home of this bird. In India he is seldom found at a lesser altitude

than about 4000 or 5000 feet above the level of the sea. Hence the bird is not nearly so delicate as other Indian birds; hardy as regards climatic influences, and content with almost any food. In the aviary he will be found feeding with the American robins and other soft-food birds, and again paying attention to the seed dishes, swallowing canary and millet seed entire. I have kept him with tanagers, and just now I have him in a cage with a pair of blackcaps. A piece of ripe fruit and a meal-worm are equally welcome to him. Currants mixed with his food he is very fond of. Even a little boiled rice will not come amiss. In the cage the bird cannot have too much variety of food. Even a few grains of hemp may be given, which the birds will, if the seeds be large, carry to a perch, hold daintily with their feet, and try to break by hammering with their coral-red soft beaks. These birds are extremely fond of bathing—in fact, will take a dip several times a-day; and almost incessantly will they be busy preening and arranging their pretty feathers, until these are the very perfection of neatness and good order. Not the least of this bird's merits is that he never molests any other birds, large or small, and is a model of good behaviour in the aviary, whether kept singly or in pairs. Even several pairs do not apparently molest each other. Dr Russ first bred the Liothrix in captivity in 1874, and since then several successful broods have been recorded annually. The nest is rather inartistic, either in a bush or a ledge or in a nest-box or German cage. It consists of hay, fibres, and grasses, with a few small feathers. About four bluish or greenish eggs, with brown or reddish spots, will be laid. The young appear less difficult to rear than those of other insectivorous birds, and resemble the old birds, except that the colours are faint and somewhat dull. These pretty birds can be bought for a few shillings a pair, and as they have very lively manners they make amusing cage pets.

The next bird I show is the Avadavat or Amavude finch. This finch and the other two which I show belong to the Dwarf or Fancy Finches. These finches may be considered the foreign cage-birds *par excellence*, but it should be stated at once that very little is known of the life and habits of most of these little birds in their wild state, whilst a great mass of

information on their habits in the aviary has been collected by Dr Russ. These diminutive finches are found in Asia, Africa, and Australia, whilst no representative of their family has been discovered in America or Europe. In size they vary from that of our chaffinch down to something less than our smallest wren. These of all birds deserve the name of Love-birds. At the dealers' shops in London hundreds may be seen in one cage, sitting as close together as they can, trying to keep one another warm and lovingly arranging each other's feathers. At night they will be found either to occupy an artificial nest or to sit close to each other on a perch. As regards cages, it should be remembered that some which would safely hold a canary would allow the smallest of the foreign finches to escape. The wires of cages for foreign finches must not be more than five-eighths of an inch apart, and half an inch wire is better.

Many people who never heard the name of any other foreign finch have heard of the "Avadavat" (*Estrelda Amandava*). The dealer's name is Avadavat or Averdavat. The German name is "Tigerfink" or "Getigerter-Astrild." These little birds appear to have been casually sent to Europe many years ago, and arrive now in ever-increasing numbers. The Amavude finch is one of the smallest foreign finches, and is found in great numbers in British India and Java, where he lives on seeds, building a nest in October in low bushes or between the stems of high grasses. The nest is constructed of vegetable fibres, is completely covered over, and has an opening in the side. The eggs are white, like all the Estreldæ: their usual number seems to be four. Gedney, in his 'Foreign Cage Birds,' says:—

This bird is well known to all Anglo-Indians, abounding as it does in the East Indian islands and India proper, and everywhere constituting himself a nuisance to the cultivators of land by the wanton destruction of seed. He is a tiny little fellow, about three inches long, thoroughly "game," as brilliant in his wedding clothes as a polished gem, glinting in the sunshine as he flits about amongst the tall herbage, and ever ready to pounce upon a rival and to do battle for the exclusive possession of his wee brown wife. His love note is remarkably clear and loud, resembling somewhat the liquid notes of our willow wren; and no matter how numerous may be the occupants of your bird room, the Avadavat's song can always be distinguished above other songs.

The Avadavat is smaller than our smallest European wren, of slender build, and vivacious and graceful in his movements. His plumage is dark brown, with a carmine-red tint, and covered all over with small pearl-white spots. The female is more sober in her appearance, the back being brown and the chest, &c., a brownish-yellow tint. The white spots are visible also, but less numerous. Several pairs will live very peaceably together, and towards dusk they will all sit on the same perch, very close together, selecting generally the highest perch in the cage. At that time one and then another will suddenly raise itself and sing a little melodious stanza, settling down to sleep when it is over. The female will sing nearly as well as the male.

The next bird is the Madagascar Bib or Dwarf finch—said to be one of the smallest of the finch family. I have only had this tiny bird in my possession for a few weeks, and regret that I can say very little about it.

The Double-banded or Bicheno's finch is the next one I show. The Latin name is Estrelda Bichenovii. The dealer's name is Double-banded Finch. The German dealers' is "Ringelastrild" or "Gitterflügel." Compared with the brilliant hues of other foreign finches, the double-banded finch appears at first sight very modestly attired. A pure silvery-white is the ground colour. The feathers are delicately pencilled with fine black lines or bars, which, when seen at a distance, give the bird a light silvery-grey appearance, but examined more closely, the plumage of this finch, one of the smallest of the Australian finches, is of great beauty and marvellous delicacy. The face, throat, breast, and the lower part of the body are white. A narrow black line, which crosses the throat, extends from ear to ear. A second black line across the lower breast runs parallel with the former, and gives the bird the name of double-banded finch. The wings are black, but the feathers have rows of white square spots, which on the dark ground appear something like a trellis. The Germans have named this bird, for this reason, "lattice wing." The beak is of silvery-grey tint, and the tail is black. The female bird cannot be distinguished from the male; possibly the markings of the female may not be so sharply pencilled, but this may be due to age just as well as to sex, and there is no

distinguishing mark. The double-banded finches are more abundant in the southern and eastern portion of Australia than elsewhere, and there they are rarely met with except in the interior, congregating in small parties upon open grass plains, feeding on grass seeds and minute insects. Their favourite haunts being somewhat beyond the happy hunting-grounds of professional bird-catchers for the British market, these finches are seldom to be obtained in this country; the few pairs which annually find their way over being readily bought up at high prices, Continental dealers always being ready to purchase any number of them.

The next bird is the Long-tailed Grass finch (*Poephilda acuticauda*). This is another of the pointed tail finches also found in the northern portion of Australia. The bird here treated of is grey on the head and face; the tail is black, and the two centre feathers extend beyond the rest to a point. The throat is black; breast fawn colour. Total length, five inches. It is a very rare bird in England. From personal knowledge this is a very pretty, happy, and amiable bird, but one often meets with disappointment. At night the bird is bright, healthy, and lively. In the morning it is dead. This is caused, it is said, by a gradual drying up of the heart-organs through the eating of dry seeds. To avoid this the bird (in fact all the finches) should have always a head of Indian millet in their cage or aviary, or even the heads of ordinary wild grasses.

The last bird which I exhibit is the Gouldian finch (*Spermestes Gouldæ*). These lovely birds were named by Gould in memory of his wife, and they certainly deserve the foremost place in the ranks of Australian grass finches. He measures four inches in length, his upper body and wings of a rich green, beak ruby at base, face and throat velvet-black, suddenly terminating in a broad, dazzling lilac band, which crosses the breast. There are two varieties,—what are popularly called the "red heads" and "black heads," the former being much higher in price. The female is very like the male in its colours, but is very much duller in tone. I may state that these beautiful birds were bred two years ago by an Edinburgh lady, for which she

received a special award from the Avicultural Society. They were never known to have been reared before in Britain.

At the above meeting Mr W. C. Crawford gave a short address, with lantern and microscopical illustrations, on "The Grasses, an Example of Nature Study," with special reference to one of the prizes for the encouragement of local Natural History offered by the Society.

XI.—*A WINTER IN CORNWALL.*

By Mr ARCHIBALD CRAIG.

(*Read April 23, 1902.*)

It may seem somewhat presumptuous on my part, considering the short time at my disposal, to attempt to describe such a curious and interesting county as Cornwall. As a matter of fact, it will not be possible to do more than touch the fringe of the subject at present; so in order to do this as concisely as may be, and to avoid prolixity, I have divided this paper into sections, which I shall take up one by one, in the hope that some of them may be of interest to the members of the Society. The first to be glanced at is the

Scenery, Topography, and Climate.

Since returning home I have been frequently asked, "How does the scenery of Cornwall compare with that of our own country of Scotland?" The answer to that is, There is practically no comparison between them, as the outstanding features of each are quite diverse. True it is that in Cornwall one discovers little glens running down to the sea-shore which call up reminiscences of similar scenes in the Highlands, but the Cornish ones are on a much smaller scale. The county is hilly, but it cannot be called mountainous,

as the highest elevation is not much above that of Arthur's Seat. In some parts there is a continuous succession of these rising grounds, and as the engineering of many of the roads leaves much to be desired, rising and falling as they do most abruptly, the impression is formed that Cornwall is a much hillier district than it really is. Mention having just been made of roads, it is safe to say—leaving out of the question the main highways — that narrower means of communication could not be found in Great Britain. Around the neighbourhood of Fowey, on the south coast, this was notably the case, most of the farm-roads being so confined within high hedges as to make it almost impossible to avoid running into a wandering horse or cow, much less of admitting two vehicles to cross each other. A feature of Cornwall is the tall hedgerows. These are not the least like ours at home. The bases are composed of high earthen and stone mounds combined, and on the sides of these mounds hart's-tongue ferns and a great variety of low-growing plants flourish luxuriantly, even in winter. On the top, again, of these roughly made erections stunted hazel bushes, brambles, &c., grow to a considerable height, shutting out the view on either side, so that when the track runs level you walk in a tunnel minus the roof. Where the stone-work of these mounds is bared, a curious style of building is revealed. For a time the rough blocks are laid horizontally, then perpendicularly, and often at an angle, this arrangement seeming to a certain extent to depend upon the size of the stones, those lying flat being, as a rule, larger than the others.

Some districts are well, even richly, wooded, notably Bodmin Road and its vicinity, Fowey, Falmouth, and Penzance; but a great portion of the county is bare and treeless, particularly in the Land's End and St Just direction, as well as about Newquay and most places on the north coast. In the parts sheltered from the fierce sea-winds, flowers and plants grow in profusion. In spring the woods are a mass of daffodils, lilies, and suchlike; and even in February in not a few protected areas could be noticed flower-buds ready to burst open, while wallflower was in full blow. Subtropical plants and palms grow in the open

air at Falmouth and in the Morrab gardens at Penzance. As already said, large tracts of country are devoid of trees, being nothing but barren muirland covered with whin, bracken, and coarse grass, interspersed here and there with heather. Great boulders of granite stud these wastes, and when blackened by rain they give to the landscape a weird desolate appearance that would vie with some of our inhospitable wildernesses, such as those of Lanarkshire or Rannoch. Add to this the circumstance of so many disused tin and copper mines, with their broken-down masonry and rotting machinery marring the prospect, and you have a picture in winter, or in bad weather, of utter God-forsakenness. Those muirs, however, are not without their redeeming features, as on sunshiny days, when the gorse is in full bloom and the brackens wave gracefully in the wind, a ramble over them, with the fine breeze blowing off the ocean, is not to be despised. What perhaps increases their attractiveness, under the above conditions, is the frequency of those extraordinary freaks of nature in the shape of enormous eruptions as it were of granitic formation that seem to spring out of the ground in most unexpected fashion. Illustrations of these may be cited in the famous Cheesewring, Helmen Tor, and Roche Rocks; but as attention will be called to them under the heading of "Antiquities, Churches, &c.," they may be passed over at present. One thing that struck me most markedly was the supineness of the landed proprietors and tenantry in making little or no attempt to reclaim suitable portions of this waste ground. One explanation of this appears to be the fact that very little encouragement is given to tenants to trench and cultivate virgin soil, leases and compensation for improvements not being much in vogue, so that in reality the farmer has small inducement to add to his holding. It seems to me that were the Cornish proprietors to take an example from many of our Scottish lairds, wonders might be done. The land, when cleared of whins and rubbish, is good, the elevation above sea-level is not great, —not nearly the height on which corn grows in our less favoured country,—frost and snow are rare occurrences, and there is always a sufficiency of rain. If grain would

not pay, vegetables might; and now that the mining industry is at so low an ebb, it does seem strange that large tracts are permitted to lie dormant.

As a contrast to the foregoing, there is one feature about Cornwall which compares favourably with our methods at home. I refer to the facilities offered to pedestrians for roaming across country. Footpaths over fields are numerous, granite crossing-stiles are provided to pass from field to field and from farm to farm, and it is no exaggeration to say that around Penzance alone miles and miles of delightful walking can be done through fields, with only an occasional crossing of a high-road. Compare this with the state of matters in Scotland. Let any one be rash enough to move off the beaten track in order to take a short cut across a field or meadow: if observed, he is subjected to vituperation of an offensive kind by some irate agriculturist or his myrmidons, and the trespasser may consider himself lucky if he regains the turnpike without having the impress of a collie-dog's teeth on the calf of his leg. A stringent law of trespass exists in England; that in Scotland is practically nil: why, therefore, the freedom in the former country, and the restriction in the latter? The reason is obvious: numerous opportunities are given in England for people to walk *viâ* bypaths away from the highways, therefore there is no inducement to trespass: in Scotland, few of these facilities exist, and, being deprived of the privilege, people are more apt to wander where they should not. You all know the old Scottish saying, "It's an ill bird that files its ain nest," and personally, I should not like to incur the odium of slandering my own countrymen, but a love for truth compels me to say that English people, as a rule, are not nearly so destructive of trees, plants, and property generally, as the baser sorts of Scotsmen are,—hence the reluctance of landowners to throw open their grounds to the public in this our native land. As this subject, however, is somewhat controversial, it need not be enlarged upon.

Cornwall's finest feature is its rocky coasts. These are very rugged, and although the cliffs do not attain to anything like the height of the Caithness or Sutherlandshire headlands,

still they are very grand. The prevailing rock is granite, chiefly grey, although, of course, there are a great many others, such as felspar, porphyry, slate, limestone, serpentine, &c. On the south coast there are hardly any beaches, the English Channel lapping the base of the cliffs, so that one cannot walk comfortably along the shore, even at low tide; but numerous little coves occur here and there, many of which give shelter to fishing boats, besides being utilised as lifeboat and coast-guard stations. Perhaps the two prettiest of these natural harbours are those of Looe and Fowey, on the sides of which are built the towns of the same names. At Fowey the tide finds its way inland in sinuous fashion about eight miles to Lostwithiel, and branching off this tidal river are several creeks, the hills sloping down to the shores being beautifully wooded, with quaint little hamlets, and some fine churches peeping out at intervals. Apple-orchards are very common, and a fair trade seems to be done in fruit for consumption, as well as for the manufacture of cider—a sour kind, different from the sweet variety made in Devonshire. The Fowey river and harbour form together, to my mind, one of the prettiest parts of Cornwall; and the town itself is decidedly quaint and most interesting, although where the coast is dotted with so many choice little retreats, it is not easy to pick out the best, as, after all, it resolves itself into a matter of taste. Many of the fishing-villages, particularly Polperro, are most picturesque: the houses are shot down on the steep slopes without any regard to order or uniform design, and from the windows of those higher up one can look down the chimneys of the cottages below. The so-called streets are, in some instances, no wider than an Edinburgh High Street close, and turn and twist in the most perplexing fashion.

Time does not permit, however, of any lengthened description of the numerous towns and villages: in a word, therefore, let it be said that the larger places do not present any outstanding features of interest; always excepting the churches, and it is to the smaller villages and hamlets that a visitor must turn if he wishes to make acquaintance with the unique and more old-world aspect of Cornwall. The houses, being almost entirely built of grey granite, have, particularly on a wet day, a cold and forbidding look, and possess none of the cheery,

bright appearance of the wooden-fronted and creeper-covered cottages of the Midlands of England. Like many of our Scottish houses, substantiality is the first consideration, ornamentation, either in design or floral adornment, being of secondary importance. Notwithstanding these drawbacks, they have a charm of their own, and will well repay one for the time spent in hunting them up.

Returning to the cliff scenery, the rocks about the Lizard Point and Land's End district are perhaps the finest on the south coast. The granite takes the most fantastic shapes, and at a distance one would almost be justified in supposing that portions were placed in position by some of the ancient giants, who, if we are to believe the story of 'Jack the Giant-Killer' which charmed our youthful minds, inhabited the district long ago. Some of the formations strongly resemble medieval castles, and especially is this the case at Castle Treryn, where the far-famed Logan Rock is situated. The north coast, while equally rugged, has the additional advantage of possessing magnificent sandy beaches, those about the Newquay district being wonderfully fine; while, to add to the amenity, the high cliffs are honeycombed with caves, some of them of enormous size. These caves were a perfect godsend to smugglers in the old days, when almost every man along the coast was engaged in the forbidden traffic, and many a stirring event has no doubt been enacted along that rock-bound shore, when cargoes of wine, brandy, lace, silk, &c., were being run in from France and other Continental countries. Another pleasant little pastime indulged in by the old Cornishmen was that of "wrecking," and here again these caves came in handy as hiding-places and storehouses. In one of the larger caves near Newquay concerts are often held, and some of our most famous operatic singers have been among the performers.

There is a great want of wood on the north coast, and the inland scenery is not nearly so fine as that of the south. The tide rushes in with great rapidity, and one has to be extremely careful about wandering at the base of the rocks, as should the sea overtake the luckless pedestrian there is no hope of escape save by climbing the cliffs, which, even at the easiest point, are most difficult to scale.

As may naturally be supposed, boating enters largely into

the pleasures of the Cornish folks, and in towns like Fowey almost every householder owns a boat of some kind or other. Besides the usual method of allowing such to float in the harbour, attached to chains which are fixed to an iron ring at the bottom of the sea, some residenters have erections like masts on the top of their garden walls, with ropes that run round with a pulley at the end, and to these ropes the craft is fixed. When it is desired to draw the boat to the foot of the stone stairs that run down to the water's edge, all they have to do is to loosen the rope from the cleek on the pole and haul in the vessel hand over hand. The only reason for mentioning this plan is to explain that locally this apparatus is called "frapes," the derivation of which word I cannot discover. At first sight it looks like a corruption of the French *frapper*, but the English meaning of the word does not bear out that hypothesis. Possibly it may be a relic of the extinct Cornish tongue.

As is matter of history, constant fighting used to take place between the Cornish and Continental nations, chiefly the French and Spanish, and to guard against the incursions of these enemies, a series of small castles or blockhouses were built along the rocky coasts. Numerous ruins of these still exist, and at Fowey itself there are remains of three. Between the one on the Fowey side and the other at Polruan, a small town opposite, tradition has it that a heavy iron chain was stretched across the water so as to impede the passage of hostile vessels. A link of this chain, believed to be genuine, is preserved in that most singular construction known as "The Grotto," at Pridmouth Cove, a few miles along the coast from Fowey. In our day blockhouses—which, by the way, are somewhat similar in shape to our Scottish peel-towers—have given place to coastguard stations, and these to a certain extent supply the material to man that Navy of which all loyal Britons are justifiably so proud.

Before passing on to the next division of our subject, a few words anent the climate may not be amiss. Comparing it with Scotland, it is, naturally, from the geographical position of the country, much milder, but in winter this undoubted gain is neutralised by the heavy rainfall. All winters are not, of course, so humid as the one I spent there, which was

exceptionally bad; but still, even under the most favourable circumstances, there are frequent downpours, which turn the narrow roads into sloughs of despond and make them impassable for pedestrians. In fact, the "clartiness," to use a familiar Scottish word, is inconceivable. When not raining, there is, as compensation, an amount of sunshine quite absent from Scotland, and one can sit out of doors on most dry days without wrapping up. Vegetables, such as cauliflower and broccoli, can be got from the fields in January, and lambs are to be seen running about during the same month. Potatoes do not require to be pitted, nor cattle wintered indoors, and what snow and frost occurs is of very short duration. Occasional snaps of chilly weather are experienced when the wind veers to the east or north-east, and there is a decided difference between the temperature of the south and north coasts—the latter being much the more bracing of the two as well as drier. The rainiest "airt" is from the south and south-west, and the storms that blow inland from the Channel are sometimes of terrific violence. Spring is, from all accounts, the best time to visit Cornwall—from March till the end of May, when flowers and vegetation generally are at their freshest, and before the great heat of summer makes locomotion a toil. Let me warn any intending visitor, however, not to go there with the idea of viewing magnificent panoramas such as are to be had in the Highlands of Scotland or in North Wales. The scenery is tamer, and completely different from those localities, but, all the same, it has a charm of its own, and is by no means to be despised.

Enough has been said to give a cursory idea of what the country is like, so let me go on now to the second division—

The People, Customs, Etc.

The pure Cornish are, as is well known, Celts, being apparently more allied to the Cymric or Welsh than to the Irish or Scottish Gaelic-speaking races. Many of the names of places have a similarity to those found in Wales. To take one instance only, the prefix "Lan" is very common, evidently the same as the "Llan" prevalent in the more northern country. The ancient language is, of course, dead, and from what can be

gathered, few remains of its literature, either in manuscript or in print, exist, but some of the words used by the people to-day are no doubt remnants of the extinct tongue. The great majority of the population are dark in hair and complexion, light or red hair being very unusual, and are stoutly built, somewhat after the Dutch type. The men are not very tall, but are broad-shouldered, muscular, steady fellows, and, as previously mentioned, Cornwall is a splendid recruiting-ground for our Navy, not forgetting those equally brave heroes who, carrying their lives in their hands, do not hesitate to "man the lifeboat" when occasion requires.

It would hardly be possible to come across people more obliging, civil, and respectful than the working and farming orders in the country districts; and there is an absence of that hateful, independent boorishness that is unfortunately to be met with in so many places of Great Britain among a similar class. Of course there are, as everywhere, exceptions to this rule, but they are not numerous. The smaller centres of population, however, in common with most little provincial towns in England and Scotland, are not free from the infliction of that insignificant coterie who visit only among their own set, think themselves superior to all other residents and visitors, and justly merit a place in Thackeray's 'Book of Snobs.' It is somewhat amusing to watch the airs of these gentry as they pass along the thoroughfares, or attend church, concerts, &c. To use a French phrase, it is a case of "le nez retroussé," coupled with a thanking of the Almighty that they are not as other folks. There is a considerable foreign element in the county, many sailors of various nationalities having settled down from time to time, intermarrying with native women, and their descendants still bear unmistakable traces of Continental origin in their features, &c. In Fowey, several families of the name of Vargo exist, and those claim descent from a shipwrecked mariner of the ill-fated Spanish Armada.

Living is fairly cheap, and if one resided permanently there, a much smaller income would suffice to keep things going than is required in Edinburgh. Visitors, however, as is almost universally the case, have to pay more than residents for house accommodation and food, while house rent is high; but even at the enhanced prices, provisions are much less than at home,

with the single exception of fish, which are abnormally dear. Potatoes are sold in the shops by the gallon, which, as a schoolboy can tell us, is a measure of capacity as well as a liquid measure. It sounds a little strange to Scottish ears to purchase potatoes by the gallon, but such being the fact, it is almost permissible to expect that whisky could be bought by the peck!

The Cornish are decidedly musical, and during the winter months concerts are got up in the various towns for all sorts of charitable purposes, as well as for the benefit of athletic clubs and other objects, and it is surprising how excellent is the talent displayed by the amateur performers. Cornwall has also not been behind-hand in producing professional talent. Mention need only be made of Madame Fanny Moody as one instance of this.

Two virtues appertaining to Cornish folks, that cannot fail to strike a stranger, are their honesty and temperance,—not that these attributes are by any means confined to that remote part of England, but except in places where the tourist element has spoiled a certain section of the people, the trading class are found to be fair and just in their dealings, and excess in liquor among the native population is a very rare occurrence. Most of the farmers are of the working class, there not being many of what are known as gentlemen farmers with capital, and the holdings are generally small. The word "croft" occurs, and is somewhat similar in meaning to that in vogue in our Highlands. A peculiarly shaped spade is used, and is, I believe, confined to Devon and Cornwall. This is a broad heart-shaped looking article, coming to a sharp point, and lying almost flat, not upright like the ordinary implement. The shaft is from five to six feet long, and bent like a low arch, the idea evidently being to reduce the back-bending of the user to a minimum. It seemed to work well among soft ground, but did not appear to be of much utility in turning over hard soil.

We now come to the third division of our remarks on Cornwall—viz., its

Industries.

As far back as its history goes, Cornwall's greatest industry has been mining—viz., tin, copper, and iron, besides other less

familiar minerals in smaller quantities. By the way, there is a very fine collection of specimens of these in the Truro Museum well worth inspecting. Nowadays, while it cannot be said that this source of wealth is dried up, yet the industry is a mere shadow of its former self. About Camborne and Redruth district several mines, notably Dolcoath, are still working, also in the Carradon neighbourhood; but towards St Just only one mine, the Levant, is in use. The workings of this last run a long way below the sea, as did those of the famous Botallack mine in the immediate vicinity. No more saddening spectacle can be seen anywhere than in different directions presents itself to the eye,—emblems of ruin in the shape of broken-down masonry, rotting machinery, tumble-down chimney-stalks, and shafts filled with water, speaking to a vast amount of capital sunk, and to a wage-earning community deprived of their daily bread, and forced to scatter to the four winds of heaven. Many of the old miners emigrated to Johannesburg, and were doing well until the war in South Africa compelled them to become refugees. It is satisfactory to know, however, that many are now returning to the sphere of their former labours. In the district north of Liskeard the ruinous condition of things was markedly noticeable. Where, not so long ago, hundreds found employment, not a soul was to be seen—nothing but disused workings, and huge heaps of refuse cast up from the mines upon which practically no vegetation grew. The evening I passed through was calculated to increase the depressing appearance, as a thick mist was drifting along the hill-sides, accompanied by, at intervals, blinding showers of rain, the whole prospect forcibly reminding one of some of Gustave Doré's masterpieces. *Apropos* of this subject, tradition says that the oldest mine is that known as the "Ding-Dong," which is supposed to have been worked before the birth of our Saviour. This statement is only given for what it is worth, to prove such an assertion not being an easy matter. Whether the Cornish mines may ever be resuscitated, so as to defy foreign competition, is a problem that need not be here discussed.

It is a trite remark that when one industry dies, another springs up to take its place, and this is providentially the case in Cornwall. China or white clay—the kaolin of commerce—

is now a flourishing and, let us hope, increasing branch of trade. Experts tell us that this substance is largely the resultant of decomposed granite, its headquarters being in the St Austell district. Unlike coal, iron, &c., it is not secured by sinking long shafts, but is dug out of the open, just as stone is in quarries. Some of these excavations are of enormous size, and contain zigzag paths for the workmen to pass up and down. The clay is pumped up by powerful engines, and then goes through a variety of washing processes to free it from the gritty granite, until ultimately it is turned out in blocks, as white as chalk, to be shipped to a great many parts of the world. It is used for filling cotton, as well as in the manufacture of the finer kinds of pottery, while a large quantity goes to paper-mills to assist in the production of paper. On a very minute scale this same material, dished up with a little scented matter, is sold as tooth-powder. The chief shipping-ports are Par and Fowey, and at the latter place vessels of nearly all the European nationalities congregate for loading purposes. There is besides an inexhaustible supply of granite, and this stone forms a considerable source of revenue. The grey colour predominates, something like the Aberdeen variety, but red sorts are not uncommon, including porphyry and many others to which I cannot give a name. The serpentine rock at the Lizard is, when polished, most beautiful, containing as it does so many different shades; but, save for the making of ornaments, it is not of much use commercially speaking.

Pig-breeding is not despised by the Cornish folks, but more for supplying local demand than for export; and vegetable and flower culture bulk largely in the industries of the county. As already hinted, far more could be done in this way if a little more energy and capital were forthcoming. A large business is also done in fish, the greater bulk of the takes being sent to London, Plymouth, and other large centres of population. Pilchards are caught in great quantities, and, after being preserved, are sent abroad, chiefly to Italy. For the benefit of those who are not familiar with this particular fish, it may be stated that a pilchard in size is midway between a sardine and a herring, and travels in shoals similar to the last named. Unlike herrings, however, they are not gutted, but put into strong salt for several days just as they

come out of the sea, and then packed tightly into barrels for transmission to the markets. Along the coasts one runs across curious little stone towers like miniature castles. These are known as "huer's houses," and were erected as places of vantage from which to watch the advent of the shoals. When these were sighted the watcher raised the hue and cry, and out went the fleet of fishing boats. The word "huer" is, I am told, synonymous with "crier."

We now come to the last division of our subject—viz.,

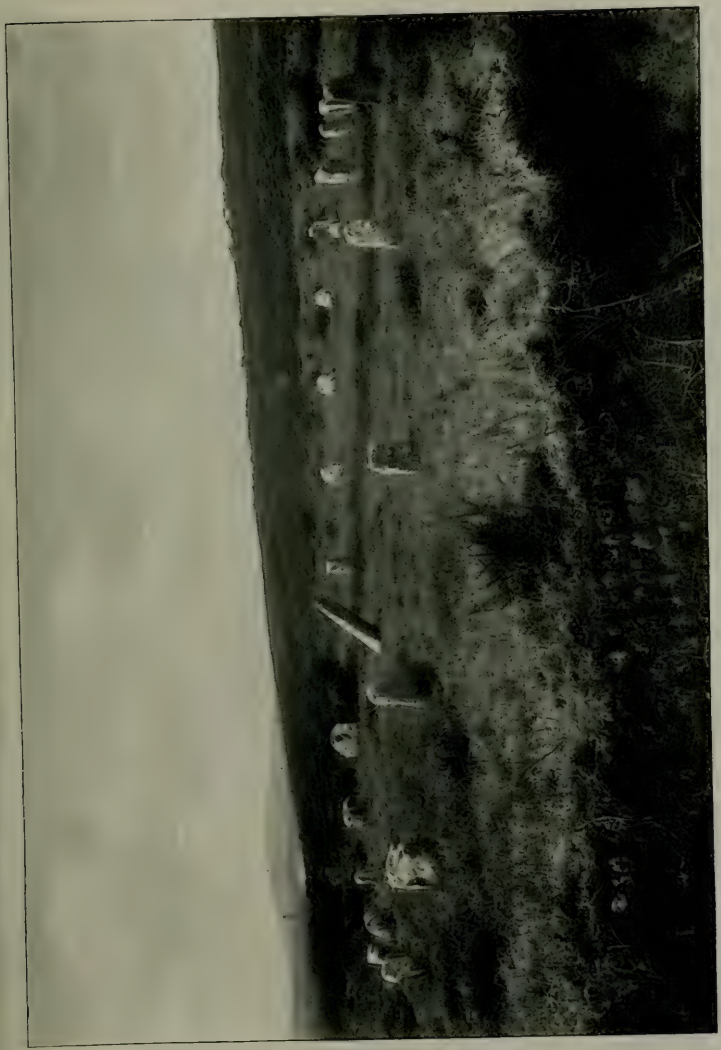
Antiquities, Churches, Etc.

This is far and away the most interesting aspect of Cornwall, especially to those imbued with antiquarian tastes; but even people who have no special leanings in that direction cannot fail to derive pleasure from viewing the fine old churches, the ancient cromlechs, barrows, camps, and other remains, that take us back to a very remote period in British history. It is safe to say that no county in England can boast of so many relics of the past, and attention will now be called, as briefly as possible, to a few of these. Let us take the churches to start with. Many of these are dedicated to saints seldom heard of elsewhere, bearing curious names, a small number of which may be quoted as samples—viz., St Winnow, St Fimbarrus, St Sampson, St Marnarch, St Petroc, St Blaise, St Levan, and St Julitta; while here is a curious fellow to wind up with, St Veep. These form a mere sprinkling of the saintly characters whose names are still perpetuated in stone and lime: in fact, if it were possible to manufacture a hagiological automatic machine, a few turns of the handle would result in the ejection of an assorted gross of the finest saints in the calendar. Old churches spring up everywhere, some of them in very ruinous condition, — notably Lanteglos, near Polruan,—while others are in good preservation. They are, as a rule, built of granite, and are not all externally beautiful, although some, such as St Austell and Fowey parish churches, and others that could be named, are singularly fine in their carving. It would take a long time to describe these, so a very few general remarks must suffice. Those whose interiors have not been modernised and ruined by whitewash and other

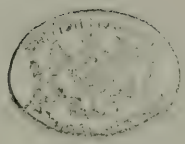
vandalistic processes are, of course, the most interesting, and some of the old oak-carvings on the wagon roofs and pew ends, albeit of a rude type, are really worth studying. In a few the carved chancel-screens still exist, with faded remains of coloured pictures of Scriptural events painted on the panels. Others, again, have armorial bearings still visible on the ends of the box-shaped pews; and in one church there were numbers of wooden boards, like escutcheons, fastened to the walls and pillared arches, with illuminated texts painted on them. Many mural monuments exist, as well as memorial slabs on the floors: some of the former are quite unique in design, the various materials employed in their construction being alabaster, marble, varieties of granite, slate, and even wood painted to represent stone. One evidently was intended for a delineation of the last day; while another consisted of three tiers of dumpy wooden images like Chinese gods, probably portraying three generations. In the parish church of Lostwithiel is a small alabaster carving intended to show the flaying of St Bartholomew, after whom the church is called: one can see a fellow deliberately skinning the martyr with a small knife. These examples could be added to indefinitely. In a few of the sacred edifices were old dilapidated boards in the belfry containing instructions to the bellringers, some of them in doggerel rhyme of the worst type. In St Cleer parish church, near Liskeard, various things were specified that these individuals were to avoid, such as quarrelling, striking, and swearing, under a penalty of sixpence for each offence. Truly the bellringers of olden times would appear to have been rather a rowdy lot!

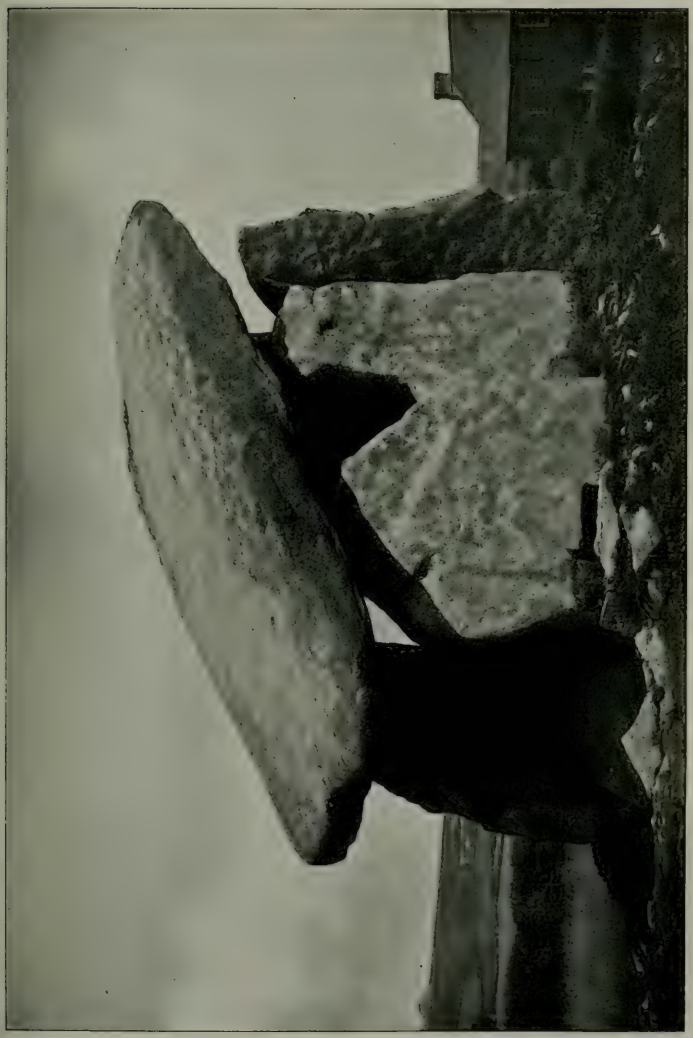
Before passing from the churches to other antiquities, one peculiarity may be brought under notice. In two, if not more, were remains of what is called "The Leper's Squint." To understand what this means, we must go back to days, happily departed, when that loathsome disease leprosy was not so very uncommon in Britain. The wretched sufferers, while prevented from mixing with ordinary mortals, were not entirely debarred the consolation of religious devotions, and were admitted into churches by a side door and allowed to stand or sit in a space apart from the audience, probably screened off. To permit of them seeing the priest at the altar, a slanting

PLATE XXXII.—A WINTER IN CORNWALL.



BOSCAWEN-UN CIRCLE, NEAR PENZANCE.





THE TREVETHY STONES, NEAR LISKEARD.

opening was cut in the wall, and through this slit the unfortunates could see and hear what was going on without giving offence to their healthier neighbours in the building.

Numerous examples of those historical instruments of ignominy, the stocks, are to be found lying about the porches and belfries: fortunately they are merely objects of antiquarian interest nowadays. Granite crosses are of common occurrence all over the county, not only in churchyards, but at the junction of roads, many of them bearing weather-beaten traces of carving: some are very tall, others dumpy, and a few are erected on the top of a series of steps composed of the same material. What are commonly called "Standing-stones" crop up everywhere, some being as high as sixteen feet above ground, pointing, of course, to the fact that they go down into the earth to a considerable distance as well. Another antiquity of frequent occurrence in lonely parts is what is known, presumably for want of a better name, as the "Druidical circle." I ran across some very perfect specimens of these, the finest of which was "Boscawen-un" in the vicinity of Penzance. As you will observe from the illustration (Plate XXXII.), it consists of nineteen stones,—the same number as in another good example in St Buryan neighbourhood designated "The Merry Maidens," but with the addition of a twentieth in the centre. This one lies in a slanting direction, but whether this has been done of set purpose or the stone has slipped over is matter of conjecture. Around these monuments of a bygone age clings a halo of superstition, and the story goes that the huge unchiselled blocks were once men or women turned into stone for some heinous sin committed. Notably is this the case in a circle near the Cheesewring bearing the name of "The Hurlers." Tradition says that a set of men were playing at ball on Sunday, and were turned into granite as a punishment. The game in Cornwall is known as "hurling," and from what I could gather it seems to be something like a pastime which gave intense delight in our youthful days, and which, in Edinburgh at least, bore the name of "dully."

Another fascinating antiquity distributed fairly evenly over the county is the cromlech, or "Quoit" as it is termed locally, supposed to mark the burial-place of some notability crumbled

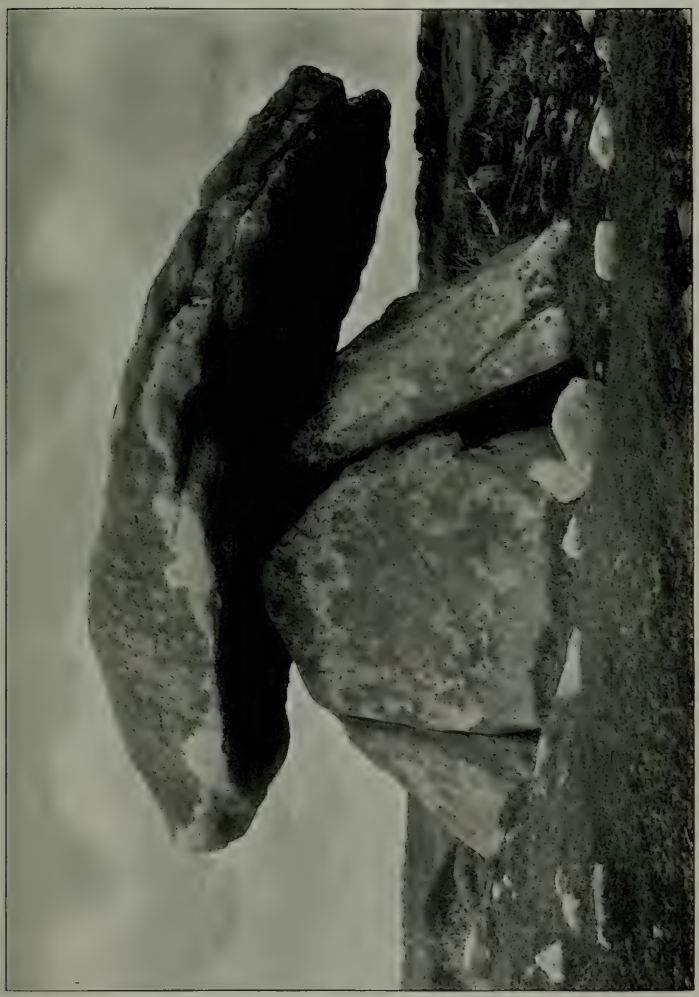
into dust centuries ago. It consists of upright stones, varying in height in different localities, with a huge block laid flat on the top. How these were put in position I do not profess to know, but that they were erected by the hand of man is evident, their construction being quite different from those wonderful freaks of nature such as the Cheesewring, &c., to be noticed immediately. One of the largest and finest of these cromlechs is what is called "The Trevethy Stones," near Liskeard (Plate XXXIII.); but what perhaps exemplifies their construction more aptly, though on a smaller scale, is the famous "Lanyon Quoit," about five miles from Penzance (Plate XXXIV.), and the almost equally famous "Chun Quoit," also near Penzance (Plate XXXV.) In the same neighbourhood as the Lanyon cromlech are other two objects of great interest. One is the "Men Scryfa" or inscribed stone, bearing a set of deeply cut letters which a little trouble can decipher; and the second is the "Men-an-tol" or Crickstone (Plate XXXVI.), the most bizarre curiosity in the county, so far as came under my personal observation. The Crickstone proper is a large round stone shaped like a ring, about three to three and a half feet in diameter, standing on end, and containing in the centre a circular hole about a foot and a half wide. On each side, roughly about eight feet off, are two upright masses rising about three feet from the ground. What this strange relic of the past was originally intended to represent is hard to say, but in later days a use was found for the Crickstone itself. The superstitious believed that certain diseases could be cured by thrusting the unfortunate patient through the hole. This operation may have worked well enough if the person operated upon was thin in body; but when the obese had to be dealt with, the wretched victim was usually sent to his or her long home during the process. On the top of the hill near by are the ruins of the famous Ding-Dong mine already mentioned.

The British circular camp is a familiar object, and, just as in Scotland, is here found on the summit of an eminence. Probably the best example is the Castle-an-Dinas, a few miles from Penzance, which is about 86 yards in diameter; but another very good one is Chun Castle, and this measured about 50 yards across. Mention may also be made of Castle Dore, near Fowey, a good specimen, but woefully spoilt by

PLATE XXXIV.—A WINTER IN CORNWALL.

THE LANYON QUOIT, NEAR PENZANCE.

PLATE XXXV.—A WINTER IN CORNWALL.



THE CHUN QUOIT, NEAR PENZANCE.

dense masses of whin, bracken, &c., which cover up the formation. This old camp was utilised by the Parliamentary forces who opposed King Charles in 1644. In almost every instance all these prehistoric remains stand in wild and barren districts, far from towns and villages. In all likelihood those that existed elsewhere would be destroyed during the march of civilisation, as few are to be seen in the cultivated portions.

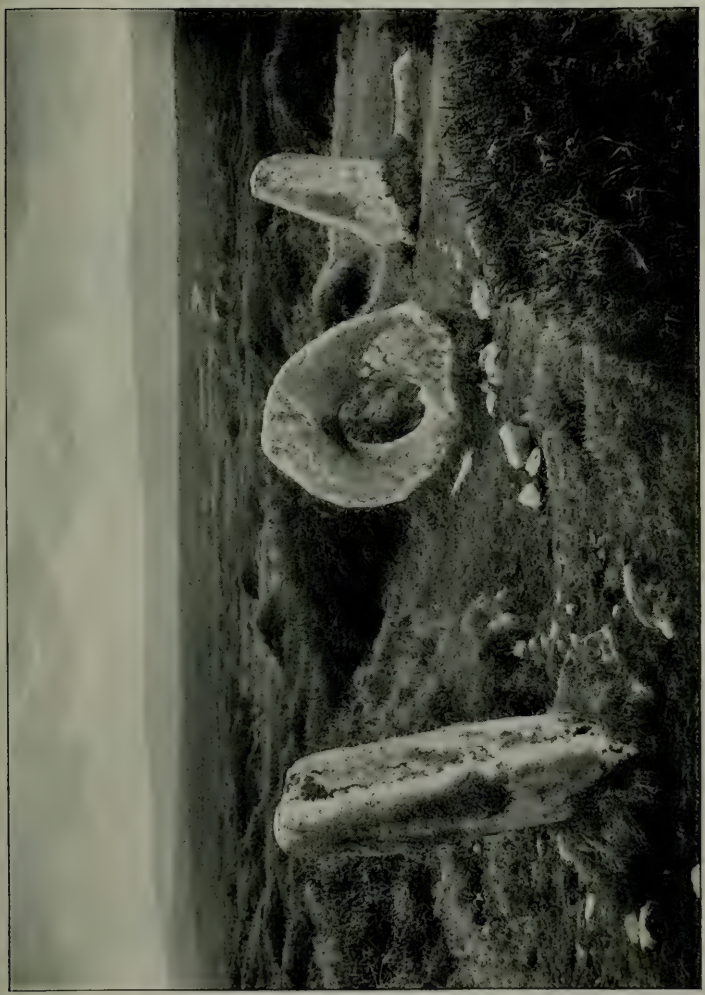
Another most interesting antiquity, of which a few examples are still extant, is what, judging from the ruinous remains, is conjectured to have been a kind of village or settlement, consisting of rude stone huts communicating with each other by means of narrow passages. The two which I had the pleasure of examining were Chysoyster, and one near Caer Brane and Chapel Uny, whose name has escaped my memory,—the latter, if anything, better preserved than the former. The dense mass of vegetation that has been allowed to overgrow these structures hides to a large extent the original ground-plan, and this again is a case of lack of interest on the part of the proprietors and the public generally. The expenditure of a moderate sum of money would go a long way towards clearing out the rubbish, and helping to preserve a few, at least, of these memorials, which in this progressive age are fast becoming a vanishing quantity. Some attempt at excavation has undoubtedly taken place at the example near Caer Brane, and a few of the underground passages, roofed over with immense slabs after the style of the galleries in the Highland brochs, have been cleared out, as also a circular chamber, roofless now, whatever it may have been in its pristine state. Not far from this place is a fine specimen of the bee-hive shaped hut, probably used as a place of sepulture.

Holy wells must at one time have played an important part in the history of Cornwall, as divers instances of these may be discovered all over. Most of them were connected with baptisteries, more or less crumbling to ruin now, save where some philanthropic individual, or body of individuals, have stepped in and prevented further decay by a judicious tinkering up or rebuilding. Numberless were the marvellous cures of sundry complaints that were effected upon sufferers

coming to drink or get bathed in the waters, accompanied by some priestly mummery to add celebrity to the occasion.

Mention has been made of such freaks of nature as the Cheesewring, Helmen Tor, Roche Rocks, &c., and I am fain to confess myself somewhat at a loss how to describe them so as to bring their general appearance to the mind's eye of those who have not witnessed such strange vagaries. Conceive to yourselves huge, unchiselled, shapeless masses of granite shooting out of the level, and suggesting the idea that they had been thrown out of the bowels of the earth during some extraordinary convulsion of nature, piled one on top of another, small blocks supporting others twenty times their size and weight to a bewildering extent. Many of these stones are of an enormous size, weighing several tons, and the question is, How did they get into their present position? To look at them, one would think a good push would be sufficient to knock the larger blocks off the smaller; but in reality, though top-heavy to appearance, they are so firmly fixed that nothing less than dynamite or a regiment of soldiers would move them, and even then the latter would have their work cut out for them. The only theory I have ever heard advanced that savours of feasibility is, that after the great upheaval centuries of rain and tempest washed away the surrounding soil and left the lumps just as they were when underground. This may be right or it may be wrong, but the idea need not be pursued further. The group in the Carradon district, of which the famous Cheesewring (Plate XXXVII.) forms a small part, is perhaps the finest example, and to see this to perfection a wild, wet, misty day is the best, although possibly not the most comfortable. To observe the "haar" driving in clouds across the muir, every now and then being cleared off by a gust of wind so as to reveal the enormous stones standing out in relief against the sky, has a solemn and weird effect, and gives a much better notion of their magnitude than can be obtained through the medium of bright sunshine. It can quite easily be imagined that, among piled-up masses such as these, stones may be found poised in such positions as to be capable of being slightly moved by an exercise of more or less strength. These are known as "Logans" or rocking-stones, and many

PLATE XXXVI.—A WINTER IN CORNWALL.



THE MEN-AN-TOL OR CRICKSTONE, NEAR PENZANCE.

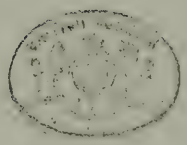


PLATE XXXVII.—A WINTER IN CORNWALL.

THE CHEESEWRING, NEAR LISKEARD.

examples are pointed out to visitors. Some of these are genuine, in so far as they can be made to oscillate slightly; but others are frauds, and only to be believed in by the ultra-credulous.

In conclusion, let me merely reiterate what has already been said, that it is not possible to do justice to this subject in one paper; but if any members of the Society should contemplate visiting this outlying part of South Britain, it will be a pleasure to me to afford them every information in my power, so as to direct them to what I consider the salient features of this most interesting county.

XII.—*AN OUTLINE OF THE GEOLOGICAL HISTORY OF THE COAST OF FIFE BETWEEN ABERDOUR AND KIRKCALDY.*

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(*April 23, 1902.*)

Probably one of the very finest sections of the Lower Carboniferous rocks exposed in Britain is that seen on the coast from near Colinswell, west of Burntisland, to the harbour at Kirkcaldy. A short account of its history may therefore be of interest to the Edinburgh Field Naturalists. The subject may be understood more easily if an outline of the general features in the history of the rocks there be given first, and this be made subordinate to a description of what is actually to be seen.

Following upon the long period of continental conditions with an arid climate which prevailed while the volcanic rocks of the Ochils and Sidlaws were being formed, there ensued a

period of great terrestrial disturbance, during which much of the rock-material previously formed was removed by denudation. If we may judge by the thickness of rock removed during this period it must have been one of immense length, seeing that the whole of the Caledonian Old Red and much of the Orcadian was wasted away in the interval. If, as we seem to be justified in doing, the aggregate thickness of these rocks is estimated at over thirty thousand feet, and the waste proceeded at a rate as high as one foot in *two* thousand years, instead of the usual standard, one in six, the period works out at sixty million years.

Following this period of waste, there commenced a second period of arid conditions, with Britain (or a large part of it) under continental conditions as before. It was the desert sands, the wady deposits, and the sediments deposited upon the floors of the inland lakes of this period which combined to build up the Upper Old Red—those sandstones which lie unconformably upon the volcanic rocks of the Ochils, and whose soft outcrops now form the Howe of Fife. Near the close of the period in question the whole land began to subside, and the arid climate of former times gave place to climatal conditions of a much more humid character. Plants, which had been conspicuous by their absence in the earlier period referred to, now began to flourish under the more genial climate, animals of various kinds gradually spread over the changing surface, and a new order of things commenced.

Presently the land began to be lowered beneath the sea—the part where Edinburgh and Tweedside now are being the first to disappear. Sediments began to accumulate over the old floor of desert-formed rocks, and the lower beds of the Lower Carboniferous rocks were spread out over all the part submerged. But no part of Fife was under water until a later period. Long before that event occurred what is now Fife consisted of a rising ground far above sea level, with a considerable hill formed of Upper Old Red Sandstone over the area where the Lomonds of Fife and the adjoining Howe of Fife are now. In the meantime, the Edinburgh volcano—that from which came the volcanic rocks of Arthur's Seat, the Calton Hill, and Craiglockhart Hills—had slowly raised its head above the waters, and, in course of time, had grown up

to be a volcano as large as Vesuvius, with a big parasitic cone on its eastern flank, where Arthur's Seat stands now. Eventually, this important volcano ceased to erupt, and finally died out as the land continued to sink. Soon after this event estuarine sediments began to be deposited upon the slopes of the Old Red Sandstone hill in Fife, and the sandstones seen below Grange, around Colinswell, and to the east of Aberdour were laid down. These are part of the Granton Sandstone Series. By this time volcanic action, quieted down in the Lothians, had begun to break out in Fife. A series of small cones formed the starting-point of larger volcanoes — in some cases dying out as the points of eruption changed their position. One of these abortive attempts at building up a volcano was met with in the course of some workings to the west of Grange, where the baby volcano was found, smothered in bed, as it were, by a great pile of sandstones which had been heaped upon it.

As the land continued to sink other sediments were formed, each one spreading over a larger area than the one that preceded it—the hill forming what is now the Howe of Fife in the meantime rising far above the water. At this stage the remarkable and widespread deposit known as the Burdiehouse Limestone was formed. It is not, I think, directly of organic origin, but is really a mixture of chemically-precipitated carbonate of lime (with some dolomite) and carbonaceous matter, in nature allied to oil-shale. Soon after this we find evidence that the great series of Oil Shale Beds, whose hydrocarbon is of so much importance in the Lothians, gradually accumulated in the estuary as the land continued to subside. Still the Howe of Fife eminence stood above the waters. It is these Oil Shale rocks, as I pointed out many years ago, which form the great series of strata seen along the Fife coast from St Andrews, past the East Neuk of Fife to near St Monans, and which are also seen around Burntisland and Kinghorn. Early in this period volcanic action commenced in real earnest, and we find clear evidence of the event in the rocks around what is now the Binn of Burntisland. From this centre, or series of centres, one eruption after another took place, chiefly in the form of quiet effusive eruptions instead of explosive outbursts. From this volcano there flowed out to the north, north-east,

and west what amounted in the long-run to a thick pile of basalt lava streams. The fine crag named after King Alexander affords an excellent illustration of the earlier phases of the volcanic eruption here. If we study the beds seen there we shall find a record of many different lava streams piled on each other, with evidence of long pauses between, during which there was a quiet deposition of estuarine or marine sediment. There is no place where this interesting feature can be better observed than at and near Pettycur. Between this point and King Alexander's monument two or three beds of lava are seen, each separated from the other by a small thickness of sedimentary rock, which speak eloquently of the changes in progress at the time these rocks were formed.

Just below the inn at Pettycur there is a bed of lava, rather steeply inclined, as they all are, towards the east. On this bed lies a pile of sediments which have evidently been accumulated in an estuary. Near the base one band of these old sediments includes a big ejected block which must have fallen during an explosive eruption of the neighbouring volcano down through the air plump into the soft mud on the sea bottom. In falling it has crumpled and squeezed up the unconsolidated sediments beneath, as one can readily see. Then, after this interesting little episode, sedimentation went on once more, and covered up the stranger. The volcano had, however, only temporarily quieted down, for we find the higher beds of sediment plentifully mixed with material shot out from the old volcano during one of its explosive fits, which, as before remarked, were not of frequent occurrence. Next comes two or three beds of lava with some little sediment between, as before. Then, just before we reach the point selected for the Battery, we find a thick bed of estuarine sediment containing many spoils of the adjacent land, in the shape of trunks and leaves of the giant Lepidodendroid trees that flourished at no great distance. These, of course, are the ancient representatives of the club-mosses of the present day, or rather of their allies the Selaginellas, but instead of being at the most a few inches, many of these towered to a height of from forty to sixty feet. Following this comes on a thick pile of beds of basalt lava, which form the headland where the big guns have lately been mounted. At Kinghorn harbour comes next above this

yet another group of old sediments, coutaining also trunks and stems of trees like those before-mentioned.

If we review what was taking place inland at this period, which the record of the rocks enables us to do with tolerable certainty, we find that the volcanic rocks which emanated from the Binn did not extend as far to the north as the Howe of Fife; nor, in the direction of the East Neuk of Fife, did they extend as far as St Monance. There is some reason to think that the lava flows did now and then go as far as where Inchkeith is now—though one cannot be quite sure that these may not have travelled from some other vent now concealed beneath the waters of the Forth.

It is quite clear, however, as any one can see by studying the rocks seen on the the shore north of the Abden shipyard at Kinghorn, that the volcano continued in activity some time later, and, indeed, all through the period while the vast pile of strata, some three thousand feet in thickness, which now form the Lothian Oil Shales, were being laid down. The normal conditions existing were evidently those of a great estuarine or delta area, near to the sea in one direction, for marine fish made their way up quite frequently, and not very far from a land surface in another, because the remains of land plants occur in tolerable abundance. The animals *native* to the spot were clearly of the same general nature as those which occur in the water of deltas now. Furthermore, while these conditions obtained, sheets of lava, again and again, rolled downward from the adjoining volcano into the sea, covering up the older sediments as they did so, and in turn being covered by newer sediments as time went on and the subsidences made room on the sea-bottom for their accumulation.

One interesting episode is that represented by the rocks on the shore a few hundred yards to the north of the Abden shipyard. Overlying one of the lavas is a thin bed of shale, one band in which yields *Pteronites persulcatus*, *Streptorhynchus crenistria*, and other fossils, in abundance. This I have called the *Pteronites* bed. At the bottom of this shale, and lying directly upon the scoriaceous surface of an older basalt lava, is a very thin band containing the remains of a considerable number of species of fish. These are all in the form of fragments of bone, scales, and teeth, none of them being connected

with the bones which should naturally be next to them in the complete skeleton. This is the celebrated Abden Bone-Bed which has formed the subject of valuable papers by Dr Traquair.[1] The list may be given here :—ELASMOBRANCHII—*Diplodus parvulus, Tristychius arcuatus, Euphyacanthus semistriatus, Helodus falcatus, Oracanthus armigerus, Caliopristodus pectinatus, Cladodus mirabilis, C.* sp., *Acanthodes* sp. TELEOSTOMI—*Rhizodopsis* sp., *Strepsodus striatulus, Megalichthys* sp., *Cœlacanthus abdenensis, Elonichthys pectinatus, Eurynotus crenatus,* and *Cheirodus crassus.*

Close above the shale which contains the Bone Bed is a thin band of what was formerly volcanic mud. In this a diligent search may be rewarded by the discovery of some interesting ferns, *Rhacopteris inæquilatera* amongst others. Overlying this is a grey limestone, whose light colour stands out conspicuously against the sombre browns and russets of the associated volcanic rocks. Overlying the limestone comes a second fish bed (which cannot easily be got at), and on that lies another band of basalt lava, which forms part of the small headland known as Hoch-ma-toch.

The history of this part of the series is of considerable interest. At the bottom below the Bone Bed is a lava flow. Then there is evidence of a local and apparently sudden destruction of a considerable number of fish (perhaps through some volcanic outbreak close by). Then a record of estuarine conditions, with the volcanic mud being washed into shallow water from the neighbouring volcano. To account for the presence of the limestone we must postulate a change of level probably taking place somewhat abruptly, and the existence of clear sea water, and, I think, of *deep* water too. On the sea floor was then slowly laid down what is part of a sheet of limestone, which, though not very thick, is part of a bed of rock which extended continuously to the south as far at least as Lancashire. I regard this limestone, which we may call No. 1, as the lower part of the Hurlet Limestone, which is so well known in the West of Scotland. I think that the average rate of formation of such a limestone as this, not allowing for pauses in deposition, may be one foot in 25,000

[1] See Trans. Geol. Soc. Edin. (vol. v. p. 310), and Proc. Geol. Assoc. (vol. xv. p. 143).

years. The limestone, all counted, is about ten feet in thickness here. With the advent of the conditions under which No. 1 Limestone was formed, the hill so often referred to as now represented by the Howe of Fife became submerged.

The Bone Bed overlying No. 1 Limestone seems to point to a recurrence of catastrophic conditions; while the succeeding basalt lava may, possibly, suggest a temporary return to shallower water conditions. I think that most periods of subsidence include also local and temporary upheavals—the subsidence being the net result of the whole. On the top of the basalt lava first mentioned is a thin red band, reminding one, so far as superficial aspect goes, of a laterite, or old soil which has been "burnt" by contact with an overlying lava. The latter is there; but it is open to question whether the red bed in question is an old soil or not. At anyrate, overlying the upper basalt lava of Hoch-ma-toch comes more estuarine shale, with a band of red volcanic mud near its base, and graduating upward into grey clay, which in turn passes up into a second limestone of marine origin, which forms long reefs close to the shore. This we shall call No. 2 Limestone.

The shale just mentioned as occurring between the limestone and the underlying lava flow contains many species of marine invertebrata. I have collected from it the following: *Lithostrotion junceum*, two species of coral not determined, *Discina nitida*, *Lingula squamiformis*, *Spirifera trigonalis*, *Streptorhynchus crenistria*, *Orthis michelini*, *Athyris ambigua*, *Rhynchonella pugnus*, *Productus longispinus*, *Productus semireticulatus* (*P. giganteus* occurs in the limestone below), *Nucula tumida*, *N. attenuata*, *Leptodomus* sp., *Pteronites persulcatus*, *Anthracoptera* sp., *Aviculopecten sowerbyi* (which is common), two or three species of Polyzoa, *Loxonema*, two species, *Bellerophon urei*, *Euomphalus carbonarius*, *Macrocheilus* sp., *Naticopsis plicistria*, and two species of *Orthoceras*. Encrinite stems are common, the most abundant being *Poteriocrinus crassus*, but two others are met with. I have given the list (which will probably have to be extended), because the bed in which the fossils occur is one frequently visited by collectors.

The second limestone just mentioned can be traced for about a third of a mile northward along the coast. It is

faulted in a very striking manner just to the south of the rifle target, and in one of the fault fissures this rock is seen to be much dolomitised, and to pass by insensible gradations into Hydrohæmatite or Turgite, which is not commonly recorded in our mineral lists.

Climbing over the cliff above the target we come upon an interesting sea-cavern, which was worn by the sea when the land stood a few feet (say 20) lower than it does at present. It occurs on nearly the same level as most of the other upraised sea-caverns around the coast of Scotland. Why they should have been formed more commonly at the period in question than at any other has not yet been explained.

Going on in the direction of Seafield Tower, we find, in the sandstones which overlie the limestone just mentioned, interesting examples of two intrusive sheets of rock, which can clearly be seen to cut across the rocks in which they occur. At any rate, the eruptive rocks in question are not lavas. As a matter of fact, it is not certain that any outpourings of lava later than the one which supports the target and in which the cavern has been excavated occur in this neighbourhood. Apparently with the subsidence which led to the conditions under which limestone No. 2 was formed the volcano ceased to give forth any more material at the surface. Most of the eruptive rock met with as we go nearer Kirkcaldy, and which is so well seen around Raith, was certainly formed underground, and occurs in the form of intrusive sheets instead of as lava flows. In the two thin intrusive sheets just mentioned occurs Stilbite, which, by the way, can be met with also at Pettycur. It is of the vermilion-red variety.

Going in the direction of Seafield Tower we meet with limestone No. 3, which, like those which preceded it, represents a purely marine deposit, formed, I think, during one of the temporary returns to deep-water conditions which this district underwent. Like the other two, this limestone can be traced far into the north of England, occurring all the way with nearly the same characters, fossils, and thickness.

Next above No. 3 Limestone begin the local representatives of the Edge Coal Series of the Lothians. Here, in Fife, coals are not so marked a feature of these rocks as they are to the south of the Forth. But it may be mentioned that the coal

seams in the Edge Coal Series are, though not always very thick, amongst some of the most persistent sedimentary rocks anywhere known.

The series in which these coals occur occupies nearly the whole of the shore from Seafield to east of Kirkcaldy. It is mainly of estuarine origin. I may remark here that deposits of freshwater origin in the Lower Carboniferous rocks exist only in text-books—the sediments are all either purely marine or else of estuarine origin, under which latter category may be classed the lagoon deposits. I cannot adopt the view that any coals are of terrestrial origin,—at least, any I have yet had an opportunity of examining.

There is not much need to enter into any great amount of detail with regard to the rocks under notice. But no description of the coal section under notice would be complete if it did not contain some reference to the disturbances which the Carboniferous Rocks have undergone. In Fife they have been thrown into a great series of folds, whose axes may be said to range in a north-westerly direction between Kinghorn and Kirkcaldy, and to be north-easterly in the area around Starleyburn, just west of Burntisland. These folds are of post-Carboniferous and pre-Triassic age, for there is clear evidence of their having been folded, faulted, and greatly wasted by denudation, prior to the period last named. Thereafter they were covered first by the Trias, then by the Rhætic Rocks, and finally by those of the Jurassic age. Whether they were covered by the Cretaceous Rocks also may never be determined. The faults just referred to are very well seen at many places on the shore; and they include a remarkable group of small reversed faults or overthrusts, which occur chiefly between Craigfoot and the Tyrie Bleach Works, in one of the limestones.

I think it was but in comparatively recent geological times that the last remnant of the Trias was removed from Fife. It occurred, I think, as a strip extending from Kirkcaldy across the Forth to the east of Inchkeith, and thence along what is now the low ground of the Dalkeith coal-field.

It was from the Trias that the remarkable staining which gave the characteristic red colour to "The Fife Red Measures, d^5," in the first instance arose.

There is not room here to give even a bare outline of more recent events—of the Tertiary volcanic outbursts, or of that interesting episode which I speak of as The Age of Snow. But it may be mentioned in conclusion that, associated with some of the remarkable Raised Beaches so well seen in Fife, there occurs here and there, close to Tyrie Bleach Works amongst others, traces of the boreal molluscan fauna which formerly peopled the Forth.

REPORT OF THE MICROSCOPICAL SECTION.

By Mr JAMES RUSSELL, Convener.

In deciding upon subjects for session 1901-2 the Section wished to pursue the study of some typical forms of Animal and Vegetable Life. With this object in view the members resolved to adopt one or other of the excellent memoirs published under the auspices of the Liverpool Marine Biology Committee—known as "L.M.B.C. Memoirs"—as a text-book. The work of the session was accordingly commenced by the study of the *Ascidia*, treated of in Memoir I.

According to Professor Herdman, Ascidians are now regarded as the degenerate descendants of a very lowly-developed group of the Chordata. Professor Garrod "considers them to be degenerated Vertebrata which should be placed quite at the end of that sub-kingdom." The species studied was the *Ascidia mentula*, specimens of which were kindly procured for the Section from the marine station at Naples by Dr Davies.

After the embryo Ascidia is hatched it leads for a day or two a free-swimming existence, and in this larval stage attains its highest degree of organisation, having developed along with other organs a notochord, thus claiming at this period to rank among the vertebrata. As, however, it approaches its adult state, a process of degeneration sets in. It attaches itself by its posterior end to some foreign body, such as a rock, a stone, or a seaweed. The tail, which formed its organ of locomotion,

disappears, being absorbed into the body or cast off in shreds; the notochord, which gave it rank among the vertebrata, is dissolved; but its outer covering, called the test or tunic, is growing apace, and when it has reached its adult stage it looks more like a piece of inanimate cartilaginous matter than a living thing.

The appearance of the adult Ascidia is something like a leathern bottle with two openings—one at the anterior end, called the branchial aperture, and the other a little way down on the dorsal side, called the atrial aperture. The margin of each of these apertures is divided into a number of small lobes, and the number of these is held to be a means of distinguishing species. In the species under consideration there are eight lobes on the margin of the branchial aperture and six on that of the atrial. As a nerve runs to each of these lobes from the nerve-ganglion or brain, they are the most sensitive part of the animal. This nerve-ganglion is a small mass of dark-coloured matter situate on the dorsal edge, midway between the branchial and atrial apertures. By a little delicate manipulation it can be laid bare, and the individual nerves traced almost to their endings.

As has been said, the outside covering of the Ascidia is called the test or tunic — hence the name of the order, tunicata. This test, which is an excretion from the next inner layer called the ectoderm, is of a cartilaginous consistence, is easily cut with a knife, and when freed from extraneous matter is very transparent. It is traversed by numerous blood lacunæ, the course of which can be easily discerned by the naked eye when a piece is held up to the light. The size of the specimens examined was from four to six inches.

By removing carefully the one side of the test longitudinally the whole internal economy of the Ascidia is laid bare, and we can thus examine the separate parts and see their relation to each other. Next to the test is a delicate layer called the ectoderm, and inside the ectoderm is a thicker layer called the body-wall or mantle. This layer contains a large number of muscles running longitudinally and transversely, and thus forming a kind of network. The mantle surrounds the whole animal, with openings at the two apertures.

Cutting open the body wall, we come to a large organ called the branchial sac. On the ventral side the branchial sac is contiguous with the body wall, but on every other side there is a considerable vacant space between these two. The part of this vacant space at the dorsal side of the branchial sac and extending to the atrial aperture is called the atrial cavity, while the vacant space on the other two sides is called the peribranchial cavity. Extending through this peribranchial cavity are numerous connectives which bind the branchial sac to the body wall.

The wall of the branchial sac deserves close examination. It consists of three distinct series of bars or blood channels:—

1. The transverse vessels which run horizontally round the wall and open into two large vessels which run longitudinally —the one on the ventral side called the ventral blood sinus, and the other on the dorsal side called the dorsal blood sinus.

2. The five longitudinal vessels which run vertically between the transverse vessels and open into them. Between these longitudinal vessels there are five slits called stigmata.

3. The third series of vessels, called the "internal longitudinal bars," run vertically in a plane internal to the previous two series, but are attached to the transverse vessels by short tubes at the crossings, and at these points short papillæ project into the branchial sac.

The ventral and dorsal blood sinuses communicate with each other by means of a transverse vessel near the branchial aperture, so that there is thus intercommunication throughout the whole of the wall of the branchial sac.

Proceeding with our dissection, we cut open the wall of the branchial sac right through the branchial aperture, thus laying this latter out flat. We then find that at the margin of the branchial aperture there is a slight infolding of the test. A similar infolding takes place at the atrial aperture.

Round the neck of the branchial aperture, and also round that of the atrial aperture, run strong muscles called the sphincter muscles: these sphincter muscles resemble much in appearance and function the india-rubber bands which formerly used to be attached to the wrist part of some cloth gloves.

Below the sphincter muscle at the branchial aperture is a

row of tentacles, presumably for the purpose of excluding undesirable substances. Below the tentacles is the pre-branchial zone, bounded on the lower or inner side by two bands called the peripharyngeal bands, which encircle the neck of the branchial sac. The upper of these bands is continuous in its passage round the branchial sac, but the continuity of the lower band is broken by its attachment to two other organs—one on the ventral side called the endostyle, and the other on the dorsal side called the dorsal lamina.

The endostyle is a thick-walled ciliated groove running along the whole length of the ventral side, and terminating both anteriorly and posteriorly in a cul-de-sac. At the anterior end it is in communication with the lower of the peripharyngeal bands.

The dorsal lamina is also a thick-walled ciliated groove, communicating at its anterior end, like the endostyle, with the lower of the peripharyngeal bands, and running down the dorsal side to the œsophagus, the entrance to which it encircles.

The œsophagus forms the entrance to the stomach, an organ of considerable size lying across the left side of the lower part of the body. Its continuation is the intestinal canal, which starts from the ventral end of the stomach, turns back across the body of the animal, and after making two bends, one towards the anterior end of the Ascidia and the other towards the posterior end, it empties itself at the dorsal side into the atrial cavity.

Having got thus far in the dissection of the Ascidia, we are able to trace the course of its nourishment. The branchial aperture is the mouth of the animal, and into this there flows a constant stream of water, carrying with it microscopic particles of organic matter which serve for food. The water passes at once into the branchial sac, then through the clefts or stigmata in the wall into the peribranchial cavity, whence it is ejected through the atrial aperture. The minute particles of food, on the other hand, are caught by the peripharyngeal bands, and carried forward along these towards the dorsal lamina by a flow of mucus secreted in the groove of the endostyle, and urged forward by the ciliary action of this organ. Arrived at the dorsal lamina, they descend this

organ, still forced along by ciliary action, till they reach the œsophagus, whence they pass into the stomach. Here they are subjected to the usual processes which fit them for nourishment, while the refuse passes along the intestinal canal into the atrial cavity, whence it is ejected along with the water through the atrial aperture. The soluble parts of the food which have been fitted for nourishment pass through the wall of the intestine into the small blood spaces, and are thus conveyed to all parts of the animal.

The heart or seat of the circulation of the blood is merely a delicate, slightly enlarged tube, lying behind the stomach. It has no valves, and is connected at its ventral end with the great ventral blood-vessel running alongside the endostyle, and at its dorsal end with the great dorsal blood-vessel running alongside the dorsal lamina. As has been noted, these two large blood-vessels are connected with each other by a circular vessel which runs round the neck of the branchial sac behind the peripharyngeal bands. They are also connected with the transverse and interstigmatic vessels, and from them connectives are also given off to the body-wall and test, so that a complete system of circulation is constituted.

The blood thus leaving the ventral end of the heart passes into the great ventral blood-vessel, and is thence distributed into all the smaller blood channels, and as it passes through these in the wall of the branchial sac it comes into close proximity with the water passing through the stigmata, and thus receives its supply of fresh oxygen, and returns purified by the dorsal vessel to the heart.

A peculiarity in the circulation of the blood in the Ascidia is that it is not continuous in one direction. Its flow from the ventral end slackens, and then stops, when the flow commences in the opposite direction. This change in the direction of the flow takes place every minute or two. The cause of this curious phenomenon is thought to be the blood being forced into the smaller vessels in greater volume than can get through, so that they become engorged, and ultimately force back the blood, thus causing a reversal in its flow.

The Ascidia is hermaphrodite,—that is, it possesses both male and female reproductive organs. These lie close together on the left side of the body alongside the stomach and intestine,

and are provided with delicate ducts which open into the atrial cavity. The mature ova and spermatozoa are thus carried out of the body by the current of water flowing through the atrial aperture.

The type of Vegetable Life chosen for study was Codium, —No. IV. of "L.M.B.C. Memoirs." Codium is a genus of the Siphonaceæ (Confervoid Algæ). It is a marine plant, with branched filaments interwoven into a spongiform frond of a dark-green colour. The species which came under observation was *Codium tomentosum,* a plant about eight inches or so in height, found at the south end of the Isle of Man. It grows in shallow rock-pools at or near low-water mark, and is attached to the substratum by numerous small rhizoids. The fronds are cylindrical, and usually dichotomously branched, and consist of a single multi-nucleated cell. They become thicker towards the apex, and end in a rounded point of a much darker colour than the lower part. Reproduction takes place by the discharge of the contents of certain sporangial cells in the form of numerous small ciliated zoospores. These sporangial cells are borne on the sides of the fronds, on what are called the palisade cells.

Codium was chosen as the type of single-celled plants. A vegetable cell has been defined as "a closed sac composed of an (originally) imperforate membrane formed of the chemical substance called cellulose, this membrane enclosing fluid contents so long as the cell retains its vitality." It is by the aggregation of cells that the plant is built up. Ordinarily the plant consists of an infinite number of cells, each with at least one nucleus, but in the type under consideration the plant consists of but a single cell with an indefinite number of nuclei. The branched filaments of Codium are thus but the extension and modification of the original cell.

Mr Crawford, who conducted the demonstrations, had in addition specimens of allied genera, such as *Botrydium,* a microscopic plant found on damp clayey ground, in which the cell retains its original spherical form. It is attached to the substratum by a ramified filamentous base. *Vaucheria,* an interesting plant, growing in fresh or salt water or on damp ground, and in which the cell becomes filamentous. It is in

the apices of these filaments that the zoospores are produced, and through the orifices of which they escape when ripe. *Bryopsis*, a marine genus growing upon rocks in tide-pools, forming green, feathered, silky tufts from one to four inches high.

On the concluding evening of the active work of the session a demonstration on microscopical manipulation, showing the correct lines on which the illumination of objects under the microscope should proceed, was given by Mr West. This demonstration was much appreciated by the members.

PRESENTATION OF PRIZE FOR COLLECTION OF FRESH-WATER CRUSTACEA.

At the evening meeting of April 23, 1902, Dr Sprague and his daughter, Miss B. Sprague, were presented with the prize awarded to them for the excellence of their collection of fresh-water Crustacea. The prize took the form of the following volumes: 'Cladocera Sueciæ' and 'Copepoda,' by Prof. Lilljeborg, and 'State Report on the Entomostraca of Minnesota.' Mr James Russell, Vice-President, who occupied the chair, in making the presentation spoke of the gratification it gave the Council to recognise, as they now did in this tangible form, the value of the work which had been done by Dr and Miss Sprague in this difficult branch of Natural History. Dr Sprague, owing to the state of his health, was unable to be present, but was represented by his son, Mr Ernest Sprague, who, on receiving the volumes above-mentioned, read a communication from Dr Sprague, expressing the pleasure which he and his daughter had experienced in their search for, and study of, these minute creatures, and of the stimulus they had received in their work from the encouragement held out by the Council in their offer of a prize. The whole proceedings in connection with the presentation were of a most interesting nature,

and the handsome volumes—two of them specially bound in green morocco—were handed over by the Vice-President amidst applause.

A NORTH AMERICAN RASPBERRY AT WEST LINTON.

By Mr J. LINDSAY.

On July 13 of last year (1901) the Society made an excursion to West Linton, when two residents of that place very kindly put their services at the disposal of the members, namely, Mrs Robertson and the late Mr R. Sanderson—the former a well-known local botanist, and the latter equally well known for his intimate knowledge of the district. On that occasion Mrs Robertson showed a number of berries from a shrub which was said to be pretty widely distributed in that locality, and of which a specimen was pointed out to us at Slipperfield. It was believed by several of the members to be an American Rubus, but it was resolved to wait until the following summer in order to secure flowers, which were at this time past for the season. Mrs Robertson duly forwarded blooms about the middle of July this year; and at the beginning of August one of our members on holiday at West Linton, Mr G. R. Hamilton, secured several early berries. Owing to the cold and wet spring and summer of this year, flowers and fruit of the plant were much later than last year. On examination, it was concluded that the shrub was *Rubus spectabilis*, and this has been confirmed by one of our honorary members, Mr Hugh Fraser, late manager to Messrs Thos. Methven & Sons, Nurserymen, who remembers seeing this Rubus in abundance at Dolphinton some twenty years ago, when it was planted in the woods and coppices on the estate of the late John Ord Mackenzie, Esq. of Dolphinton, as a cover for game. The plant seems now to have spread considerably, as it has been found in various places within a radius of six or seven miles.

Rubus spectabilis, or the showy raspberry, is a native of North America, being found on the banks of the Columbia or Oregon river, and was introduced into Britain in 1827. It is a hardy deciduous shrub, growing to a height of five or six feet, and having a stem without prickles. The leaves are in leaflets of threes, each leaflet ovate-acute, unequally serrated, and slightly downy beneath. The flowers, which are slightly odorous, are borne singly on long terminal flower-stalks, dark- or rose-purple in colour, the sepals shorter than the petals. The fruit is very similar in size and shape to the common raspberry of our gardens (*R. Idæus*), but dark yellow or amber coloured, somewhat astringent, and it is said to make excellent tarts. An ornamental species frequently planted in gardens in this country, belonging to the same group of hardy deciduous North American raspberries, is *Rubus odoratus*, the sweet-scented or Virginian raspberry, introduced into Britain in 1800. Unfortunately, the Virginian raspberry, though possessing very handsome leaves, seldom fruits in this country, being unlike in this respect to the subject of this note, *R. spectabilis*, which fruits freely. An allied form, *R. arcticus*, a low-growing hardy herbaceous plant, is also often found in British gardens. Indeed it has been claimed as a native species, from the Highlands, but Hooker, in his 'Student's Flora of the British Islands,' says this claim is made on very doubtful authority. It is common, however, in Norway, Sweden, and Siberia, where it fruits abundantly, though, like *R. odoratus*, very seldom producing berries in Britain. The fruit of *R. arcticus* is of a delicious flavour, and has been characterised by Linnæus as "the prince of wild berries,"—an honour sometimes claimed also on behalf of our native cloudberry (*R. Chamæmorus*).

The presence in the West Linton district of this North American raspberry, *Rubus spectabilis*, is very interesting, and the plant is likely to continue to spread if not interfered with. Birds are very fond of its berries, and they are generally devoured long before they are fully ripe. Mrs Robertson deserves the best thanks of the Society for having drawn the attention of the members to this denizen of a far country.

EXHIBITS IN NATURAL HISTORY.

THE following objects in Natural History, exclusive of those illustrating papers, were exhibited during the session at the evening meetings of the Society. Mr Speedy showed the following: A white thrush from Argyllshire; a cross between a blackcock and a pheasant, shot at The Haining, Selkirk; and wild cats from the Highlands. An Egyptian scarabeus and a Burmese book made of palm leaves were shown by the President; and Tamil school-books made of palm-leaves, by Major Grahame. The Secretary exhibited several Indian insects, as the Atlas moth, the leaf insect, the leaf butterfly, the stick insect, the praying insect, and others; also ova of trout and salmon in different stages of development, sent by Mr J. Thomson, Millholm. An albino mole, caught in Dalmeny Park, was exhibited by Mr Chas. Campbell; a specimen of root-malformation caused by a cockle-shell, by Miss Sprague; and the following by Mr Pinkerton: Bipalium Kewense, a carnivorous worm; Peziza (Helotium) æruginosa, in fruit; and a locust (Acrydium Ægyptium) sent by Mr Tomlinson, Musselburgh, as having been got alive in a crate of vegetables there.

A number of lantern slides prepared by members were shown on the screen during the session. These included the Hanging Gardens of Babylon, from an engraving in 1685, by the Secretary; four slides of sand, by Mr Forgan; and a slide of St Catherine's Chapel, at Glencorse Reservoir, photographed by Dr Davies on October 24, 1901, when the chapel was visible at the bottom of the reservoir, owing to the prolonged drought. Mr Bruce Campbell exhibited a slide of the nest of the great tit in a pheasant feeding-box; also a slide showing the difference between a stock-dove and a wood-pigeon. A large number of micro slides were also shown at the evening meetings by various members of the Society. Mr Terras exhibited slides of red, brown, green, and blue algæ; Mr T. Wright, several parasites and ticks; Miss Huie, trans. sect. of common wood-louse, Euglena viridis stained and sectioned, trans. sect. of rat

intestine with leucocytes, embryo mouse, and a few botanical preparations; while Dr Davies showed an interesting collection of living specimens, mostly from the Upper Elf Loch, Braids. Mr J. Lindsay also exhibited a number of slides illustrative of the structure and life-history of sponges and sea-urchins.

Among the Natural History exhibits of last session, one of a very interesting nature was then omitted to be mentioned—viz., a piece of luminous wood, covered by the mycelium of a fungus. This was shown by Mr James Adams, Dunfermline, and gave rise to some discussion amongst the members.

ADDRESS BY THE PRESIDENT,

ARCHIBALD HEWAT, F.F.A., F.I.A.,

TO THE ANNUAL MEETING OF THE SOCIETY ON THE 22ND OCTOBER 1902.

WHEN, a year ago, you did me the honour of electing me President of our Society—after I had served for three years as a Member of Council and thereafter for three years as one of the Vice-Presidents—I accepted the position with much hesitation, for I can make no claim to be considered a scientific naturalist, however much I may admire and enjoy the marvellous works of Nature. In this I am like him who is "contented if he but enjoy the things that others understand." Business has been too engrossing for me to have found that leisure I should have been so glad to have spent in nature-study—which introduces to the kingdom of the sublime. My election, however, having been alike unanimous and harmonious, I felt sure that, in endeavouring to discharge the duties of the chair, I could rely upon the hearty support and assistance not only of the members of council but of the membership of the Society as well. In this I have been in no way disappointed; and I desire to avail myself of this opportunity of thanking you for having overlooked my defects, and for having

made the discharge of my duties so pleasant and so agreeable as I have found them to be. You have done this in the best and most practical form, for it is with no small satisfaction that I find myself able to inform you that, not only has our membership during the past session reached the highest number of the past fourteen years, but the attendance also at our indoor meetings has, I think, seldom been better. Thirty-three new members were admitted during the session. The phenomenally bad weather of last spring and early summer is alone to blame for our field-excursions having been, on the whole, not quite so pleasant and so successful as in former years. This is all the more to be regretted seeing that the places selected for our excursions had met with such general approval by the members.

I do not propose to detain you this evening with a review of the work of the past session. That you may yourselves do, far better, by looking over the billets of the sessional meetings and the lists of excursions, as well as by a careful perusal of the 'Transactions,' when ready, at your own firesides.

I would however remind you of the charming variety of the subjects and objects which have been brought before us. Such as could be observed and handled alike in the field, the laboratory, and the study; by the unaided vision, as well as by that marvellous revealer of vast and otherwise unknown realms—the microscope.

Our programme is limited by the bounds of Nature alone, and the mind of finite man can place no bounds upon the Infinite, who works and reveals Himself through Nature which can be seen and felt, as well as through the Spirit which, like the wind that bloweth, is unseen and impalpable.

We have studied birds and beasts, fishes and insects, plants and rocks. We have compared and contrasted them. We have considered their uses in the economy of Nature. We have seen them in their beauty as a whole, and we have dissected and microscopically examined them, discovering something of their inner workings, their marvellous construction and adaptability to the functions they have to perform, and to the environment in which they exercise them. We have considered things antiquarian too, for these bring us to contemplate man himself—the greatest, because the highest, work of Nature.

We have wandered afield under the gladdening sun and the moistening rain — the two chief supporters of animal and vegetable life. We have seen Nature at home busying herself with her manifold everyday duties, never resenting a call from the reverent and sympathetic naturalist, to whom she has much to say, much to reveal, and of which those who pass by on the other side, caring for none of those things, know nothing—to their great loss.

What refreshment of spirit, stimulus of mind, and invigoration of body have we not received through our communings with Nature, out under the blue canopy of heaven or in under the roof of our own cosy curtained sanctum? It is this, and such as this, that raises us to a higher ideal of true manhood, with its infinite possibilities and great responsibilities, which reveals an ever-widening horizon, taking us out of our narrow, hardening shell, and causing us to look upon the affairs of everyday life with a real and increasing interest.

We can find everything in Nature if we only know how and where to look for it. An observer has discovered in the animal world a type of the man who lets everything alone and takes not the slightest interest in the affairs of life—the *oyster!* He says that, so far as he knows, "it really lives a blameless life, is always sober, never fights, does not interfere with its neighbours' affairs. It pursues the quiet peaceful life which is the outcome of a good digestion and a hard head. It interferes with nothing, it cares for nothing." That is mere selfish animal existence, and of a low type. The naturalist cannot descend to a life like that—and remain a naturalist. Therefore, let as many as can become naturalists, rise above the mere oyster-existence and aspire to be intelligent, active, useful citizens, no matter what their daily occupation may happen to be. Nature-study knows no social rank; it elevates all who engage in it, and begets and prolongs true friendships.

The naturalist who studies the ever-open book of Nature discovers much by which to arouse himself and his fellows. If he finds himself becoming lazy, with a tendency to business, or intellectual, "loafing," he can "go to the *ant* and consider her ways." If he is becoming careless and improvident, let him

go to the *bees* and observe their skilful, plodding, well-planned labour; and to these again—the ant and the bee—let him go when he finds too great individualism, or the tendencies of the anarchist, developing within him; for there he will find law and order—inferiors, superiors, and equals all working together in perfect harmony for the good of the community as a whole. By such observation he will find much to encourage and stimulate him to become a good citizen; and there he will find successful co-operation and the good fruits of wise and prudent "combines."

From these and "the *squirrel*, flippant, pert, and full of play," with, if not because of, its accumulating store, he gets the idea of the savings bank, and learns to "make hay while the sun shines" and so provide for the proverbial, if all but inevitable, "rainy day." When he thinks of his duty towards those who may be dependent upon him, he gets his lesson from the *pelican*, which, in poetic fancy, gives its life for its young, and he straightway goes and assures himself, so that when his life ebbs away the proceeds of the life assurance policy may be equally beneficial to the nestlings he may leave behind. And, when he thinks of his habitation, with its goods and chattels, he remembers the fabled *phœnix*, out of whose ashes arises another nestful, and off he goes to seek the benefits of fire insurance. The operations of the stock exchange, too, do not escape the observations of the naturalist, for in them he sees what is not unlike the upward tossing of the *bull* with its horns, and the downward pulling of the *bear* with its paws—the innocent *lamb* looking on the while, not knowing how much its fleece is an object of keen desire to some of those who keep the bulls tossing up and the bears pulling down!

As membership in our Society is not limited to the lords of creation, I am glad to find our proceedings this evening graced, as usual, by the presence of so many ladies. To them may I venture to say—Do not be over-anxious as you wrestle for a solution of that vast and highly important, though most distracting problem, "Wherewithal shall I be clothed?" Take your vasculum, come with us on one of our excursions, and "consider the *lilies* of the field." They will proclaim to you, in eloquent silence, that without toiling or spinning on their

part they excel in grace and beauty even Solomon, who in all his glory was not arrayed like one of them.

To ambitious men, and especially to those whose dreams have not yet been realised, let me say, the best specific for their disappointment, and its consequent depression, is to "behold the birds of the heavens"—"ye gentle birdes! the world's fair ornament and heaven's glorie"—soaring upwards on untrammelled wing, sweetly singing with glad unburdened hearts, rejoicing in the beauty and freedom of their very existence; life to them, in such circumstances, being really worth living.

A *spider* may be a small and insignificant item in this vast universe, but even it finds its home in kings' palaces; as one did in what could be called a palace simply because, for the time being, the place gave shelter to a distressed and baffled king. Was it not to that historic spider, and to the observations thereon of an unconscious naturalist, that we Scots owe our freedom and independence as a nation? Because King Robert the Bruce read from the book of nature—observing the perseverance of that difficulty-overcoming spider—and was thereby encouraged to strike his final but successful blow for freedom, we in Scotland were able to join with heart and soul in those loud and loyal acclamations of joy which burst from a great patriotic nation and empire—greater than the world had ever seen—when, less than three months ago, in that brilliant assembly in Westminster—Scotsmen occupying uppermost seats—and on the Scottish Stone of Destiny, was crowned King Edward I. of Scotland and VII. of England, who wears his crown to-day by right of his descent from that royal Scottish naturalist of six centuries ago!

A careful observer has recently had to go to natural history to find an adequate description of what, in his opinion, are the qualifications necessary to fit one to become a Member of Parliament. These, he says, are "the constitution of an *elephant* or an *ox*, the digestion of an *ostrich*, and the jawbone of an *ass*"—and he must know, for he is not only himself a member, but he has several relatives in the House of Commons.

Where would be our trade and commerce, our supremacy on the seas, but for the observations of naturalists? Britannia

might never have ruled the waves as she now does had not a Scottish observer—James Watt—improved, if he did not actually invent, the steam-engine; and had the object-lesson of the *duck's* foot not suggested the paddle, as did the tail of the *fish* the screw-propeller of the ocean-going *greyhounds.* That marvellously-constructed and skilled navvy—the *mole*[1]—has taught our engineers how to tunnel through great mountains and under broad rivers. Careful observation of its cylindrical form, of the shape and working of its excavating forepaws and propelling hind-legs, show how admirably the mole has been adapted to tunnel-boring. It also, I would remind you, affords us a warning to use and exercise all our faculties, lest by disuse any of them becomes atrophied. It has the organs of vision, but, as burrowing underground does not call them into exercise, they have all but died out. Let each of us then, as naturalists, use our eyes, and not become "blind as a mole" as we walk through this beautiful world.

I fear I may have been presenting too low, too sordid a view of nature-study in thus linking it with trade, commerce, politics, and suchlike worrying, care-begetting items of the daily struggle of modern life. We who are immersed in them would rather seek relief from them and find refreshment by going out into the wilderness, where, in the hallowed calm, we would be alone with Nature, to hear and to see what can be neither heard nor seen in the roar and rush of city business life. Fortunately, we are so constituted that, when otherwise confined, we have only to close our eyes and abstract our mind from the "business" in hand to find ourselves, in memory and in imagination, living over again pleasant and profitable rambles of past and sunnier days. We can thus, almost by a mere effort of the will, bring in to our pent-up business life a glint of the blue sky, a breath of the heath-clad hill, a whisper of the murmuring stream, and an echo of the music of some feathered songster, which will revive and send us on our way rejoicing—the pleasant past uniting with the hopeful future in carrying us cheerily through present, if arduous, toil.

Robert Burns, as did many another, got his poetry out of his daily toil. While others saw nothing but the brown earth yielding to the relentless plough, he held sweet converse with

[1] See 'Transactions,' vol. iv. pp. 150 *et seq.*

such a "wee, sleekit, cow'rin', tim'rous beastie" as the common *field-mouse*, with whom he claimed to be its "earth-born companion an' fellow-mortal." As he looked upon its "wee bit housie," cosy for the coming winter but ruined when the cruel coulter passed through it, he enunciated a humbling truth when, moralising, he said, "the best laid schemes o' mice and men gang aft a-gley." He saw deeper than most men into the "wee, modest, crimson-tipped flow'r" which we all know as the common *daisy*, or gowan, for he saw in its untimely end that often, even before "the grass withereth" or "the flower fadeth," in ordinary course, man—as in his own case—is soon cut off, even in his prime; for, again moralising, he says:—

> "Ev'n thou, who mourn'st the Daisy's fate,
> That fate is thine—no distant date;
> Stern Ruin's ploughshare drives elate,
> Full on thy bloom;
> Till crush'd beneath the furrow's weight,
> Shall be thy doom!"

It is here that a Society such as ours comes in to offer the kindly, sympathetic help and direction so much needed in guiding and interesting busy folk in the observations of Nature and in their attempts to read the lessons she longs to teach.

Our winter sessional meetings, our summer field-excursions, and our indoor microscopical work, afford large and pleasant opportunity for that refreshing, invigorating, and elevating relaxation which we all need. The apparatus may be as complicated or as simple as we choose. One thing, however, that is absolutely necessary—assuming the sympathetic spirit of the true lover of nature—is an observant eye, aided, if need be, by a good field-glass.

It is the living, growing animal and plant that should be studied, rather than the dead "specimen"—the mere "mass of tissues and vessels, a stuffed skin or a skeleton"—killed it may be from sheer wantonness or by one unworthy of the name of naturalist, only to fill "his private collection, and destroying for himself and others the possibility of observing and studying their life." The true and reverent naturalist respects life, and would grant even "The Mouse's Petition":—

"Oh, hear a pensive prisoner's prayer,
For liberty that sighs;
And never let thine heart be shut
Against the wretch's cries!
. . . . . .
If e'er thy breast with freedom glow'd,
And spurned a tyrant's chain;
Let not thy strong oppressive force
A free-born Mouse detain!
. . . . . .
The well-taught philosophic mind
To all compassion gives;
Casts round the world an equal eye,
And feels for all that lives."

How much does the observant, tutored eye add to the pleasure of a ramble in the country! It transforms what might otherwise seem to be but the bare walls of an unsightly warehouse into a gallery of the most beautiful of pictures—baffling to the most skilled of artists—which neither wealth can purchase nor power deprive us from seeing and enjoying.

Nature, too, comes in at last with her kindly hand, tucks in snugly under the daisies, covering with her lovely mantle the decay that comes at last to all here below, concealing that death which, had we but eyes to see, is really but the beginning of a new and better life.

In our rambles we have wandered around and within the roofless, ruined abbey, with its grass-grown floor, its unglazed and broken windows, its desolated aisles and its crumbling walls, painted, as no human artist ever could, with the silver-grey and golden-yellow of the close-clinging *lichen;* adorned with the *wallflower,* "grey Ruin's golden crown that lendest melancholy grace to haunts of old renown"; the *moss,* "nature's livery round the globe"; the graceful *fern;* the repellent *nettle;* and "old Scotia's sweet *blue-bell*"; the *yew-tree,* which "lends its greenness to the grave"; the *thistle,* also, "pledge to the memory of departed worth"; and verdantly covered over by the *ivy,* whose "home is where each sound of revelry hath long been o'er; where songs' full notes once pealed around, but now are heard no more," and which "lov'st the silent scene, around the victor's grave." We hear, too, the

coo of the *dove*, the screech of the *owl*, the chatter and the song of many a feathered occupant of these forsaken haunts of men. As we think of their ministries of teaching and of healing, of preaching and of alms-giving, of hospitality and of learning, we try to recall the priest at the altar, the cloistered monks, the chanting choristers, and the worshipping assemblies of the now ruined, but erstwhile magnificent, fane. The belted knight, too, of lordly mien, with his squires, their ladies fair and their feudal dependants, who owned and ruled from the strong castle which is now a mere empty shell and crumbling ruin—fit emblem of man's feeble and fleeting power. But now, alas!—

> "The breezes of the vernal day
> Come whispering through the empty halls,
> And stir, instead of tapestry,
> The weeds upon the walls."

While we are glad to reassemble and enter upon the work of a new Session, our Annual Meeting, at which we mark time, reminds us of comrades who have fallen by the way. We mourn the loss of Colonel W. Ivison Macadam, who, a few months ago, was struck down at the post of duty, wearing the King's uniform, as he was about to leave for London to take his place and part in the Coronation celebrations. Colonel Macadam joined our Society in 1875, when it was merely a Field Club, and had served on the Council. It was on his motion that our winter evening meetings were commenced in 1879. Mr Heggie, too, has gone, and we are the poorer by his removal. He entered the Society in 1881, and had served on the Council.

Let us who remain endeavour to extend the usefulness and the membership of the Society, attend its meetings with regularity, contribute to its 'Transactions,' take part in the discussions, and, when spring-time comes again, go out on the field-excursions. Thus shall we do good to others while getting benefit to ourselves.

ANNUAL BUSINESS MEETING.

THE Society held its Annual Business Meeting on October 22, at 20 George Street, when the President, Mr Archibald Hewat, occupied the chair. After the adoption of the minutes, a specimen of the motherwort (*Leonurus cardiaca*) grown as a garden plant at Portobello, sent by Mr Calder, and a stem of bramble galled by *Diastrophus rubi*, shown by Miss Sprague, were submitted for the inspection of the members. Mr A. Murray intimated that he had seen a nest, with young, of the window-swallow or house-martin (*Hirundo* or *Chelidon urbica*) at West Savile Road on September 29, 1902, and had kept it under observation until midday on October 8, when soon after the birds left the nest. Messrs Bruce Campbell and Tom Speedy both referred to instances of second broods of the house-martin lingering until late in the season.

The reports of the adjudicators in the Prize Competitions were next taken up. The following report by Mr Alexander Somerville, B.Sc., F.L.S., was read:—

The collection of Grasses bearing the motto "Sesleria," consisting of 134 sheets of specimens gathered in the counties of Edinburgh, Haddington, and Linlithgow during the summer of this year (1902), reflects the highest credit on the competitor for the Society's prize, and I may say at once that I consider that it well deserves the prize.

Whether we consider the care exercised in selecting illustrative specimens, the success that has attended the drying of them, the neatness and taste in mounting them, or the accuracy observed in naming so large a series, we cannot but feel admiration for the industry and skill of which there is so clear evidence, and which have admitted of the formation, in a single season, of a collection of such outstanding excellence.

An examination of the sheets enables us to group the plants under five heads, as follows:—

(1) Species indigenous, or probably so, in Scotland . .	61
(2) Varieties of species indigenous, or probably so, in Scotland .	24
(3) Species indigenous in England, but appearing as "casuals" only in Scotland	14
(4) Alien species which are "casuals" only within the British Isles	19
(5) Unnamed sheets (13), and duplicates (3) . . .	16
	134

Of indigenous species, 61 is a large number to have been met with in one summer season, especially when we group with them the 24 sheets of varieties of various of these species. The Grasses, however, which fall to be included under the next two heads—viz., the "casuals" and "aliens," are, as a group, almost more remarkable. No less than a quarter of the whole collection were found at the Leith Docks, indicating how the exchanging of merchandise between countries tends to make additions to their respective floras.

The arrangement of the collection is after Hayward's 'Botanist's Pocket-Book.' It might have been well, in the case of a collection of such magnitude, to have adopted the arrangement and nomenclature of 'The Student's Flora,' or of the 'London Catalogue of British Plants,' 9th edition; but in this matter the collector was left free to exercise his choice.

In regard to one or two sheets I have to remark as follows:—

19. *Agrostis canina*, L. This seems to be rather *A. alba*, L. There are no awns, and the leaf sheaths are not smooth.
50. *Schlerochloa maritima*, Lindl. The specimens here—which are a little misleading—I think must be considered to be *Festuca rubra*, L.
51. *Schlerochloa loliacea*, Huds. This, I fear, is only *S. maritima*, Lindl.
65. *Festuca Myurus*, L. I fear this is but a luxuriant form of *F. sciuroides*, Roth., or an alien species.
68. *Festuca ovina*, L. Rather *F. rubra*, though specimens of the two species are sometimes very much alike.

It may be of interest, in conclusion, to mention that the following species in the collection—some of them abundant in the east of Scotland—are absent from, or are but rare "casuals" in, the west—viz., *Phleum arenarium*, L., *Alopecurus agrestis*, L., *Avena flavescens*, L., *Poa compressa*, L., *Glyceria distans*, Wahlenb., *Lolium temulentum*, L., and *Hordeum murinum*, L.

ALEX. SOMERVILLE, B.Sc., F.L.S.

18*th October* 1902.

On the envelope bearing the motto "Sesleria" being opened, it was found that the collection had been made by Mr Allister Murray, Royal Blind Asylum, Craigmillar, and the prize was accordingly awarded to him. The following is the list of Grasses:—

[LIST

LIST OF A COLLECTION OF GRASSES GATHERED IN THE COUNTIES OF EDINBURGH, HADDINGTON, AND LINLITHGOW, FROM JUNE TO SEPTEMBER 1902.

(*The arrangement is after Hayward's 'Botanist's Pocket-Book.'*)

1. Setaria Italica; Leith Docks, Sept.
2. Phalaris arundinacea; Pond, Inveresk, Aug.
3. canariensis; North Berwick, Aug.
4. (?) ; Leith Docks, Aug.
5. paradoxa; Leith Docks, Aug.
6. Anthoxanthum odoratum; Esk, July.
7. elegans; Granton, Sept.
8. Phleum pratense; railway bank, Inveresk, Aug.
9. arenarium; Leith Docks, Aug.
10. Boehmeri; railway bank, Inveresk, July.
11. pratense, var. bulbosum; Canal bank, Sept.
12. pratense, var. stolonifera; Canal bank, Sept.
13. Alopecurus pratensis (common everywhere).
14. geniculatus; Duddingston Loch, July.
15. agrestis; Colinton, Aug.
16. Gastridium lendigerum; Leith Docks, Sept.
17. Milium effusum; Avon, July.
18. Apera Spica-venti; Leith Docks, Aug.
19. Agrostis canina, Pentlands, Aug.
20. Eragrostis elegans; Leith Docks, Aug.
21. Agrostis vulgaris, var. pumila, Pentlands, Aug.
22. alba; railway bank, Inveresk, July.
23. alba, var. stolonifera, Craigmillar Quarry, Aug.
24. Ammophila arundinacea; shore, Longniddry, July.
25. Arundo Phragmites; Duddingston Loch, Aug.
26. Aira cæspitosa; railway bank, Inveresk, Aug.
27. flexuosa, Pentlands, Aug.
28. caryophyllea; railway bank, Inveresk, Aug.
29. præcox; railway, Gorebridge, July.
30. Aira cæspitosa, var. lutescens (?); Caribber Glen, July.
31. Avena fatua; Leith Docks, June.
32. strigosa; field, Davidson's Mains, July.
33. pratensis; Arthur's Seat, Aug.
34. pubescens; Borthwick Castle, July.
35. flavescens; shore near Gosford, July.
36. sativa; Leith Docks, Aug.
37. Arrhenatherum avenaceum; railway bank, Inveresk, July.
38. avenaceum, var.; shore, Dalmeny, Aug.
39. avenaceum, var.; clay-hole, Portobello, Aug.
40. Holcus lanatus; railway bank, Inveresk, Aug.
41. mollis; Roslin Glen, Sept.
42. Triodia decumbens; Pentlands, Aug.
43. Koeleria cristata; shore near Gosford, Aug.
44. Melica uniflora; Roslin Glen, July.
45. nutans; Avon, July.
46. Molinia cærulea; Pentlands, Aug.
47. Catabrosa aquatica; Duddingston Loch, July.
48. Glyceria aquatica; Canal, Craiglockhart, Aug.
49. fluitans; Duddingston Loch, July.
50. Schlerochloa maritima; shore, Aberlady, July.
51. loliacea; shore near Gosford, Aug.
52. distans; Leith Docks, Aug.
53. distans, var. Borreri; Leith Docks, Aug.
54. rigida; Peffermill, July.
55. Poa annua (common everywhere).
56. pratensis; Craigmillar Park, July.
57. compressa; railway bank, Inveresk, Aug.
58. trivialis; Craigmillar Park, July.
59. nemoralis; Leith Docks, Aug.

60. Poa nemoralis, var.; Leith Docks, Aug.
61. (?) ; Almond near Cramond, Aug.
62. Briza media ; Pentlands, Aug.
63. Cynosurus cristatus ; Blackford Hill, Aug.
64. Dactylis glomerata ; Blackford Hill, June.
65. Festuca Myurus ; Leith Docks, July.
66. sciuroides ; railway bank, Inveresk, Aug.
67. sciuroides, var. nana ; railway bank, Inveresk, July.
68. ovina ; shore near Gosford, July.
69. ovina, var. tenuifolia ; Pentlands, Aug.
70. rubra ; railway bank, Inveresk, July.
71. elatior ; Almond near Cramond, Aug.
72. (Blank.)
73. pratensis ; Almond near Cramond, July.
74. pratensis, var. loliacea ; East Meadows, Edinburgh, July.
75. gigantea, var. triflora ; Esk, near Inveresk, Aug.
76. gigantea ; Caribber Glen, July.
77. Bromus erectus ; Leith Docks, Aug.
78. asper ; Almond near Cramond, July.
79. sterilis ; Craigmillar, July.
80. madritensis ; Hailes Quarry, Sept.
81. maximus ; Hailes Quarry, Aug.
82. secalinus ; Leith Docks, Aug.
83. secalinus, var. vulgaris ; pit refuse, Niddry, July.
84. racemosus, var. ; Bonally Road, Aug.
85. racemosus, var. ; Craigmillar Quarry, Aug.
86. mollis ; Craigmillar Quarry, July.
87. arvensis ; shore near Granton, July.
88. arvensis, var. ; Leith Docks, July.
89. arvensis, var. ; July.
90. (?) ; Leith Docks, July.
91. (?) ; Granton Quarry, July.
92. Bromus (?) ; Granton, Aug.
93. unioloides ; Leith Docks, Aug.
94. tectorum ; railway bank, Inveresk, June.
95. Brachypodium sylvaticum ; Caribber Glen, July.
96. Triticum caninum ; Canal, Slateford.
97. caninum, var. nemorale ; Almond near Cramond, July.
98. repens ; Canal, Slateford, Sept.
99. repens, var. aristata ; Craigleith, July.
100. repens, var. littoreum ; shore, Cramond, Aug.
101. repens, var. ; shore, Cramond.
102. repens, var. ; Cramond, July.
103. junceum ; shore, Longniddry, July.
104. junceum, var. ; North Berwick, Aug.
105. hybernum ; Leith Docks, Aug.
106. æstivum ; Leith Docks, Aug.
107. æstivum, var. ; Leith Docks, Aug.
108. Lolium perenne ; Craigmillar Park, Aug.
109. perenne, var. ramosum, North Berwick, Aug.
110. Italicum ; Craigmillar Quarry, July.
111. Italicum, var. ; Craigmillar Quarry, Aug.
112. Italicum, var. ramosum ; Leith Docks, Aug.
113. Italicum, var. ; Leith Docks, Sept.
114. temulentum, Leith Docks, July.
115. temulentum, var. arvense ; Leith Docks, July.
116. linicola ; Craigmillar Quarry, July.
117. Various forms of Lolium Italicum.
118. Elymus arenarius ; North Berwick, Aug.
119. Hordeum murinum (common everywhere).
120. bulbosum ; railway bank, Inveresk, July.
121. jubatum ; Leith Docks, Aug.
122. distichon ; Leith Docks, Aug.
123. hexastichon ; Leith Docks, Aug.

124. Hordeum vulgare; Leith Docks, Aug.
125. Secale cereale; Leith Docks, Aug.
126. Nardus stricta; Pentlands, Aug.
127. Panicum (?); Leith Docks, Sept.
128. (?) ; Almond near Cramond, July.
129. Panicum (?); Roslin Glen, Aug.
130. (?) ; Leith Docks, Aug.
131. (?) ; shore between Granton and Cramond.
132. (?) ; Leith Docks, Aug.
133. (?) ; near Granton.
134. (?) ; Leith Docks.

The following report by Mr James M'Andrew was then read:—

For the President's three prizes for the best collections of Natural History objects collected during the summer by juveniles, two competitors have sent in packets—one of grasses and the other of lichens. These packets have been handed to me for my opinion as to their merits. The collection of grasses contains a goodly number of the common species, a few foreign grasses from the garden, and a few plants which are popularly named grasses, as Rib-grass, Grass of Parnassus, &c. All these are correctly named with the popular names, and are very neatly mounted. In criticising the collection I would point out that the Latin botanical names should also have been given, and that complete specimens of each grass, including roots and leaves, should have been mounted. This is a very common and natural mistake on the part of amateur botanists.

The collection of lichens is confined to the species which have been more or less used for dyeing purposes, called *crottle* lichens. A few of the specimens mounted are incorrectly named, which, considering the difficulty of Lichenology, is not to be wondered at. The collection, however, is very praiseworthy, and its value is enhanced by a very good introductory essay.

It is almost impossible to judge fairly between two such dissimilar collections. The collection of grasses is the more correct, but this is balanced in the case of the lichens by the essay. As there are only the two competitors, and as both deserve a prize, I would recommend, if the President and members are agreeable, that each competitor get a prize of equal value. Such endeavours as they have shown merit the fullest encouragement.

JAMES M'ANDREW.

Following on the adjudicator's recommendation, the President intimated that the first two prizes would be divided equally between the two competitors. On opening the sealed envelopes containing the competitors' names, it was found that the collection of Grasses had been made by Miss Catherine Fraser, 18 Park Road, Trinity; and the collection of Lichens by Master Carl Steele, 41 Regent Street, Portobello. The President intimated that these prizes will be presented at a future meeting of the Society. The adjudicators were cordially thanked for their services.

The revised Rules, a copy of which had been sent out with the billet for April 1902 for the consideration of members, were formally submitted and unanimously adopted. The Secretary then read his report, as follows:—

During the winter session 1901-1902 six indoor meetings of the Society have been held. It is gratifying to state that the attendances have been very satisfactory, and that there was no difficulty in obtaining communications and exhibits for these meetings.

For the summer session twenty meetings were arranged. The season was not, however, favourable for field meetings, two having to be abandoned and four having a specially small attendance, owing to the inclemency of the weather. The average attendance for the other meetings was about 15.

Compared with last year, the membership is increased by 13, the total number of ordinary members being 220,—the highest number for the last fourteen years. 33 new names were added to the list, while 20 were withdrawn. Of these, 14 resigned; 3 died (Mrs Clapperton, Colonel Ivison Macadam, and Mr Heggie); and 3 were removed from the register of members.

Twelve meetings of the Microscopical Section were held at the house of the convener, Mr James Russell, and of these the members were duly notified in the billets. The syllabus for the ensuing session has been issued to the members, and it is hoped that this year there will be a larger attendance than last.

The hope expressed in last report that this session would show an advance over the last has in some respects been realised. It rests with the members now to make this a starting-point for a still further advance.

Mr Crawford moved the adoption of the above report, which was carried unanimously. The Treasurer then formally submitted his balance-sheet for year to 14th October 1902, which had been printed and circulated amongst the members, showing a balance of £42, 3s, 9d. in favour of the Society. On the motion of Dr Watson the accounts were approved, and the Secretary and the Treasurer were accorded a hearty vote of thanks for their services during the session. Mr James Russell, Convener of the Microscopical Section, referred to his report, which would be found in the forthcoming part of the 'Transactions' (see *ante*, pp. 376-382), and at the same time spoke of the work to be undertaken by the Microscopical Section during the coming winter. The President conveyed the thanks of the Society to Mr Russell.

The President thereafter delivered his address (see *ante*,

pp. 386-394), and on the motion of Mr Gloag was cordially thanked. The election of office-bearers then took place, the recommendation of the Council being approved of. (The complete list is as follows, the names in italics being those now added: President—Arch. Hewat, F.F.A.; Vice-Presidents — Jas. Russell, David Gloag, *John Lindsay;* Secretary—W. Williamson; Treasurer — G. Cleland; Editor of 'Transactions'—*Dr Davies, F.L.S.;* Auditors—R. C. Millar, C.A., and J. T. Mack; and the following Councillors: Jas. Fraser, Major Grahame, Miss I. Elliot, Mrs Maxwell, Robert Watson, Miss Sprague, Miss E. A. Townsend, Allan A. Pinkerton, *W. C. Crawford, F.R.S.E., Bruce Campbell, A. D. Richardson,* and *David E. Young.*)

Dr Watson referred to the retirement of Mr John Lindsay from the office of Editor, and it was unanimously resolved that the Society place on record its high appreciation of the valued services of Mr John Lindsay as Editor of the Society's 'Transactions' for the long period of twenty-one years. Mr Lindsay returned thanks, and the meeting adjourned.

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LIST OF PAST PRESIDENTS.

Dr Robt. Brown (*deceased*),	1869.	Mr John Walcot,	1879–1882.
Mr R. Scot Skirving (*deceased*),	1869–1874.	Mr A. B. Herbert,	1882–1885.
Mr Wm. Gorrie (*deceased*),	1874–1877.	Mr Symington Grieve,	1885–1888.
Rev. R. F. Colvin (*deceased*),	1877–1879.	Dr William Watson,	1888–1891.
		Dr Sprague,	1891–1895.
		Dr Davies,	1895–1898.
		Mr W. C. Crawford,	1898–1901.

OFFICE-BEARERS, 1901-1902.

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Arch. Hewat, F.F.A., F.I.A.

Vice-Presidents.

A. B. Steele. | J. Russell. | D. Gloag.

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Allan A. Pinkerton.

Editor of 'Transactions.'

John Lindsay.

Secretary.

W. Williamson.

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R. C. Millar, C.A.; J. T. Mack.

LIST OF MEMBERS, 1901-1902.

Honorary Members.

Fraser, Hugh, 17 Cambridge Gardens, Leith.
Henderson, Prof. John R., M.B., C.M., The College, Madras.
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Macfarlane, Prof. J. M., University of Pennsylvania, Philadelphia, U.S.A.
Scott, Thos., F.L.S., 3 Menzies Road, Torry, Aberdeen.
Walcot, John, Craiglockhart Hydropathic, Slateford.

Corresponding Members.

Archibald, Stewart, Dalarossie Schoolhouse, Tomatin, Inverness.
Cruickshank, T. M., South Ronaldshay.
Hobkirk, Charles P., 9 Parish Ghyll Road, Ilkley, Yorks.

Ordinary Members.

(As at October 15, 1902.)

Adams, James, Comely Park, Dunfermline.
Aitken, H. J., 116 Marchmont Rd.
Anderson, Miss M. G., 18 Montgomery Street.
Anderson, R., 67 Princes Street.
Banks, William, 2 Kilmaurs Road.
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Belfrage, Wm. Christie, Durham House, Durham Rd., Portobello.
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Bird, George, 38 Inverleith Place.
10 Blacklock, William, 19 Bruntsfield Avenue.
Bogie, D., M.A., 8 Blackwood Cres.
Bonnar, William, 8 Spence Street.
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Brotherston, Mrs G. M., 16 Comiston Drive.
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Bryden, Mrs, Linksfield, Aberlady.
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Campbell, Col., 30 Waterloo Place.
Campbell, John Rattray, 11 West Glebe, Dalkeith.
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Carter, Albert, 82 W. Holmes Gardens, Musselburgh.
30 Chapman, M., Torbrex Nursery, St Ninians, Stirling.
Clapperton, Miss Mary E., 10 Greenhill Terrace.
Cleland, George, Bank of Scotland, 61 Leith Walk—*Treasurer.*
Coats, William, 10 Duddingston Crescent, Portobello.
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Cowan, Charles Wm., Dalhousie Castle, Bonnyrigg.
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Craig, Miss Margaret G., 18 Queen's Crescent.
Crawford, Francis Chalmers, 19 Royal Terrace.
Crawford, Miss Jane C., 1 Lockharton Gardens, Colinton Road.
40 Crawford, Mrs, 1 Lockharton Gardens, Colinton Road.
Crawford, W. C., 1 Lockharton Gardens, Colinton Road.
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Dowell, Mrs, 13 Palmerston Place.
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Elliot, Miss E., 39 Colinton Road.
Elliot, Miss I., 39 Colinton Road.
Ewart, James, 1 Dundas Street.
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Field, John M'Dougal, 1 Hart St.
Fish, D. S., Royal Botanic Garden.
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Forgan, Wm., 3 Warriston Crescent.
Forrest, John L., 8 Glengyle Ter.

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70 Gibson, J., M.A., 19 Bernard Ter.
Gibson, Mrs, 4 Colinton Road.
Gloag, David, 9 Barnton Terrace.
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Grieve, Symington, 11 Lauder Road.
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80 Hall, H., Royal Botanic Garden.
Hamilton, G. R., 14 Caledonian Rd.
Harris, J., Royal Botanic Garden.
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Harvie-Brown, J. A., Dunipace, Larbert.
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Henney, Mrs, 3 Abercromby Place.
Henney, W., 3 Abercromby Place.
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Hewat, Arch., 13 Eton Terrace—*President.*
90 Huie, Miss Lily, Hollywood, Colinton Road.
Hunter, John, 1 Straiton Place, Portobello.
Hutton, Mrs, 10 Gardner's Cres.
Jamieson, J. H., 54 Bruntsfield Gardens.
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Johnston, J. A., 7 Annandale St.
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100 Laing, Rev. G., 17 Buckingham Ter.
Law, Mrs, 41 Heriot Row.
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Lindsay, John, 24 Montgomery St. —*Editor of 'Transactions.'*
Lindsay, William, 18 South St Andrew Street.
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M'Andrew, James, 21 Gillespie Crescent.
Macdonald, J. J., Commercial Bank, Comrie.
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MacDougall, R. Stewart, M.A., D.Sc., Royal Botanic Garden.
110 M'Gillivray, Wm., 4 Rothesay Pl.
M'Intosh, James, 42 Queen Street.
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Mack, J. T., 101 George Street.
M'Gregor, Donald, The Royal Gardens, Kew.
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Mackenzie, N., Royal Botanic Garden.
MacLauchlan, J. J., 19 Coates Gardens.
M'Lean, Miss, 5 Cambridge Street.
Macpherson, Alex., 1 Roseneath Pl.
120 Macvicar, Miss K., 34 Morningside Road.
Malcolm, C. A., 8 Keir Street.
Malloch, Jas. Jamieson, Schoolhouse, Juniper Green.
Malthouse, G. T., Harper Adams Agric. Coll., Newport, Salop.
Mason, J. Gordon, S.S.C., 51 Hanover Street.
Maxwell, John, 125 George Street.
Maxwell, Mrs, 61 Braid Road.
Menmuir, W. Henry, L.D.S., R.C.S.E., 47 Comely Bank Road.
Millar, R. C., 6 Regent Terrace.
Millar, T. J., 27 Albany Street.
130 Miller, J. A. Graham, 13 Lennox St.
Mitchell, Miss M., 153 Warrender Park Road.
Morison, Peter, 24 Great King St.
Morris, Joseph, Fern Bank, Clermiston Road, Corstorphine.
Morrison, Hew, Librarian, Public Library, George IV. Bridge.
Muir, John, 24 Barnton Terrace.
Munro, John Gordon, 7 Howe Street.
Murray, Allister, Royal Blind Asylum, Craigmillar Park.
Nesbit, John, 162 High Street, Portobello.
Nisbet, Wm., 36 Elm Row.
140 Normand, J. Hill, of Whitehill, Aberdour.
Oliver, John S., 12 Greenhill Park.
Osler, Alex., Anatomical Museum, New University.
Oxley, Miss M. E., Dalry House, Orwell Place.

Parkes, C. W., Inland Revenue, Dundee.
Paton, John, 33 Roselea Drive, Dennistoun, Glasgow.
Paul, Rev. D., LL.D., Carrielee, Fountainhall Road.
Paulin, George Alex., 6 Forres St.
Pentland, Miss, 73 Inverleith Row.
Pierce, W. J., 16 Forrest Road.
150 Pillans, Hugh H., 12 Dryden Place.
Pinkerton, Allan A., 47 Viewforth.
Pittendrigh, T. M., 45 Comely Bank Road.
Pyatt, W., M.A., Fettes College.
Rae, M. J., 94 Thirlestane Road.
Raeburn, Harold, 32 Castle Terrace.
Ranken, William, 11 Spence Street.
Ranken, William Ford, 63 Coten End, Warwick.
Reid, Andrew, 1 Laverockbank Terrace, Trinity Road.
Richardson, A. D., 7 West Catherine Place.
160 Richardson, Mrs Ralph, 10 Magdala Place.
Ritchie, William, 75 Morningside Rd.
Robertson, Dr W. G. Aitchison, 26 Minto Street.
Robertson, W., 35 Polwarth Gardens.
Roriston, James G., 8 Dalziel Place.
Rose, Miss, 3 Hillside Crescent.
Rowe, Miss C., 19 Great Stuart St.
Russell, James, 16 Blacket Place.
Sanderson, Mrs H., 95 Shandwick Place.
Sarah, H. A. P., 19 Braidburn Cres.
170 Sconce, Colonel, 18 Belgrave Cres.
Semple, Dr Andrew, Caledonian United Service Club, 14 Queen St.
Sharp, Henry J., 7 Rosebank Terrace, Bonnington, Leith.
Sime, David, 27 Dundas Street.
Slight, G. A., 1 Royston Terrace.
Smith, Harry W., 23 Nelson Street.
Smith, Dr James, 4 Brunton Place.
Smith, Rupert, 51 Minto Street.
Smith, Thomas J., care of Messrs Watson & Sons, 313 High Holborn, London, W.C.
Speedie, M. H., 2 Alford Pl., Mayfield Terrace.
180 Speedy, Tom, The Inch, Liberton.
Speedy, William Hogg, Braeside, Liberton.
Spence, A. J. L., 1 Mansionhouse Road.
Spence, Mrs, 1 Mansionhouse Road.
Sprague, Dr T. B., 29 Buckingham Terrace.
Sprague, Thomas Archibald, 36 Bushwood Road, Kew Gardens.
Sprague, Miss, 29 Buckingham Ter.
Steele, A. B., 41 Regent Street, Portobello.
Steele, Mrs, 41 Regent Street, Portobello.
Stevens, Dr John, 2 Shandon Street.
190 Stevenson, Miss, 21 Montgomery St.
Stewart, Robert, S.S.C., 7 East Claremont Street.
Tait, John Scott, C.A., 3 Albyn Pl.
Taylor, John, 84 Great King Street.
Terras, James, B.Sc., 21 Teviot Pl.
Thacker, T. Lindsay, care of Messrs T. Nelson & Sons, Parkside.
Thomson, John, 20 York Place.
Thomson, Lockhart, Derreen, Murrayfield.
Townsend, F. J., 20 St Catherine's Place, Grange.
Townsend, Miss E. A., 20 St Catherine's Place, Grange.
200 Traquair, Dr, 8 Dean Park Crescent.
Urquhart, Arthur E., Royal Botanic Garden.
Waddell, James Alexander, of Leadloch, 12 Kew Terrace, Glasgow.
Walker, Alex. D., 1 St Vincent St.
Wallace, Forbes T., 2A Hill Street.
Wanless, Miss, 12 Wilton Road, Craigmillar.
Wardlaw, George, 14 St John's Hill.
Watson, Robert, M.A., 12 Chalmers Street.
Watson, Dr Wm., The Lea, Corstorphine.
Watson, Mrs, The Lea, Corstorphine.
210 Wear, Sylvanus, 17 Dudley Gardens, Leith.
Weir, James Mullo, S.S.C., 5 W. Brighton Crescent, Portobello.
West, G. T., Royal Botanic Garden.
Williamson, Wm., 4 Meadowbank Terrace—*Secretary.*
Wilson, Rev. D. W., Stobhill Manse, Gorebridge.
Wilson, Wm., 8 Claremont Terrace.
Wood, Miss Daisy, Viewforth, Brunstane Road, Joppa.
Wood, T. A. D., Viewforth, Brunstane Road, Joppa.
Wright, J. P., 6 Grosvenor Cres.
Wright, Thos., 12 Brunton Terrace.
220 Young, David E., 60-62 High Street.

RULES

OF THE

Edinburgh Field Naturalists' and Microscopical Society.

INSTITUTED IN 1869 AS THE

EDINBURGH NATURALISTS' FIELD CLUB.

(*ADOPTED, October* 1902.)

I. This Society, instituted for the Study of Natural History in all its Branches, shall be called THE EDINBURGH FIELD NATURALISTS' AND MICROSCOPICAL SOCIETY.

II. Ladies and gentlemen shall be eligible for admission to the Society, which shall consist of Honorary, Corresponding, and Ordinary Members.

III. Every candidate for admission as an Ordinary Member of the Society shall present an application to that effect, with a recommendation signed by two Members of the Society. Such application and recommendation shall be submitted at one Meeting of the Society and shall be considered at the next Meeting, a majority of the votes of those present being sufficient to elect the applicant to membership, voting being by ballot.

IV. Ordinary Members shall, on election, pay the sum of 5s. to the Funds of the Society, and contribute thereafter 5s. annually at the November Meeting. Ordinary Members elected after April 30th in any year shall, on election, pay the subscription for the then current year, but shall not be called upon for any subscription for the year next ensuing. Any one wishing to compound for the yearly subscriptions may do so on payment of the sum of £3, 3s. No one shall be considered an Ordinary Member of the Society until the subscription has been paid.

V. Any Member, after having paid all annual subscriptions due, including that for the then current year, may withdraw from the Society on giving intimation in writing to the Honorary Secretary of the intention to do so.

VI. The Council shall deal with Members whose annual subscription is in arrear in such manner as they shall deem expedient.

VII. A majority of the Members present at any Meeting, consisting of not less than fifteen Members, shall have the power of expelling any Member whose conduct they may deem objectionable, provided notice of a Motion to that effect shall have been given at a previous Meeting.

VIII. The Office-bearers of the Society shall be a President, three Vice-Presidents, an Honorary Treasurer, an Honorary Secretary, and, if necessary, an Assistant Secretary, and an Editor of the 'Transactions,' and these shall be elected annually at the Annual General Meeting. These Office-bearers, with twelve Ordinary Members of the Society, elected to be Councillors, shall constitute the Council, and five shall be a quorum.

IX. The four Senior Councillors shall retire annually, and they, with the Senior Vice-President, shall not be eligible for re-election to these offices until after the expiry of a year.

The Council shall prepare a list of those Members whom they propose to nominate as Office-bearers for the ensuing year and to fill the vacancies arising from the retiral of Councillors. This list shall be printed and issued to Members with the billet calling the Annual General Meeting. Members may erase the names proposed and write others in place thereof, and shall vote by putting these lists into the ballot box. The lists shall not be signed.

X. The Honorary Secretary may at his discretion call Meetings of Council for the transaction of business; but he shall call a Meeting of Council at the desire of the President, or of two Vice-Presidents, or of any three Members of Council.

XI. Indoor Meetings of the Society for submitting and discussing communications, and Field Meetings for practical work, shall be held at such times as the Council shall determine. A list of the places suggested for Field Meetings shall be submitted to the Members at an indoor Meeting for approval; and the Council shall make necessary arrangements for holding all such Meetings.

XII. Ordinary business may be transacted at any Meeting of the Society, and Minutes of the proceedings at all Meetings shall be taken by the Honorary Secretary. These shall be read at the next indoor Meeting of the Society; and, if passed by a vote of the majority present, shall be duly signed by the Chairman, and all such Minutes shall be entered in a book to be kept by the Honorary Secretary for the purpose.

XIII. Any Member may introduce friends at any Meeting of the Society.

XIV. The Annual General Meeting shall be held in the fourth week of October, and the Honorary Treasurer and the Honorary Secretary shall then submit statements regarding the position of the Society, and the business transacted in

the year. An Abstract of the Honorary Treasurer's Accounts, duly audited, shall be circulated with the billet calling the Annual General Meeting.

XV. Two Auditors shall be appointed at the Annual General Meeting to audit the Accounts of the Society for the ensuing year.

XVI. At all Meetings the Chairman shall have a casting vote.

XVII. The Society shall publish 'Transactions,' which shall put on record work done at its Meetings. These 'Transactions' shall, subject to the approval of the Council, be arranged for publication by the Editor.

XVIII. The Council shall have power during any Session to enact such Bye-Laws as may be deemed necessary, and these shall have full force until the ensuing Annual General Meeting.

XIX. Notice of any Motion proposing an alteration of the Rules must be given in writing before the first day of October to the Honorary Secretary for consideration of the Council, and such Motion shall be printed in the billet calling the Annual General Meeting. Such Motion shall be considered at the Annual General Meeting, and, if approved by the vote of the majority of Members present, shall forthwith be given effect to.

XX. Corresponding Members may be elected, and Honorary Members nominated, at any Meeting of Council. Intimation of such election, or nomination, shall be made in the billet calling the first indoor Meeting of the Society thereafter, at which Meeting the election of Honorary Members shall take place, a majority of the votes of those present being sufficient.