TRANSACTIONS

OF THE

EDINBURGH FIELD NATURALISTS'

AND

MICROSCOPICAL SOCIETY

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OF THE

EDINBURGH FIELD NATURALISTS'

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MICROSCOPICAL SOCIETY

INSTITUTED AS THE

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VOL. V.

(SESSIONS 1902-1907)

BRITISH MUSEUM NATURAL HISTORY

Published for the Society by

WILLIAM BLACKWOOD AND SONS

MCMVII

CONTENTS.

SESSION 1902–1903.

SESSION 1903–1904.

5

SESSION 1904–1905.

SESSION 1905–1906.

SESSION 1906–1907.

LIST OF PLATES.

VOL. V. PART I.

TRANSACTIONS

OF

The Edinburgh Field Naturalists' and Microscopical Society

SESSION 1902-1903

CONTENTS.

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BY

WILLIAM BLACKWOOD & SONS

MCMIII

Price to Non-Members, Four Shillings.

TRANSACTIONS.

SESSION 1902-1903.

I.—*SOME ADDITIONAL NOTES ON THE BIRDS OF PERTHSHIRE.*

By Mr BRUCE CAMPBELL.

(*Read Nov. 26, 1902.*)

The following notes are supplementary to my paper read in December 1901, and refer chiefly to the same district. In May last Mr Laidlaw and I spent a day or two in the north of Perthshire, our principal object being to visit, and photograph if possible, the nest of the Golden Eagle of which we had heard on our visit of the previous year. We left Edinburgh on a Friday evening, intending to visit the nest on the following day. When Saturday came it neither brought our guide nor any tidings of him. However, we met with a youth who kindly drew an accurate sketch of the hill and the exact spot where the nest was usually situated. Armed with our chart, we set out on Monday morning. We drove eight or nine miles along a road, where we left our conveyance and procured a couple of hill ponies. These, it may be mentioned, we intended to use chiefly in fording the river. We proceeded along a path for four or five miles, observing by the way four eagles, several ravens, dippers, &c. We now proceeded to cross the river on the ponies, two at a time.

After the first two of our party got safely across, the ponies were turned into the river, which they crossed themselves and brought over other two of the party. The ponies however refused to go back themselves for the remaining two of the party, and one of us had to mount and lead the "fiery untamed" across. After all had crossed safely we proceeded a short distance, left the ponies, and began to climb the hill—somewhat steep, especially when carrying a half-plate photographic outfit. On reaching the top I looked over the precipice, and observed a fox "basking" on the face of the rock. I beckoned to the rest of the party, and we had a good look at Reynard, who, on learning that he was observed, leisurely trotted along the face of the rock, and was soon lost to view. We were wading up to the knees in snow on some parts of the hill. On consulting our chart we found we were not far from the nest; and after a short search we succeeded in finding it, but we also found that it had not been tenanted this season. The eagle is strictly preserved by the proprietor.

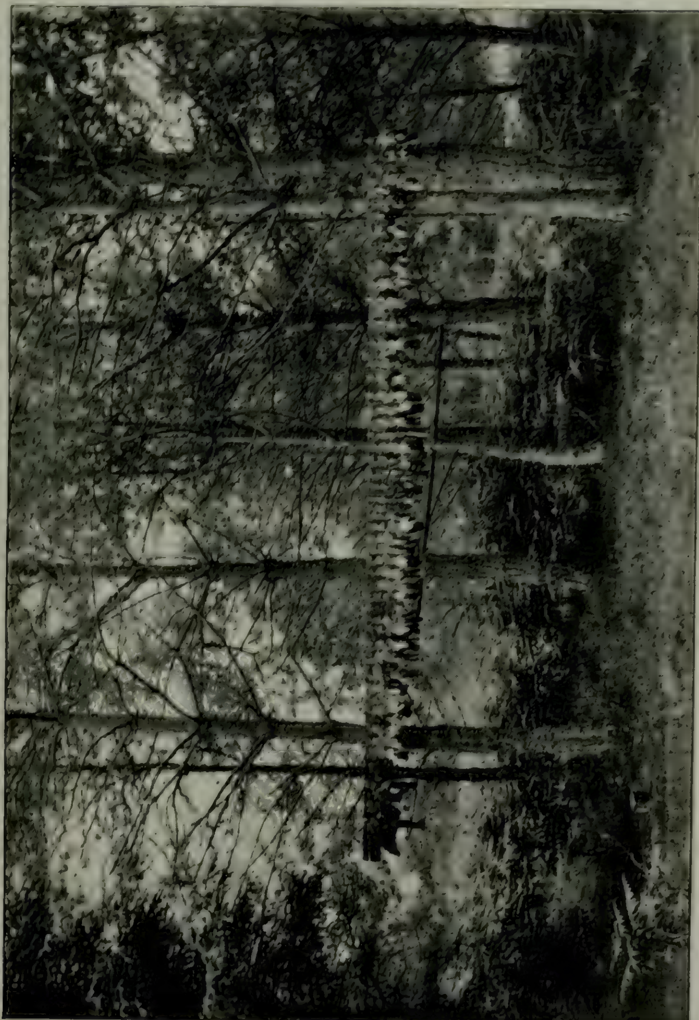
We now turned our faces homewards, lunched at the foot of the hill, and crossed the river as before. We came across the bleached remains of several red deer, and noted a pair of goosanders flying up the river. We now saw several herds of deer coming down from the hilltops, and were told this was a sign of rough weather. I intended taking several views of the district, and had just got my camera erected when a blinding snowstorm came on. However, I managed to take a group as a souvenir of our visit. Luckily we were not far from where our conveyance was stabled, and getting into it we soon reached the residence of our host, and did ample justice to his Highland hospitality.

I visited the locality again in July, and will show a few slides of what I saw then. I was much struck by the way in which the jay manages to exist, in spite of all manner of persecution. Johns, in his 'British Birds,' says: "There exists among gamekeepers a custom of selecting a certain spot in preserved woods, and there suspending, as trophies of their skill and watchfulness, the bodies of such destructive animals as they have killed in pursuit of their calling. They are generally those of a few stoats, magpies, cats, jays, &c. All these are judged by the keeper to be destructive to game, and

NEST OF PARTRIDGE.

NEST OF YELLOWHAMMER.

PLATE II.—THE BIRDS OF PERTHSHIRE.



A GAMEKEEPER'S RAIL.

are accordingly hunted to death,—the jay perhaps with less reason than the rest, for though it can hardly resist the temptation of plundering either eggs or young of any nest of partridge or pheasant that falls in its way, yet it does not subsist entirely upon animal food, but also feeds upon acorns and wild fruits, &c. The jay is a good mimic. I kept one for some weeks, and it imitated to perfection the barking of a neighbour's dog. This jay ate all sorts of food—cheese, potatoes, &c."

The nest of the jay is usually placed near the top of a low tree. I have seen one in a juniper bush. The materials used in its construction are small sticks, roots, and dry grass, and it generally contains five eggs. In August last I observed a flock of crossbills feeding on the larch trees close to the railway at Ballinluig. I also observed a pair of marsh-tits on August 3 in the vicinity of Ballinluig.

[Several slides of nests, gamekeeper's "rails," &c., were shown: three of these are here reproduced. On one of the "rails" were suspended the bodies of 38 jays, 3 kestrels, 1 long-eared owl, 1 sparrow-hawk, 2 stoats, and 1 weasel,—all these had been killed during the month of July 1902.]

II.—*NATURAL HISTORY IN EARLIER DAYS.*

By Mrs AITCHISON ROBERTSON, M.D.

(*Communicated Nov. 26, 1902.*)

At the meeting of November 26 Mrs Aitchison Robertson, M.D., read a very interesting paper on "Natural History in Earlier Times," compiled from works written mostly during the fourteenth, fifteenth, and sixteenth centuries. That remarkable work, the 'Historia Naturalis,' written by Pliny at the beginning of the Christian era, was casually referred to. At the beginning of the thirteenth century Marco Polo wrote his fantastic tales, in which he describes many curious beings, such as the giant race of which Gog and Magog were representatives, the tailed men, and the Land of Darkness. In the fourteenth century John de Mandeville wrote a singular book of travels in French, which acquired extraordinary popularity, and was translated into many tongues. It consists mostly of tales of imagination relating to men whose heads he saw beneath their shoulders, men with a single eye or with lips large enough to cover their faces whilst sleeping, the weeping crocodile, the vegetable lamb, &c. One of the earliest illustrated books on natural history is the curious compilation entitled 'Ortus Sanctatis' (1491), printed in black letter, and containing a medley of natural history, arts, medicine, &c.

The sixteenth century was rich in naturalists. At this period Olaus Magnus, Archbishop of Upsala, published his illustrated 'Historia de Gentibus Septentrionalibus' (1533), devoted to a description of the customs, superstitions, and religious rites, &c., of the inhabitants of Norway and Sweden, together with the natural history of these countries. But the most famous naturalists of this period were Gesner and Aldrovandus. Gesner, who in 1541 became professor of physics and natural history at Zurich, wrote on many subjects, publishing during his life no less than 72 books, and leaving MS. for 18 others. His greatest work, the 'Historia Animalium,' contains the name and description of every animal then known, with many legends regarding them. Ulysses Aldrovandus was professor of botany, and later of natural history, at Bologna. His "Herbarium" occupied 60 large folio volumes. The researches of his life were embraced in his *magnum opus,* comprised in six large quarto volumes, and designed to include everything that was then known about natural history.

In the seventeenth century Eusebius Nierembergius wrote an elaborate 'Historia Naturæ,' published at Antwerp in 1635; and Dr John Johnstone also wrote a 'Natural History of Quadrupeds,' printed at Amsterdam in 1657. Other famous naturalists of this period were Sluper (1572), Topoell (1607), and Johannes Zahl (1696).

Among the curious creatures described by these earlier naturalists, and in which they seem to have thoroughly believed, are pigmies and dwarfs, of which Olaus Magnus gives illustrations fighting against cranes, devils, and fairies; while fauns and satyrs, and monsters of every kind, such as the elephant-headed or dog-faced man, the man-ass, and the dog-man, are figured and described, as if they had been encountered every day. The eale, credited with having movable horns, and the leucocrotta, an animal able to imitate the human voice, were believed to exist. The unicorn is another fabulous animal, the existence of which was believed in until comparatively recent years. Large sums of money, even as much as £10,000, were given for the venerated horns of this animal, in the belief that they prevented the owner from being poisoned: they even formed royal gifts. But, as a matter of fact, these reputed unicorn horns belonged to the common sea-lion or narwhal.

The metamorphosis of men into wolves is an idea of very ancient date, and Olaus Magnus describes the many horrors committed in Sweden by these wolves.

That goats eat serpents is even still believed; but of all extraordinary beliefs, that of the barnacle goose is perhaps as extraordinary as any. This goose was supposed to be generated on trees and dropped into the water alive. In the Orkney Islands it was said that the fruit of certain trees produced geese.

The dragon figures largely in the mythical history and poetry of most nations, and mermaids and mermen are another class of mythical beings thoroughly believed in by our forefathers. Olaus Magnus figures an enormous polyp dragging a sailor from his ship. This may really apply to the octopus, specimens of which have been met with possessing arms 30 feet in length.

The connection between the soul and bees was once generally allowed, hence bees were admitted to Paradise by Mahomet.

[In illustration of the above paper, a large number of beautiful lantern slides, prepared by Mrs Aitchison Robertson from the figures contained in the works of the various authors referred to, were exhibited.]

III.—*GRASSES OF THE LOTHIANS.*

By Mr A. MURRAY.

(*Read Dec. 17, 1902.*)

I have been asked to say a few words about the collection of grasses now exhibited. These, as many of you know, belong to the natural order Graminaceæ, without doubt the most important in the vegetable kingdom, for if you leave out Solanaceæ, Leguminosæ, and Cruciferæ, man is wholly dependent upon the plants of this order for his food. Bread is the product of wheat (*Triticum æstivum* and its vars.), oats (*Avena sativa* and its vars.), and barley (*Hordeum vulgare* and its vars.); and in some countries rye (*Secale cereale*), Indian corn (*Zea mays* and vars.), and rice (*Oryza sativa*) are added or used by themselves. We can easily imagine that if this order of plants, which provides food for man and beast, were suddenly to cease growing, there would be such a famine as would nearly depopulate the globe of man and many of the lower animals before substitutes could be provided. Besides supplying food, many of the species are used for other purposes. Ropes are made from some, and also paper, and they often form part of our beds. Though generally of low stature, yet some are found of such a length and size as to be used as masts for small ships and boats, the range being from one inch to nearly one hundred feet, as in the bamboo cane. Again, consider the rich verdure which carpets our fields, and which is so restful to our eyes. What would our English and Scottish fields be like without their covering of grass? Many of the species are, besides, very graceful and ornamental, and the study of so important and useful a family can hardly be over-valued.

For many years I have felt the want of a knowledge of these plants, and again and again I have said, "I must devote some time to the study of grasses," but I never made a start until the Society's prize was offered: this had the effect of setting me agoing, and once set agoing, I am not easily stopped. I am very pleased that I won the prize, but I am far better pleased that I have learned so much about the Gramineæ; and I fully intend, if spared, to complete my collection as far as possible as representing the British Grasses.

I shall now deal with the specimens which I have gathered, and will take them in their order as arranged.

1. Seteria, or Italian millet. There are 24 species in this genus, two said to be British but not found here. This species was fairly plentiful at Leith Docks, from seed spilt while some cargo was being delivered.

2. Phalaris—canary-grass; 23 species, 2 British, one undoubtedly an introduction, but useful as providing food for our pet birds.

3. Anthoxanthum—sweet-scented vernal grass; 6 species, 1 British: two specimens mounted, one an alien. This is the grass which gives the odour to new-mown hay; it is very common.

4. Phleum—cats'-tail-grass; 8 species, 4 British: three species and two vars. mounted of P. Bœhmeri. I only saw this single specimen. P. arenarium gathered in several places; P. pratense and vars. grown as a hay crop under the name of Timothy grass.

5. Alopecurus—fox-tail-grass; 21 species, 6 British: three specimens mounted. A. pratensis, a common but rather coarse grass. A. agrestis scarce.

6. Gastridium—2 species, 1 British: the one mounted the only one seen. A pretty little grass.

7. Millium—millet grass; 15 species, 1 (M. effusum) British: a very tall graceful grass, not very common, but plentiful on the Avon in Caribber Glen.

8. Agrostis—bent grass; 100 species, 7 British, five of which I have gathered: mostly useful pasture grasses. A. Spica-venti not common in Scotland, although I found it in several localities. A. stolonifera soon covers a large space of ground by its long creeping stems or stolons.

9. Ammophila—2 species, 1 British: a coarse but very useful grass on our sandy shores, its creeping and fibrous roots forming a network which prevents the sand from being removed by the wind.

10. Aira—hair grass; 25 species, 4 British. I have mounted four species and one variety. Very pretty but useless grasses, all common.

11. Avena—oat grass; 34 species, 6 British. I have mounted six species and vars., including the common oats. A. fatua, the wild oats, is not very common; A. strigosa can be gathered in almost every corn-field. The other species are all common.

12. Arrhenatherum—false-oats; three species, 2 of them British. I have only one species and two vars. of this very common grass. It is a regular pest to the farmer.

13. Holcus—soft grass; 7 species, 2 British, both very common. Cattle will not eat either if they can get anything else. Pigs are very fond of the creeping roots of H. mollis.

14. Triodia—10 species; the one British species is strictly a hill or mountain grass. Sheep are very fond of it, so much so that it is sometimes difficult to get a perfect specimen.

15. Koeleria—13 species. There is only one British species, a very distinct little grass, fairly common on Arthur's Seat.

16. Melica—24 species, 2 British: one of the species, M. uniflora, is fairly common, but I have only seen M. nutans at one spot on the Avon.

17. Molinia—M. cœrulea, the only species, a northern grass. Sheep and cattle eat it. It is a very tough grass; the fishermen of Skye used to make ropes of it.

18. Catabrosa—C. aquatica, the only species. A very common aquatic grass, greedily devoured by all cattle, and said to be very nourishing.

19. Glyceria fluitans—a very common grass at the sides of lochs, in ditches, and such like places. Cattle are fond of it, and the seeds are collected in some parts of Germany and called manna seed. It is used in soups and gruels, and said to be very nourishing. One of the largest of our British grasses, plentiful by the Canal side.

20. Schlerochloa—this is often included in Poa, and I think scarcely separable from it.

21. Poa—meadow grass; a very large genus, over 140 species, 15 British. I have ten mounted. Very interesting and useful grasses, most of them good pasture-grasses. Poa annua will spring up, and ripen seed, which will fall and germinate also in about six weeks. It is a terrible pest in gardens. Poa distans, a very distinct grass, is abundant in Leith Dock enclosure, but not common outside. Poa compressa is also common at the Docks, but is found in many localities about the Lothians. The others are all fairly common.

22. Briza—quaking grass; 9 species, 2 British: although I think B. media is the only true native, B. minor is only an escape. B. minor and B. maximus are common in gardens.

23. Cynosurus—dogs'-tail-grass; 8 species, 1 British: C. cristatus common almost everywhere, but of very little use.

24. Dactylis—19 species. D. glomerata is the only British species. A very common and, if not allowed to run to seed, a very useful grass. Though a succulent grass, neither cattle nor horses are fond of it, but eat it. Sheep are fond of it.

25. Festuca—fescue grass; 66 species, 11 British. I have 11 species and vars. mounted: nearly all of these are good pasture and hay grasses.

26. Bromus—brome grass: 66 species, 12 British. I have mounted 18 species and vars. of this genus. I think of all the genera of grasses there is not one so confusing as this. A change of soil and locality makes the same grass appear so different that one can scarcely make it out. They are nearly all handsome and very graceful species. It is said that if the seeds of B. secalinus are eaten, they have a bitter taste and the same narcotic qualities as Lolium temulentum. The seeds of B. mollis cause giddiness in man and quadrupeds, and are fatal to poultry.

27. Brachypodium—25 species, 2 British. The only species I have gathered is B. sylvaticum, which is a very pretty grass, but of little use.

The beautiful yellowish-green of the foliage in spring and early summer is very effective on a rocky bank, where it is often found.

28. Triticum—28 species, 4 British. This is the most important genus of the Gramineæ. To it belong the various vars. of wheat. I believe it is not known where it is a native of, but it is grown in every temperate country in the world. The four British species of the genus are useless weeds, especially couch grass or quickens. The great network of the roots of T. junceum, however, and its vars., help to bind the sand along our sea-shores. There are 11 species and vars. mounted.

29. Lolium—darnel; 10 species, 3 British. This is not a very ornamental grass, but a very important one, especially L. perenne and L. Italicum. The first is the best hay plant we have, and also about the best pasture one. L. Italicum is very similar, only coarser in growth and quality, but is much grown where grass and hay are sold. L. temulentum is supposed to be the tare of Scripture. It is a very curious and interesting plant, with its long plumes, and large seeds which are said to be poisonous. This grass is not common, although I found it in several localities. It is most plentiful at Leith Docks. Once seen it cannot be mistaken for any other grass. L. perenne is said to have been the first grass cultivated as a fodder-grass.

30. Elymus—lyme grass; 24 species, 3 British, but only one, E. arenarius, is found in this district. It is a large, handsome grass, but only useful as a sand-binder on our sea-shores.

31. Hordeum—barley; 12 species, 3 British, only one of which I have been able to gather. This genus also contains a valuable grain plant, the barley (H. vulgare), of which there are several vars. The other species are useless.

32. Secale—rye; 2 species, neither of these being natives, but S. cereale is grown as a grain, the flower of which makes very good bread. In northern countries it is much used.

33. Arundo phragmites, a grass which every one has seen at Duddingston Loch, which is surrounded by it—a tall reed-like grass with dark-brown panicles. At one time this was a very important grass, as most houses were thatched with it. In some districts it is still used for this purpose, but only in limited quantities now. A very handsome grass.

34. Nardus stricta, a very common but useless and insignificant mountain grass.

The few words I have said about these grasses does not anything like represent what could be said. Many papers might be written about them. Since sending in my specimens for competition I have gathered myself or got from Mr Fraser four or five grasses that I had not previously gathered. Before closing I must add how greatly I am indebted to Mr M'Andrew for much information about these grasses as well as for many of the names.

IV.—*ANTS IN RELATION TO FLOWERS.*

By Mr J. G. GOODCHILD,
H.M. Geological Survey, F.G.S., F.Z.S.,
Custodian of the Collections of Scottish Geology and Mineralogy in the Edinburgh Museum of Science and Art.

(*Read Dec. 17, 1902.*)

So much has been written about Ants, from the days of Solomon downwards, that it is no easy matter to find much to say about them that has not already been said by some one else. Nevertheless, it may now and then serve a useful purpose to bring together some few facts already more or less well known, if their bearing upon some particular question has not already been duly considered. As there is certainly one aspect connected with the natural history of Ants, which has not yet been presented to the public in quite as clear a light as its importance seems to merit, I propose in this Address to invite attention to the subject indicated by the title above.

At the outset we shall have to consider a few points relating to the morphology of Ants in general, as well as some few other matters relating to such of their habits as are common to the section of the Hymenoptera to which they belong. So far as the former is concerned we can do this best by studying the chief external characteristics of a typical form with the aid of a strong magnifying-glass, or under a low-power objective in a microscope. (When this Address was given this was done by means of a photo-micrograph of an Ant taken by Mr Adams of Dunfermline, whose kindly aid in this and some allied matters I take the present opportunity of acknowledging.) Like all other Arthropoda, Ants possess a segmented (non-vertebrate) body, furnished with jointed limbs. As they are insects, the body is distinctly separated into fore, mid, and hind parts, and the forepart or head is furnished with a single pair of antennæ; in which point they agree with the Myriopoda, and differ from the Crustacea, which have two pairs of antennæ, and from the Arachnida, which have none. To the forepart or head pertains most (though not all) of the sensory functions, and it is there, of course, that are placed the powerful and complex mouth parts which play so important a *rôle* in the work done by Ants. The parts equivalent to our jaw move like the blades of a pair of shears, and open and shut from side to side of the animal instead of up and down as the jaws of vertebrates move. The head bears one pair of eyes situated at the side, and supplementary ocelli, which are situated on the top. The antennæ have one long basal joint, at the end of which the remainder of the antennal joints are articulated at a sharp angle, so that the junction is bent like a knee.

The mid-part or thorax may be regarded as the seat of locomotion. It is divided into three segments, each of which possesses a pair of jointed legs in all Ants, and two pairs of wings in the Males, and also in the Queen Ants until after the nuptial flight, when they break them off as no longer needed. The wings are naked, membranous, few-veined, and unequal. They are horizontal; and the lower pair is provided with a series of minute hooks which catch into the reflected posterior margin on the upper wings, for the purpose of keeping both pairs together during flight.

The hind-part of the body or abdomen in all Ants is sharply divided into two. Close behind the "waist," a sharp constriction by which, in all insects, the abdomen is united to the thorax, there is in Ants a second constriction, which is characteristic of the group of Ants in general. The use of this appears to be to permit of increased flexibility at that part of the body. Just as the head is the principal seat of the intellect and the thorax that of locomotion, so the abdomen may be regarded in the light of a chemical laboratory, wherein are carried on not only the processes of reproduction and assimilation, but the manufactory and repository of that important means of offence and defence the formic acid. This powerful irritant is similar in its properties to the poison used by the Wasps and Bees, and also to the irritant fluid found in the Stinging Nettle. Unlike their near relations the Wasps and Bees, Ants are not provided with a sting. Hence when they desire to inflict a painful wound they have first to bite with their powerful shear-like mandibles, and then to inject the formic acid into the wound, which they do by flexing the abdomen and thence squirting the irritant acid. It will be observed that in this respect the Ants are far behind the Wasps and Bees, which are provided with a much more effective means of offence, and are able to carry out their intention not only in less time, but by a much neater and, so to speak, much more scientific method. Those persons who have not realised what effects formic acid can produce upon a wound, might take an early opportunity of holding a pricked or cut finger for a minute close above a colony of Ants whose nest has been disturbed a few minutes before. Formic acid produces irritant effects of some importance also in relation to vegetable growth, as will be seen further on.

So far as the morphology of Ants is concerned in the present connection, the only other feature that calls for notice is the fact that the terminal parts of their limbs consist of acutely-pointed and forked claws, which are sufficiently sharp to penetrate a little way into a delicate skin when an Ant is crawling over us. This fact also is of importance in the present connection.

A few words about the life-history of Ants may be given here. As in the case of Bees, a community of Ants consists of at least three different forms: (1) The Queen Ant, who is the mother of all the workers; (2) the Male Ants, corresponding to the Drones in a beehive; and (3) the Worker, or so-called Neuters, which are morphologically females. The two former are provided with wings, while the Workers are wingless. Some bright sunshiny day soon after midsummer the young Queen Ants and the Males sally forth from the ant-nest into the open air and spend the day on the wing in the nuptial flight. Towards evening most, or all, of the Males have lost their lives or have been devoured by insectivorous animals of many kinds. The number of the young Queen Ants, too, has been seriously thinned. But those who survive wing their way to some home—either to that which they had left in the forenoon, or, more usually, to a site chosen as that of a new colony. Arrived there, the first act of the Queen is to double herself back upon her wings and so break them off, as the nuptial flight takes place only once in the life of an Ant, and so these appendages are no longer required. If she has chosen to have a home of her own, the widowed Queen, soon after her arrival, sets to work to prepare, in a small way at first, for the expected family. Most of the autumn is supposed to pass thus. With the advent of winter the Queen Ant, still all alone, is supposed to remain in a dormant state, from which she does not arouse until the advent of the warm weather of the year following. Some time in April she lays her first egg, and she continues to lay, at short intervals, for a period of considerable length, which may extend to several years. The larvæ are hatched about a month later, and about another month is passed in the condition of pupæ. Normally (and perhaps invariably) the direct offspring of the Queen Ant are Workers, and not Males. How young Queen Ants arise does not yet seem to be known. As regards the Males we are also at a loss for information. Lord Avebury (Sir John Lubbock) states that in captivity his Workers occasionally laid eggs, and that these, when hatched, gave rise to Males. I have elsewhere suggested [1] that all Male Ants may be thus parthenogenetically produced. Whether this will prove to be the case remains to be seen. But about the physiological interest of the observed facts there cannot be any doubt.

I will not stop here to consider the successive stages in the gradual evolution of the new colony; nor how the Queen Ant manages to train up the elder children in the management of the rest of the growing family; nor how she educates them in their earlier days. Much has been written already upon this by others who have had much more extensive opportunities of studying the facts at first hand than I have. But instead of taking up space unnecessarily, I will at once pass on to the consideration of some points in the habits and mental disposition of Ants which bear more directly upon the subject chosen for this Address.

Ants are undoubtedly very remarkable creatures in regard to their sagacity. This is certainly true even after due allowance has been made for some exaggerated statements that have been made regarding them. Whether any of this sagacity can be properly referred to what we commonly

[1] Trans. Scottish Nat. Hist. Soc., vol. for 1902.

understand as REASON is quite another matter. Instinct of a very high order it undoubtedly is. But whether this instinct can be regarded in any other light than the almost necessary outcome of social habits which have prevailed through very long periods of time is very much open to question. There are many facts connected with Ants which seem to me to entitle them to claim a very high antiquity—higher, indeed, in some cases, than that of the continents in which they occur. If I am correct in holding this opinion that the instincts of these and other Social Hymenoptera is the outcome of an ancestral history whose commencement dates far back in the Past, many of the difficulties which confront us when we realise their utter want of resource on such occasions as when they are placed under conditions to which their ancestors have not grown accustomed will at once vanish. In the course of an infinite number of generations their ancestors have gradually acquired the habit of dealing successfully with particular cases of difficulty, and the habit of doing so has been so long transmitted that it has become practically as much fixed as their morphological peculiarities in each case. But when Ants find themselves placed under conditions which have seldom or never occurred in any part of their ancestral history, they are just as much at a loss to meet the difficulties of the case as any other animals on the same level in the scale of creation would be. I want to suggest that much of the sagacity of Ants in general is due to the fact that there has been going on, for a very long time, a persistent, but close, contest between Ants on the one hand and Plants on the other, and that the struggle has left its mark upon both. The nature of the contest may be gathered from the statements which follow.

Ants, like all other animals, need food of some kind. In some respects they may be said to be omnivorous, as there is hardly anything of either animal or vegetable origin that one kind of Ant or another does not eat. But they all show a decided preference for food of a saccharine nature. Some individuals, told off for particular kinds of duty which precludes their preparing their own meals, are fed by other Ants (Worker-Ants always being meant, unless otherwise stated) with a kind of nectar, which they sip from the lips of the Hebe who is deputed to act in that capacity. Whether the sustenance so provided for the relays of Workers represents their normal food or not is one of the many points about Ants that yet remain obscure. But there is reason to believe that even if saccharine matters do not form the staple of their food, they can thrive on them alone; and it is quite certain that they prefer them as food to any other that can be offered. Amongst Ants of all kinds, and from all parts of the Earth where Ants are found, this fondness for sweets is evidently their ruling passion. Where saccharine matter and Ants occur in close proximity, hardly anything will prevent their coming together. Many of the devices by which this is brought about have long been known. The well-known fondness of Ants for honey-dew has, of course, led to the domestication of the Aphides by Ants. Another curious and equally interesting result of the same insatiable fondness for sweets has given rise to the evolution of the Honey Ants, such as the Australian *Camponotus inflatus*, figured in Plate IV. fig. 1 of Lubbock's 'Ants, Bees, and Wasps.' Other species occur both in Mexico and in Texas. In the Honey Ants the abdomen is enormously distended through the gradual extension of the rings of membrane between the chitinous abdominal segments. These individuals have been undoubtedly evolved from the ordinary Workers of the species in response to the requirements of the normal Workers, who need "animated honey-jars" to supply them with the much-desired nectar. In South America these Honey Ants are collected, and are sold in the markets, on account of the nectar they yield when crushed, which is made into a drink of much the same nature as the old English mead. The Honey Ant does not convert food of its own getting into honey, but simply receives it from other Ants, who inject the nectar into the mouth of the living receptacle, in whose stomach it undergoes a kind of preliminary fermentation, which appears to render it better suited as food for the Workers, as well as for the larvæ, than it would be otherwise. When fully distended the abdomen of the Honey Ant is about the size of a small grape. These Honey Ants have been described independently by several observers, amongst the latest of whom is Dr McCook, whose book is entitled 'The Honey Ants of the Garden of the Gods, and the Occident Ants of the American Plains.'

As a further illustration of the relation between Ants and nectar, may be mentioned the fact that certain Acarids of more or less degenerate structure attach themselves to Ants. Lord Avebury tells me that one he had observed lived about what one may term the "neck" of some of the Worker-Ants. When the Ant stoops forward to feed on some nectar the Mite comes forth from its retreat and feeds on the nectar at the same time as its host. This is an unusual form of commensalism.

It is not necessary to go further into the evidence bearing upon the fondness of Ants of all kinds for nectar, as the fact is now generally well known to all who take even a casual interest in the ways of these little folk. But we may well pass in review here what is the use of nectar to the very many plants which secrete it, even though, to most people with a taste for Natural History, those reasons have long been known.

To bring about the development of the seeds of a plant, it is necessary that the pollen from the anthers of the flower shall come into contact with the stigma, which is connected with the ovary where the embryo seeds are formed. It matters not how the contact is brought about so far as the fertilisation of the seeds is concerned, and it may be effected simply by the pollen being transported even by the wind from the anthers to the required position within the same individual flower, or from one flower to another on the same plant. But large numbers of experiments have proved that in the great majority of cases seeds so fertilised do not give rise to plants either as numerous or as full of natural vigour as those which have been fertilised by the transference of pollen from another plant of the same species. It has to be remembered in this connection that the conditions which determine the survival of a particular species of either animal or plant are very complex, and are usually opposed by other conditions which tend in the opposite direction. It may indeed be said of most organisms, plants included, that their struggle for existence is very keen, and that the chances that a given individual will survive are almost exactly balanced by the chances that it will not. A very slight difference will, and commonly does, serve to turn the scale either way. Hence the plant which produces good seed in fair abundance will leave more descendants than one which has been less favourably circumstanced in that respect; and the one that leaves more descendants will be more sure, for the time being, of maintaining its own species. So if self-fertilisation is less beneficial to the plant than cross-fertilisation, it is obvious that in the long-run the plant that can bring about cross-fertilisation will have the advantage over one that cannot do so. In all these processes TIME is one of the great factors concerned—time, that is, rather in the geological sense than in the sense in which the word is ordinarily used. And just as in the case of animals, a given habit or tendency is likely to be transmitted, and as beneficial modifications tend to prolong the life of the species, so we may justifiably refer to these responses on the part of both animals and plants to external stimuli as if they were due to actual volition on the part of the individuals, instead of being, as they really are, the outcome of a long series of slight modifications which have proved beneficial to the organism as a species and not to it as an individual. I shall therefore adopt that tone in the remaining remarks, and shall refer to changes in plant morphology as if they had arisen at the will of the individual.

Assuming that it has been clearly proved that it benefits plants to have pollen brought to them from other individuals of the same species, we may go on to consider some of the devices which plants have employed as means of bringing about this desirable end. In the first place, they have to find out suitable agents for the purpose, and to select out of many the best for the purpose. The action of the wind answers well enough for some. Other agents fulfil the requirements of another set. But a large number of plants have found out that large flying insects, such as certain Lepidoptera and most Bees, give results which are most satisfactory of all. That being the case, the question arises, How best to attract them so that they may come and do the work? How *we* should set about work of a similar kind is plain enough if we only consider how, say, money is raised for some charitable purpose. We get up a bazaar, and we stock it with a number of trifles, including confectionery, and get some attractive ladies to agree to take stalls. Then we hang out a great number of brightly coloured flags which can be seen a long way off, and we put up notices at the entrance showing the desirable visitor which way to go; and there are endless devices to attract people to come, and to make their ingress as pleasant as possible. So visitors see the flags, and they come to the doors, and they are tempted to enter, and in doing so they usually leave behind a little of what they brought in with them; and then they follow the direction-marks, and go to one of the stalls where, say, some sweets are to be had, and they take these, and in doing so leave behind some more of the commodity desired. The visitors have got something they wanted, and so have the people in the bazaar. Then the visitor departs, and everybody is happy all round. So with flowers.

You will generally see at the door of the bazaar one or two policemen, and some special devices for excluding people who want to get the good things without giving anything in return. So, too, with flowers.

A flower is a bazaar. There are little niceties carefully stowed away in the back part of the flower, in the shape of drops of nectar; the bright petals of the flower are the flags making known the fact to insects afar off that something of special interest to them is to be had by those who come in the right way, and who bring with them a *quid pro quo*. The flower bedecks itself with brightly coloured stripes, which politely inform the visitor which way it is considered best to go to get what is wanted. And it sets forth a little feast as a reward to the visitor who is bidden as a guest.

So a Bee, for example, starts some fine morning to visit some particular kind of flower in search of honey and pollen; and she keeps to that kind of flower the whole of that day, never by any chance visiting another kind. Her hairy back and body rub off the pollen from the anthers of the first flower visited, and while she is rummaging about to get at the tiny feast of honey at the far end of the next flower, she produces the desired effect of transferring some pollen from plant No. 1 to plant No. 2. That done, the plant has attained its chief object in life.

When this Address was given a large number of illustrations of the various devices employed by plants in order to attain to this result were shown on the screen. But the subject has been so frequently illustrated that the reader will only have to turn to almost any one of the many books dealing with the natural history of plants (Kerner's most especially) to find abundant examples shown.

In the case of other plants, they have opened their bazaars in the evening; and as brightly-coloured flags don't show up well in the dusk, wild-flowers of this kind put out white ones, and make up the effect by using strong sweet scents. In either case the result attained is the same.

Now all that amount of trouble and expense cannot be incurred by the plant without some adequate return. It wouldn't pay in the case of a bazaar to let in a number of dirty little boys, who would carry off the sweets without paying a copper in the shape of either entrance-money or the price of the goods. So, as I said, these have to be kept out by every possible means. In Kerner's 'Flowers and their Unbidden Guests,' one of the most delightful books on Botany any one can read, there are admirable accounts of a great many of the devices employed by plants with the express object of keeping away undesirable visitors who rifle the honey and do the plant no good in return. I must refer the reader to this book for a fuller account of the subject than is given anywhere else.

The general nature of those devices which have for their object the protection of flowers from the visits of undesirable guests cannot be dealt with in an Address a few pages in length like this, and especially without illustrations. A large number of them were shown by means of lantern-slides on the occasion above referred to. They comprise almost every possible arrangement of bristles, hairs, and spikes, some quite dry, many of them sticky with some viscous bird-lime kind of secretion. Nobody studying these could have very much doubt that the plant has had Ants in mind in using these various contrivances for preventing the ingress of small insects to the chamber containing the honey meant for the Bees. Then plants seem long ago to have found out the device that gardeners are wont to use when they are troubled with Ants in their conservatories. The gardener puts the flower-pot in a saucer of water, which no Ant dare attempt to swim. Many plants with opposite leaves connate at their base hold up a little pool of water, which, whether meant wholly for the purpose of excluding Ants or not, yet most effectually answers that purpose. Gardeners in some other cases prevent troublesome animals from climbing their trees by painting a ring of tar around the stem. Many plants have hit upon a similar device; and we have but to glance at most plants with viscous stems to see how admirably this protective device succeeds. No intelligent Ant would ever dream of making the attempt at getting at the honey in the upper part of a flower which has defended itself from attack in that way. Another set of plants, acting upon the hint that Ants can be kept away by the judicious use of bird-lime, have developed a milky juice, which is quite fluid when within the stem, but which rapidly hardens into a nasty sticky mess on exposure to the air. Our little friend the Ant swarms up the stem in search of honey, but when it nears the goal its needle-pointed claws perforate the thin skin of the plant and let out a tiny drop of the milky juice. Ants are very clean little creatures, and they immediately try to get this mess off their feet; but, as will be seen, this only makes matters worse, and the affair ends by the unwelcome visitor being securely fastened to the stem, like a criminal on a gibbet, as a warning to others not to try that sort of thing again.

Other plants, such as *Impatiens tricornis*, which have tried without success to ward off the attacks of our persevering little folk, have decided to come to terms with the Ants; and really this seems, especially to the lover of Ants, to be the better policy after all. These plants grow a little nectar part of the way down their stem. The Ants swarm up to this, have a feed, and go away, under the impression that there is no more to be had. Crafty plant! to outwit the Ant in that way.

Ants are very nervous little creatures, and although they can climb about into all sorts of positions, they do not dare to let go and take even a very small jump. Many plants have long ago discovered that little weakness, and have put very awkward turns and sharp bends in the way leading from the stem of the plant to the flower. No Ant dare to venture that much, so the plant is safe from the attack of this particular kind.

Again, Ants have a great dread of getting wet feet. Nothing whatever will induce them to take their walks abroad before the dew is off the grass. Flowers, ever alert to keep upsides with the Ants, have turned that fact to good account.

A considerable number of them open early in the morning and remain open until the dew dries up and the troublesome little honey-hunters come forth, when these plants shut up for the day, unless the great business of their life has been got through and they have been fertilised by visitors of the right sort.

Some few plants are injuriously affected in other ways by the visits of Ants. In a few cases this is due to the action of formic acid upon the plant tissues, which acts in much the same way as most other irritants, by causing an abnormal growth at the spot affected. In some other cases, as in that of the trees visited by the Umbrella Ants of Brazil, *Œcodoma cephalotes*, these Ants visit many cultivated trees, such as coffee and orange trees, and cut circular bits out of the leaves, which they carry away over their heads, held like parasols, in order to thatch their wonderful little dwellings. Other leaf-cutting Ants attack the foliage of the Bull's-horn Thorn, a species of acacia found in Nicaragua. But as it is obviously not to the advantage of a tree to be even partially defoliated, some defensive means has had to be adopted. In this case, oddly enough, the defensive force enlisted is that of a colony of Ants of a particularly warlike kind, *Pseudomyrma bicolor*, which are housed by the plant within hollow thorns, and which are provided by the acacia with abundant food and nectar. In return for these services this standing army forms an effective guard against the attacks of the leaf-cutting Ants, as well as against other depredators. My friend Mr Richard Nicholson of Benalla, near Melbourne, tells me also of the Bull-dog Ant, which in like manner protects the blackberries of Australia from attack.

There are very many other examples of the same kind, which there is not room to quote here; but I may conclude this part by some mention of the *Serratula* described by Kerner, which is liable at a certain early stage of the growth of the flower to the unwelcome visits of a flying beetle, which eats out the tender heart of the flower and ruins it at once. It is not good for the plant that its flowers should meet with a serious injury of this kind, so it has arranged that just before the critical stage in the development of the flower is reached the bracts of the capitulum should each yield a tiny drop of particularly good nectar. Certain warlike species of Ant have found this out, and when the time comes they take possession of the capitulum, feeding there to their heart's content. One member of the party mounts to the top to act as sentinel, and when he descries the approach of the enemy he signals to the guard to turn out. This they do by holding on to the bracts with their middle pair of legs, and keeping their jaws ready to inflict a wound, and their abdomen ready to squirt formic acid into it. So, if the beetle incautiously comes too near, he soon has to leave with, so to speak, tears in his eyes. Directly the critical period is past no more nectar is given off by the bracts, the Ants take their leave, and the flower blooms on in ordinary course.

In reflecting upon these facts one cannot refrain from speculating upon the relative intelligence—if such a term is allowable—of Ants as compared with Plants. What we are considering is, of course, not so much cases of intelligence in the sense commonly understood, as that habit of adapting themselves to new conditions which both organisms show. In a certain way this may be regarded as a manifestation of intelligence, but it is of that kind which, instead of responding within a very short space of time to unwonted circumstances, takes many centuries, as it were, to think the matter out.

What we are really dealing with is, of course, only a case of Natural Selection and the Survival of the Fittest. But the results may be regarded, as I have treated them here, as if they had arisen at the will of the individual, and had been brought about in its own lifetime, instead of being, as they are in the great majority of cases, simply the aggregate result of a long series of slight modifications in habit and form which have proved beneficial to the species and not to the individual.

In the discussion which followed the delivery of this Address, Mr Gloag mentioned a case he had met with in Forfarshire, in which a considerable number of plants of *Dianthus deltoides* harboured, each of them, a colony of Ants at their roots. The plants were thriving remarkably well. There were no Ant colonies at the roots of other plants growing near. Has the formic acid any chemical effect upon the constituents of the soil there which might be beneficial to this Pink ?

I will only add, in conclusion, that it is certain that no one who considers even the few facts here set forth (to say nothing of those given in larger works) can have for a moment any doubt about the important influence exerted by Ants in determining much connected with the morphology and habits of flowers. I am myself disposed to regard Bees on the one hand and Ants on the other as two of the most important determining factors concerned in the evolution not only of floral structures but also of much else that is of interest in the world of plants.

V.—*SOME OBSERVATIONS ON THE DISTRIBUTION OF THE SMALLER CRUSTACEA.*

By THOMAS SCOTT, LL.D., F.L.S., Honorary Member.

(*Read Jan. 28, 1903.*)

The distribution of the Crustacea, and especially of the smaller species, has in recent years been attracting more attention than formerly. That it should do so is not only not surprising, but one is rather inclined to wonder why these minute crustaceans have been so long and so much neglected. For whether we regard their extremely varied and often beautiful forms, or their interesting, and in many cases strange, life-histories, they are found to constitute one of the most fascinating studies that can engage the attention of the zoologist.

In the following observations on the distribution of the smaller species of crustacea, I shall for the most part confine my remarks to those that have been observed in connection with the investigations which have for a considerable number of years been carried on under the direction of the Scottish Fishery Board. And, *first,* I propose to notice, briefly, the influence of the *seasons* on the distribution of the smaller crustacean species: this is sometimes more easily observed in regard to fresh-water forms than amongst those that live in the open sea. *Second*, reference will be made to the occurrence of certain species off the Scottish coasts which seem to owe their presence there to the influence of *oceanic currents*. And, *third*, a number of species—chiefly parasitic—will be referred to, the distribution of which appears, so far, to be inexplicable.

First, The influence of the *seasons* on the distribution of the smaller crustacea. Though the changes of the seasons have, no doubt, a certain influence on the distribution of the smaller crustacean species, it is not always easy to ascertain, even approximately, how far this influence may be exerted, or to what extent the ordinary seasonal influences may be neutralised by changes that are accidental and temporary. Only by continuous observations extending over a number of years can any satisfactory knowledge concerning the influence of the seasons on distribution be acquired. But though such a study may be difficult, and the results sometimes disappointing, it is nevertheless full of interest; and one of the reasons which make it unusually interesting is due to the unlooked-for incidents which are to be met with occasionally. I have stated that the ordinary seasonal influences may be interfered with by accidental and temporary changes: the following example will show how this may occur. The various species of *Daphnia* are, under ordinary circumstances, not greatly affected by seasonal changes. I have found them in Duddingston Loch, Loch Leven (Kinross), Forfar Loch, and other lochs which I have visited at various seasons, to be nearly, though not quite, as numerous in winter as in summer. (See Part III. of the 16th Annual Report of the Fishery Board for Scotland, p. 132 *et seq.*) But though the distribution of *Daphnia* in these lochs did not appear to be greatly affected by seasonal changes, it was otherwise with those observed in an artificial pond near Comely Bank, Edinburgh. I visited this pond, with a friend, on July 3, 1898, and found *Daphnia pulex* abundant; on the 25th of the following month, or a little more than seven weeks after the first visit, I examined the pond a second time: the weather in the interval had been dry and warm, so that there was less water in the pond than at the first visit. Under these circumstances I had expected that the entomostraca would have become more crowded together, and that a larger gathering would thus be obtained. The actual result, however, was very different. Entomostraca of any kind were few, and as for *Daphnia*, not a single specimen was got, even though the pond was carefully searched. Probably in this case the warm dry weather, acting on a decreasing body of water, had killed them. In this connection I would refer to the joint observations of Mr Lindsay and myself at the Upper Elf Loch, Braids, in the years 1896, '97, and '98, the results of which were communicated to the Society in two papers now embodied in the Society's 'Transactions.' In the second of these papers will be found a description and tabular view of the seasonal variations in the entomostraca of this little sheet of water—some of these variations being rather remarkable.[1]

Amongst the many species met with in the lochs of Scotland, the following may be mentioned as being more markedly susceptible to ordinary seasonal influences. *Holopedium gibberum* was common in Loch Arklet in September and November 1897, and abundant in June 1898, but not a trace of it was observed on the 15th of March of the latter year. It was common in Loch Achray in September 1897 and June 1898, but was entirely absent on November 27 and March 17. It was common in Loch Doon (Ayrshire) on July 6, 1898, but was not observed in September, December, and March preceding. The same species was taken in Loch Oich in August 1897 and in August and October 1898, but was absent from the gatherings collected in December and January. Two other species of cladocera also exhibit a somewhat marked susceptibility to seasonal changes, but the first more distinctly so than the other. In the lochs in which they occur they are usually common in the summer months, but are scarce or absent in winter.

Amongst the pelagic copepoda which I have found in the lochs of Scotland, the only species which exhibited any marked

[1] See 'Transactions,' vol. iii. pp. 375-378.

susceptibility to seasonal influence is *Diaptomus laciniatus*, Lilljeborg. This species was found in Loch Doon, in Ayrshire, but only in September 1897 and July 1898, while in the intervening months of December and March no trace of it could be detected. The distribution of *Diaptomus gracilis*, G. O. Sars, is very different. I have found this species not only in most of the lochs examined, but have gathered it all the year through. There are other fresh-water species which exhibit a tendency to seasonal change in their distribution, but the change does not appear to be so marked as in those already alluded to.

The effects of the seasons on the distribution of the *marine* crustacea are no doubt also considerable, but other changes, accidental and temporary, may occur which may so obscure and neutralise those more regular changes which the seasons usually produce as to cause them partly or wholly to escape our observation. Continuous stormy weather, for example, gives rise to currents, which may be comparatively cold or warm according to the direction from which the wind has been blowing, and these currents, pushing their way along our coasts, alter for a time the normal temperature of the surrounding water, and so react on both animal and vegetable life. But such currents will not only have a certain influence on the local fauna,—they may also be the means of bringing occasionally within our faunal limits, and even into our estuaries, rare and interesting organisms whose usual habitat is beyond the British area.

Many examples might be given which seem to indicate the effect of seasonal change on the smaller marine crustacea, but the following may suffice. In some gatherings of small crustacea sent from the Clyde in 1901, *Podon Leuckartii* (G. O. Sars), one of the cladoceran species, was found moderately frequent in those collected in the spring months, but not in those collected later in the year. On the other hand, *Podon intermedius* (Lilljeborg) and *Podon polyphemoides* (Leuckart) were observed only in the later gatherings. In a paper on some of the results of the investigations carried on in the Firth of Forth by the Fishery Board for Scotland I have shown, for the seven years from 1889 to 1895, both inclusive, that the maximum abundance of *Calani* in their young free-swimming stage, in the Firth of Forth, occurred during April and May, and occasionally in June. The increase is rapid till the maximum is reached, and the subsequent decrease appears to be as rapid. This was due to the fact that these three months form the principal spawning period of this group of the crustacea. It is also shown in the same paper that though *Calanus heligolandicus,* one of the more common of the marine copepoda, exhibited for the seven years scarcely any perceptible difference in its distribution as the result of seasonal changes, the distribution of *Temora longicornis* showed, on the contrary, considerable diversity in the frequency of its records for the different months; and as this diversity occurred year after year with a certain amount of regularity, it was probably caused by the succession of the seasons, and the changes consequent thereupon. The maximum number of records for each of the seven years occurred in April and May; the records for the succeeding months, from June to October, were fairly regular, and were on an average scarcely half the number recorded for April and May; but the average monthly records from November to March were only about two-fifths of the average for the previous five months. In other words, the average number of records for April and May was 51; for the five months from June to October, 23; but for the five months from November to March it was only 9.

Second, The influence of *currents* on the distribution of the smaller crustacea. The species whose distribution is chiefly affected by currents are those usually described as pelagic or free-swimming; and several interesting examples, exclusively marine, have been observed. One of the more prominent of these is the occurrence on the north and east of Scotland of *Eucalanus crassus* and *Eucalanus elongatus. Eucalanus crassus,* Giesbrecht, was described by Dr Giesbrecht in 1888, and it has been recorded by him off the east coast of South America, in the South Pacific, and in the North Atlantic up to latitude 41°, as well as from the Mediterranean; and I have also obtained it in gatherings collected in the Gulf of Guinea. This species has on several occasions been taken in the Moray Firth, and on November 19, 1897, a considerable number of specimens were captured there; but though they included several adult males and females, the majority were immature. I do not know of a single record of this species from the east or south-east coast of England, but Dr Wolfenden has taken it, along with other southern forms, in the Faroe Channel. Its occasional occurrence in the Moray Firth may therefore be owing to the action of currents passing round the north of Scotland into the North Sea. I have lately met with what looks like a southward extension of the distribution of the species on the east of Scotland, several specimens having been obtained in a tow-net gathering of crustacea collected off Aberdeen on November 11, 1901. This is the first time I have met with *Eucalanus crassus* so far south on the East Coast. *Eucalanus elongatus* (Dana) has also occasionally made its appearance in the Moray Firth, as well as another nearly allied form—*Rhincalanus nasutus*, Giesbrecht,—a form which I am inclined to regard as identical with Prof. G. H. Brady's *Rhincalanus gigas.* These probably, like the others, owe their presence in the Moray Firth to the action of oceanic currents.

In a paper in Part III. of the Eighteenth Annual Report of the Fishery Board for Scotland, I record *Corycæus anglicus* for apparently the first time in the Firth of Clyde. The specimens had been obtained in a surface tow-net gathering collected on May 29, 1899, in the vicinity of Ailsa Craig. At about the time these specimens were obtained near Ailsa Craig, Mr I. C. Thompson had been getting the same species in abundance off Port Erin, Isle of Man. It is therefore probable that these Clyde specimens were stragglers from the same swarm that Mr Thompson had met in with, and that this swarm had entered the Irish Sea by the North Channel. I had once before observed *Corycæus anglicus* in Scottish waters—viz., in the Firth of Forth in 1896; and it has more recently been captured, but very sparingly, between Lerwick and Sumburgh Head, Shetland, in the Moray Firth, and off Aberdeen.

But besides the occasional introduction of southern species within our faunal limits by oceanic currents, other forms whose natural habitat is arctic or sub-arctic make their appearance at intervals, and sometimes in abundance. These are usually found early in the year, and are probably brought to our shores by a more than usual southward trend of cold water from the North Atlantic. The following examples will illustrate this migration of sub-arctic and arctic forms. *Thalestris krohnii* (Kröyer) (=*Thalestris serrulatus* of Brady's Monograph) is a free-swimming arctic copepod, of a brick-red colour when living. This copepod has been recorded from various parts of the Arctic Sea, off the coasts of Finmark, and between Novaya Zemlia and Spitzbergen and elsewhere. But though a decidedly northern species, it sometimes makes its way far to the southward. Dr Brady, in his 'Monograph of the British Copepoda,' records its occurrence at the Scilly Isles (1880); I. C. Thompson obtained it near Puffin Island (Irish Sea) in 1889; and in 1890 I reported its occurrence in the Firth of Forth and in Dornoch Firth. My son has also obtained it in a surface gathering from the Gulf of St Lawrence. In all these instances, however, so far as known to me, it occurred very sparingly.

The next species I would refer to is the amphipod *Euthemisto compressa* (Göes). In 1892 an immense shoal of *Euthemisto compressa* was observed off the Yorkshire coast. The sea was described as literally alive with them, and great numbers were afterwards washed ashore by sea-winds, and afforded a feast for starlings and other frequenters of the tidal line (see T. H. Nelson in the 'Naturalist' for May 1892). Some of the specimens made their way into the Firth of Forth, and were captured in the tow-nets of the fishery steamer which was at that time in the Forth estuary, being mentioned among the "records" for that year. This species is not uncommon in the Arctic seas. It is interesting to notice that in 1891 and 1892 there was also a considerable increase in the numbers of *Parathemisto oblivia* (Kröyer) taken by our tow-nets. The greatest increase inside the estuary occurred in 1891, while at the mouth of the estuary the greatest increase observed was in 1892. The cause of this remarkable southward migration of *Euthemisto compressa* along our east coast might be due to an unusual southerly movement of cold water from the North Atlantic. No similar migration has been observed in recent years.

In 1893 I reported the occurrence of the sub-arctic amphipod *Anonyx nugax* (Phipps) in the vicinity of May

Island. The specimens, however, were captured in February 1889, but at that time, as the species was unknown to me, I hesitated to record it. The same species was taken for the second time in Scottish waters by Mr F. G. Pearcey on Jan. 10, 1901. Specimens were captured by tow-net in the Cromarty Firth at a depth of about 7½ fathoms; and it is of interest to note that on both occasions the species was obtained so early in the year. The Rev. A. M. Norman, in his revision of the British Amphipoda ('Annals and Magazine of Natural History,' ser. 7, vol. v., February 1900), has some interesting remarks on this species. My largest Scottish specimen measures about four-fifths of an inch in length, but Arctic specimens attain to over one and a half inch in length (40-43 millimetres).

Having thus given several examples of crustacean species whose distribution appears to be directly or indirectly influenced by *seasonal changes* and by *oceanic currents,* I now proceed, thirdly, to mention a number of species whose distribution is somewhat peculiar, and for which there is, so far, no satisfactory explanation. Some of the best examples of this kind of distribution are to be met with amongst parasitic species, but I shall first refer to one or two free-living forms which, in this respect, are not without interest. The first I shall mention is the marine ostracod *Conchœcia elegans.* We owe the addition of this species to the British fauna to the researches of Sir John Murray, who, a number of years ago, found it abundantly in Loch Etive, near Oban, at a depth of 50 fathoms, and it is still common in the deeper parts of that loch. But though *Conchœcia elegans* is so common in this particular loch, it has been rarely met with anywhere else in the British seas,—indeed, I know of only two other records: one specimen was dredged in deep water 180 miles north-east of Buchan Ness on May 22, 1901; and another was obtained from the stomach of a whiting captured at a depth of 65 fathoms about ten miles off Aberdeen a few days previous to the one last mentioned. Professor G. O. Sars of Christiania describes the species as very abundant among the Lofoten Islands down to 300 fathoms.

The next species I shall notice is the fine large copepod, *Euchæta norvegica*, Boeck,—another of Sir John Murray's additions to the British fauna. This copepod is found, sometimes in great abundance, in the deep water of Upper Loch Fyne, so much so that a large drop-jar may be filled by a single short haul with the tow-net. It is also got, but more sparingly, in other parts of the Clyde area. Yet it is so scarce in other parts of the British seas that there is no mention of it in the excellent 'Monograph of the British Copepoda,' by Professor G. S. Brady, published in 1878-80; and I have never once met with it on the east coast of Scotland, and only occasionally off the Shetland Islands. There are similar interesting examples among fresh-water species, such as the occurrence in Duddingston Loch of *Cyprois flava*, an ostracod discovered in this loch many years ago by the Rev. A. M. Norman, and which I have occasionally found there. On one of these occasions the species was moderately common, yet it is doubtful if this ostracod is found living anywhere else in Britain. Other examples might be given, but I shall rather proceed to notice the curious habitats of some of the parasitic species.

Although a number of the parasitic crustaceans found on fishes are not confined to one particular kind of fish, such, for example, as *Caligus rapax*,—a species which seems to have a kind of "roving commission,"—the habitat of many of them is limited to a particular kind of fish, and sometimes even to a particular part of the fish. This is well shown in the case of *Lerneopoda bidiscalis*, de Vismis Kane. This parasitic copepod has hitherto only been found adhering to the ends of the claspers of male specimens of the tope (or toper),—a large kind of dog-fish. The ends of the claspers, where these parasites adhere, are frequently lacerated and bleeding. Whether the laceration is caused directly by the parasite, or by the efforts of the fish to shake off its tormentors, is not known. The *Lernæenicus sprattæ* (Sowerby), found on the eye of the sprat, is another interesting example of limited distribution, for not only is the species confined to the sprat, but it is also confined to the eye of the fish. Another species of the same genus is found on the eye of the herring, and a *Lerneopoda* on the eye of the Greenland shark. The head of the *Lernæenicus*, which is buried deep in the substance of the eye, is furnished with two divergent barbs, one on each side of the head, so that the head cannot be removed without dissecting the eye. The presence of the parasite probably causes the eye to become blind. In illustration of this, on one occasion my son tried to catch a sprat—one of a number which had made their way into one of the Leith Docks. This particular sprat had a parasite on one of its eyes, and its would-be captor managed to get his hand almost within touch of the fish on that side on which the parasite was attached, apparently without being noticed, and was about to grasp it, when it turned round, and, seeing him, made off like a flash of lightning.

Nicothoë astaci furnishes a most interesting example of limited distribution. This copepod, so frequent on the gills of the common lobster, is apparently found nowhere else, at least in its adult stage; and it is somewhat strange that, though the parasite is so frequent, there are so few published records of its occurrence. Indeed, I know of no Scottish records of *Nicothoë* except those I have myself published. I seldom fail to find the parasite on lobsters that have not cast their shells for some time previously. Though comparatively a small species, this parasite is of interest from the two great wing-like lateral expansions of the posterior part of the thorax. These expansions appear to be the result of an extraordinary development of the fourth thoracic segment. The ovisacs are also large, and, with the lateral expansions, give to the species, which otherwise is not unlike some of our common Harpactids, an appearance unusual among copepods. Adult specimens of the parasite are extremely inactive, and if removed from the lobster's gills and placed in sea-water, they make no apparent effort to change their position. The only evidences that they are alive are the peristaltic movement of the intestine and the persistence of their semi-transparent pinkish colour. Speaking of their sluggishness, Milne-Edwards —quoted by Dr Baird—states that they allowed themselves to be torn to pieces without making the least movement or quitting their hold. But they also seem to be tenacious of life, for my son removed several specimens from a lobster's gills and placed them in sea-water, where they continued to live for at least five weeks.

A copepod is found on the hake (*Merlucius merluccius*) which differs from many others in the mode of its attachment. This species, instead of fixing itself to some vital part of the fish, such as the gills, sends out a process which penetrates one of the scales, and expands between the outer and inner surfaces of the scale into a thin round disc, which is ornamented with several clear narrow slits arranged like the radii of a circle: it is from this latter peculiarity that the species derives its name of *Anchorella stellata.* It is scarcely possible to remove the copepod without also removing the scale along with it. All the specimens I have hitherto noticed have been attached to scales in the neighbourhood of the pectoral and ventral fins, especially the former. The first specimens observed looked like globules of semi-transparent mucus, but finding that the globules were somehow fixed, I was led to examine them more closely, and so was enabled to add another species to the copepod fauna of our seas. I have so far only found this parasite on hake sent from the Clyde, but it is likely to occur on the same fish from other parts of our coast. It is interesting to note that Kröyer, who first described the species, obtained his specimens also from the hake.

Another parasitic crustacean, remarkable because of its size and from the position in which it is found, is the large *Charopinus dalmanni* of Retzius. This species is usually found in the spiracles of the grey skate (*Raia batis*), and adult female specimens attain a length of fully two inches. I have sometimes found the parasite in both the spiracles of the same skate, and frequently two, and occasionally three, specimens in the one spiracle. The species is not uncommon on large grey skate brought to the Aberdeen fish-market, and it has also been obtained on a grey skate captured at the mouth of the Forth estuary. Two other species of *Charopinus* have been recorded—viz., *C. ramosus*, Kröyer, found on *Raia clavata* and *Raia maculata*, and *C. dubius*, found on *Raia circularis;* but these two species are usually found on the gills of the different skates, instead of in the spiracles.

Two parasitic copepods belonging not only to two different genera but also to two different families have been found on the gills of the spotted dragonet (*Callionymus maculatus*). The one is called *Hæmobaphes ambiguus*, and belongs to the family Lernæidæ; while the other is *Chondracanthus ornatus*, and is a member of the family Chondracanthidæ. Usually only one specimen belonging to one or other of the two species is found on the one fish, but sometimes two, and even three, specimens are obtained on the same fish, and in that case they may both belong to the same species, or both species may be represented. For example, one of the fishes examined had a *Chondracanthus* on one side of the head and a *Hæmobaphes* on the other; another specimen had a *Chondracanthus* and a *Hæmobaphes* on the same side; while a third had two *Chondracanthi*, both being on the same side. A sample of fifty-five fishes yielded twenty-three parasites, and comprised fifteen *Hæmobaphes* and eight *Chondracanthi*. Both species were undescribed. Though the parasites are moderately large, it is difficult to make out, without dissection, whether they are present or not; and probably it is on account of this, and because the spotted dragonet is a fish that is not very common, that these parasites were not sooner observed.

The fish parasites referred to in the preceding notes differ greatly in their sexual forms, for while the females are comparatively large the males are usually very small, and, moreover, the females in their adult stage are fixed to their host for life, though the males are to some extent free, and may therefore be found adhering to different parts of the body or appendages of the female. Notwithstanding this difference in the adult stage of the female and male, the female in its earliest stage is also usually a free-living organism. During this early stage in the life of these parasites, the difference between the species, or at least between some of them, is scarcely, if at all, recognisable; and because of this close identity it has been suggested that the changes observed in their adult forms, and which have led to their separation into distinct species and genera, are simply the result of the difference in their host, or the particular part of the host to which they have fixed themselves. Take, for example, the *Lernæa branchialis*, so frequently found on the gills of whiting, cod, and other Gadoids, and which has the appearance of a red worm twisted round upon itself. The *Lernæa* when young is a free-swimmer, and should therefore be able to attach itself to any fish that happens to come in its way, and for that matter, to any part of the fish; but the adult is never found anywhere except on the *gills* of the fish, and usually on the gills of a Gadoid. It may be that only those young Lernæa that happen to attach themselves to the gills are able to survive and reach the adult stage, while those which become fixed to other parts, finding an environment unsuited to the kind of life they have to live, and food differing from that which they require, necessarily perish. But only a knowledge of the life-histories of these parasites will throw light on some of the difficulties that have been alluded to.

Though the examples of restricted distribution I have referred to are no doubt interesting, the next example I would mention seems to me to be still more remarkable, and a reference to it will, for the present, conclude these observations. It is the occurrence of what appear to be free-living copepods in the nostrils of the cod and of some other teleostean fishes. My attention was first directed to this peculiar habitat by observing a whitish coloured object close to the outer edge of one of the nostrils of a lumpsucker (*Cyclopterus lumpus*). This whitish object, on being carefully examined, proved to be a *Bomolochus*, apparently identical with *Bomolochus soleæ*, Claus, so named from its having been taken by Claus on the back of the common sole (*Solea vulgaris*). But though the *Bomolochus* happened to be first noticed in the nostrils of the lumpsucker, it did not appear, from subsequent examination, to be very common on that fish. I was, however, not a little surprised to find that the lumpsucker was not the only fish that harboured copepods in its nostrils, but that they were also present in the nostrils of other kinds, and especially in those of the cod-fish. I have examined a considerable number of cod-fish since the copepods were first observed, and find that they are moderately common in the nostrils of that fish. My son has obtained them in the nostrils of cod captured in the Irish Sea; and Mr Lindsay has also found them in the nostrils of cod he examined, and which were caught near the Isle of May. *Bomolochus soleæ* has now been got in the nostrils of at least six other kinds of fishes besides the lumpsucker and the cod—viz., the haddock, whiting, saithe (or coal-fish), ling, plaice, and flounder, and probably also in the nostrils of the lythe (or pollack). In view of the frequent occurrence of these copepods in the nostrils of the cod, it is somewhat curious that they should have been so long overlooked. As many as twenty-nine specimens have been obtained in the nostrils of a single cod-fish, and these comprised males, females (with ovisacs), and young in various stages of development. These copepods do not seem to be true parasites, but should perhaps rather be called commensals, as they appear to live on the mucus which the nasal fossæ usually contain. Should the copepods, while they are alive, be removed from the nostrils of the fish and placed in sea-water, they will be seen to swim quite freely, which seems to indicate that their habitat in the nostrils of fishes is not compulsory, but that they live there from choice, and find in the nasal fossæ both food and shelter. Two other, and apparently undescribed, species of *Bomolochus* have been recently obtained, and are described in Part III. of the latest Report of the Fishery Board. One of them, *B. onosi*, was discovered on the inside of the gill-covers of a five-bearded rockling from the Firth of Forth; while the other, *B. zeugopteri*, was found adhering to the back of a specimen of Müller's topknot (*Zeugopterus punctatus*) from the Firth of Clyde.

In mentioning these parasitic copepods I have merely touched the fringe of a most interesting part of the subject of distribution—a part the study of which may yet yield important results to those who have time to take it up.

VI.—*THE HEDGEHOG.*

By Mr TOM SPEEDY.

(*Read Jan. 28, 1903.*)

A RECENT article and correspondence in the 'Scotsman' on the hedgehog elicited a great deal of interest, and many people spoke to me on the subject. It therefore occurred to me that a few observations on the hedgehog might not be unacceptable to the members of this Society. The statements made in the article and letters referred to, as to some of the traits of this quaint night-pig, should be accepted with the proverbial grain of salt. That stoats will open and make a meal of a hedgehog I do not believe. Some years ago I shut a stoat and a hedgehog together in a large cage. The result was that I took the hedgehog out the following morning uninjured. Trying the same experiment with a large rat, they shortly seized each other and rolled over and over, struggling for the mastery. The rat was the aggressor, but the stoat was the victor. The same remark in regard to the stoat applies to the horned owl,—in this country, at least. I have lived where horned owls and hedgehogs are numerous, but that the one preyed upon the other I never had the slightest suspicion, and do not believe.

The story of foxes rolling hedgehogs to water and seizing them while struggling may, in the absence of positive proof, be safely consigned to the region of romance. As to hedgehogs rolling on fruit and carrying it off on their spines, I have yet to be convinced. The so-called gipsy-cooking recipe of hedgehogs—viz., to cover them with a paste of clay and roast them—is an old one; but I have never been able to verify a single instance of roasted hedgehog being included in the gipsy bill of fare. The flesh of the hedgehog may be "very delicate," as asserted by one of the correspondents of the 'Scotsman,' but unless he has actually tried it, of what use is his testimony? Other writers assert that "their flesh is not good for food." This, however, I will venture to say, that the smell of hedgehogs must in some way be akin to the scent of game, as I have seen pointers and setters stand as staunch as if a covey of grouse or partridges had been a few yards from their nose. The hedgehog is classed among the Insectivora, though, as is well known, it is passionately fond of flesh and eggs. In the suburbs of Edinburgh the hedgehog is far from being scarce. Again and again have I dissected them and examined the contents of their stomach, but I have never found it contain any vegetable matter. At the same time, I have no desire to dogmatically assert that they do *not* eat fruit, but in all those I dissected I found the stomachs full of beetles only. Hedgehogs get credit for devouring snails and slugs, and certainly if confined in a walled garden these disappear. This, however, is by no means convincing as to what constitutes the staple food of these creatures, it being exceedingly dangerous to rest any theory on experiments made with animals in confinement. I have frequently kept hedgehogs in a walled garden, and, as far as my experience goes, they will not eat fruit. They would take bread and milk or flesh, and a rabbit's liver was always removed first. Slices of apple put down were never interfered with. Being very nocturnal in their habits, it is exceedingly difficult to arrive at an accurate conclusion from observation as to what constitutes their food. I would therefore solicit gamekeepers and others interested to dissect and closely examine the stomachs of any hedgehogs they may destroy. By this means much information in practical natural history may be acquired. It must not, however, be supposed that the result will be satisfactory if confined to one season or one locality. As already mentioned, those I have dissected had been feeding exclusively on beetles, and had I not known otherwise, I would have been forced to the conclusion that they eat nothing else. Observations will therefore require to be taken over a series of years, and in all parts of the country.

To my mind, the carnivorous character of their teeth indicates that nature intended hedgehogs to prey upon flesh. Being anxious to find out how hedgehogs carry eggs, one of these animals was put into a walled garden for the purpose of watching and seeing him in the act. He collected all the dead leaves from beneath the fruit-trees into a corner, in which he concealed himself during the day. As he never emerged from his concealment till dusk, it was difficult to watch his manœuvres; but the activity he displayed in running about was most remarkable. Eggs were laid down, and nobody ever saw him lift one, though he occasionally had them removed before morning, when the shells were found among the leaves.

The depredations of the hedgehog are not confined to eggs. It has been known to invade the pheasantry and kill the young birds even when half-grown. This fact I would have been slow to believe had I not had it confirmed by personal observation. It would be superfluous to recapitulate what I wrote in a book on sport some years ago as to hedgehogs killing domestic poultry while acting the part of foster-mothers to young pheasants in coops. I there recorded that on several occasions hedgehogs entered coops in the darkness, killed the hens, and in some cases tore off their heads and disembowelled them.

The hedgehog displays great cunning in the concealment of her young. Should they be discovered when newly born and the nest tampered with, the mother never returns, but leaves them to perish. If young are produced in confinement, the mother sometimes devours them, as is frequently done by other animals. Such, at least, was my experience with one that gave birth in these circumstances. On another occasion I found a large female in the first week of June, and had her turned out in the high-walled garden of a neighbour, knowing from experience that my own garden would not keep her in. In a few days she produced her young, but unfortunately the curiosity of two boys was so strong that they searched for and found the nest. It contained three young ones, which I observed were born blind. They were of a whitish-blue colour, and their spines, though formed, were quite dumpy, white, and flexible. I had the little helpless creatures put back in the nest, but the following day they were all dead, the mother having evidently deserted them. When a few weeks old and able to travel, the instinct of the hedgehog accords with that of the fox, which never fails to remove her young so soon as she knows that her hiding-place has been discovered.

It has been said that hedgehogs are poison-proof, but this I do not believe. Prussic acid at once proved fatal, and I should not value the life of a hedgehog very highly after it had swallowed half a grain of strychnine.

It is a never-failing law of nature that, in all circumstances, animals are largely endowed with the instinct of self-preservation. While the lion trusts to its strength, the fox to its cunning, and the hare to its swiftness, the precautions of the hedgehog for its safety are of a very different character: it relies entirely on its spines. On the approach of danger it never attempts to get out of the way, but puts itself into an attitude of defence by tucking in its body, head and feet, and converting itself into a ball of impervious prickles. Protected by this hedge or fence, the hedgehog is one of the most curious objects in nature.

VII.—*A FEW WORDS ON FRESH-WATER MITES (HYDRACHNIDÆ).*

By Mr C. D. SOAR, F.R.M.S., Etc.

(*Communicated, Feb. 25, 1903.*)

The study of these interesting creatures was commenced a great number of years ago, the earliest known writer on them being Stephan Blankaart, a Hollander, who published his paper in Amsterdam in 1688. Then came Swammerdam, Linné, Roesel, De Geer, and others; but the first really serious attempt to study and name these very beautiful objects was when O. F. Müller began to write about them in 1776. In 1781 he published his great work on water-mites—'Hydrachnæ quas in aquis Daniæ palustribus detexit descripsit,' &c., 1781. Lipsiæ. The opening words of this volume are particularly interesting: it shows the enthusiasm of the man in his solitary hobby, and how he tried to induce others to take it up, but without result. I think it may be as well to give you some of his own words from his book:—

"Twelve years have now passed since I laid before the public a genus of insects full of unknown species, and mentioned their specific names in Danish, German, and French, in order that I might excite in entomologists a stimulus for learning about this new genus. I called them Hydrachnas, or water-spiders, because they chiefly resemble spiders and land acari, but they always live in water. They were close at hand, and they deserved no slight consideration on account of the many varieties of their form, the beauty of their colours, and the singular character of their multiplications and copulations, and because they are not infrequently swallowed by our cattle in drinking water. I added that they could be sent anywhere in a bottle filled with water, and I promised that I would repay all expenses and publicly offer my thanks to those who were desirous of acquiring some little glory by the discovery of a new species. But the result was not answerable to my desires. Not even a single Hydrachnid was offered to me by a single person."

In fact, says Müller, the most eminent entomologists held the Hydrachnas in the utmost indifference, as though it were a credit to them to be totally ignorant of the subject.

This book is very nicely got up. It contains 82 pages of letterpress, and 11 plates with 71 figures, all well engraved and printed. It is also hand-coloured. In all, Müller describes and figures 49 species. When we consider the microscopes in use in Müller's time and compare with our own, it is a fine piece of work, and shows how much Müller was in love with his subject.

Müller described the mites all under one generic name—Hydrachna—the differences being shown in the specific name only. Now, Hydrachnidæ is the name of the family, but Hydrachna is still retained as the name of one genus only. Piersig gives a list of a number of Müller's mites which have now been placed under their proper generic names, while still retaining, as they should do, the specific names given by their author.

The first writer to give another genus, I believe, was Fabricius in 1805, who introduced the name Atax. Since that date one generic name after another has been added, until now we have, I think, 60 in all. At least, Piersig, in 'Das Tierreich,' 1901, gives 57 genera, and I believe two or three have been added since. The species have also multiplied at the same rate, the number being now, in the words of Dominie Sampson, "prodigious." One genus alone, Arrhenurus, has a hundred certain species and about fifty doubtful, and the list is still increasing.

Of course, the specific differences in some of these water-mites are very small—indeed so much so, that I doubt if Müller with the instruments at his command could have seen them at all. I have often had to boil mites in liquid potash to see the necessary structure for the identification of the species.

There is something, however, I think, of much more importance to study than the mere naming and identification of species, and that is the life-history of these beautiful mites.

This part at present is very little known or understood, or what useful part they play in the economy of nature; so, like Müller, the man whose name I have mentioned so often, I wish to induce others to take up and make a hobby of these interesting little things. There is plenty of scope, as the subject is not nearly exhausted. We in Great Britain are yet a long way behind the Germans in our knowledge of water-mites. Piersig and Koenike have done more work on the subject than any previous writers. In America Mr R. H. Wolcott of Nebraska has written some splendid papers on Atax and Curvipes (Piona). Sig Thor in Norway is another name well known to all who study Hydrachnids.

I shall now show you a few drawings of British water-mites: all those coloured have been drawn and coloured while the creature was alive; those without colour were drawn from dead specimens. We have found in Great Britain at present representatives of thirty-three genera, but all the species have not been recorded which are known. I thought, however, a few species just to show how great is the variety in colour and form would be interesting, and perhaps something new to the majority of the members.

The first genus I will take is Arrhenurus, Duges—at one time spelt without the *h*. This genus was introduced in 1834, and several of Müller's species have been placed in it. It contains, as I have said, the largest number of species, and exhibits the greatest variety of form and colour. All are hard-skinned and have skins like a coat of mail, and in some cases with proper illumination under the microscope have rather a metallic appearance. The males are quite different from the females in structure, having the posterior margin in some cases elongated backwards as much again as the length of the body; others have the body projected backwards into two horn-shaped appendages, with a petiolus between. Then again, there are some in which the posterior portion has the appearance of a frill. Of course, these forms vary in different species to any extent. Then as regards colour we find some almost black, others blue, green, yellow, or brilliant red. Red, in both scarlet and crimson, in water-mites, is a very favourite colour.

Arrhenurus caudatus, De Geer (Plate III. fig. 1: A, dorsal, B, ventral surface of male; C, dorsal, D, ventral surface of female). Here you will see how great is the difference in structure between the sexes. The males of a great number of the Arrhenuri have also a peculiar spur on the fourth segment of the fourth leg. They do not all have this. There is also a depressed line on the dorsal surface of both male and female. In Great Britain we have had recorded a large number of this genus by Dr George of Kirton-in-Lindsey in the pages of 'Science Gossip,' and in his list of Hydrachnids of Lincolnshire. Arrhenurus caudatus has been found in the Upper Elf Loch by Mr Williamson (Aug. 1900).

Arrhenurus globator, Müll. (Plate III. fig. 2: A, dorsal, B, ventral surface of male; C, dorsal, D, ventral surface of female), is a very common mite in England, but I have not yet heard of it having been found in Scotland. Here again we find the spur on the fourth segment of the fourth leg.

Arrhenurus claviger, Koenike (Plate III. fig. 3: A, ventral, B, dorsal surface; C, petiolus). A brilliant red mite, with the horns I spoke of and the petiolus between. The legs have not been drawn, but they are similar to fig. 1 and fig. 2.

Arrhenurus nodosus, Koenike (Plate III. fig. 4, dorsal surface of male). This will give you an idea of the third form I mentioned.

The next genus is Brachypoda, Lebert, which contains only one species. This genus was previously known as Axona. The only known species is versicolor, Müll. (Plate IV. fig. 1: A, dorsal, B, ventral surface of male; C, dorsal, D, ventral surface of female). It is a very small and common mite, and when first caught is brilliant in colour. Here again we find the spur on the fourth leg. It is also hard-skinned. It has been found in Scotland by Mr Taverner and Mr Williamson. When taken, as a rule it is found in large numbers.

Midea orbiculata, Müll. (Plate IV. fig. 2: A, dorsal, B, ventral surface of male; C, dorsal, D, ventral surface of female). This is another genus with only one known species. It is the most brilliant mite I know of when taken in good condition. The male is without the spur on the fourth leg, but it has a peculiar formation of the tarsus of the third leg. I have taken a number of this species in England, but I do not think it has yet been found in Scotland.

The genus Eulais, once spelt Eylais, which contained at one time only a single species—E. extendens—now includes about fifty. The principal point of identification is the eye-plates. All the feet have claws, but the fourth pair of legs are without swimming hairs. Both male and female are alike in structure. The one I send as a specimen is Eulais georgei, Soar (Plate IV. fig. 3: A, dorsal surface; B, epimera and mouth-organs; C, mouth-organs on larger scale; D, view of inner side of palpus. The skin of these mites is very soft and easily broken. They often swim for a long time ventral surface upwards, trailing the fourth pair of legs, which are not used for swimming, behind them. The eye-plates are not shown on this drawing, but figures are in 'Science Gossip.' I have not heard of it having yet been found in Scotland.

Pionacercus vatrax, Koch (Plate IV. fig. 4, is the male). In this species we have a spur on the fourth segment, as in the Arrhenuri, with the addition of a peculiarly developed foot. It is a very small mite, not common. P. leuckarti (Piersig) has been found by Mr Williamson at Bavelaw Moss.

Hygrobates longipalpis, Hermann. The members of this genus are nearly always found in running water. They are very common. Three species only are known in Great Britain at present. Piersig gives eleven known species in 'Das Tierreich.' The male and female are alike except in the genital plates, which I have shown in the drawing (Plate V. fig. 1: A, male; B, female). They are powerful swimmers, but are without the swimming hairs at the joints of the legs which we find in other swimming mites. I have had a great many from Scotland.

Hydryphantes frici, Thon (Plate V. fig. 2). This genus is noted for a chitinous plate on the dorsal surface between the eyes, and it is on the shape of this plate that in several cases identification lies. In others it is the shape and number of the discs on the genital area. I send this because the only specimen I have seen was found in Scotland by Mr Taverner.

Pseudosperchon verrucosa, Protz (Plate V. fig. 3). The name of this genus has been altered by Piersig from Sperchonopsis. There is only one species known at present. The first was found in Saxony by Protz in 1896. The only specimen I have seen was found by Mr Taverner in Scotland. It has no swimming hairs, but there are a number of warty glands on both dorsal and ventral surface of its body. I cannot say whether this specimen is male or female.

Piona paucipora, Sig Thor (Plate V., fig. 4, is the male). The genus Piona was first known as Nesæa, afterwards as Curvipes: it is now known as Piona—at least, Piersig has named it so in 'Das Tierreich,' but I find it has not yet been adopted by other writers. Mr Wolcott in America uses the name Curvipes; so does Sig Thor in his last paper on South African Hydrachnids. The genus is fairly large, and contains some very beautiful species. The fourth segment of the fourth leg of the male is formed very curiously. This mite has been found near Edinburgh by Mr Williamson.

Torrenticola anomala, Koch (Plate VI., fig. 1, is the female). This is the only species known in Great Britain at present. This was found by Mr Taverner in Scotland. Mr Williamson has a specimen from Callander.

Frontipoda musculus, Müll. (Plate VI. fig. 2). This is another genus with a single species, but although there is only one known species it is found in different colours. A lateral view of three specimens is shown. Sometimes a red mite is found with green legs, but it is the same species; there is no difference in structure. They are fairly common everywhere.

Thyas vigilans, Piersig (Plate VI. fig. 3). We have several representatives of this genus in Great Britain,—Thyas longirostris, T. extendens, T. thoracatus, T. venusta, and the species here figured. I have seen only one specimen of this mite. I found it in a very small pond on Sunningdale Common a month or so after Piersig had found and described it. At the time I found it I did not know it had been described. I soon discovered I had something new. I returned to that pond, intending if possible to find another; but I got no more, neither then nor since. Its great feature is the median eye. It is a crawling mite, not a swimmer. T. venusta has been found at Bavelaw Moss by Mr Williamson.

Neumannia vernalis, Koch, is a beautiful mite, and fairly common. Mr Williamson has found it near Edinburgh.

Laminipes ornatus, Koch (Plate VI. fig. 4). All the males of this genus have a peculiar formation of the fourth segment of the fourth leg. They also differ much in the ventral surface. They are not very common, but beautiful in structure and colour.

Atax ypsilophorus, Bonz. This mite is found parasitic on fresh-water mussels. I do not know the name of the mussel. We have several species of Atax in Great Britain, two or three of which are parasitic, the others free-swimming, of which Atax crassipes is a common example.

A larval form of Hydrachnid not known to me was found last year by Sir John Murray and Dr T. N. Johnston in the stomach of a trout taken in Loch Rannoch. I am about to publish in the 'Quekett Journal' a note regarding this, by the kind permission of the finders, so I shall say no more here; but it is particularly interesting to find the parasitic stage of these creatures in such strange places.

Of course, it is impossible to furnish a full description of every drawing in this paper: each mite wants a very considerable amount of space to itself, to detail its history, measurements, locality, &c.; but I have endeavoured to give, I hope successfully, a rough idea of some of the beauty and interest to be found in a pond, lake, or river of fresh water.

VIII.—*COTTON AND ITS CULTIVATION.*

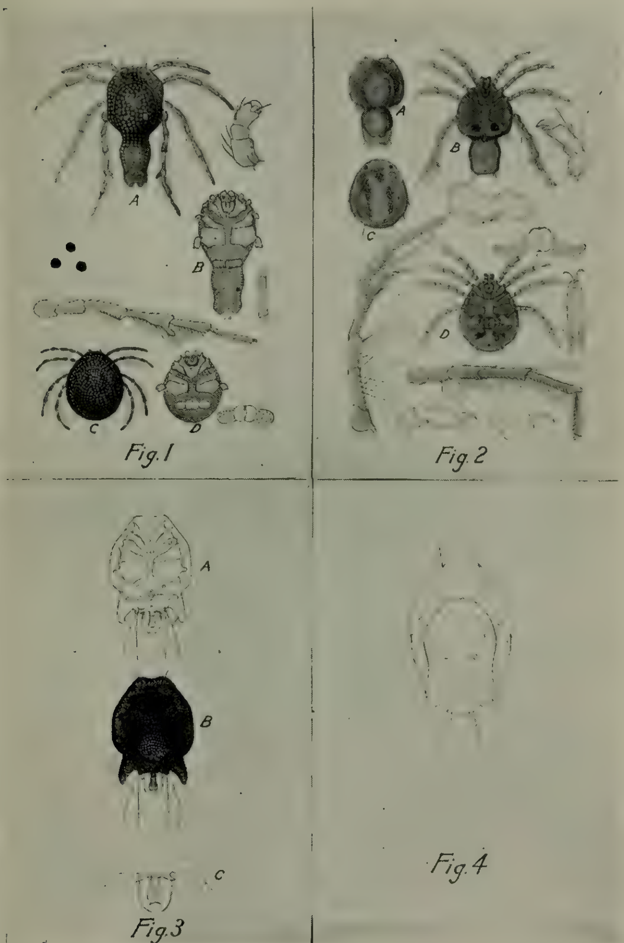
By Mr T. F. BINNIE.

(*Communicated, March 25, 1903.*)

I AM not going to give you anything technical or scientific to-night, but just a few results of observation. I am not a botanist, and am not versed in scientific terms. What I hope to do is to furnish a few facts about cotton—its habitat, the means by which it is successfully cultivated, its various qualities, and its uses.

Like most products in general use and of great utility to mankind, cotton can be grown in a great range of latitude. Wheat can be grown in the tropics and up to the arctic circle, oats and barley the same, maize in the tropics and high up in

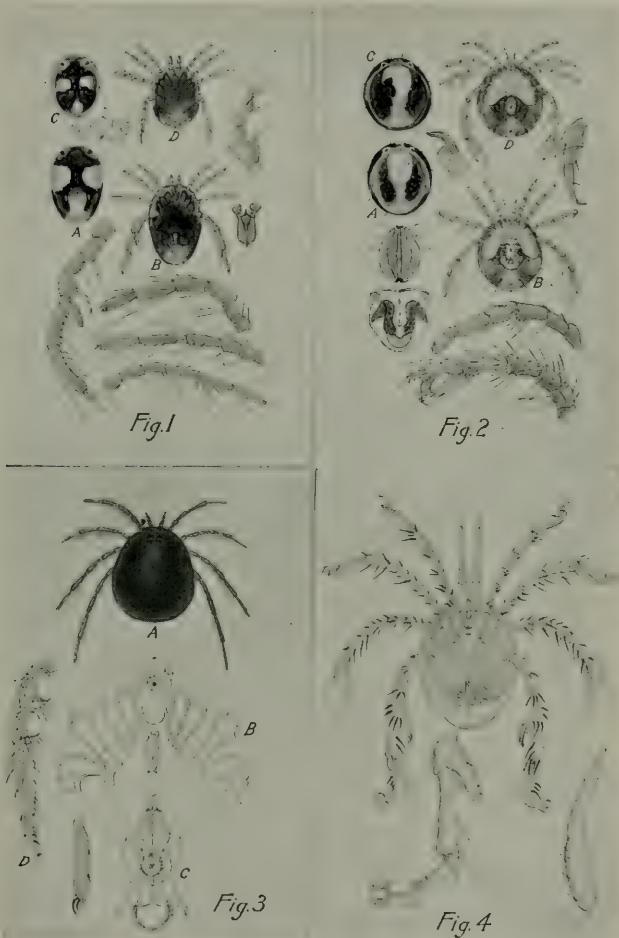
PLATE III.—FRESH-WATER MITES.



FROM DRAWINGS BY CHAS. D. SOAR.

FIG. 1. ARRHENURUS CAUDATUS, DE GEER.
FIG. 2. ARRHENURUS GLOBATOR, MÜLL.
FIG. 3. ARRHENURUS CLAVIGER, KOENIKE.
FIG. 4. ARRHENURUS NODOSUS, KOENIKE.

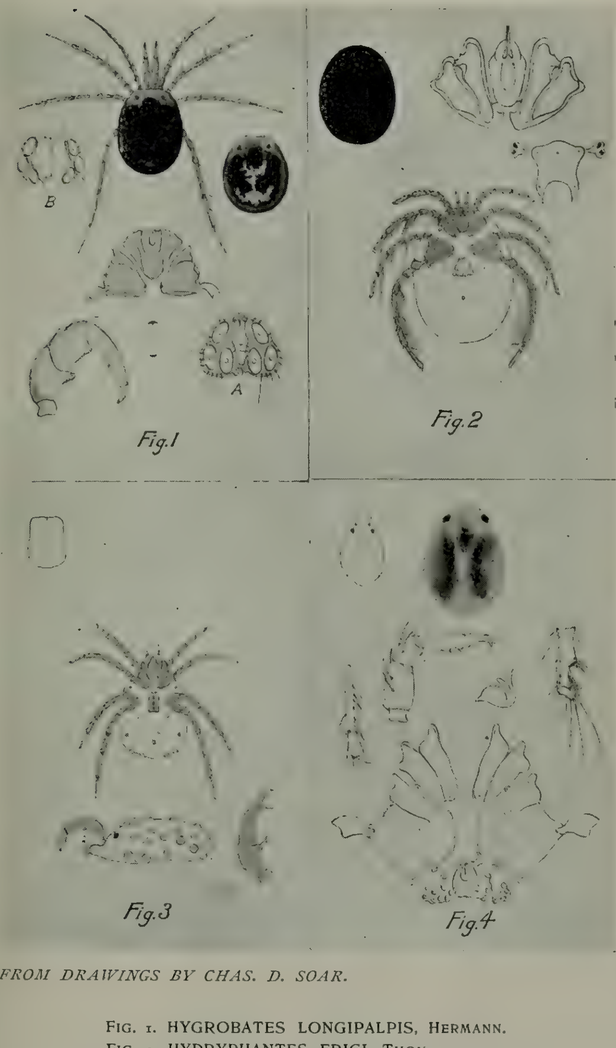
PLATE IV.—FRESH-WATER MITES.



FROM DRAWINGS BY CHAS. D. SOAR.

FIG. 1. BRACHYPODA VERSICOLOR, MÜLL.
FIG. 2. MIDEA ORBICULATA, MÜLL.
FIG. 3. EULAIS GEORGEI, SOAR.
FIG. 4. PIONACERCUS VATRAX, KOCH.

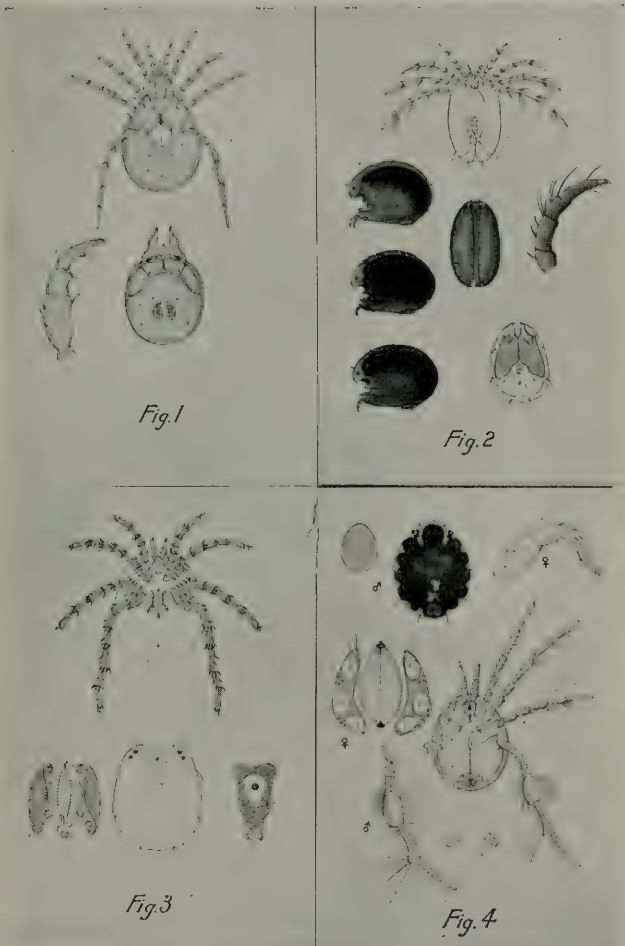
PLATE V.—FRESH-WATER MITES.



FROM DRAWINGS BY CHAS. D. SOAR.

FIG. 1. HYGROBATES LONGIPALPIS, HERMANN.
FIG. 2. HYDRYPHANTES FRICI, THON.
FIG. 3. PSEUDOSPERCHON VERRUCOSA, PROTZ.
FIG. 4. PIONA PAUCIPORA, SIG THOR.

PLATE VI.—FRESH-WATER MITES.



FROM DRAWINGS BY CHAS. D. SOAR.

FIG. 1. TORRENTICOLA ANOMALA, KOCH.
FIG. 2. FRONTIPODA MUSCULUS, MÜLL.
FIG. 3. THYAS VIGILANS, PIERSIG.
FIG. 4. LAMINIPES ORNATUS, KOCH.

the temperate zone; so also with flax and the cultivated grasses. Cotton can be grown even north and south of the subtropical region as well as in the tropics. Cotton is now almost a necessity to the whole human race, but it is one of the lately found necessities. It is difficult to get oneself to believe that cotton was comparatively little used in the days even of our grandparents. Flax (linen) filled the place now almost universally occupied by cotton. So much is this the case, that terms remain in general use that are not descriptive of the articles they are applied to. We hear constantly of bed- and table-linen. Bed-cotton would be a more descriptive term to-day. The fact of the use of a term shows the use of the article to which it is applied. The article changes, but the name remains. Now it is quite likely that cotton was in use as early as linen, possibly earlier,—both were certainly used in very remote times; but linen was in greater use because the methods by which the fibre could be prepared were simple, while cotton was difficult to prepare. One mechanical invention has caused the great change from the use of linen to cotton,—but more of that hereafter. Meantime, I just suggest how soon a more or less strange commodity comes to be almost a necessity.

Let us now consider the range of latitude in which cotton is grown. We need not look far back,—our interest in cotton is of to-day. In Asia cotton is grown in large quantity, in Japan, Southern Central Asia, and in West India. In Africa it is grown in large quantities in Egypt only, but it can be grown anywhere in that continent except the extreme south and the high mountain regions of the interior—deserts, of course, excepted, but even there it is only lack of moisture which prevents its growth. In South America, like Africa, it can be grown over vast areas, although as a matter of fact little attention has been paid to it. In North America it is grown in Mexico and in all the Southern States of the Union, although in Virginia, Kentucky, and Missouri it is an uncertain crop. The limits of successful cultivation are just south of these States.

I propose dealing to-night specially with cotton cultivation in the United States, where I have had considerable experience of it; but first, let us just consider the importance of the crop elsewhere. As we proceed you will notice that wherever cotton is grown successfully labour is plentiful and cheap. That is a *sine quâ non* of successful cotton-planting. The crop is not one demanding excessive labour in its cultivation, but the gathering of it is tedious, and no machine has yet been developed to replace human hands. One man can cultivate about twenty acres, but a family cannot pick it. Another feature you will notice is that not only is labour plentiful and cheap where cotton is grown, but it is generally servile. I don't know about the labour in Russian Asia, —elsewhere it is certainly servile,—but in Central Asia cultivation is carried on under special Government patronage, and is commercially more or less an experiment.

In Japan cotton has long been grown, but now in greatly decreased and decreasing quantity. When Japan was closed to commerce and had no railways and no mills, it was used locally, being grown and spun at home. The opening of the country to commerce and the establishment of large mills is, curiously enough, the cause of the decrease in home-grown cotton. Japanese native cotton has a coarse short staple, and the higher quality of the staple of Indian and American cotton is preferred. Japan now uses over 700,000 bales of imported cotton, and runs over 1,000,000 spindles.

In Russian Central Asia about 85,000 bales of cotton, weighing 500 lb. each, are grown. The whole product is used in Russian mills. As I have already remarked, the cultivation is fostered by the Government—I have no doubt, partly to provide traffic for the Trans-Caspian Railway. This cotton is grown under irrigation.

The crop of British India is very important, although little of it reaches our islands. The land under cultivation in India is about 15,000,000 acres in extent, and the crop amounts to about 2,750,000 bales, weighing 400 lb. each. Indian exports to Europe are decreasing, and will possibly stop altogether before long. For this there are several reasons. The establishment of mills in Bombay, Calcutta, and other places has caused the home consumption of cotton to rise to about 1,700,000 bales annually, while a new market for raw cotton in China and Japan takes 600,000 bales. Europe only takes about 300,000 bales and this chiefly continental, only a trifling amount reaching our islands. India has 4,100,000 spindles. The last reason I give for the decreasing European consumption of Indian cotton is its low quality. Its staple is short and unsuitable for fine spinning, and it cannot compete with the higher qualities of Egyptian and American cotton. In our market Indian cotton is called "Surat."

Egyptian cotton is, next to a specially fine American variety called Sea Island, the best grown. In colour it is brownish. The staple is long and strong, while very fine. At present it is almost all grown, under irrigation of course, in the Delta of the Nile. While the new dam at Assiout will enable it to be grown in upper Egypt, the quality is almost certain to be lower than that of the Delta cotton. There are now about 1,750,000 acres under cotton in Egypt, and the crop is over 1,000,000 bales of 500 lb. each.

At present the Liverpool cotton merchants are trying to get the staple systematically cultivated in Nigeria and the Gold Coast country, but meantime it is experimental.

In South America cotton is grown to a small extent in Brazil and Peru. Peruvian cotton is of a tree variety, and it is not used in cotton mills at all. It has a peculiar, strong, woody, crinkly staple, which, when mixed and spun with wool, can hardly be distinguished from wool. The whole Peruvian produce (40,000 bales of 200 lb. each) is used in woollen mills.

Brazilian cotton is partly of the tree and partly of the herbaceous variety. The tree lives four or five years, and attains a height of about 20 feet, but neither in quantity nor quality is the staple of much account.

Cotton was cultivated in the West Indies before the American colonies took it up. It might well be grown profitably in the West Indies now, but something seems to stand in the way of almost everything there.

The most important cotton region of the world is in the United States of America. The leading planters there are energetic and intelligent; some of them are men of great ability and high education. The majority are wise enough to follow the lead of the most progressive. A minority are lazy and shiftless, just drifting along on the edge of bankruptcy, blaming their want of success generally on the nigger.

Let us visit a Sea Island plantation in Georgia. The cotton is grown on sandy, low-lying islands, and in a few low-lying flat districts very near the coast. We find the soil very sandy, and, where not cleared, covered with pitch-pine forests. The farmers are of sturdy German build, living generally in good houses built of logs hewn on their own land. Their live-stock consists of horses or mules and little oxen, all small and wiry. The soil is so sandy and easily cultivated that light stock only is necessary. This is a happy coincidence, as heavy stock does not do well. They grow oats, maize, and rice for home use, and melons, tomatoes, and vegetables to ship north in spring and early summer. The farmer's main crop is cotton, and he grows the long staple Sea Island variety, for which he gets a price at least twice as large as that brought by the upland variety. Only about 85,000 bales of it are raised altogether, and Georgia produces over 50,000, or about two-thirds of the whole. Great Britain takes about 24,000 bales of this crop, and I believe the greater part of the British import is spun into thread in Paisley.

The cotton-gin is a comparatively simple machine. The cotton, with seed firmly attached to it, falls into a trough in front of a sheet of iron. This sheet of iron is nearly upright, and has slits cut in it about an eighth of an inch wide. Behind this sheet of iron there is a shaft with a large number of small circular saws attached at regular intervals. These saws rotate rapidly, and are so placed that they project slightly through the above-mentioned slits. The saws catch the cotton and pull it off the seeds. While the cotton is drawn by the saws through the slits, the seeds are too large to get through. The stoppage of the seeds by the slits gives the resistance necessary for tearing the cotton off. Behind the saws there are rotary brushes revolving more rapidly than the saws, and in the same direction. The brushes take the cotton off the saw-teeth completely, and by a simple device the cotton is removed from the brushes and carried by rollers to the rear of the machine in the shape of a continuous sheet of lint. The press, where it is compressed into bales, is conveniently placed behind the gin, so that the process is continuous,—almost automatic.

The fineness of cotton yarn is counted by the number of hanks of yarn to the pound weight. Thus 40 hanks weighing 1 lb. ranks as 40 counts, 60 hanks as 60 counts, 120 hanks as 120 counts, and so on.

For all spinning of finer counts than 120 Sea Island cotton is used: 120 counts is about the limit of Egyptian spinnings, and Egyptian is next in quality to Sea Island. The staple of this cotton varies from $1\frac{1}{2}$ inch to $2\frac{1}{2}$ inches. This is what makes it available for the very finest spinning.

Upland plantations in Georgia and South Carolina are very much alike, although the soil in Georgia is, as a rule, better than in the latter State. The farms vary from sandy to a red, rather clayey, soil, with good loam in the bottom of the valleys. The products are much the same as on the coast, except in the character of the cotton grown. The land looks poor, but it is cheap, and labour is plentiful and very cheap. The cotton crop is king, the prosperity of the country depending on it. The quality is very different from Sea Island. The staple is short, varying from $\frac{7}{8}$ inch to $1\frac{1}{2}$ inch, and neither so silky nor so strong. While Sea Island is sold at prices varying according to the length and fineness of the staple, the upland variety is sold according to colour more than anything else. The whitest and cleanest brings the best price.

The cultivation is simple, and little capital is required to run the average plantation. The method of cultivation throughout the uplands generally, east of the Mississippi river, is as follows: Cotton is grown year after year on the same land without any rest or rotation of crop, although the best farmers prefer to change the crop occasionally, say once in four or five years. The plough is run straight across a field twice, throwing the surface soil to right and left, and leaving a furrow 4 or 5 inches deep, similar furrows being run at distances of about 3 feet. In the furrows a fertiliser is spread. This is generally a compost of stable litter, cotton seed, leaves, and acid phosphate, the mixture having been allowed to decompose during the previous two or three months. The soil is then thrown back by the plough, to cover the compost and form a ridge about a foot high, with a corresponding depression between each row. The seed is planted on the summit of the ridge by aid of a very simple and cheap machine, drawn by a mule. This implement forms a little channel, drops the seed into it, and covers it much after the manner of a turnip drill: only one row is planted at a time. In from five to ten days the seed is up when conditions are favourable, and when the first pair of true leaves appear the rows are chopped. Chopping is really just thinning. The hoe is used, and men, women, and children do the work. The plants are thinned to 8 or 10 inches apart. Weeds spring up rapidly, and the plough is used to remove them and keep the plants well covered up with soil. This is necessary, as the rains are very heavy, and wash the soil from the ridges, exposing the roots to the sun. During the growth of the plant four hoeings and ploughings are necessary. The last ploughing is done after the first flowering is over, and when the fruit is advancing towards maturity. This last ploughing is called laying by the crop. After this nothing is done till the bolls in the lower branches have opened, allowing the cotton to hang out, and then picking begins. The seed is planted in April or early in May. The first blooms appear about the third week in June, and picking generally begins early in September, varying, of course, with latitude, altitude, and exposure.

On the very rich bottom lands of the Mississippi valley, and all over the rich bottom uplands of Texas, cultivation is very much the same as already described, but arrangements differ a little. The rich soil yields a larger plant, and the rows have to be 4 or 5 feet apart, and the space between the plants greater also. On these rich soils no fertilisers are used. I have seen the fortieth successive crop of cotton just as strong and good as on newly cleared land. In Texas I have seen planting done without any preparation of the soil since the previous year's crop. The winter's rains had washed down the ridges to a general level, and the planter was just run along half way between the old rows of the year before, the soil being afterwards thrown up on each side to protect the plant. In one part of Texas, farmed by German planters, I have seen cotton planted without ridges on smooth and level fields; but where rains are more frequent and the climate moister, experience favours the method of planting on a ridge. On the poorer uplands the plant, to yield well, ought to attain a height of 3 to 4 feet at maturity. On badly farmed uplands it is often not over a foot high. The yield ought to average from 800 lb. to 1000 lb. of seed cotton per acre, and the lint or fibre after ginning should range from 250 lb. to 300 lb. A good farmer, even in uplands, sometimes gets from 1200 lb. to 1500 lb. of cotton seed per acre. On the rich lands of the Mississippi valley and Texas it is usually from 4 to 6 feet high, but on the richest land it grows high enough to conceal a man on horseback. The yield on the richest lands is often 1500 lb., and I have known as much as 3000 lb. of seed cotton per acre yielding 1000 lb., or two bales of lint, and this without any crop rotation or fertiliser.

After picking, cotton is taken to the gin-house, where the lint is removed from the seed. Before the invention of the gin this process was expensive to an almost prohibitory extent, but now it is easy and cheap. Let me illustrate. In the year 1747 seven bags of cotton were exported from Charleston, S.C., and again in 1787 three bags were sent to England. The consignees were informed that it was not worth producing, as the lint could not be separated from the seed. Before the invention of the gin a slave's task, over and above his ordinary work, was the separation of 4 lb. of cotton from the seed per week, and this was only demanded per head of a family. This meant two years' work to do what a gin does in twenty minutes. Eli Whitney of Georgia invented the gin in 1794, and the first gin driven by water-power was built in 1795 in South Carolina. This was one of the great inventions of history, converting, as it did, a great staple from practical uselessness to enormous commercial importance. In 1793, the year before the invention of the gin, the whole export of cotton from the United States was about 1000 bales, and all the production was exported, while last year the production was about 11,000,000 bales.

So much for lint cotton; but the plant yields more than the staple. The seed has come to be of great importance in commerce. A few years ago the whole of the seed was either decomposed as a fertiliser or thrown away. Now it yields an enormous revenue, and supplies the raw material of a great industry. I have already pointed out that two-thirds of the weight of the cotton as picked is in the seed. Over 5,000,000 tons of seed are produced in the United States alone, worth about £10,000,000 in the raw state. The seed is dealt with in oil mills as follows: The short cotton still adhering to the seed is made into wadding. Then a machine called the huller removes the shells. The shells are used to feed cattle when coal is cheap, and as fuel when coal is dear. The kernel is cooked by steam, ground to pulp, and pressed in hydraulic presses. It yields enormous quantities of oil, and the residue is the well-known cotton-cake used for fattening cattle. The oil is used in a rather crude form for miners' lamps, in a more refined form for railway and other lamps, and in its most refined form as a substitute for, or adulterant of, olive oil, and is greatly used for cooking in Italy, Spain, France, and the United States, and almost universally for tinning sardines. It is used in butter-making in Holland, and in the United States it is made into lard, rivalling pure hog's lard in whiteness, and is largely preferred to hog's lard for culinary purposes. Thus the seed brings from 10s. to £2 per acre to the planter —a clear gain, as formerly it cost money to get rid of it.

The inner bark of the cotton-stalk bears a fine fibre, like flax or jute, but it is not used at present, as no machine has yet been devised to separate and clean it. So you see there is still at least a chance left for a mechanical genius to distinguish himself, and as a side issue to make a fortune legitimately.

IX.—*TEASELS.*

By Mr A. B. STEELE.

(*Read April 22, 1903.*)

In appearance teasels somewhat resemble thistles, and, like them, have assumed a protective covering of prickles. These sharp-pointed, straight, or curved bodies serve either as a protection against the attacks of animals or as climbing organs. They have apparently been adopted by the teasel for defensive purposes, for towards the top of the stem the spines or prickles become more formidable. The flowers, too, are amply protected from the assaults of grazing animals by the long quill-like spine which projects from beneath each floret, as well as by a general covering of very long bracts, well armed with spines standing up all round the head. They are closely allied to composite plants, but differ particularly in each flower of the head possessing a kind of outer calyx, and in the stamens, four in number, being free,—an important distinction from the composites, in which the stamens are joined by their anthers. There are only three species of teasel in the British flora: the small teasel, or shepherd's rod (*Dipsacus pilosus*); the common or wild teasel (*D. sylvestris*); and the fuller's teasel (*D. Fullonum*).

The small teasel is not uncommon in England, but is absent from both Scotland and Ireland. It has large roundish root-leaves, and a slender, slightly spiny stem, two to four feet high. The leaves of the stem are smaller, and usually with a pair of leaflets at the base. The flower-heads are white and globular.

The common or wild teasel (*D. sylvestris*) is the best known and most abundant. Its natural home is on rough dry banks, among brambles and tall grass, growing to upwards of six feet in height. It is abundant on the Blair braes, between Dysart and the Wemyss; but coal-mining and increasing population have tended to its diminution. *D. sylvestris* is the only species native in Scotland, but in many parts is only introduced. It is certainly a native of Fife, where it has been growing for centuries, and where it occurs from Alloa to St Andrews. It is rarer on the south side of the Forth. Sibbald records it from a brae below Abercorn Castle in 1588, Greville says it was got on the south side of Duddingston Loch, and Woodford records it from the Pentlands west of Colinton. It is said to have been found on Arthur's Seat and at Musselburgh, but during the last twenty years I have not observed it in flower in the county. The plant is a biennial, and a rosette of stalked, coarsely toothed, lanceolate leaves is all that makes its appearance the first year. In the second year, with its tall showy stem and pink flowers, it is a very conspicuous plant. Each of the small pink flowers is succeeded by a single seed, which is angular, and crowned with a rim that once was the calyx. The leaves are opposite, and united at their bases, forming a cup in which water is collected. These leaves are among the finest examples of what botanists term a connate leaf. The quantity of water collected by a single pair of leaves is sometimes more than half a pint. The supply enables the plant to endure long droughts, and also acts as an effectual barrier to wingless insects trying to reach the flowers. But these cups serve another and more important purpose. They act as traps for insects by which the plant is nourished, for it is an insectivorous plant. The water collected by the leaves is sometimes coloured quite a dark-brown by the presence of decayed animal matter. Kerner says that there are cells at the bottom of the cups from which living threads radiate. But Dr Francis Darwin was the first to discover digestive glands at the base of the leaves, and that the living threads discovered by Kerner were in some way connected with the assimilation of food. The connate leaves have been to a certain extent adapted for the capture of insects, whose decaying remains are absorbed by the plant. The leaves of the first year's growth do not form cups and are not smooth. The stems are everywhere armed with sharp prickles, except where covered by the water in the cups, and here they are quite smooth, so that no ladder of escape is afforded to the drowning victims.

The water collected by the teasel has long been believed to be a cure for warts or corns, as well as a remedy for sore eyes and a beauty wash for the face. Secretions of insectivorous plants are known to cure warts and corns: those of the Sundew have been long used for this purpose. In 1777 Lightfoot in his 'Flora Scotica' says that the liquor which exudes from the hairs of the Sundew is said to take away warts and corns. The old herbalists called the cups of water Venus's basins, and country people may still be seen when the flowers are seeding collecting the water, to be used either for curative purposes or for beautifying the faces of the village girls. Lyte in his translation of Dodoens in 1586 says that the heads of the teasel are hollow, and the most of them contain worms, which when worn or tied about the neck will cure and heal the ague. Gerarde also refers to this. If the flower-heads of these plants are opened longitudinally in the autumn, a small worm is frequently found in the centre; and some people still believe that if three, five, or seven, always an odd number, of these worms be sealed up in a quill and worn in good faith, they will act as a charm against sickness. The heads of the plant used to be made into hair and cloth brushes by setting them in frames.

The fuller's teasel (*Dipsacus Fullonum*) is by many botanists supposed to be a mere variety of the preceding, from which it differs only in the scales of the flower-heads being hooked instead of straight, and the outer covering of bracts being shorter and spreading. The flower-heads of this plant form an article of considerable importance to the cloth manufacturer. They are used for dressing certain kinds of woollen cloth. Probably the wild teasel with the straight prickles was at first used, until this variety with the hooked spines was found to answer the purpose better. It has been cultivated for this use ever since the reign of Richard I., and from the time of Edward III. has been a regular article of commerce in cloth-manufacturing districts. Its cultivation demands constant attention and labour throughout the year. The heads are cut from the plant with a knife peculiarly formed. The heads are very carefully dried by fastening them to poles, and great care is taken to prevent them getting damp after being cut. The large heads which ripen first are called "Kings"; the next crop has smaller heads called "Princes," and these are best adapted for the dressing of fine and delicate cloths. Every piece of broadcloth requires from 1500 to 2000 teasel heads to bring out the proper nap, after which they are useless. The price varies from £4 to £22 a pack, which contains about 900 of the largest heads or 1600 of the smallest. At first the heads were set in frames, so as to form a comb or brush with which to raise the nap. But now they are fixed in regular order upon cylinders, which rotate and perform the operation more rapidly and perfectly. They are made to revolve in a manner so that the hooks of the teasel come in contact with the surface of the cloth, and thus raise the nap, which is afterwards cut level.

Without this plant the cloth manufactory could never have made the progress it has, as the purpose for which the teasel is employed has never been effected by the most carefully contrived machinery. Wire machines are very generally used, one of the latest being the "Moser Raising Gig," but being less elastic than the fine hooked heads of the teasel, they are more liable to injure the fabric, and are only used for certain kinds of cloth. In consequence of the introduction of artificial machines, the teasel plant has not been so much cultivated in England. It is still cultivated in South Milford, Malton, and York districts. French teasels are, however, now largely imported and used, because they are smaller and not so keen as the Yorkshire teasels. They are still used very considerably in Yorkshire and in the west of England, but not to the same extent as formerly. Raising machines with wire cards have replaced teasels in a good many manufactories, but flannels, blankets, rugs, doeskins, beavers, meltons, milled worsteds, and all faced cloths, are still raised by teasels. It is remarkable that an ancient and apparently rude contrivance like the teasel should have held the field so long against mechanical invention and progress. It is the only instance on record where art has so long failed to supersede a natural product.

At the above meeting Mr J. Elrick Fraser read an extremely interesting communication on the cinematograph as an aid to Nature Study. In the course of his paper Mr Fraser gave a detailed description of the apparatus employed in taking cinematograph pictures, and referred to the advantage to be derived from its use in the study of living Natural History objects. The communication was illustrated by a large number of views of living and moving animals, the object being to illustrate the application of the cinematograph to the study of such in their native habitats and under natural conditions of life. Amongst the views exhibited were several especially beautiful, and from a Natural History point of view most interesting, pictures taken by himself at the Bass Rock, in which the flight of various species of birds which resort to that locality was admirably depicted.

REPORT OF THE MICROSCOPICAL SECTION.

By Mr JAMES RUSSELL, Convener.

The attention of the members during the session was directed to the study of the Pteridophyta or Vascular Cryptogams, the object being to learn their morphology and follow their life-history, and thus see their relationship phylogenetically to the Phanerogams. This comparative mode of examination has revealed the fact that between the Gymnosperms, as the more lowly developed of the Phanerogams, and the Pteridophyta, as the more highly developed of the Cryptogams, there is no sharply defined barrier. The more advanced development of the Phanerogams is limited to the sporophyte, while what has been gained in this direction has been lost by the oöphyte, which has been reduced from an independent plant to a few cells wholly dependent upon the sporophyte for their existence. In the genera studied the independent existence of the oöphyte, and thus the alternation of generations, was clearly traceable, especially in the Filices.

All the Phanerogams are *heterosporous*—that is, producing spores of two kinds—while the first of the vascular cryptogams studied, the Selaginella, is also heterosporous, and thus forms a connecting-link between the Phanerogams and the Cryptogams.

The Selaginella is a large genus, but there is only one British species—*Selaginella selaginoides.* The species studied, however, was *Kraussiana,* a native of South Africa, but cultivated in most greenhouses. It is a plant with a creeping stem, which rises a few inches above the ground, and forks repeatedly. At each bifurcation of the stem a colourless root-like organ arises, called a rhizophore, which grows downwards and seeks the ground, on reaching which it branches and forms rootlets.

As has been said, it is heterosporous—that is, its fertile spikes bear both microspores or male spores, and macrospores or female spores. The covering or sac in which the microspores are produced is called the microsporangium, and that in which the macrospores are produced the macrosporangium. Each microsporangium gives rise to a mass of spore-producing tissue, from which arise the spore mother-cells; each of these spore mother-cells ultimately divides into four, thus forming four microspores, which, when ripe, are liberated by the rupturing of the sporangium. When these microspores fall on damp ground they at once begin to germinate, and ultimately each one produces a spermatozoid, which is set free by the walls of its mother-cell becoming dissolved. The macrosporangium also gives rise to a mass of spore-bearing tissue, which in turn forms spore mother-cells, of which, however, only one comes to maturity. This one divides into four daughter-cells, which in the end absorb all the other mother-cells. Each of these daughter-cells gives rise to a macrospore. These macrospores begin to germinate while still in the sporangium, and the completion of the germination is carried on after the spores have fallen to the ground.

The tissue in the macrospore which the germination produces is called the prothallus, and this prothallus gives rise to the archegonia or female organs. The archegonia become mature about the same time that the spermatozoids are set free from their mother-cells. If then there be water on the ground, and some of the spermatozoids are brought within the influence of an archegonium, one of them will penetrate the neck of the latter, and thus reach the ovum in the archegonium and fertilise it. This fertilised ovum gives rise to the embryo of the new Selaginella plant, which in turn again will bear the microsporangia and macrosporangia.

The second type studied was one of the Filices—the *Aspidium Filix-mas.* In this fern the spores are produced in sacs called sporangia, grouped together in clusters called sori on the under-side of the pinnules of the fronds. Unlike the spores of the Selaginella, the spores of the Ferns are all of one kind, so that these plants are *homosporous.* When the spores are ripe, the sporangium bursts at a particular place and sets them free. If they fall on damp soil, they soon begin to germinate. The first appearance of germination is the formation of a root-hair which grows downwards into the ground; this is followed by another outgrowth called a prothallus, which grows upwards towards the light. As the prothallus increases in size it changes its vertical position to a horizontal one, and in favourable circumstances may reach half an inch in length and at the widest part about a quarter of an inch in breadth. It lies like a scale upon the ground, and from its under side numerous root-hairs arise; and it is also on this under side that the sexual organs—the antheridia and archegonia—are produced. This prothallus is the oöphyte or sexual generation of the plant.

As a general rule, both antheridia and archegonia are produced on the same prothallus; but in certain cases, especially if its nourishment has been defective, the prothallus may only bear antheridia. The antheridia give rise to the spermatozoids or male organs, which are liberated from their mother-cells by the bursting of the latter under the influence of water. While the antheridia have been maturing so also have the archegonia, in the venter of each of which is formed an ovum. When an archegonium is ripe, some of the cells forming its neck become disorganised, and their protoplasm is converted into mucilage, which swells up, and thus forces open the passage in the neck, and also exudes and forms a viscid drop at the mouth. If, then, water be on the ground, and any of the liberated spermatozoids are brought under the influence of the viscid drop at the mouth of the archegonium, one of them is caught in it, and wriggles down the neck till it reaches the ovum, which it fertilises. The fertilised ovum then gives rise to the embryo of an independent young fern plant.

In addition to this mode of reproduction, some ferns reproduce themselves vegetatively by means of small buds or young plants on the fronds, such, for instance, as the *Asplenium Fabianum* and others of that genus.

The last type studied was one of the Equisetaceæ or Horsetails—the *Equisetum arvense.* This genus is also *homosporous,* and here also there is alternation of generations, which in many respects closely resembles that of the ferns; but the want of space prevents any detailed description.

The book followed was D. H. Scott's 'Structural Botany,' Part II., "Flowerless Plants."

During the session Mr G. T. West, of the Royal Botanic Garden, gave several interesting demonstrations on the proper method of obtaining a critical illumination of objects under the microscope.

EXHIBITS IN NATURAL HISTORY.

During the past session the following objects were exhibited at the evening meetings:—

Mr A. Murray showed grasses collected in the Lothians. Mr West, Polynoë propinqua and Nereis cultrifera (foot only) under the microscope. The Secretary, specimen of abnormal tree growth, specimen of pipe fish or sea adder (*Syngnathus acus*, Linn.), and some Canary Island photographs. Mr Binnie and the Secretary, specimens of cotton (Long Staple, Short Staple, Benders, Uplands, Sea Island, and Egyptian). Mr Allan A. Pinkerton, shell of Dreissena polymorpha from Canal near Hermiston, and shell of Ancylus fluviatilis from Gogar burn. Mr A. B. Herbert, skins of various species of birds from Natal. Mr Tom Speedy, wild cats from Argyllshire.

A portion of the February meeting was specially set aside for exhibits, when a large number of Natural History specimens and microscopical preparations were shown by members of the Society.

ANNUAL BUSINESS MEETING.

The Annual Business Meeting of the Society was held at 20 George Street on the evening of Wednesday, October 28—Mr Arch. Hewat, F.F.A., F.I.A., President, in the chair.

The Secretary exhibited a specimen of the greater pipe fish (*Syngnathus acus*, Linn.), and some Canary Island photographs.

The Secretary then read his report, as follows:—

"During the winter session 1902-3 there have been held 6 indoor meetings of the Society, and the good attendances of last session have been maintained.

"For the summer session 21 meetings were arranged. Notwithstanding the wet season, which to some extent hindered the attendance, the average number present was 19.

"The membership this year is again increased by 13, the total number of ordinary members as at October 1 being 233, or one in excess of the highest number previously recorded. The names of 33 new members were added and 20 were withdrawn: of these, 14 resigned and 5 were removed from the register of members; in addition to this, one member died. We have also to record the death of one of our corresponding members, a well-known botanist, Mr C. P. Hobkirk.

"Meetings of the Microscopical Section were held at the house of the Convener, Mr James Russell. The syllabus for the ensuing session has been issued to the members, and it would be encouraging if more interest were taken in the work of the section.

"It is hoped that the increasing interest in nature study will reflect itself in larger attendances and a still larger membership, and that the session 1903-4 will be a record one."

The Treasurer presented his statement of income and expenditure for the past year, copies of which were already in the hands of members, and which is appended hereto.

Mr Russell, Convener of the Microscopical Section, referred briefly to the work of the section during the past session, details of which will be found in the report which appears in the present part of the 'Transactions' (pp. 59-61). He expressed the hope that the meetings would be more numerously attended during the coming session.

The election of office-bearers and councillors was next proceeded with, the recommendation of the Council being approved of. The following is a complete list, the names printed in italics being those of members elected to fill vacancies: President, Arch. Hewat, F.F.A.; Vice-Presidents, David Gloag, John Lindsay, *James Terras*, B.Sc.; Secretary, Wm. Williamson; Treasurer, Geo. Cleland; Editor of 'Transactions,' Dr Davies; Auditors, R. C. Millar and J. T. Mack. Also the following Councillors: Robert Watson, *Mrs Law*, Miss E. A. Townsend, Allan A. Pinkerton, W. C. Crawford, Bruce Campbell, A. D. Richardson, David Young, *Miss Mitchell*, *Miss Gray*, *James M'Andrew*, and *Archibald Craig*.

The proceedings terminated with the usual votes of thanks.

Edinburgh Field Naturalists' and Microscopical Society.

STATEMENT OF INCOME AND EXPENDITURE FOR YEAR TO 16th OCTOBER 1903.

INCOME.

To Balance from last Account			£42 3 9
" Annual Subscriptions from 188 Members, for Session 1902-1903		£47 0	
" " 1903-1904		0 15	
" New Members, 1903-1904		3 5	
			51 0 0
" Arrears of Subscriptions— Amount outstanding, 14th Oct. 1902		£8 0	
" irrecoverable	£2 0		
" still outstanding	0 15		
		2 15	
" recovered			5 5 0
" Donation for Publication Fund			0 10 0
" 'Transactions' sold			2 13 0
" Interest			1 7 4
			£102 19 1

Arrears of Subscriptions outstanding— Sessions 1900-1902	£0 15 0
Session 1902-1903	4 5 0
	£5 0 0

EXPENDITURE.

By Rent of Hall for Meetings, &c.		£6 2 6
" W. Blackwood & Sons—Printing 'Transactions,' Billets for Meetings, &c.— Session 1901-1902	£8 15 3	
" 1902-1903	44 9 9	
		53 5 0
" Advertising Expenses— Session 1901-1902	£1 9 0	
" 1902-1903	4 11 0	
		6 0 0
" Hire of Lantern, &c.		2 10 0
" Commission for collecting Subscriptions		0 12 6
" Gratuities to Hall-keeper and at Excursions		0 15 6
" Stationery		1 17 9
" Secretary's Outlays and Postages		6 7 4
" Treasurer's " "		1 13 4
		£79 3 11
" Balance due by Bank of Scotland		23 15 2
		£102 19 1

PRIZE FUND.

To Donation for the Encouragement of the Study of local Natural History	£5 0 0
By Balance due by Bank of Scotland	£5 0 0

GEO. CLELAND, *Hon. Treasurer.*

20th October 1903.—We hereby certify that we have audited the foregoing Statements of Income and Expenditure, and found them correctly stated and satisfactorily vouched, the balance in favour of the Society being Twenty-eight pounds, fifteen shillings, and twopence sterling.

R. C. MILLAR,
[illegible] } *Auditors.*

PRESENTED
30 NOV. 1903

THE EDINBURGH FIELD NATURALISTS' AND MICROSCOPICAL SOCIETY.

COUNCIL, 1902-1903.

President.

ARCH. HEWAT, F.F.A., F.I.A.

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Mr R. SCOT SKIRVING (*deceased*),	1869–1874.
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Rev. R. F. COLVIN (*deceased*),	1877–1879.
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Dr WILLIAM WATSON,	1888–1891.
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Mr W. C. CRAWFORD,	1898–1901.

LIST OF MEMBERS as at October 1, 1903.

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Belfrage, Wm. Christie, Durham House, Durham Road, Portobello.
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Brotherston, Mrs G. M., 16 Comiston Drive.
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Bryden, Mrs, Linksfield, Aberlady.
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Crawford, Mrs, 1 Lockharton Gardens, Colinton Road.
Crawford, W. C., 1 Lockharton Gardens, Colinton Road.
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Deuchar, Mrs, Harlaw, Hope Terrace.
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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.
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Forgan, Wm., 3 Warriston Crescent.
Forrest, John L., 8 Glengyle Terrace.
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Fraser, J. Elrick, 93 Hanover Street.
Fraser, Miss, 44 Polwarth Terrace.
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Gibson, Mrs, 4 Colinton Road.
80 Gloag, David, 9 Barnton Terrace.
Goodchild, J. G., 2 Dalhousie Terrace.
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Grieve, Sommerville, 21 Queen's Crescent.
Grieve, Symington, 11 Lauder Road.
Grieve, Mrs Symington, 11 Lauder Road.
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Hamilton, G. R., 14 Caledonian Road.
Harris, J., Royal Botanic Garden.
90 Harrison, H. J., 10 Cluny Place.
Harvie-Brown, J. A., Dunipace, Larbert.
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Henney, W., 3 Abercromby Place.
Hewat, Andrew Fergus, 13 Eton Terrace.
Hewat, Arch., 13 Eton Terrace—*President.*
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100 Hutton, Mrs, 9 Gardner's Crescent.
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Laidlaw, Thomas G., Bank of Scotland, Perth.
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Law, Mrs, 41 Heriot Row.
110 Leighton, Gerald, M.D., 17 Hartington Place.
Lewis, David, Roselea Villa, Grange.
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Lindsay, William, 18 South St Andrew Street.
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M'Call, James, Loanstone, Penicuik.
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M'Intosh, Donald Cameron, M.A., Edinburgh Ladies' College.
M'Intosh, James, 42 Queen Street.
Macintyre, J., 175 Morningside Road.
Mack, J. T., 101 George Street.
Mackenzie, Mrs, 13 Mentone Terrace.
Mackenzie, N., Royal Botanic Garden.
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Macpherson, Alex., 1 Roseneath Place.
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Maxwell, Mrs, 61 Braid Road.
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Millar, T. J., 27 Albany Street.
140 Miller, J. A. Graham, 13 Lennox Street.
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Moore, Wm. Fawcett, 17 Blacket Place.
Morison, Peter, 24 Great King Street.
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 St., Portobello.
150 Nisbet, Wm., 36 Elm Row.
Normand, P. Hill, of Whitehill, Aberdour.
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Ogilvy, Wm., Millburn, Argyle Crescent, Portobello.
Parkes, C. W., Inland Revenue, Dundee.
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160 Pillans, Hugh H., 12 Dryden Place.
Pinkerton, Allan A., 47 Viewforth.
Pittendrigh, T. M., 45 Comely Bank Road.
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Ramsay, Miss, 8 Eyre Crescent.
Ranken, William, 11 Spence Street.
Ranken, William Ford, 63 Coten End, Warwick.
170 Reid, Andrew, 1 Laverockbank Terrace, Trinity.
Richardson, A. D., 8 Sciennes Gardens.
Richardson, Mrs Ralph, 10 Magdala Place.
Ritchie, William, 75 Morningside Road.
Robertson, Dr W. G. Aitchison, 26 Minto Street.
Rose, Miss, 3 Hillside Crescent.
Rowe, Miss C., 19 Great Stuart Street.
Russell, James, 16 Blacket Place.
Sanderson, Mrs H., 95 Shandwick Place.
Sarah, H. A. P., 19 Braidburn Crescent.
180 Sconce, Colonel, 18 Belgrave Crescent.
Scott, Alex., 24 Blackwood Crescent.
Semple, Dr Andrew, Caledonian United Service Club, 4 Shandwick Place.
Sillars, Duncan, 205 Dalkeith Road.
Sime, David, 27 Dundas Street.

Skelton, J,, 86 Marchmont Road.
Slight, G. A., 8 Wardie Avenue.
Smith, Harry W., 23 Nelson Street.
Smith, Dr James, 4 Brunton Place.
Smith, Rupert, 51 Minto Street.
190 Smith, Wm. D., 43 Montgomery Street.
Speedie, M. H., 2 Alford Pl., Mayfield Terrace.
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, B.Sc., 11 Marlborough Rd., Chiswick, W.
Sprague, Miss, 29 Buckingham Terrace.
Staig, R. A., c/o Miss Todd, 58 Randolph Gardens, Broomhill, Glasgow.
200 Steele, A. B., 41 Regent Street, Portobello.
Steele, Mrs, 41 Regent Street, Portobello.
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Stevens, Dr John, 2 Shandon Street.
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TRANSACTIONS

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SESSION 1903-1904

CONTENTS.

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SESSION 1903-1904.

I.—*FOREIGN WILD-FLOWERS IN THE EDINBURGH DISTRICT.*

By Miss BEATRICE SPRAGUE.

(Read Nov. 25, 1903.)

In the first week of October I found in the field to the south of Drylaw House a specimen of a flower which, by means of the description in Messrs Bonnier and Layens' 'Flore de la France,' and a coloured plate in Mr Bicknell's 'Plants and Ferns of the Riviera,' I identified as Specularia speculum. A day or two later, I found in a potato-field close by several plants of Trigonella corniculata, Trigonella cœrulea, and Melilotus parviflora, growing in a belt of weeds some eight feet wide bordering a cart-track. It appears from Koch's 'Synopsis of the German and Swiss Flora' that all four plants are natives of Germany. I thought they might perhaps have been introduced with seed, but on making inquiries at Drylaw Mains Farm, to which both the fields in question belong, I was told that all their crops are raised from home-grown seed. Can any of our members contribute any other facts bearing on the occurrence of the plants?

The finding of these aliens suggests to me that it might perhaps be an interesting and useful line of inquiry to examine samples of agricultural seeds as supplied by seedsmen to our farmers.

At this meeting Mr T. C. Day gave a most admirable demonstration in Colour Photography, illustrated by many beautiful lantern slides showing the application of the process to the study of Natural History.

Dr Gerald Leighton read a paper on the Haunts and Habits of British Reptiles. The paper was illustrated by a large number of most interesting lantern slides, prepared by Dr Leighton himself: one of these had special interest, as it exhibited a viper in the act of swimming.

II.—*MILLPORT MARINE BIOLOGICAL STATION.*

By Mr JOHN LINDSAY.

(*Read Dec. 16, 1903: Revised Sept. 1904.*)

At a winter-evening meeting of the Society in February 1897 there was shown a collection of natural history specimens from the Marine Biological Station at Millport: these specimens included representatives of the Cœlenterata, the Echinodermata, the Crustacea, the Mollusca, and the Fishes. Dr Davies, at that time President of the Society, gave on the same occasion a very interesting account of the various steps which had led up to the founding of this Biological Station at Millport, illustrating his paper by a number of lantern slides. A *résumé* of Dr Davies' address will be found in our 'Transactions' for Session 1896-97 (vol. iii. pp. 292, 293). As the Station at Millport was then in course of erection only, I have thought that a paper giving a short account of what has been accomplished during the past seven years by this institution might prove of interest to the members of our Society. The record has been one of continued success from the beginning until now.

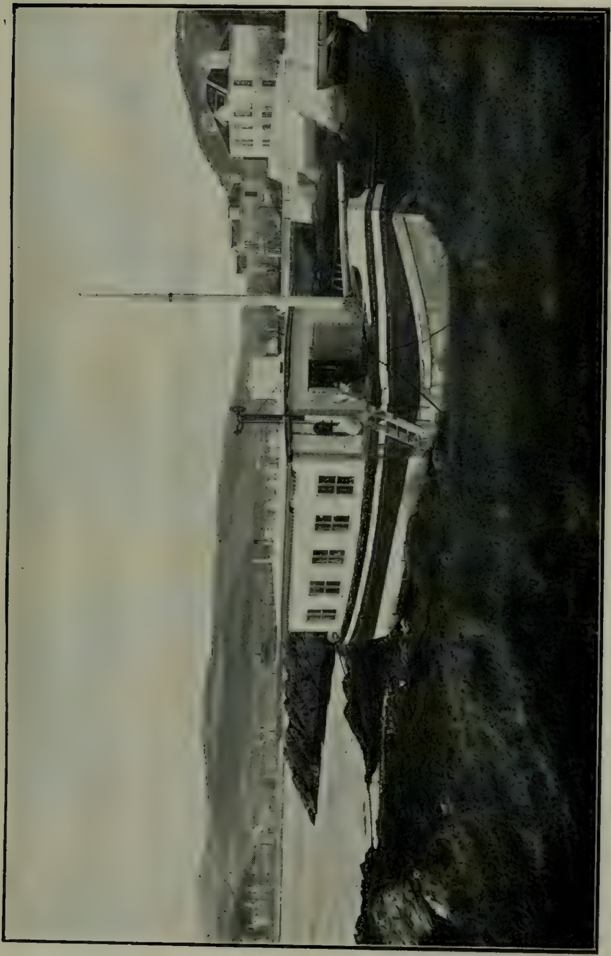
A brief recapitulation of the circumstances which led to the founding of the Millport Biological Station may first be given. The Scottish Marine Station, as it was called, had its origin on the East Coast, being located near Granton, where some of the members of this Society frequently visited it. In 1882 the Scottish Meteorological Society, as the outcome of its investigations for a few years previous to that time into the physical conditions affecting our Scottish fisheries, organised a Fisheries Exhibition in Edinburgh, the surplus funds of which, amounting to some £1600, were devoted to further investigations on former lines. The additional project of establishing a biological station, though it was now earnestly desired by several scientific workers, would not have been accomplished, through lack of funds, had Mr (now Sir John) Murray, of the "Challenger" Expedition, not given effectual help. The station on the Firth of Forth was founded and equipped by him, all that was asked from the Meteorological Society being an annual grant of £300 for three years, after which time it was hoped that, by Government aid and private subscriptions, the station might become self-supporting. No grant from Government, however, was at any time received, yet from 1882 to 1885 some good work was done here. A small screw steam-yacht, named the "Medusa," was specially built; and an old lighter was bought, fitted up as a laboratory, and moored to the side of the quarry near Granton. This boat, known as the "Ark," was long a familiar object to many. Buildings were also rented on the shore at Granton, for the purposes of aquaria, laboratory, and museum. But it was soon found that investigations such as were being then carried on were quite incomplete unless extended to the West Coast. The "Medusa" had already paid short visits to the Clyde, and in June 1885 both the "Medusa" and the "Ark" were taken through the Forth and Clyde Canal to Millport Bay. At Millport Mr (afterwards Dr) David Robertson, "the Cumbrae Naturalist," had been doing splendid work, privately, for a number of years, and his delight at the prospect of a marine station being founded there was great. His own dredging work had been carried on hitherto chiefly by means of row-boats, and the benefits of the steam-yacht "Medusa" for this purpose were soon evident. In a letter Dr Robertson says: "The steamer is fitted up entirely for dredging and securing the spoils. Dredging with such appliances is such an immense advantage over the oars, that one would be inclined to think that going out in a small boat was spending the days of one's life very unprofitably. Mr Murray has it in contemplation to have a marine station somewhere in the West of Scotland. Arran had been strongly recommended, but when they saw the extent of rich dredging-ground and variety and extent of shore, all within so short a distance of the central point, Millport, besides an easy run to all the lochs of the Firth, they were all in one mind that Millport was greatly preferable to Arran or any other place that had been thought of. Fortunately, all round Cumbrae the dredging was exceedingly successful."[1] The time had not yet come, however, for the building of a biological station at Millport, and as a substitute for it, the "Ark" was in 1885 "drawn up on the shore at Millport in a small creek named Portloy, where she lay safe till the night of 20th December 1900." (See Plate VII.[2]) During the greater part of that time the vessel did duty as a museum and laboratory combined, and was visited by many thousands of persons, the number for 1896 alone being 5528. The funds then collected warranted a start being made with the erection of a permanent building, and the first sod was cut by Dr Robertson on August 7, 1896. When the foundation-stone was laid, on October 17 following, Dr Robertson was too ill to be present, and died on 20th November, a few days before completing his 90th year. According to Dr Robertson's wishes, his large and valuable collections were housed in "The Robertson Museum," as it is now called, in the upper floor of the Station buildings. These buildings were opened on May 15, 1897, by Dr John Murray, and the equipment of the Station has since gone on apace.

Before entering into any details regarding the work of the new Station, the destruction of the "Ark" may here be noticed. During the night of December 20, 1900, when the vessel was securely anchored, as it was thought, in Portloy creek, Millport was visited by a most destructive gale, accompanied by an abnormally high tide. In the

[1] Quoted at p. 338 of 'The Naturalist of Cumbrae—A True Story: Being the Life of David Robertson,' by the Rev. T. R. R. Stebbing, M.A. London: 1891.

[2] The block for this illustration has been kindly lent by John A. Todd, Esq., Hon. Secretary to the Marine Biological Association of the West of Scotland.

PLATE VII.—MILLPORT MARINE BIOLOGICAL STATION.



From Photo by Dr A. E. Davies.

THE "ARK" AT MILLPORT.

morning it was discovered that the "Ark" had gone to pieces, "many bits of her wood fittings being found in a field adjoining the Marine Station, where they had been carried by the wind a distance of fully a quarter of a mile." Its time of usefulness was fortunately past, as the Station near Keppel Pier was now in good working order, and the "Ark" would sooner or later, in the natural course of events, have become that unsightly object, a decaying old hulk.

The founders of the Millport Biological Station had a two-fold object in view which has never been lost sight of—viz., "(1) to establish and maintain a fully equipped research laboratory; and (2) to make the Station a centre of general interest and education in the very fascinating study of Marine Natural History." A special feature of the buildings is the Museum already referred to, so intimately connected with the life-work of Dr Robertson. Here, in this upper floor, the collections of the Cumbrae Naturalist are ranged round the walls, while Starfishes, Echini, Crustacea, Mollusca, and many other forms of marine life, are set out in table-cases on the floor. Special mention must be made of a collection of marine invertebrates from the Station at Naples, presented by Dr Anton Dohrn. Mrs Robertson has gifted a very fine collection of local seaweeds, gathered and mounted by herself, besides handing over many other things,—books, pamphlets, and natural history objects,—at various times, for the use of the Station. Sir John Murray, again, has presented to the Museum a series of fishes, collected by the "Medusa" round the Scottish coasts. Many visitors to Millport in summer gladly pay the nominal price of admission to the Museum for the sake of seeing the curious forms of life here exhibited. Adjoining the Museum is a very useful reference library, which is constantly being added to by gift and purchase.

The other and working department of the Station buildings is the Laboratory, on the ground-floor. Here, until lately, most of the research and educational work had to be carried on, sometimes under difficulties for lack of room. This Laboratory contains ten tables, three of these being university tables, for students from Glasgow, Edinburgh, and Aberdeen. The Aquarium or Tank Room is also on this floor. During the autumn of 1901 and 1902 our member, Mr R. A. Staig, now assistant to Professor J. Graham Kerr in Glasgow University, was engaged at the Station in preparing and mounting type specimens of the more important groups of marine animals, for teaching or exhibition purposes. Numerous sets of these specimens were presented to schools, the cost being met from a fund generously provided for that purpose by Mr James Coats, jun., of Ferguslie.

So rapidly did the work of the Station increase, that in a very few years after it was erected an extension of the buildings was felt to be necessary. The ground on which the Station stands was given by the late Marquis of Bute at a merely nominal feu-duty, and it was hoped that more ground could be got from the present Marquis. It was found, however, that the terms of the late Marquis's will preclude the feuing, or otherwise alienating, any part of the island, so that the extensions of the Station buildings had to be confined to the ground already secured. These extensions have now been made, with very satisfactory results. Besides a new house for the Curator, special research-rooms have been fitted up; an additional Laboratory, with tables for forty students, has been provided; while workers, male and female, can now be boarded at the Station, within certain limits as to numbers, instead of finding accommodation elsewhere, as heretofore. Some idea of the extent of these additions may be gathered from the fact that the frontage of the Station buildings is now 104 feet, while formerly it was only 30 feet.[1]

It is rather unfortunate that what would have proved a most interesting feature of the extended buildings has had to be given up for want of space. This was a room adjoining the Library, to be fitted up with tanks for keeping live animals. The glass vessels in the Museum for this purpose were felt to be a failure, and in the Curator's Report for 1901 it was stated that "a set of large glass-fronted tanks, having

[1] The ceremony of formally inaugurating the extended premises took place on Sept. 27, 1904, when Lord Provost Sir John Ure Primrose, Honorary President of the Association, addressed a large company of ladies and gentlemen gathered in the new Laboratory of the Station. Dr J. F. Gemmill, President of the Association, who also spoke, said that "the extensions were practically the gift of Mr James Coats, Ferguslie; and it was an open secret that if circumstances of lease had allowed them, his generosity would have been equal to much greater extensions."

a constant flow of cool water going through them, ranged in a separate room, but adjoining the Museum and forming part of it, would add immensely to its popularity and usefulness." I had a very striking illustration of this, when, one afternoon lately, a few visitors—evidently a family party—found their way into the Laboratory after having paid a visit to the Museum. Mr Staig and myself happened to be the only occupants at the time, and we showed them, by means of the microscope, some samples of tow-nettings, crowded with minute life, which had been made that morning. They were then taken into the Tank-room, and had the various living occupants pointed out to them. They left with many expressions of gratitude; and in a short time one of the party returned to ask if we could recommend any work which would tell them something about such animals as those they had just seen. We at once named Dr Marion Newbigin's book, 'Life by the Sea-Shore,' as well suited for this purpose. To the ordinary visitor, living animals appeal in a way that museum specimens, however excellent of their kind, can never do.

The Teachers' Classes, begun at the Station in 1901, have been a marked success, and fraught with great benefit to those who were able to take advantage of them. The course of instruction here given has been recognised by the Scotch Education Department, and is carried on as a Nature Knowledge Course under Art. 91(*d*) of the Scotch Code. F. W. Young, Esq., H.M. Inspector, reports thus on Session 1903 (the latest available): "There is good reason for much satisfaction with the work and progress of the Teacher-students who have attended a course of study for the third year in succession. Several very enthusiastic naturalists have been evolved, and they have all now obtained a sound working knowledge of the subjects studied, which ought to be of effective service in the Nature Knowledge Lessons given in their schools."

An important step was taken in June 1901, when the Station received a new constitution, under the name of "The Marine Biological Association of the West of Scotland." As a result of this change, it was hoped that the Station would be placed "on a firmer foundation, by uniting its supporters into a definite body, as members of which they would be able more directly to make use of the scientific facilities of the Station, and also to further its interests."

The rapid survey given above of the work at Millport Biological Station would be quite incomplete were some space not now allotted to the dredging operations. It was soon felt, after the buildings were finished, that a steamer for collecting purposes was indispensable if the work of the Station was to be carried on satisfactorily. This requirement was ultimately fully met by the very handsome donation of £2700 from the gentleman already repeatedly mentioned as a generous giver,—this sum being designed for the building and equipment of the vessel, and its maintenance for five years. The steam-yacht "Mermaid" was then specially built, and furnished with all the necessary modern appliances for the work. Since April 1901 it has been in use for nearly three-fourths of each year, and has well fulfilled all that was expected of it. A supply of material for the practical work of the Station has thus been amply secured; and workers have been afforded opportunities of accompanying the vessel, and taking part in the dredging operations. This, to most, has been a delightful and instructive feature of the life and work of the Station. True, the weather is not always what one would wish, for storms have a way of rising suddenly on the West Coast, and often when least expected. As the Rev. Mr Stebbing humorously remarks in his book on the Cumbrae Naturalist, "Dredging in a rough sea is not to be recommended: it is apt to engender feelings of animosity against marine zoology in the breast of the student,—in short, to make him sick of it." But there are many calm days in summer when sailing amongst the lovely lochs and bays of the Firth of Clyde is a most enjoyable experience. Then there is the excitement consequent on each haul of the net, and the satisfaction when a more than usually rich harvest has been gathered. Such are the compensations for any accidents of rough-and-tumble which may now and then be encountered, and which are usually soon forgotten.

A most interesting outcome of the work done by the "Mermaid" is the knowledge thus gained of the various forms of life present in the Clyde area, as compared, say, with the Forth. This point has been well put by Dr M.

Newbigin, in the following words: "We may say generally that our littoral fauna is of two types,—the Mediterranean type, which predominates on the South and West, and the Northern or Scandinavian type, which predominates on the North and East. In addition, on the West we find certain peculiar animals which are not truly members of our fauna, but are brought, more or less passively, by the Gulf Stream. Animals which occur all round our coasts may generally be assumed to be common to the Scandinavian and Mediterranean faunas, while our East Coast rarities are Scandinavian types. The differences between East and West are often exceedingly striking, and cannot fail, for example, to astonish any one passing from the Firth of Forth to the Firth of Clyde."[1] Perhaps in no group are these differences more noticeable than in the Crustacea, and I have much pleasure in giving here the following remarks on that group, kindly sent me by Dr Thos. Scott of the Scottish Fishery Board, one of our honorary members, who is a specialist as regards the Crustacea, particularly of its minuter forms. Dr Scott says:—

"I shall begin with the Decapoda, and in this group a few, and in some cases rather curious, differences are observable. For example, the swimmer crab (*Portunus holsatus*) is one of the most common of the Forth crabs, while there is no really satisfactory record of its occurrence in the Clyde. I do not think you will find it in Dr Henderson's list of the Clyde 'Higher Crustacea': Mr Alex. Patience has found a crab somewhat like *P. holsatus*, but I do not remember if it turned out to be that species. Then there is *Gonoplax rhomboides*, which in recent years has been found not to be so very rare in the Clyde, but not a single specimen has yet been observed in the Forth. *Macropodia longirostris* (Fabr.) and *Inachus dorynchus* are both moderately common in the Clyde, while as yet there is no Forth record for them. Other two species belonging to this group may also be referred to. *Pandalus bonnieri* and *P. propinquus*, but especially the first, appear to be moderately frequent in the Clyde, more so than was believed a few years ago; yet no trace of either the one or the other has been found in the Firth of Forth, or, for

[1] 'Life by the Sea-Shore: An Introduction to Natural History,' by Marion Newbigin, D.Sc. (Lond.), pp. 164, 165. London: Sonnenschein & Co. 1901.

that matter, along the east side of Scotland, although I have searched very diligently for them. Then *Pasiphœa sivado*, Risso, which I have found in quantity near the mouth of the Clyde estuary, and odd specimens in other parts, has not once been seen in the Forth.

"The schizopod fauna of the two estuaries are pretty much alike, but there is one notable exception, viz., the great abundance of *Nyctiphanes norvegicus* in Loch Fyne, and occasionally in other parts, while in the Forth I very seldom obtained it. About twenty years ago, or perhaps a little more, Dr Henderson said of this schizopod species that the young are not uncommon in the Forth at the surface, especially in winter and spring. I am afraid he made a mistake, just as I did sometime afterwards, by confounding it with the adult stage of another species. The species were not so readily distinguished at that time as they were later,—at anyrate, I can say that, after becoming familiar with the various forms, I did not find *Nyctiphanes* common in the Forth, either in the old or the young stage; but a closely allied genus, *Rhoda* (or, as it was then called, *Borcophausia*), was, and is, common during winter and spring." Passing over the Sympoda or Cumacea, as well as the Amphipoda, the Cladocera, and some other of the minuter crustaceans or Entomostraca, as being alike found in the two sea-areas, Dr Scott goes on to notice, among the Copepoda, a curious difference as regards *Euchæta norvegica*, which, he says, "is ofttimes very abundant in Loch Fyne, and is also found in other parts of the Clyde area, but not a trace of it has been seen in the Forth. *Bradyidius armatus* is also common in the Clyde, but I have no record of it as yet from the Forth. On the other hand, *Acartia longiremis* is moderately frequent—sometimes common—in the Forth, but I have never found any satisfactory evidence of its occurrence in the Clyde."

These curious examples of unequal distribution might easily be added to, but enough has been said to emphasise the fact that in the sea as on land, and in animals as amongst plants, we are often confronted by what seem to be strange anomalies. To the elucidation of some of these we may look with confidence to the work now being done at the Millport Biological Station.

With the work of the Station thus steadily advancing, the expenses of upkeep, &c., are also increasing, and an effort is at present being put forth to raise an Endowment Fund of £25,000, the interest of which would go to supplement the annual income. A fair beginning has been made with the raising of this Fund, but much still remains to be done. More students and additional members are also needed. Several of the members of our Society have already been workers at the Station, while Mr Crawford and Dr Davies are both original members—Dr Davies being also a member of Committee. Another of our members, Mr D. C. M'Intosh, M.A., as a result of research work conducted at the Station, has published a paper on "Variation in Ophiocoma nigra (O. F. Müller)," which was read before the Zoology Section of the British Association in 1903. This paper may be termed a "recess study," as it was worked out during a school vacation. Indeed, for any one with Natural History tastes and predilections, no pleasanter holiday could be imagined than in such work as is offered at the Millport Marine Biological Station. The student could here learn in a week what he could hardly acquire in a twelvemonth's study of text-books.

[In illustration of the above paper, Mr Lindsay exhibited and described the following examples of the fauna of the Clyde sea-area—viz.: The Common Octopus (*Octopus vulgaris*), young form; the Sea-mouse (*Aphrodite aculeata*); the Sea-pen (*Pennatula phosphorea*); and the Gaping File-shell (*Lima hians*). A crab (*Eupagurus prideauxii*) and a sea-anemone (*Adamsia palliata*) living together as commensals, and frequently found in the Clyde sea-area, were also shown and described by Mr Lindsay.]

III.—*NOTES ON SENEBIERA DIDYMA AND LITHOSPERMUM ARVENSE.*

By Miss BEATRICE SPRAGUE.

(*Read Dec. 16, 1903.*)

THE lesser wart-cress (*Senebiera didyma*) takes its specific name from the two lobes into which the fruit is divided, this characteristic distinguishing it at once from the common wart-cress (*Senebiera coronopus*). According to Hooker and Arnott's 'British Flora' (8th edition, 1860), it grows on "waste ground near the sea, in the south and south-west of England; about Exeter, Truro, Penrhyn, and Milfordhaven, shore near Caernarvon, South of Ireland." Sir J. D. Hooker, however, in his 'Students' Flora of the British Islands,' says it is found from Fife southward, and is spreading; also that it is a colonist, its original habitat being temperate South America. The whole plant has a strong cressy odour. It grows in profusion round Torquay.

Lithospermum arvense occurs in cornfields and waste ground. It flowers from May to June, but we found a few belated flowers at the beginning of November. The flowers are about one-third of an inch across, creamy white and honeyed; and have a faint but delicious scent, which I think is unusual among the Boraginaceæ. We have found it growing in two localities near Torquay.

At this meeting Mr Goodchild, of H.M. Geological Survey, gave an extremely interesting paper on Agates, illustrated by a large number of very beautiful lantern slides.

IV.—*NOTES ON FUNGI FROM WEST KILBRIDE, AYRSHIRE.*

By Mr D. A. BOYD, Corresponding Member.

(Read Jan. 27, 1904.)

I. The Jew's-Ear (*Hirneola auricula-judæ*, Berk.).

This fungus is included in the very extensive group known as the Hymenomycetes, which embraces a large number of genera and species. These often differ greatly in size, shape, and general appearance; but all agree in one important character—viz., the spores are attached to well defined basidia, and these spore-bearing basidia are produced on a surface termed the hymenium, which, at maturity, is always openly exposed, without any covering whatever. The hymenium may be distributed over the surface of vertical plates or gills, as in the mushrooms and toadstools; or of tubes, as in the various species of Boletus; or of pores, as in the Polypori; or of spines, as in Hydnum. But in various other genera, such as Corticium, Stereum, and Hirneola, the spore-bearing surface is free from gills, pores, &c., and seems perfectly smooth when viewed superficially. When examined microscopically, however, it is seen to be rough through the presence of innumerable spore-bearing basidia, too minute to be detected by the unaided vision.

Hirneola, the genus under notice, is included in the Tremellini, a section remarkable for the gelatinous nature of the fungi embraced therein. Hirneola auricula-judæ, commonly known as the Jew's-Ear, occurs on dead branches of Elder in many parts of the country. When in a moist state, it has a decidedly ear-like feeling when pressed between the fingers. Specimens can be easily preserved by drying very gradually. They then assume a somewhat firm and horny texture. They may be restored to a soft and flexible condition by placing them over-night between folds of moistened linen or other cloth.

II.—The Scarlet Cup-Fungus (*Lachnea coccinea*, Jacq.).

This beautiful fungus—the Peziza coccinea of the older text-books—is described by Mr Phillips, in his 'Manual of the British Discomycetes,' as "the most handsome species in our flora," and most people will probably concur in his opinion. In the depth of winter, when the dreary woods display few brightly coloured objects to attract the eye of the passer-by, its brilliant cups are conspicuous, whether seen growing on the bare ground or in the midst of a setting of verdant moss. It occurs on rotten branches of hazel, and may be found on the ground, in moist woods and coppices, during the late autumn, winter, and early spring. It belongs to the large group known as the Discomycetes, in which the spores are produced in asci or bags, which are embedded in the tissue of the hymenium. In this species, as in the vast majority of the others, each ascus contains eight spores. A vertical section through the hymenium, showing the asci and spores, forms a very interesting object for microscopic examination.

V.—*NOTES ON THE RARER WOODLAND PLANTS OF SCOTLAND.*

By Mr DAVID SYDNEY FISH.

(*Read Jan. 27, 1904.*)

Beneath pine-forests there usually exists a carpet of dwarf, often creeping, plants. The forests of Scots pine forming the native coniferous forest are not only interesting by themselves, but in connection with the various plant carpets that they more or less shelter. Some of these pine-forest carpets are in Britain singularly characteristic of its northern counties. In the case of one of our rarest plants, Moneses, no record exists of its being found so far south as Edinburgh: if the other genera to be specially mentioned presently are scarce in Scotland, they are more so in England, not straying far, or often, beyond the Border counties. To contrast the under-vegetation of the pine-forest with that of the broad-leaved would involve space too considerable. It is sufficient to say that, although equally interesting in its way, the coniferous forest merits more attention in this country than the dicotyledonous one, as the greater portion of the land can be covered with coniferous growth only, while the interest of its carpet is added value to the naturalist.

The plants that clothe the ground, to varying extent, beneath the shadow of the pines may be roughly placed in two divisions—those that do not derive advantages from the tree presence, and those that do. The former reach an equal or greater luxuriance, or, in other words, grow, flower, and increase more freely when fully exposed to the light of meadow, mountain, or moor. This type of undergrowth is usually well represented in sylvicultural districts, where virgin forest is absent or infrequent. This light-demanding vegetation dislikes the forest. During the period that occurs between felling and the re-closing of the canopy (or when arboreal vegetation was not) such plants will occupy the ground, and meeting nothing more vigorous than themselves, they continue to do so, although sickening perhaps, from time to time, when the trees are crowded and the shade dense. The familiar bell-heath (*Erica Tetralix*) will serve as an example of such plants. This properly is a light-demanding, social plant of moor and mountain. When Erica or Calluna penetrates beneath the trees, or survives the change of land from heath or moor to forest, the usually bright flowers often become duller, are more sparsely produced on the drawn shoots, and the plants disappear as the forest thickens. Erica is not a solitary example. It is, however, a fair type of a plant that is ever ready, should opportunity offer, to extend its ground on every possible occasion. The suppression or death of light-demanding carpets in the forest indicates increasing possibilities that will then exist for the growth and increase of the true pine-forest carpets. By "true" is inferred those plants that are seldom found elsewhere. In Scotland the pine-forest plants that fall under this category are Moneses, Linnæa, Goodyera, and, to a less extent perhaps, Trientalis, Pyrola, &c.

Whatever may have been, there is no doubt that now the presence of the forest has left its impress on these plants. They revel in the shade and moisture secured for them, and it may be correctly surmised that if these plants find so much there to aid their growth and increase, they are not likely to be found far from the vicinity of its trees, although dwarf shrubs or rocks may at times replace arboreal vegetation. In this connection another point arises. The cessation of the forest is quite likely to bring about the extermination of its lowly undergrowth. The sudden felling of the trees which takes place where the "clear cutting" is practised, or the same result ensuing from wind, may kill the delicate undergrowth that is unable, after years of forest adaptation, to withstand the altered conditions which will then prevail. This alteration is in several directions,—the drying up and disappearance of the humus, the reduction or increased variation in the supply of moisture, both of soil and atmosphere, and the usurping of the ground by stronger plants formerly kept in abeyance by the forest's shade. All tend to bring to an end the existence of these rarer plants. They live with the forest, and it has been substantiated in several instances that they die with the forest.

Coniferous woods are not, and never have been, peculiar to Scotland: at present they are not extensive here, and are in a much-broken-up state. Large communities of coniferous trees, accompanied by their undergrowths, cover great tracts of Scandinavia. From hence they extend south and east, ascending the mountains as the Mediterranean is approached. Crossing Asia, they reappear in the northern countries of the great western continent, slightly varied in form, and farther south our native carpets are accompanied or supplanted by several genera unknown to European forests, such as Chiogenes, Mitchellia, and Pyxidanthera (the favourite "pine-barren beauty").

The decay of pine-forests, and their conversion to moor or heath, is economically bad. The longer, too, the moor remains a moor, the greater difficulty of making it again a forest. A large portion of the moorland of Scotland was once wooded, the trees being felled and cleared because of their accessibility over those on mountain slopes. In several localities the once well-wooded character of the land has been proved by the timber found buried and preserved among the peat.

The term "moor" is usually applied to land encrusted with a layer of acid humus, strongly preservative or even antiseptic in character, and as regards plant-food, lacking in proteids. This humus is principally formed by the remains of sphagnum, which, always elongating, is continually adding to the thickness of the peat layer. "Heath," as usually understood, indicates a drier condition of the peat than is found in moors, the peat also consisting usually of a larger proportion of woody remains, as the stems of Calluna, Erica cinerea, and other ericaceous plants. Beyond this difference in moisture, and therefore in the vegetation and its remains, there is little difference between heath and moor, and not infrequently both states occur side by side.

The change from moor or heath to forest is one that requires the hand of man in most cases. As, however, the change from forest to moor takes place naturally, so also may the opposite occur, although less frequently. Different species of Pinus possess different degrees of vigour when they are left to themselves among the infertile soil of the peat-lands. For instance, Pinus montana uncinata will thrive where the Scots pine languishes. In a moor the chances of a start in life for the young pines lie chiefly in the hillocks of Erica rather than in the softer sphagnum portions. As the trees grow there slowly accumulates upon the ground, previously wholly held by Carex, Eriophorum, Sphagnum, Erica, and the like, a layer of pine needles and other *débris*. Here and there the sphagnum of the moor yet crops up, while the other plants disappear from some portions, holding their ground in a few. The forest *débris* forms an ideal rooting medium for its true carpet plants. Continually renewed, it varies but little with time. Worms being for the most part absent, there is little or no intermixing of the surface with the subsoil. Here, too, is found remarkable evenness of moisture and temperature throughout the year.

The history of the pine-forests dominates the history of their plant carpets. The dwindling of our pine in Scotland, its isolation in forests by intervening tracts of treeless ground and their varying rise and fall, account in some measure for the present rarity of plants that should and would, under more favourable circumstances, be found associated with them. Among the scarcer of these plants is one worthy of special attention—Moneses grandiflora, S. F. Gray (Pyrola uniflora, Linn.) It is extremely rare in Scotland, and does not occur elsewhere in the British Islands. Moneses is conspicuous during June and July. Those months cover its flowering period in our northern woods. In flower the plant is three inches or so in height, and bears at the extremity of the recurved portion of the scape a solitary flower. This one-flowered scape is sufficient to distinguish Moneses from the far more frequently met with British Pyrolas, all with many-flowered scapes. Only once have I detected a twin-flowered scape. Other differences between the flowers of Moneses and the native Pyrolas (Pyrola absorbs Moneses according to some authorities) are, placing the characters of Moneses first—Petals flat or only slightly concave, *not* connivent; anther-cells produced with horns, the pollen escaping from their apex, *not* opening by pores close to insertion of filaments.

Moneses is remarkable for the way in which autogamy or self-pollination takes place, should cross-fertilisation not occur. "The bud about to open and the young flower whose petals have just expanded are borne on stalks which are strangely curved; and they are thus inverted and pendent. The style is vertical with the stigma, pointing downwards. The filaments are S-shaped, and hold the anthers, which are of the pepper-castor type, with the two pores invariably uppermost, so that the pollen does not fall out of itself, or at any rate cannot come upon the stigma. Insects approaching from below brush first against the stigma, and directly afterwards against the anthers, which are in consequence upset and besprinkle the intruders with pollen. This pollen is then carried to other flowers of Moneses, where it is retained by the viscid stigmas and fertilises the ovules. During the period of bloom two changes are effected, which, though not very striking in themselves, are yet of extreme importance with a view to autogamy. In the last stage of the flower the curve of the pedicel no longer amounts to a semicircle, and consequently the flower is no longer absolutely pendulous, but

PLATE VIII.—RARER WOODLAND PLANTS.

MONESES GRANDIFLORA, S. F. GRAY, OR PYROLA UNIFLORA, LINN. (2½ NAT. DIA.)

PLATE IX.—RARER WOODLAND PLANTS

MONESES GRANDIFLORA, S. F. GRAY: NORTHERN SCOTLAND.

only facing obliquely down; the style is no longer vertical, but with this new position of the flower points also obliquely downwards, and the stigma is thus brought underneath some of the anthers. The filaments are still curved in the shape of the letter S, but in the opposite direction to that held by them at the commencement of the flowering period; the anthers are therefore inverted, and have their faces directly downwards. The least shaking of the slender stem is now sufficient to cause a fall of pollen, with which the viscid stigma cannot fail to get sprinkled."[1] In July the buds for the succeeding year's flowers are noticeable at the extremity of the shoots. So ready do they appear that one would scarcely believe that twelve months or so will elapse before they open. The leaves are quite glabrous, spathulate, with obtuse apices. They are somewhat thin in texture, and suggest those of a shrub. The small cauline ones are scooped, and serve as water receptacles. (Plate VIII. illustrates the above-mentioned phases of flower development, &c.)

Pyrola, a diminutive of *Pyrus*, has not been so inaptly applied to these plants as some think. Some, for instance, as Pyrola secunda, are much like seedlings of Pyrus—superficially, of course. The same may be said of Moneses, and still more of Chimiphila, an allied Continental and American genus, which one writer has described as a "Pyrola trying to become an Arbutus." The leaves of Moneses are more gradually attenuated at the base than in the native Pyrolas.

Moneses, like Pyrola, increases vegetatively by underground stems, that send up rosettes of foliage leaves. The life of each aërial shoot extends from two to three years. Thus shoots of this year's growth should be found with flower-buds in the summer of 1905, and flower, seed, and perish in 1906.

Accompanying these notes is a plate illustrating a small portion of a Scots pine wood, beneath which Moneses grows. It has interesting points. Once the site of a sphagnum moor, it is now a typical example of a pine-forest on an unfavourable peat-moss formation. Before the trees seen in the photograph occupied the ground a much older series existed, some of which still exist hard by. (See Plate IX.)

The companions of Moneses are Erica Tetralix, spreading in

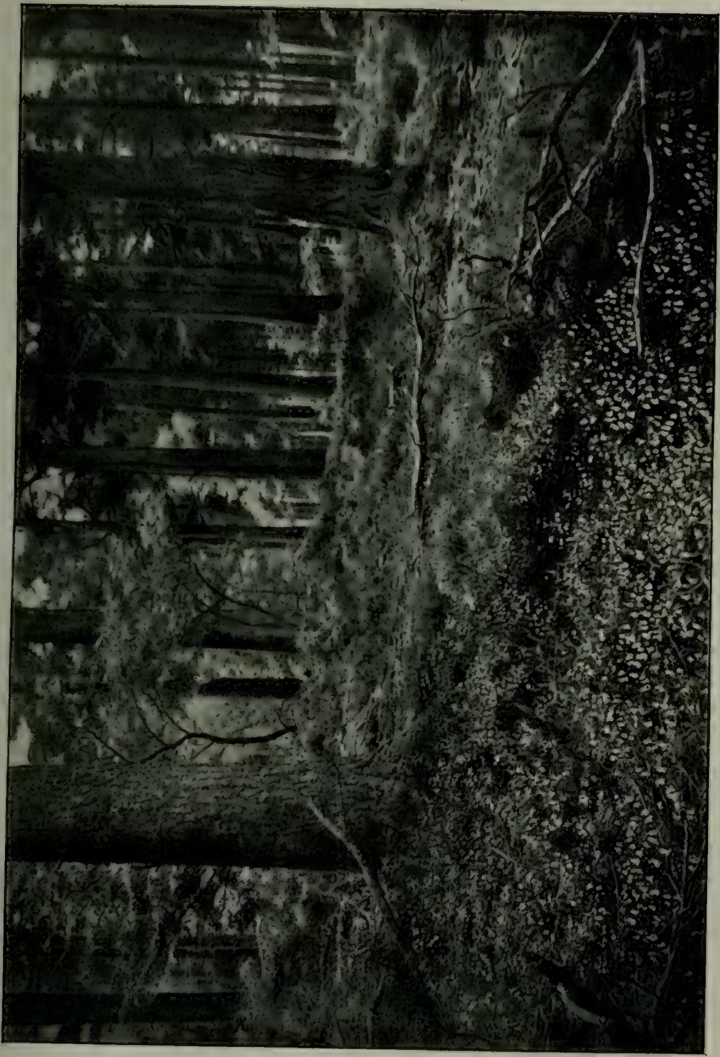
[1] 'The Natural History of Plants,' vol. ii. p. 382.

tufts a yard across, very sparsely flowered, frondose lichens, sphagnum, and moor grasses. The slowly decaying remains of former generations of these plants, together with the coniferous *débris*, form a loose porous compost, into which one can easily thrust one's hands. Below this upper layer the peat is of considerable solidity. The most southerly station in Britain for this plant has special interest to me. More than half a century ago my father, the late D. T. Fish, was interested in the Scone station for this rare native plant. At that time it grew and flowered freely there.[1] Why this beautiful plant should be so scarce in Britain when so plentiful in certain localities on the Continent is not easily answered. In fact, it is possibly due to the scarcity of virgin forest in Scotland, and still further, our summers do not appear to suit it to the same degree as does the far warmer inland summers abroad. Moneses has seldom been under cultivation. It is necessary in the first place to secure the creeping shoots with roots—not merely the foliaged shoots, with a small portion beneath. These white stems should be kept in damp moss, for they speedily wither on exposure to air. Plant them in humus of a similar kind in which they are found, choosing a shady spot. I have only met with it in cultivation at Geneva and Edinburgh; at the latter place it is grown in the Royal Botanic Garden. It is well worth growing, and flowers more freely perhaps under cultivation than does any Pyrola. An enthusiastic hardy-plant grower informs me of his intention of importing a quantity for garden use, although it can never equal its native beauty unless naturalised in pine-woods. In the alpine regions it ascends to as great an elevation as does the mountain pine.

Of far more frequent occurrence in Scotland is Linnæa, a monotypic genus differing from most Caprifoliaceæ in its dry, not succulent fruit. Its association with the Master of Botany of the eighteenth century is interesting. Linnæa borealis occurs in quantities in the north of Scotland, but is not in any way a well-distributed plant. When it does occur, there is usually plenty, but many forests which would afford ideal conditions for its growth are without it. In the south of Scotland it occurs in several localities. The luxuriance with

[1] Not so lately; see 'Flora of Perthshire,' p. 217.

PLATE X.—RARER WOODLAND PLANTS.



LINNÆA BOREALIS, LINN., ROXBURGH.

NATURAL HISTORY

which it thrives in a Roxburgh station is indicated in one of the illustrations (Plate X.) Mr W. B. Boyd of Faldonside, who first discovered it there, inclines to the idea that it was introduced to the locality with the trees. The latter are about a hundred years of age, and came from the north of Scotland. In England, Linnæa is found, according to Bentham, in a single locality in Northumberland. In Europe it is widely spread. In Scotland the principal flowering months for Linnæa borealis are during June and July. The flowers are very fragrant, especially at night, and the perfume is perceived some distance from the forest. The English name for Linnæa is "twin flower." Occasionally three flowers occur on a scape. I have not noticed in this country the rare white-flowered form sometimes met with on the Continent. It is normally pink, with red colouring within the corolla, which is intermediate between bell- and funnel-shaped.

For Goodyera repens, according to 'English Botany,' the most southerly station is at Dalmeny. But a hundred paces or so from the Linnæa carpets in Roxburgh mentioned previously there is a fair quantity of Goodyera, which appears to be gaining ground beneath the pines. It flowers during July, and perhaps is nowhere so plentiful in Scotland as in a wood near Troon, where its whitish flowers are quite a feature.

Trientalis europæa, the Chickweed Wintergreen, varies much in size, and also in the number of segments into which the calyx and corolla are divided—from five to nine. The stamens are equally variable in number, while the leaves, which approach a whorled arrangement, usually agree in number with the petals. The flowers of Trientalis europæa are usually white, but occasionally pink. The tube of the corolla is very short, and this gives the flowers a starry appearance, unlike many of the Primulaceæ. Although its name might suggest but little variation from its normal size, few plants range so greatly in stature. Specimens from Lapland and the neighbourhood of the Behring Straits have leaves not two inches in length, and stems from two to three inches in height, the flowers remaining, however, of the usual size. Contrasted with such are those found in more favourable regions, some with stems over twelve inches in length. The floor of those Scottish woods in which the plant abounds is prominently sprinkled in early June with the pure white blossom. (See Plate XI.) It rapidly spreads by its extensively creeping rhizomes, and the plants found in dry hungry soil have the same starved appearance as those from polar regions. Trientalis grows, too, in forests other than coniferous, and also on open heaths. Trientalis americana is equally variable, and appears to run into T. europæus. A plant flowered this year at the Royal Botanic Garden, Edinburgh, had very deep pink flowers, each one-fourth inch across, but this colouring is not usual.

The Pyrola are interesting plants, that in some districts are confined to pine-forests, while in others they are not. The differences between the several species native to Britain depend on the length and shape of the style, &c. P. minor is the most frequent. P. rotundifolia has the largest flowers.

The history of woodland plants has many points of interest: few only have here been touched upon, and those bear but briefly upon their life in Scottish forests.

[Illustrating the paper, of which the above is an abstract, thirty slides were shown on the screen, depicting various forest plant carpets, &c.]

VI.—*A SHORT TALK ON LICHENS, CHIEFLY CLADONIÆ.*

By Mr JAMES M'ANDREW.

(*Read Feb. 24, 1904.*)

In a single paper on such a wide subject as lichens one can only briefly glance at them. Such questions as the Schwendenerian theory of lichens, their life-history, their distribution and classification, their effect on the earth and on scenery, the purposes they serve in the economy of nature, their economic uses for medicine, for dye-stuffs, for food for man and beast, &c., would each require a paper to itself. As our Society

PLATE XI.—RARER WOODLAND PLANTS.

TRIENTALIS EUROPÆA, LINN. (½ NAT. DIA.)

has offered a prize in October of this year for the best collection of lichens of the Edinburgh district, my purpose will be served if I excite some interest in this study and induce some members to compete.

The study of lichens is one of the most difficult in botany, and even at the present day, after many years of careful observation by very competent authorities, many points as to their chemistry, the functions of some of their organs, and their life-history, have not been satisfactorily solved. To do justice to their study very minute and careful microscopic work is necessary. No vegetable productions are more liable to variation, and without a knowledge of the fruit it is almost impossible to distinguish species accurately. The number of species of British lichens is about 1710. The popular names of some of them are cup-moss, old man's beard, Iceland moss, rock-hair, lung-wort, cud-bear, stane-raw, orchil, reindeer moss, earth-bread, Tripe de roche, rock-moss, dog-lichen, &c.

Lichens occur everywhere, growing upon the most unlikely substances, as cooling lava, the hardest quartz, naked glass, coral reefs, in arctic regions, above the snow-line, in tropical forests, on the arid desert, the sea-shore, bark of trees, and even on living leaves, and some are parasitic on others. No lichens, however, are entirely aquatic. They form the very outposts of land vegetation, and are the first forms of vegetation, preparing and disintegrating the soil for higher forms of plant life. They shun places where the atmosphere is deleterious and also the dark recesses of tropical forests. They are able to resist an amount of heat and cold which would be fatal to more organised plants. They increase in abundance towards the arctic regions, but in number of species towards the equator.

The economic uses of lichens are various. They are used as dye-stuffs, food for man and beast, in medicine, for perfumery, &c. Among dyes from lichens we have orchil from Roccella tinctoria; litmus from orchil, cud-bear, &c. Lecanora tartarea, a native lichen, is nearly equal to orchil as a dye-stuff. In short, this property of affording colouring-matter is more or less characteristic of the whole tribe of lichens. Some without any visible colouring-matter nevertheless contain colouring principles which yield beautiful tints when treated with alkalis as soda and potash. These pigments depend upon the presence of special acids in the thalli of the lichens. Some of the crustaceous lichens are employed in France in the manufacture of oxalic acid. Gum has been got from Ramalina fraxinea, and the bases of perfumes from Usnea, Ramalina, and Cladonia.

As medicines some lichens were formerly highly esteemed, but their virtues were often more imaginary than real. They were used as demulcents, febrifuges, astringents, purgatives, and tonics. Iceland moss (*Cetraria islandica*) is the only species which has retained a place in British pharmacy, but it is now principally employed as an article of diet for invalids and convalescents, and is being gradually superseded even in this by other more nutritious productions. This same lichen is extensively used in Iceland as food. It contains about 47 per cent of lichenine, a form of starch. "Tripe de roche" and the Gyrophoras are eaten in the extremities of hunger, as was done by Dr John Franklin and his men. Lecanora esculenta, manna-bread, is eaten by the Tartars and other tribes. Several lichens are ground to powder and mixed with meal or flour. Their value as food consists in the starch in their composition. Some lichens are extensively used as food for cattle, especially Cladina rangiferina, to which I shall more particularly refer farther on. Usnea yields food for goats and reindeer. Alectoria jubata is got from felled trees when the snow is too frozen for the reindeer to get their common food.

How varied, too, are the effects produced by the presence of lichens on scenery! Rugged rocks, wayside dykes, forest trees, barren heaths, arctic tundras, the ruined castle, and the Highland cottage, are all beautified by their covering of lichens. Their form, their power of deriving sustenance almost entirely from the atmosphere, their wonderful endurance and vitality, their ability to repair broken-off pieces, all show their peculiar fitness for the work they are designed to accomplish in the economy of nature.

Lichens are cellular perennial cryptogamic plants having affinities both with fungi and algæ. Their position among the cryptogamia is between these two, and as Nature has no sharp and fast lines in her divisions, her boundaries generally over-lap, and so it is here. The genus Endocarpon may be regarded as a connecting-link with the Hepaticæ, and has fruit embedded in the thallus like Riccias, and Lichinas and Collemas with the algæ. Fries says that lichens have the vegetation of algals and the fruit of fungals. They have a vegetative system containing gonidia and a reproductive system of female thecasporous fruits and male spermogonous organs. De Bary, followed by Schwendener, some years ago propounded the Schwendenerian theory, which makes lichens a product of the medulla of the lichen — a fungus, taking captive, stimulating, and feeding upon algæ — the green gonidia. This theory has been adopted by many eminent botanists, but the principal lichenologists reject it. Dr William Nylander of Paris characterises it as presumptuous, premature, and absurd, and the Rev. J. M. Crombie says: "As to the alleged identity of the lichen hypha with a fungus mycelium, it is to be observed that the two are totally different in their nature. The hyphæ of lichens are rigid, elastic, containing lichenine, not becoming putrid by maceration, with no faculty of penetrating or involving, while the hyphæ of fungi are caducous, soft, flexile, with their walls thin. Hence as there is no algal in the lichen so neither is there any fungus, though there is a parallelism between the fructification of lichens and the asciferous section of fungi." Another author says, "It is well known that parasitic fungi destroy the living organisms upon which they fasten; and if the assumed parasitic fungus does not destroy its assumed algal host, but, on the contrary, excites it to more active growth and more enlarged production of tissue, then it is clear that it cannot be a fungus but the vegetative tissue of a veritable lichen." There *may* be some plausibility in this theory as long as observations are confined to such plants as Collemas, but it requires a great amount of credulity to believe that a fungus and an alga would produce a Cladonia, for instance; yet, on the other hand, it is maintained by Stahl and others that lichens have been obtained synthetically by sowing the spores of fungi upon favourable algal cells, and thus proving their dual nature. This parasitism is without parallel in the animal kingdom or in any other part of the vegetable kingdom.

The lichen as a plant has no axis either ascending or descending, no branches nor leaves as in phanerogams. It is altogether an aërial plant, finding for itself a situs and then deriving nourishment from the atmosphere. It can scarcely be doubted, however, that mineral matters are to a very slight extent absorbed from the soil or from their bases of support and contribute to the colour of the thallus. Lichens are light-loving plants, but appear to shun the direct rays of the sun. Starch, gum, oil, sugar, resin, &c., as well as many mineral substances, have been found in lichens. Their life is twofold—active and passive—growing when supplied with moisture, and resting when the atmosphere is dry, and this accounts in a great measure for their almost indefinite duration of existence, for some are hundreds of years old. The lichenine which they contain is readily dried and as readily moistened. This lichenine is a special kind of gelatin peculiar to lichens, and is intermediate between dextrin and starch and readily imbibes water. Cladoniæ, for instance, if kept dry for years, can be revived by sprinkling them with water or even by exposing them to the atmosphere.

The vegetative or growing portion of lichens is the thallus, which may be said to comprehend the whole plant—root, stem, and leaves—in one, and also because it contains within its tissues or bears upon its surface the reproductive organs with the fruit. The reproductive organs are the apothecia or female organs, spermogones, the presumed male organs, and pycnides, a secondary kind of fructification. The apothecia as well as the thallus and the spores are all variable either in form, size, colour, consistence, or internal structure. As a rule, lichens are more or less of a spherical mode of growth, and this is the form of greatest security, because it possesses the property of greatest symmetry in relation to all its parts. The thallus may be vertical or horizontal. When vertical, it may be fruticulose, as in Cladoniæ and Ramalina; or filamentous, as in Usneæ and Alectoria. Usneæ, when full grown, are perhaps the most beautiful of lichens; their colours are often brilliant, their habit elegant, and in fruit very striking. When the thallus is horizontal it may be crustaceous, as in Lecanora; or foliaceous, as in Parmelia and Sticta. Among the Parmeliacei occur the highest forms of which lichens are capable. Some lichens have no proper thallus, and some grow under the bark of trees, as Arthonia. Excrescences on the thallus are soredia or protruding gonidia capable of propagating some species, like the gemmæ of mosses and hepaticæ. The stratified cellular layers of the lichen proper are the cortical layer, the gonidial layer, and the medullary layer. The medullary layer in the highly branched species, as Usnea and Cladonia, forms a tough cord in the centre, which is at length exposed by the cracking of the cortical layer.

Lichens are said to have many modes of reproduction, some authorities giving as many as six. The normal method of fructification is by spores developed in a special organ called the apothecium, which is always found upon the surface or attached to the edge of the thallus. In Cladoniæ the apothecia surmount the tops of podetia, which are cylindrical and vertical prolongations of the thallus, and which may be regarded as modifications of the simple thalline foliole or squamule. In Cladoniæ the podetia are crowned with a cup-like cavity, on the toothed margins of which grow the apothecia. Sometimes the cup is replaced by globose fruit either singly or conglomerate. The Cladoniæ, from their having a vertical as well as a horizontal, a secondary as well as a primary thallus, are ranked among the highest typical forms of lichens. Popularly, but erroneously, they are named "cup-mosses." This family of lichens is foliaceous or fruticulose, having fistulose podetia bearing the apothecia in scyphi or cups, or in globose masses. The thallus is generally foliaceous or squamulose at the base, and sometimes granulose or crustaceous, &c. Cladoniæ are divided into three groups, which is the first step in their determination. These groups are Pycnothelia, of two species in Britain; Cladonia, with about thirty-four species; and Cladina, with four or five species. The second step in their determination is to carefullly notice the colour of the apothecia, and whether the apothecia are situated on scyphi or not. The two divisions here are Phæocarpæ, with apothecia pale or flesh-coloured turning fuscous when old, and Erythrocarpæ, with apothecia red like red sealing-wax. You will see from this that the presence of apothecia on Cladoniæ is indispensable to their correct determination. The next and third important aid in their determination, as in other lichens, is the use of chemical reagents, those now used being first pointed out by Dr Nylander of Paris in 1866. These reagents do not of themselves constitute a special specific, but only an additional and confirmatory, character. They are—1. Hydrate of potash, shortly denoted by K, and composed of equal weights of caustic potash and water. 2. Hypochlorite of lime, denoted by C or CaCl, composed of chloride of lime and water. 3. A solution of iodine, which is scarcely ever used with the Cladoniæ, whose spores are all simple and similar, and among the smallest of lichen spores. Iodine tinges the thecæ of Cladoniæ blue. Full directions for using the reagents are given in any good text-book of lichens, as those of Leighton and Crombie. K giving a yellow reaction is K +, and giving no reaction is K −, and so with C. Formulæ are also used when these two reagents are applied immediately after each other, as K + C +, or K − C −, &c. A more or less fuscous colour by K or C is disregarded and considered negative. The reaction is always the same for the same species, if the plants are young, healthy, and growing, and are more vivid on the young and growing parts of the lichen. The reaction must be immediate and not tardy. These thalline reactions depend upon the presence in the thallus of certain colourable materials in the form of acids, as erythrinic, chrysophanic, and lecanoric acids. Take a few examples and see how they apply. Cladonia pungens and C. furcata are outwardly like each other and have no scyphi, but the reactions distinguish them, C. pungens having K + C +, and C. furcata K − C −. C. squamosa and C. subsquamosa are like each other, but C. subsquamosa gives at once a brilliant yellow turning crimson with K, while C. squamosa gives no reaction. C. digitata and its varieties growing at the decaying roots of trees give K + a vivid yellow, and has red apothecia; while the cosmopolitan C. pyxidata, with flesh-coloured apothecia, gives no reaction K − C −. C. cervicornis has K + C +, and C. alcicornis, like it, has K − C +. The majority of Cladoniæ have no reaction K − C −. Of course, other points, in fact every point, has to be taken into account in the determination of species. The description of any Cladonia in such a text-book as Leighton's 'Lichen Flora of the British Islands' is very dry and puzzling reading. The species of Cladina are more easily determined. They have no leafy thallus, the podetium has no scyphi, they are repeatedly branched, are more or less smooth, the apothecium terminal, and some have the axils perforated.

The species of the genus Cladonia are for the most part very variable, and are so connected by intermediate states and forms (the result very likely, in part at least, of hybridism) that it is difficult to separate them. The consequence is, that no two lichenologists agree as to species or varieties. To add to the difficulty, the chemical reactions of the thallus, apart from the character of the basal thallus and the podetia, are not of decided value in this genus. On this point Dr Nylander says, "The genus Cladonia is not so well adapted to show the excellence of reactions on account of the tinctorial particles being often but sparingly present by reason of the frequent tenuity of the cortex."

Cladoniæ are distributed all over the world, and our own British Islands are particularly rich in species, though, strange to say, the true Cladina rangiferina is as much absent from Ireland as reptiles are. Cladoniæ are chiefly terricole species, preferring peaty soils, and as a rule open and exposed habitats, and some grow on semi-putrid wood. They are very social in their habits. In northern regions lichens form by far the largest portion of the vegetation. Here Cladoniæ, mixed with other lichens as Stereocaulon, are seen spreading over extensive tracts almost to the entire exclusion of other vegetation. It is a beautiful sight to see an almost limitless plain in Lapland and similar countries covered with Cladina rangiferina a foot high, giving the appearance of snow tinted with various colours from the admixture of other lichens.

The most useful and interesting of all the Cladoniæ is undoubtedly Cladina rangiferina and its allied species C. sylvatica, which latter is by far the more common. In Norway it occurs in three varieties, *sylvatica, alpestris,* and *grandis.* The true C. rangiferina is rather rare in the British Islands, though perhaps the most widely distributed of all lichens. It is not often found in fruit. It is called reindeer moss, cow moss, white moss, and caribou moss. It is invaluable to the inhabitants of northern latitudes. It is on a footing with the grains and grasses, &c., of more temperate climates, and by supplying the place of these, it renders habitable vast districts which otherwise would be dreary deserts. Reindeer obtain it in winter by scraping away the snow. It is collected, dried, and stored for feeding reindeer, sheep, cattle, and pigs. It is also mixed with chopped straw, salted and softened with hot water. When on a journey a reindeer is allowed 4 lb. a-day of this lichen as its food. Reindeer grow fat on this lichen and yield excellent milk and butter. On the borders of Lapland and Scandinavia frequent disputes have arisen from reindeer straying across the boundary in search of this food, but a sort of understood compromise has been made allowing the Scandinavian reindeer to trespass into Lapland, while the Lapps in return have been permitted access to the Scandinavian fishing-grounds. The same two lichens are sometimes powdered, mixed with flour, and eaten in times of scarcity. They were also formerly used as an ingredient in perfumery from their aptitude to imbibe and retain odours, and in this way their powder was the basis of various scents. In recent years in Russia and Scandinavia an alcoholic spirit—a kind of brandy—has been distilled from these lichens, especially when potatoes were scarce and dear. Our common Cladonia pyxidata was used in the middle ages as a cure for hooping-cough. The Norwegians stuff the chinks in the walls of their houses with lichens and mosses, and they also use them for bedding. Bird-stuffers use Cladina as an ornamentation to their stuffed specimens. It is also one of the few lichens which have been found in a fossilised state.

In conclusion, I would say that the two common text-books on Cladoniæ are Leighton's and Crombie's works on British Lichens, and also that a good many species of the genus Cladonia have been recorded from the Pentlands, though they are not always found in fruit there, and consequently are more difficult of determination. I would strongly advise the members to read some delightful chapters on lichens in general, in the late Dr Hugh Macmillan's 'First Forms of Vegetation,' and also in his 'Holidays on High Lands,' in which is much interesting information conveyed in very attractive language.

VII.—*NOTE ON THE DAMAGE DONE TO FIR-TREES BY SQUIRRELS.*

By Mr S. ARCHIBALD, Corresponding Member.

(*Read Feb. 24, 1904.*)

That squirrels do damage to the trees in a fir-wood can easily be seen by any one who walks through such a wood in these northern parts. I have just been re-reading in the 'Transactions' for 1901-2 the two papers on the squirrel by Mr Tom Speedy and Dr W. Aitchison Robertson, who write from rather different points of view. My residence giving opportunities for observation, a brief note may not be out of place, even after the lapse of two years.

In the young fir plantations around here during the winter of 1901-2—just when the papers referred to were being written—the nimble little creatures first made a complete clearance of the cones, and then attacked the trees, peeling off the bark in great splashes, generally from several sections of the same tree. Some members of my household saw them plainly at work just forty yards from our own door. The number of trees thus attacked was very great, and the results were exactly similar to those recorded by Mr Speedy: the resin exuded in great quantities all over the bare places, the wood became very brittle, and after a gale the ground was strewn with tree-tops, broken off about six or eight feet from the apex. Of course broken stumps are of little use except for firewood, and even those not broken are much deteriorated. Many such that I have noticed seemed to be "dying on their feet." These being plain facts, can any one say that squirrels do no appreciable damage to fir-woods?

The cause of squirrels attacking fir-trees to such an extent in this and some other districts is most probably a scarcity of other food; and, of course, the greater the number of squirrels in any district the sooner will food-supplies be exhausted, and the greater will be the consequent damage to fir-trees by our pretty little furry neighbour in his natural endeavours to "make a living." In districts where other squirrel food is plentiful, fir-woods will not suffer so much from squirrels.

With all that Dr Robertson says of the squirrel as a *pet* I entirely sympathise, and I feel sure every member of the Society is like-minded. But should he still remain a sceptic as to the damage done by his friends in their native haunts, let him pay a visit to any of these when the rigours of our arctic winter are over, and see for himself.

VIII.—*NOTES ON MOSSES FROM WEST KILBRIDE, AYRSHIRE.*

By Mr D. A. BOYD, Corresponding Member.

(*Read Feb. 24, 1904.*)

The two mosses submitted for exhibition this evening cannot be accounted rare species, although perhaps they may be unfamiliar to bryologists whose work has chiefly been carried on in inland districts, or where the nature of the prevailing soil is otherwise than sandy.

Tortula ruraliformis was formerly regarded by Dr Braithwaite as a maritime form of T. ruralis, and as such is described by him in his 'British Moss-Flora' under the name of var. arenicola. It had previously, however, been described by a French bryologist as a separate species, under the name of T. ruraliformis, which, of course, is entitled to be preferred. It differs very obviously from T. ruralis in the shape of the leaves, which have the upper portion of the lamina tapering towards the white hair-point; in the colour of the plant, which is a golden-green; and in the habitat, which is sandy places near the sea. It is abundant in many localities on the Ayrshire coast; while T. ruralis, which grows on walls and roofs, and prefers inland localities, is much less frequently met with in this district.

Brachythecium albicans is another common species on sandy sea-shores, but is generally regarded as rather rarely to be found in a fertile state. Fruiting specimens are abundant at West Kilbride at present, and examples are submitted, along with a few duplicates for distribution, in the hope that they may prove interesting to bryologist members of the Society. There are three types of Brachythecium—viz., first, those which have the seta or fruit-stalk roughened with little external granules throughout its entire length, as in the very common B. rutabulum; secondly, those which have the fruit-stalk smooth below but rough above, as in the common B. populeum; and, thirdly, those which have the fruit-stalk smooth throughout its entire length, as in the species under exhibition. The generic name Brachythecium is descriptive of the shortness of the capsule, as compared with that organ in other genera of pleurocarpous mosses.

At this meeting Mr Tom Speedy read a paper on "Vermin and the Pole-Trap," in which he advocated the use of the pole-trap in the interests of the game-preserver, and, while admitting that he was taking the unpopular side of a specially unpopular subject, maintained that "in its modern form the pole-trap is the most humane of any kind of trap." He endeavoured to show that "much more cruelty exists among birds and beasts by their preying upon each other without let or hindrance than when man interferes with the so-called balance." He stated, however, "that a bill backed by five members is to be brought before Parliament as follows—viz., 'From and after the passing of this Act every person who on any pole, tree, wall, fence, or other position elevated from the ground, shall affix, place, or set any spring-trap, gin, or other similar instrument calculated to inflict bodily injury to any wild bird coming in contact therewith, and every person who shall knowingly permit or suffer or cause any such trap to be so affixed, placed, or set, shall be guilty of an offence, and shall be liable on summary conviction to a penalty not exceeding forty shillings, and for a second or subsequent offence to a penalty not exceeding five pounds.'" Mr Speedy continued, "Such is the text of a bill which five pseudo-humanitarian M.P.'s purpose introducing into the House of Commons with the view of its being placed upon the Statute Book. It is generally understood that the hands of the Government will be sufficiently full for the next few years, . . . so that there will be little opportunity for the introduction of any such grandmotherly legislation." [1]

IX.—*WILD LIFE AROUND EDINBURGH.*

By Mr CHARLES CAMPBELL.

(*Read March 23, 1904.*)

It has ever been my good fortune to live in the country, while the operation of that great law of nature, the struggle for existence, compels me to spend most of my time in town. But in what leisure time I have had, nothing has given me greater pleasure than roaming through the woods and watching the humble life there, or wandering far out on the sands to list the sea birds' cry. Even in my daily journeyings to and from the city I was never out of touch with nature, for whether in the summer morning when the spiders' webs by the way-side glisten with dew, or in winter when the hoar-frost or a gentle fall of snow transformed the bleak landscape into a fairyland, there was always something interesting to see or hear. But the city is ever creeping outwards, and the face of the country is gradually being changed, and with it of necessity the number and character of its humbler creation. I am referring only to the district west of Edinburgh, with which I am best acquainted, and I have in my mind's eye one little spot which will no doubt before many years be coloured within the municipal boundaries. If ever the much-talked-of zoological garden for the city of Edinburgh comes to be an accomplished fact, I have often thought this would form an ideal corner of it. I refer to the marl pit near

[1] Notwithstanding Mr Speedy's views in regard to the introduction of this bill, it has already passed, and all humanitarians will rejoice to know that the use of the pole-trap is now absolutely illegal.—Ed.

Davidson's Mains, which vies with the Elf Loch at the Braid Hills in being one of the most popular hunting-grounds of the Natural History societies in Edinburgh. But as these expeditions generally take place in the evenings, it is questionable if the members of these societies as a body ever see the place at its best. True, to the botanist the plant life may be the same, and the microscopist may find material to analyse or dissect in his study, but to enjoy the real life interest one must be early astir and alone. It is then that one sees nature at its best, and it is surprising to find what a variety of life exists at this spot now so near the confines of the city. In giving a note of the birds I have seen here I will not say they all came under observation on one day, but they may all be seen there.

It is a typical spring morning, and as we cycle to this spot the first bird to attract our attention will probably be the magpie. In spite of the constant and bitter persecution of gamekeepers, this bird still manages to find an asylum in Corstorphine Hill and the grounds of Craigcrook Castle. I counted fifteen birds in a group one morning last year. This is a large number now, but before the noble trees of Barnton were felled to make room for the puny sticks of the golfer, twice or three times that number was no unusual sight. At the side of the hedgerow there is a bird sitting apparently well pleased with itself, pouring forth its pleasant but somewhat monotonous song. It is not so brilliant in colour as the yellow-hammer, and is larger in size. This is the corn-bunting, a bird often to be seen sitting on the telegraph wires on the country roads near Edinburgh, but of which very few have an intimate knowledge.

The marl pit is but a short distance from the Craigcrook road, and as we leave the highway a bird resembling the sparrow starts away from the ditch. It does not fly far, and with the aid of a field-glass we are able by its black head and pretty white collar to identify the reed-bunting. If we advance quietly to where the saugh-trees grow at the edge of the marsh, we shall find the willow-wren hopping among the branches. This bird is, I believe, the most regular of our local migrants. Taking cover among the trees, and, as far as we can, seeing without being seen, we have an interesting picture of bird-life before us. Skimming over the surface of the water are a dozen swallows. They have only recently arrived. The wealth of insect life attracts them here as well as it does the swifts, which are busy feeding after their long journey. The peculiar cry of the coot draws attention to several pairs of these birds which are busy hunting among the weeds. The coot can easily be distinguished by the pure white spot on the forehead, contrasting with the dusky plumage of the body. Feeding near the coot are a pair of water-hens, more dainty in appearance and graceful in action.

But our attention is attracted to another bird which, coming suddenly into view, is down again out of sight almost before we can get a look at it. Watching for it as it again comes to the surface, we see it to be the dabchick, the smallest of the grebe family. It is extremely shy and constantly on the watch. It is in breeding plumage, and is a handsome little bird. Its nest will be found somewhere among the sedges. There is no fear of its being robbed, for the edges of the pit are treacherous and dangerous in the extreme, and no local youth would dream of venturing near the edge, for it has long been a local tradition that the marl pit has no bottom.

Emerging from our shelter and walking round the margin of the pit, we disturb a couple of mallards or common wild duck, which we had not previously noticed. Crossing one of the ditches which drain into the marsh, we somewhat unexpectedly raise a small bird, which, by its curious zigzag flight, we see at once to be a snipe.

We shall now leave the low ground and seek the woodlands of Corstorphine Hill. But before doing so I wish to refer to a paper I read before this Society in March 1899 on a badger colony in Dalmeny Park. There has been nothing noteworthy to record of the colony since that date. It has not increased in size, but year after year as the young ones have come to maturity they have had to shift for themselves, and as a consequence the badger is now not at all uncommon in Linlithgowshire. It may safely be said that as long as fox-hunting is encouraged and continues in the district, so long will the badger maintain its hold, for it would be difficult to try to exterminate the badger without hurting the fox.

While records occur every now and again in the papers of the capture of badgers in different parts of the Lothians, I never expected to be able to record their appearance within four miles of the market cross of Edinburgh. Their burrow is situated somewhere on Corstorphine Hill. Perhaps some day the members of the Society may wish to visit the spot, but meantime this description will suffice. I first heard of their being there in the beginning of 1903, but I have no doubt the badgers were in the hill a considerable time before that date. Their tracks have been seen right down through Muirhouse grounds to the seashore near Granton, and the garbage which is found along the coast makes an acceptable meal. On Sunday morning, 15th August last, a dead badger was found at the foot of the steep rocks on the west side of the hill. It had possibly missed its footing and been killed by the fall.

The fox also breeds regularly on Corstorphine Hill, and has done so for many years. I shall not enter into a detailed description of the smaller animal life to be found in the neighbourhood. I have placed on the table a specimen of the lesser shrew, our smallest British mammal, but I only want to speak of the squirrel,—an animal which has recently furnished a good deal of discussion in this Society. Unfortunately I was not present when Dr Aitchison Robertson read his paper, but in the 'Transactions' for that year I find this sentence: "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." I do not wish to destroy the good opinion of the squirrel which any one who reads Dr Robertson's words will form, but I think the statement is too dogmatic to be allowed to appear in our 'Transactions' without at least being modified. I can personally give one instance of the squirrel eating young birds. On the 18th of July 1896 my father had his attention attracted by the plaintive cries and flutterings of two birds which proved to be flycatchers. The cause was soon seen, for sitting at the poor birds' nest was a squirrel coolly devouring a young fledgling, which he held in his paws as he would a nut. The nest was situated on the limb of an oak-tree near the stables at Dalmeny Park. A notice of this incident appeared in the 'Field' newspaper at the time.

To turn to bird life again, from among the covert comes the "coo-coo" of the stock-dove. Its call is easily distinguished, when once known, from the more melodious voice of the wood-pigeon. A dozen years ago the appearance of a stock-dove in the locality would have been recorded as a great rarity, but it is now almost as common as the wood-pigeon.

In my younger days I think the night-jar, or goat-sucker, was more commonly met with than it is now, but their numbers vary in different years. In the gloaming it flits silently by, hawking for moths along the edge of the woods, and is sometimes mistaken for a bird of prey.

There is another bird of which I would like to speak more fully, and one that I am better acquainted with. Most of you, I have no doubt, have read that delightful story 'The Starling,' by Dr Norman Macleod, where Jock Hall, the poacher, giving his opinion of the bird that brought the poor sergeant into so much trouble, says, "I'm fond o' birds,—our ain birds, that's maavies, linties, and laverocks, or even gooldies,—but I'm no' weel acquaint wi' thae stirlin's. I'm telt yours is no' canny, and speaks like an auld-farrant bairn." This is a true picture of how the starling was regarded about forty or fifty years ago. It was looked on as a great curiosity, and much prized as a cage-bird. To-day, if one of our commonest, it is still one of our most interesting birds. I shall give a few extracts regarding it from old books, showing the opinion of the naturalists of those times.

In Macgillivray's book, published in 1837, he gives a list of birds found in winter around Edinburgh, and second in his list comes the starling, with the remark, "Flocks are sometimes seen in the spring." His opinion of this bird is that "individually the starling's ditty is certainly not equal to that of the throstle, but yet it is by no means despicable." That the bird was sometimes used as an article of diet we can gather from his remarks: "The flesh of the starling is not much inferior to that of a thrush, although tougher, and as a considerable number may be occasionally obtained at a single shot, this bird is not unworthy of the attention of the animal designated by the name of 'sportsman.'"

In a curious old book entitled 'The Gentleman's Recreation of Fowling, with a Short Account of Singing-Birds,' published in London in 1696, there are the following references to the starling: "This bird is generally kept by all sorts of people above any other bird for whistling;" and in reviewing his list of singing-birds this old writer says: "In the first place, I look upon the starling to be the best; and never heard better than at the Greyhound in St Mary Ax, taught and sold by the ingenious master of that house." In a history of singing-birds published in Edinburgh in 1791 there is the following note regarding the starling: "It does not sing naturally, but has a wild screaming uncouth note: yet, for his aptness in imitating man's voice and speaking articulately, and his learning to whistle divers tunes, is highly valued as a very pleasant bird, and when well taught will sell for five guineas or more. To slit their tongues, as many people advise and practise, that the birds, as they say, may talk the plainer, is a cruel and useless expedient."

As an excursion to Cramond Island is included in our programme this summer I may be excused if I give an account of that remarkable gathering of starlings which existed for some years on the island. I gave an account of it in the 'Annals of Scottish Natural History,' but I have never brought it directly under the notice of this Society. The starlings deserted the island about the autumn of 1902, and beneath the trees on which they used to roost there has sprung up an undergrowth of alder bushes, and perhaps the botanists of the Society may discover other plants brought thither by the agency of the starlings. But to refer to the beginning of the roost,—for some years previous to the autumn of 1899 I had noticed great flocks of starlings flying overhead in the direction of Cramond Island. At that period, however, their numbers increased so much as to attract general notice, and interest people who did not usually pay much attention to bird life. It was not only the remarkable numbers of starlings, but the regularity and uniform time of their appearance, which excited wonderment. They seemed to have some meeting-places away inland, where they gathered, and they all journeyed together in huge flocks. The beat of their wings as they passed overhead caused quite a commotion in the air. The homing instinct appeared so strong that, no matter what the weather was, they seemed bound by some strange impulse to make their nightly journey to their island home. I have watched them battling against an easterly gale when they had to fly so low as almost to touch the waves, and some of the weaker birds had to turn back to the shore. If the weather was fine they sometimes flew at an immense height, but seldom so high that the beat of their wings could not be heard. One would naturally suppose that during the breeding-season this colony would entirely disperse, but this was not so, and quite a large flock continued to roost on the island. In talking to Mr Wm. Evans regarding this, he said the general estimate of non-breeding birds was ten per cent, but the proportion which travelled daily to and from the island seemed to exceed that number. The starlings did not nest on the island. During the day it was quite deserted, and if a starling remained on it, it seemed to be a weakling, or perhaps a wounded bird, for some amateur sportsmen were not above shooting at these harmless birds. I never was able to trace how far inland the starlings travelled, but I know that they passed overhead at Kirkliston, and travelled as far west as Hopetoun. I am of opinion, however, that each flock had its own particular feeding-ground, which it preserved for its own use. What led me to form that opinion was the fact that every morning I watched the starlings passing over Longgreen, about a dozen birds regularly detached themselves from the flock and settled on an ivy-clad tree close by. It was most interesting to watch for this little group of birds,—whether of course they were the identical birds that came every morning I cannot tell, but it afforded a striking example of the orderly manner in which the whole movements of the birds were regulated. From May 1900 to November 1901 I kept practically a daily record of their migrations, which, however useful for comparison, would form somewhat dry reading, as nearly all statistics do. The earliest time I have a note of their leaving the island was at 3.20 on the morning of the 29th of May 1900, seen by the late Mr Hogg, not by me. I have a note of them crossing to their roosting-place at 9.15 P.M., which would make a fairly long working day. During the month of July 1900 two accidents happened to the starlings, showing that bird-life is not free from tragedy, and that other than human means sometimes helps to reduce their numbers. It is not unusual to find a dead bird lying at the side of the road killed by flying against the telegraph wires, but at Cramond Brig on the 6th inst. a score of starlings were found lying on the roadway. These birds had been flying down the course of the river Almond between the trees, and had dashed into the wires. On the 14th of the same month I heard of another accident that had happened to the birds near the same place. It was some little time before I could get to the spot, but I counted no less than forty - seven birds lying dead on the Queensferry Road. These were all young starlings in their first year's plumage, and from the nature of their injuries must have been travelling at a great speed when they struck the wires. From the fact of there not being an old bird found among the dead, I wondered whether the young and the old separated into different flocks and kept by themselves, as I sometimes noticed the manner of flight of different flocks varied. Some flew slowly, with an undulating motion; some straight and swift, without deviation. During the month of October the colony attained its greatest numbers, and it was not until the advent of milder weather that they showed any decrease. It was then my usual practice to take a short walk along the shore every morning before starting for business, and on the morning of the 22nd November 1900 through my field-glasses I saw the starlings rise in a cloud from their roost. Knowing they would pass over where I was standing, the idea struck me of seeing how long they would take, and I found they took two minutes twenty-five seconds to come across, flying leisurely against a south-west wind. This idea gave additional interest to the flight of the starlings, and from the Ordnance map I found that the distance from the island to my post of observation was exactly a mile and a half, and I calculated their rate of flight at 37·24 miles an hour. On sixteen different occasions during the next twelve months I was able to time the flight of the starlings with as much accuracy as I think is possible in observations of this kind. On the 12th of November 1901 a very severe gale blew from the east. As the woods of Dalmeny abound in sheltered nooks where the rhododendron-bushes offered a secure retreat, it would naturally be supposed that the starlings would not have left the mainland to face the storm. Their homing instinct, however, proved so strong that though they were forced to rest for a time on a strip of bent-grass near Longgreen, they crossed to the island as usual. On the morning of the 13th the gale had somewhat moderated, but it was still blowing very strong. I was out along the sea-shore as usual, for it is one of the delights of living at the seaside to wander alone along the shore wondering what the waves had cast up during the night. I kept a look-out for the starlings, and was pleased to see them rise at 7.35. With the wind behind them they came across in less than a minute, or, to be exact, fifty-five seconds, which works out at the rate of 98·18 miles an hour. This was the record speed which came under my notice. Shortly afterwards, on the 19th of November, I had an opportunity of ascertaining their rate of flight under adverse conditions—that is, against a head wind. The wind was blowing due west almost with the strength of a gale, and the starlings took three minutes ten seconds to cross, equal to the rate of 28·47 miles an hour. Flying low, almost touching the water, they glided upward when they reached the shore, passing directly over my head, and almost within reach of my hand.

The actual rate of speed at which birds fly is a subject of very great interest, and no opportunity of ascertaining it should be neglected. In his wonderful book on Heligoland, Herr Gatke made out that curlews, godwits, and plovers travelled an ascertained distance of a little over four miles in one minute, or at the rate of 240 miles an hour. In the January number of the 'Ibis' Mr Eagle Clarke gives the result of observations taken on board the steamer "Irene" on October 18, 1903, when leaving the Kentish Knock lightship, where he had spent a month studying the migration of birds. He says: "The boat was travelling at 11 knots, or 12·6 miles an hour, and at this speed the skylarks passed us with the greatest ease, and as near as it was possible to estimate, were proceeding as fast again as the ship, or at the rate of 25 miles an hour, but certainly not more. It was more difficult to say what the speed of the starlings was, but they were travelling at least half as fast again as the larks, and therefore at not less than 35 to 40 miles an hour." The average rate of flight of the Cramond Island starlings was 45·21 miles an hour, or, leaving out the two extremes, 42·62, so that these observations taken under different conditions come remarkably close.

But while it was most interesting to watch the Cramond starlings from a distance, it was even more of a treat to visit them at their home. Of the many trips I made across the sands, the one I most enjoyed was on November 21, 1901. It was about 4.30 P.M. when I reached the woods, and the birds had nearly all arrived before me, though small flocks continued to drop down. The entire plantation was simply alive with birds, and as it was bright moonlight I could see them clustering together on the trees. The whole colony kept up a continuous chatter very pleasant to hear but difficult to describe. It seemed as if they were all talking and none listening. If I had the gift of descriptive writing I could find no more congenial subject than trying to explain to you the wonderful evolutions these birds sometimes indulged in before settling down to roost. I will not attempt to do so, but in watching them I often wondered what induced them to disport themselves in that manner. Was it a pure sense of the joy of living which animals seem to possess in a greater measure than man? Had they a chosen leader to guide them, or what mysterious power directed their movements? In the moonlight I took a walk round the island. Wandering among the rugged boulders that stud its northern shore, I do not think I ever felt more alone. Far up the Forth I could hear the distant rumble of the trains crossing the bridge. There was a mist over the sea, but from across the mud flats of the Almond came the whistle of the widgeon and the occasional shrill call of the curlew, while the whir of wings overhead told of some of the duck tribe seeking fresh feeding-ground. It was an experience to be enjoyed, not to be described; but the lap of the waves against the rocks warned me that the tide was now running strong, and in haste I wound my solitary way across the sands to my home, leaving the birds in peaceful enjoyment of theirs.

At this meeting Mr W. C. Crawford, F.R.S.E., read a communication entitled "A Field Naturalist's Tour in Canada."

X.—*WEST KILBRIDE AND THE NORTH AYRSHIRE COAST.*

By Mr D. A. BOYD, Corresponding Member.

(*Read April* 27, 1904.)

The Ayrshire coast-line stretches for a distance of over 80 miles from Kelly Burn on the north to Loch Ryan on the south, and may thus be said to include nearly the whole of the seaboard between the Clyde and the Solway. For the greater part of its extent it presents the appearance of a large bay, curving gradually northward from Loch Ryan to the promontory of Portincross, a distance of about 70 miles. From either extremity of this bay a beautiful view is obtainable of the greater part of its sweep, and of a wide expanse of water, from which rise the bold outlines of Ailsa Craig, Arran, Bute, and the two Cumbraes, as well as a portion of the Kintyre peninsula. In the neighbourhood of Portincross the northern coast-line reaches its most westerly point of projection, and rapidly recedes again in the direction of Fairlie.

Although generally interesting and attractive, the coast of Ayrshire lacks the striking diversity of outline and wonderful variety of detail which are so characteristic of the maritime region north of the Clyde. Along the border of the ancient division of Carrick, which lies between Loch Ryan and the mouth of the river Doon, the sea-shore is for the most part bold and rocky, with successive headlands and ranges of cliffs, and a background of hills which gradually increase in altitude towards the high watershed between Ayrshire and Galloway. Between the mouth of the river Doon and Ardrossan the hills recede from the neighbourhood of the sea, leaving a flat and storm-swept tract of country. Although the district is rich in historical associations, its physical features are somewhat lacking in interest; but it contains the ancient royal burghs of Ayr and Irvine, with several other popular summer resorts, and is notable for an almost continuous line of golf-courses, of which the links at Prestwick and Troon are perhaps the most famous. Considerable sand-hills occur in the neighbourhood of the rivers Irvine and Garnock, among which have been discovered arrow-heads and scrapers of chipped flint, fragments of pottery, remains of primitive iron-smelting furnaces, and other traces of prehistoric inhabitants. The Nobel Company's great works for the manufacture of explosives are situated on the Ardeer Sands; while the adjoining dunes, with their dry hillocks, moist hollows, and shallow pools, afford many interesting forms of animal and plant life. Among the latter, perhaps the most notable species are *Pyrola minor* var. *arenaria*, and *Lycopodium inundatum*, not known to occur elsewhere in the district.

Along the northern part of the coast-line, between Ardrossan and the county boundary at Kelly Burn, there is a rapid transition from a flat country to a region abounding in hills and swelling slopes, and affording scenery of a pleasantly varied description. The prevailing rock throughout the northern district is calciferous sandstone of the lower carboniferous series, much intersected by dykes of intrusive trap. From Ardrossan to Farland Head (Portincross), the shore consists of a series of sandy bays, containing numerous ranges of low shelving rocks which are mostly uncovered at low-water. These are composed of sandstone, protected from the destructive influences of the sea by intersecting trap-dykes. Where the sandstone has crumbled away, the igneous rock often forms little promontories jutting out into the sea. The dykes of trap are sometimes very numerous, ranging from a few inches to several feet in thickness, and may occasionally be seen crossing one another at right angles. These low rocks, with their little pools and crannies, afford a habitat to many species of marine molluscs, crustaceans, algæ, and other organisms. In the sandy fields, thin pastures, and waste ground near the shore, occur numerous interesting plants, among which may be mentioned the Isle-of-Man cabbage (*Brassica monensis*), shepherd cress (*Teesdalia nudicaulis*), spring vetch (*Vicia lathyroides*), bird's-foot (*Ornithopus perpusillus*), sea holly (*Eryngium maritimum*), prickly saltwort (*Salsola Kali*), Ray's knot-grass (*Polygonum Raii*), and moonwort (*Botrychium Lunaria*), with the mosses *Tortula ruraliformis* and *Brachythecium albicans.* The last-named species often produces its capsules in fair abundance during the earliest months of the year. (See *ante*, p. 97.)

At Chapelton, about three miles north of Ardrossan, the sandy shore is interrupted by a small salt-marsh lying between two protecting dykes of trap-rock. Although of very limited extent, the marsh yields several notable plants, including the parsley water-dropwort (*Œnanthe Lachenalii*), tassel pondweed (*Ruppia rostellata*), long-bracteate sedge (*Carex extensa*), and sea hard-grass (*Lepturus filiformis*). Here also occur *Pottia Heimii*, a neat little moss; *Tetramyxa parasitica*, a remarkable aquatic fungus, which forms small potato-like growths attached to stems of *Ruppia; Geoglossum difforme*, found on moist turf in early winter; *Sclerotinia Curreyana*, growing from a sclerotium produced in dead culms of common rush; and *Cystopus lepigoni*, forming white spore-masses on stems and leaves of *Buda.* In the neighbourhood of Chapelton are also found the tutsan (*Hypericum Androsæmum*), water parsnip (*Sium erectum*), pendulous sedge (*Carex pendula*), sea spleenwort (*Asplenium marinum*), and adder's-tongue (*Ophioglossum vulgatum*).

The farm-steading of Chapelton derives its name from a small chapel or place of worship which existed near by in pre-Reformation times. It is believed to have stood about half-way between the farm and Seamill Bridge, and was surrounded by a little hamlet or "toun," which has long since disappeared. On the adjacent slope a considerable hoard of old coins was turned up by the plough about thirty years ago, and consisted chiefly of silver pieces of the reigns of Elizabeth, James VI., and Charles I., with a few others. A little hill immediately eastward from Seamill Bridge is one of a series of round-topped hill-forts which occur at frequent intervals along the North Ayrshire coast. It was examined in 1880, and found to contain various objects of stone, bone, bronze, &c., together with bones and portions of horns of ox and red deer, bones of pig, sheep, &c. Close to the fort is a prehistoric cemetery of the bronze period, from which have already been taken about half a dozen urns of hand-made pottery filled with calcined human bones. Close to the roadside, a short distance northward from Seamill Bridge, the soil contains abundance of very minute fragments of bone, and in the adjoining field numerous rudely-constructed cists or stone-coffins have been found. The sides, end-pieces, and lid or cover of each cist were composed of thin slabs of sandstone, while the bottom was paved with smaller pieces of the same material. The cists were all placed east and west, and one or two contained complete skeletons, although in nearly every case the bones had partially or wholly decayed away. These remains have been assigned to the period of the Early Christian or Columban Church, and it is not improbable that a place of worship may have been established here by the great missionary himself.

An old corn-mill, rather picturesquely placed near the mouth of the Kilbride Burn, has given its name to the neighbouring village of Seamill. From a small hamlet, the place has rapidly increased in size until it has now become connected with the town of West Kilbride by an almost continuous line of modern houses. The Hydropathic at Seamill, which is situated between the main road and the seashore, is commodious and comfortable, and has recently been enlarged so as to afford accommodation for over one hundred visitors.

The parish of West Kilbride is so named to distinguish it from East Kilbride in Lanarkshire. The name itself is obviously derived from St Brigid or Bride, to whom a church was dedicated here, probably as early as the twelfth century. St Bride was held in high veneration in Scotland, especially in the western counties, where many churches and chapels were dedicated in her honour. Some of these are still commemorated in names of parishes; but in the majority of cases the ecclesiastical buildings have long disappeared, their sacred associations have been forgotten, and their former existence can only be traced in the names of farms and other places of minor importance. From time immemorial a fair called "Bride's day" was held at the Kirktoun of Kilbride, but its observance has gradually fallen into desuetude. Until about forty years ago the town of West Kilbride was one of the most quaintly picturesque places to be seen anywhere in Ayrshire. The streets were narrow and steep, and many of the houses were low-walled and had their roofs covered with thatch. The prevailing industry was handloom weaving, and during the hours of work the peculiar clank of the loom and rattle of the shuttle might be heard all along the village streets. But in the course of time great changes have come to pass. The thatch-roofed cottages have nearly all disappeared; the older houses have been reconstructed and "improved" almost past recognition; and streets and rows of new buildings have encroached on pleasant fields and green pastures. The rhythmic clank of the loom is no longer heard in the streets, while other and often less pleasing sounds have supplied the deficiency with too generous a measure. But although greatly changed in appearance, the streets are still steep and narrow, and the little town has not wholly lost the picturesque aspect for which it was once remarkable.

The first feature which attracts the notice of a visitor to West Kilbride is probably the unusually varied character of its scenery. From almost every part of the parish a beautiful view of Arran and the other Clyde isles can be obtained. Looking inland from the shore, hills and knolls are seen raising their heads on every side, and each summit commands a seaward view of remarkable scope and beauty. The slopes are diversified with fertile fields and leafy woodlands. On the higher ground lie extensive stretches of moor, marsh, and heather-covered hills. There is neither loch nor river; but several minor streams descend from the hills, passing in their course through wooded glens where ferns, mosses, hepatics, and microfungi grow abundantly in the genial shade. Among the flowering-plants which occur in the inland portion of the parish are the awl-shaped pearlwort (*Sagina subulata*), wall pennywort (*Cotyledon Umbilicus*), hairy stonecrop (*Sedum villosum*), grass of Parnassus (*Parnassia* *palustris*), whorled carraway (*Carum verticillatum*), corn marigold (*Chrysanthemum segetum*), cowberry (*Vaccinium Vitis-Idæa*), cranberry (*V. Oxycoccos*), pale butterwort (*Pinguicula lusitanica*), smooth-stalked sedge (*Carex lævigata*), and filmy-fern (*Hymenophyllum unilaterale*). The moss-flora is very rich, and includes *Tetradontium Brownianum, Oligotrichum incurvum, Dicranella rufescens, Fissidens incurvus, Grimmia Doniana, Weissia verticillata* (c. fr.), *Splachnum ampullaceum, Orthodontium gracile, Mnium subglobosum, Climacium dendroides* (c. fr.), *Hyocomium flagellare* (c. fr.), *Eurhynchium pumilum* (c. fr.), *E. Teesdalii* (c. fr.), *Hypnum stramineum* (c. fr.), *H. cordifolium* (c. fr.), &c.

On the east side of the town of West Kilbride, and a few hundred yards beyond the railway station, the square roofless tower known as Law Castle stands on a prominent knoll at the foot of the Law Hill. By a charter granted by King Robert I. early in the fourteenth century, the Barony of Kilbride became the property of Sir Robert Boyd, ancestor of the Lords Boyd and Earls of Kilmarnock, and also of the Boyds of Portincross. In 1468, Thomas, Master of Boyd, was married to the Princess Mary, daughter of King James II. He was created Earl of Arran, and received charters bestowing many lands upon him and his royal bride. It is supposed that the Law Castle was built in 1468 for the reception of the princess, but very probably it was never honoured by her presence, for the downfall and exile of the Boyds, father and son, and temporary forfeiture of their possessions, took place in the following year. The castle seems to have become unroofed about the time of the Restoration of Charles II., and has never since been repaired.

Near the centre of the town, an old-fashioned mansion may be seen standing with its back to the street. One of the stones built into the wall bears the date 1660, with the initials R.S. M.W., being those of Robert Simson, notary in Kilbride, and of his wife. It is believed that the oldest part of the house was erected by Simson, but it has since been several times added to by subsequent proprietors. The lands of Kirktonhall, of which this house is the mansion, became the property of the notary's second son, John Simson, merchant in Glasgow, who married Agnes, daughter of Mr Patrick

Simson, minister of Renfrew, and had the extraordinary family of seventeen sons without any daughters. Of these, however, only six survived to manhood. The eldest son, Robert, is said to have been born at Kirktonhall on 14th October 1687, reckoning by the old style. While yet a very young man, he was appointed Professor of Mathematics in Glasgow University, and continued to occupy that chair for the long period of 57 years. He died in October 1768, when in his 81st year, and was interred in Blackfriars Churchyard, the site of which now forms part of College Railway Station. During a long and active life he acquired a great reputation as a mathematician, but is specially remembered for his well-known translation of Euclid's Elements, which still serves as a basis for modern works on geometry. A curious old sundial, still to be seen standing in the garden at Kirktonhall, is believed to have been constructed by the professor. In memory of this distinguished native, a handsome monument has been erected by public subscription, and occupies a very prominent site in the West Kilbride Cemetery.

Between Seamill and Portincross lies Ardneil Bay, once a favourite resort of smugglers in the days when it was reckoned a moral virtue to outwit the revenue officer. All along the shore, but especially in the neighbourhood of Portincross, a brisk trade was carried on in the running of foreign goods without payment of the import duties. Casks of spirits, and packages of other merchandise, were often carried from Portincross to Beith and other distant inland towns. Ardneil Bay is now devoted to the more innocent pastime of golf, and the pleasantly situated links of the West Kilbride Club extend from Seamill nearly to Portincross. In the centre of the bay, the dry sand immediately above high-water mark possesses the property of emitting a peculiarly strident sound when touched with the fingers or feet, or with the point of a stick or umbrella. In this respect it resembles the "musical sands" which have been described as occurring in the island of Eigg.

Portincross is interesting for its historical associations, and remarkable for the picturesque beauty of its scenery. From documentary evidence, it appears to have been one of the possessions bestowed upon the Knights of the Temple, and afterwards held by the Knights of the Hospital of St John of Jerusalem. Its name—*Port-na-croise*, the Harbour of the

Cross—may probably have been derived from a cross set up in a prominent position near the little harbour, either to mark the boundary of the temple-lands, or as the symbol of possession by the Templars or Hospitallers. The old castle of Portincross, formerly known as "Arnele," has frequently been honoured by royal visitors, who probably found it a convenient resting-place in the course of their journeyings between Dundonald and Rothesay or other places in the west country. Several charters of Robert II. and Robert III. bear to have been granted at Arnele. The island of Little Cumbrae, which lies westward from Portincross, was once maintained as a royal deer-forest. It was occasionally visited by the early Stewart kings, and some of their charters were granted on the island. On the eastern shore of Little Cumbrae stands a ruined castle which is very similar in appearance to that of Portincross. Coming down to more recent times, we learn that one of the ships of the ill-fated Spanish Armada was driven out of its course and sank off Portincross in about ten fathoms water. In 1740 the wreck was visited by a diver, who succeeded in raising several guns of brass and iron. One of the latter still finds an appropriate resting-place on the green beside the castle. It is said to measure 8⅔ feet in length, 18 inches in diameter at the top, and 12 inches at the mouth. An interesting account of the operation of raising these guns is contained in the fourth volume of Defoe's "Tour."

After leaving Portincross, the road passes through a large trap-dyke at a place where a cutting has been specially made for the purpose. At this point a number of interesting plants occur on the rocks near the sea, including sea campion (*Silene maritima*), bloody crane's-bill (*Geranium sanguineum*), Scottish lovage (*Ligusticum scoticum*), crow garlic (*Allium vineale*), *Uromyces behenis*, *Parmelia caperata*, &c. From here onward for nearly a mile the view is very fine. On the one side, between the path and the sea, is a continuous line of sandstone rocks, many of which have been weathered into fantastic shapes. On the other side there is a narrow stretch of cultivated ground, bordered by a steep wooded bank, above which the sea-cliffs rise abruptly to a height of from 300 to 400 feet, so as to form the precipitous headland known as Ardneil Bank, and referred to in old writings as Goldberrie Head. The highest portion divides into three bold precipices known as "The Three Sisters." These cliffs are frequented by kestrels, jackdaws, rockdoves, and various other species of birds. Where wooded, they afford a place of growth for millions of hart's-tongue (*Scolopendrium vulgare*) and other ferns. The *Osmunda regalis*, or royal fern, once occurred abundantly in marshy places along the foot of the bank, but has now been extirpated. In the neighbourhood of Ardneil Bank are found the agrimony (*Agrimonia Eupatoria*), bur chervil (*Anthriscus vulgaris*), wall pennywort (*Cotyledon Umbilicus*), lesser water plantain (*Alisma ranunculoides*), hay-scented buckler-fern (*Lastræa æmula*), &c.

Between Ardneil Bank and Fairlie stretches Hunterston Bay, where hundreds of acres of muddy sand, covered with the greater and smaller grass-wracks (*Zostera marina* and *Z. nana*), are exposed at low water. These extensive flats are frequented by flocks of wild geese and other sea-birds, while the zostera-beds afford some interesting algæ peculiar to such places. In the neighbourhood of Fairlie are the estates and mansions of Southannan, formerly possessed by the Lords Sempill, and Kelburne, the residence of the Earl of Glasgow. Fairlie, with its old castle and pretty glen, lies mainly within the parish of Largs. The district around Largs, and northward to the county boundary at Kelly Burn, presents many features of considerable interest, but these cannot be adequately noticed within the scope of the present paper.

XI.—*SOME NOTES ON THE ANTIQUITIES AND NATURAL HISTORY OF CRAMOND DISTRICT.*

By Mr BRUCE CAMPBELL.

(Read April 27, 1904.)

At our excursion to Cramond Island in June last year some of our members suggested that a paper on the Natural History, &c., of the district might prove interesting, and that I, a native, and a resident for a good many years, might collect a few notes. For the antiquities I have drawn upon Wood, Gordon, and Roy. With the exception of the Roman remains, the notes refer to the beginning of last century. My notes on the birds were made during the last twenty-five years or so.

The parish of Cramond is a pleasant and fertile district, lying principally in the county of Mid-Lothian, at the north-western corner of that shire, and extending along the south shore of the Firth of Forth, into which the river Amon (modern Almond), after running a course of above thirty miles, empties itself at the village of Nether Cramond, now known as Cramond village. Part of this parish, about one-tenth of the whole, is situated in the county of West Lothian, which is separated from Mid-Lothian by the Almond, for several miles above its confluence with the Forth. The parish is bounded on the west by the parishes of Dalmeny and Kirkliston; on the south, by those of Corstorphine and St Cuthbert's; and by the last-mentioned parish on the east. The northern boundary is formed by the Firth of Forth, which at this place is from four to six miles broad. The parish appears to contain 3900 Scotch, or about 4900 British statute acres. The extreme length of this district, measuring from Leny Bridge on the west to Wardie burn on the east, is nearly six miles, and the breadth scarcely ever exceeds two miles. The eastern part of the district, lying two miles north-west of the metropolis of Scotland, appears rather level, though the ground, in some places, forms gentle risings. Near the centre of the parish is seen the northern end of a craggy ridge, very steep on the eastern side, but declining gently towards the west, called, from the adjacent parish, in which the principal part of it lies, Corstorphine Hill. The view from here is remarkably fine. To the north and west the face of the parish becomes more variegated than the eastern side, and agreeably diversified with rising grounds, particularly with Leny and Craigie Hills. The chief ornament of this part is the Almond, the banks of which stream, from Craigiehall to its confluence with the Forth, being very high and steep, almost wholly covered with wood, and frequently checkered with bold and overhanging rocks. The land, in general, rises to a good height even close to the shore: there are, however, in three or four places along the sea-side, sandy plains or links—particularly an extensive tract at the north-west extremity of the parish, called Longgreen, forming part of the park of Barnbougle.

The parish takes its name from the principal village, where the church stands, called Cramond. The name may be resolved into the Celtic compound Caeramon,—Amon being undoubtedly the true name of the river which falls into the Forth at this village, as that word signifies a river in general, and is not unfrequently applied to particular streams. In addition thereto it is to be observed that the Romans had at this place a considerable station or fort (in the Gaelic *caer*), so from this circumstance would naturally arise the word Caeramon, or the fort on the river.

A mist of obscurity, which every effort has been exerted in vain to dissipate, involves the history of this parish till the arrival of the Romans in Britain. Some imagine that a settlement was formed at Cramond during the reign of Claudius, from the circumstance of several coins and medals of that Emperor having been found here, particularly a very remarkable medallion of brass, about the size of a half-crown. On one side of this medal is the head of Claudius, with these letters: TI · CLAVDIVS · CAESAR · AVG · P.M.T.R.P.TMP. On the reverse is S.C. and NERO CLAVDIVS DRVSVS, with the figure of a person on horseback on the top of a triumphal arch between two vexilla. This, however, is but very slender evidence to oppose to the established fact that Julius Agricola, the lieutenant of Vespasian, was the first Roman commander that penetrated so far north as the Firth of Forth, and this expedition into Scotland did not take place earlier than the eightieth year of the Christian era.

That Cramond soon became one of the most important as well as one of the most considerable stations the Romans occupied in Scotland, is evident from the great number of coins and medals dug up at this place, the altars found here, the military roads, the remains of a dock, and other memorials of that great nation. The great Roman military way, the subject of the first Iter of Antoninus, from Prætorium in Lincolnshire to Bremenium in Northumberland, proceeded from the last-mentioned station, by Eildon and Soutra to Bowbridge, near the east end of the Pentland Hills. At this place evident vestiges of the causeway were visible a few years ago; and the present turnpike road from Edinburgh to Linton is cut, for nearly a mile, in the very line of its direction. The Roman military way was thence continued by Ravelston to Cramond, where several remains thereof have been found at different places, particularly in 1774, when improvements were being made on the grounds adjacent to Cramond House. The road, as is supposed, then proceeded across the Amon, and passing over Mons Hill, went by way of South Queensferry and Abercorn to Caerridden, situated at the eastern extremity of the wall of Antoninus. It is true, indeed, that no vestiges thereof can be traced betwixt Cramond and Caerridden; but, as General Roy observes, there is every reason to believe that the communication must have been continued, from this important naval station, along the Forth to the end of the wall. Maitland (History of Scotland) mentions that a Roman way ran from Inveresk to Cramond, crossing the Water of Leith at the foot of the Weigh-House Wynd in the town of Leith, but no traces of it are to be found in this neighbourhood.

The situation of Cramond at the mouth of a well-sheltered harbour, to which the military ways afforded a safe and easy communication from their southern posts, could not escape the observation of the Romans, as rendering it particularly fit for the reception of such of their vessels as had occasion to visit the Bodotrian Firth, and it is probable that this was one of the most considerable marine stations belonging to them in Scotland. The rock of freestone known by the name of the Hunter's Craig (or Eagle Rock), on the seashore west from Cramond, had (and still seems to have) on its east face a rude sculpture bearing some resemblance to the figure of an eagle standing upright with its back to the rock, by some supposed to have been executed by the Romans.

After the departure of the Romans a dark cloud of obscurity again settled over the parish of Cramond, of which the smallest memorial cannot be found in any historian till the year 995, when a bloody conflict took place between Kenneth, natural brother and commander-in-chief of the forces of Malcolm II. of Scotland, and those of Constantine, usurper of the throne, who headed his army in person.

Granton, in this parish, is famous in history for the landing of the English troops, under the command of the Earl of Hereford, from a fleet of 200 sail on 5th May 1544.

Among the manors and estates in the parish may be mentioned—Roystoun House, Granton House, Muirhouse, Piltoun, Drylaw, Craigcrook, Clermiston, Lauriston Castle (connected with the famous financier John Law), Nether Cramond (Cramond House, surrounded by some of the finest timber in the county), Barnton, King's Cramond, Whitehouse, &c.

Nor far from the village of Upper Cramond is Braehead (the residence of Mrs Howison), the lands belonging to which extend to Cramond Bridge, and from thence along the river to Cammo. Part of this property, it is said, was bestowed by one of the kings of Scotland upon a husbandman of the name of Howison on account of efficient service rendered to his Majesty. Tradition relates that the king, hunting in the neighbourhood, was attacked by a gang of gypsies or robbers who were proceeding to use him very roughly when the abovementioned person (Jock Howison), threshing grain in a barn hard by, alarmed by his Majesty's cries, ran to his assistance with his flail, and exerted that weapon so manfully as to put the rogues to flight. Whether the above tradition is founded on truth, or at what time the affair happened, cannot now be ascertained.

Cramond Church.—Near the confluence of the Forth and the Amon stands Cramond Church, which belongs to the Presbytery of Edinburgh and the Synod of Lothian and Tweeddale. In times of Popery and Episcopacy it was included in the diocese of Dunkeld. This church was dedicated to St Columba. The present church was built in 1656. In 1701 another aisle was added to the north side of the church by the Earl of Cromarty, and in the same year the south aisle was lengthened and heightened by the Earl of Ruglen. At the east end of the church are two burial-places, one belonging to Young of Leny and the other to Inglis of Cramond, the latter having a Gothic roof of flagstones. This part was formerly the choir, and is said to have pertained to the Abbot of Inchcolm. The church is covered with blue slate, and in its steeple hangs a bell thus inscribed: "Michael Burgerhuys fecit me, 1619, Soli Deo Gloria." This bell was carried away by the Parliamentary forces, but restored to the parish by

General Monk, after much solicitation employed and interest made, as appears from the Session Records.

In different parts of the parish are four tombstones, supposed to be in memory of victims to that dreadful disease, the plague, who were not allowed to be buried in the churchyard from an apprehension of the infection again spreading by inadvertently opening the graves. The dates on these tombstones are 1646 and 1647. (Two years ago the members of our Society, in an excursion to Cramond, inspected one of these "memorials" near Cramond House.)

The records of the kirk-session, which begin in 1651 (the session books preceding that period having been carried away by Cromwell), exhibit many curious memorials of the strictness of discipline which prevailed in the Church of Scotland more than a century ago.

Manufactures, &c.—The only manufacture worth mentioning is that of iron (now defunct), carried on by Cadell and Edington. Spades, nails, and files were made here. Steel manufactured here was exported to India. The works were supplied with coal from Grange to the extent of 1600 tons annually: the freight from Grange to Cramond being 1s. 6d. per ton, and the prime cost of the coal being 7s. 6d. per ton, made the price of that article 9s. delivered at Cramond.

In 1794 the harbour of Cramond, which is specified in the records of Exchequer as a creek within the Port of Leith, has belonging to it seven sloops of from 20 to 80 tons burden, measuring in all 288 tons and navigated by twenty-three men. The Amon at its mouth has about 15 or 16 feet depth of water in high spring tides, and the sea flows no farther than Cocklemill, about a quarter of a mile above Cramond, being stopped by the dam here. The common size of vessels brought up to that mill is from 40 to 50 tons, but the navigation is reckoned dangerous on account of the rocky bottom. There are posts still standing in the channel of the river, having evidently been placed to direct the course of vessels up the river.

The fisheries are at a low ebb: the oyster fishery has greatly declined since 1740, when eleven large boats, belonging to Cramond, were constantly employed during the season in dragging for that delicious bivalve. The principal part of what they caught was sold to Dutch vessels at the average price of 4s. the herring barrel; and the oyster-scalps were then so productive, that it was usual for a boat with five hands to make 30s. per day. There are now no oyster fisheries. I have a faint recollection of seeing boats dredging for oysters, the men chanting a peculiar song while rowing their boats. The Amon formerly abounded with a variety of fish, such as trout, grilse, and plenty of smelts, but the Almond is now so much polluted that no fish of any kind can live in it. Towards the end of the seventeenth century the fishings were the subject of a keen litigation between the Earl of Rosebery and Sir John Inglis of Cramond; and this cause was determined by the Court of Session in 1695 finding that each had a right of fishing on his own side of the water to the middle of the stream. But Lord Rosebery was so little satisfied with this determination, the more especially as some of the witnesses deponed that they knew the proprietor of Barnbougle debar all others and let in tack the exclusive privilege of fishing for 50 or 60 merks yearly, that in 1708, immediately after the Union, he appealed to the House of Lords. Thereupon Sir John Inglis, rather than contest the affair further, entered into a compromise by which he gave up all right to the fishings, and in return got from the earl the gallery still possessed by his family in Cramond Church.

Upon the very extensive tract of lands along the shore of this parish left dry at low water, whales have sometimes been stranded. On 2nd February 1690, no less a number than twenty-five (supposed to be the pilot or caaing whale), though of the very smallest sort, were left by the tide on the sands south of Cramond Island. Most of them measured 12 feet in length, but the lesser did not in general exceed 9 or 10. In 1701 a male whale, measuring 52 feet in length and 30 feet in circumference, and having 46 teeth in the under jaw, was cast ashore near the town of Cramond. In 1736 one was stranded at Granton, and in 1740 one at Hunter's Craig: in 1769 another was stranded at the latter place, and in the same year one at Cramond Island. This last is described by Pennant, 'British Zoology,' vol. iii. p. 81.

Rent, Agriculture, and Produce.—From a manuscript collection of charters, &c., in the Advocates' Library, it appears that in 1368 the rental of the lands of Craigcrook and Grotthill, and of Ravelstoun adjoining to them, was £17 Sc.: computing these at 600 acres gives somewhat more than 6d. per acre.

Hay is the principal crop raised in the parish, the great demand for that commodity at Edinburgh securing a constant market. *Wheat* takes the lead of all other grain, the farmers being induced to sow as great a quantity thereof as possible, in order that they may be better enabled, by its lucrative returns, to pay the high rent of the land in this district. *Potatoes* form an important article of the produce of the district.

Minerals, Bridges, &c.—Freestone abounds in many places, particularly along the shore at Caroline Park and in Lord Rosebery's grounds. Whinstone and moorstone or granite are found in great abundance, especially at Corstorphine, Leny, Craigie Hills, and Cramond Island: from the first and last mentioned places stones are quarried for the floors of ovens, a purpose for which they are admirably adapted. Petroleum, and ochre both red and yellow, are sometimes met with in the shelving rocks east of Longgreen, and at the north end of Cramond town. On the lands of Marchfield is a spring of mineral water called the well of Spaw, reckoned beneficial in scorbutic cases. There is an evident appearance of coal in the barony of Royston and in the adjacent lands of Wardie, large seams being perceivable on the sea-shore.

Islands.—There are in this parish two islands, one belonging to Barnton (now to Dalmeny Park), called Cramond Island, and the other to Granton, called Inchmickery. Cramond Island lies at the distance of 1338 yards N.N.E. of the village of Nether Cramond, rising high in the middle, with steep cliffs on the east side composed of granite. This island, containing 19 acres, is accessible at low water to foot-passengers, has on it two houses, and formerly abounded with rabbits, now almost extirpated. A fox some years ago took up his abode there for some time, also a covey of partridges. The farmer there once told me he thought he saw black game on it. Rhind (1836) says, "Some of the plants common to the neighbourhood spring up here." When the tide begins to turn it is amazing with what rapidity it approaches. It advances with a progress of not less than five or six feet per minute, and to those visiting the island circumspection is required, else a twelve hours' imprisonment will be the consequence. In December 1860 a specimen of Tengmalm's owl was caught here by Mr James Lumley, Cramond.

In the reign of James I. a legalised duel was fought on Cramond Island between Mowbray of Barnbougle and Henry Bruntfield of Craighouse. The spot chosen was a level space close to the northern shore of the island, a place being marked off and strongly secured by a paling. The spectators, who were mostly gentlemen, sat upon a rising ground beside the enclosure, while the space toward the sea was quite clear. After a somewhat lengthy combat Bruntfield, though severely wounded, slew his opponent. The affair had a somewhat more tragic ending. The mother of Bruntfield coming forward to embrace her son expired in his arms, murmuring, "Nunc dimittis, Domine."

Inchmickery, about a mile to the north-east of Cramond Island, is a barren rock with a thin surface of sod, measuring about two acres, much frequented by sea-fowl. "I [Wood] have seen the surface quite overspread with the eggs of the taron [common tern], so as completely to load a boat from Cramond. It is the opinion of the vulgar that the pasture of this islet is sufficient to maintain two sheep in good order, but that if a third is put on it will starve, while the other two continue to thrive."

Bridges.—Cramond Bridge, situated about a mile from the mouth of the river, consists of three arches, each about 40 feet in diameter: the breadth of the road within the walls is only 14 feet. The situation is extremely bad, the river making a wide curve immediately above it, by which means the stream, in place of coming directly upon the points of the piers, acts with great force upon their sides. The date upon the centre arch is 1619, but it appears that there had been another bridge before that period, as an Act of Parliament was passed in 1587 mentioning that a complaint had been made that the bridge of Cramond had for a long time fallen down and no passage could be got over it, on which account a commission was given to Lord Seton, the lairds of Dundas, Barnbougle, and Inverleith, or any three of them, to pass to the said bridge and inspect the same, and the Lords of the Secret Council were thereby empowered to grant a reasonable stent and taxation upon such parts of the county as they should think most expedient for the support of the said decayed bridge, and to impose tolls upon certain commodities passing it. This statute, however, would appear to have been of no effect, as another Act of the same import was passed in 1607. There is no other bridge over the Amon in this parish except that built by the Hon. Charles Hope Veir of Craigiehall. There are now the new bridge at Cramond Bridge and the railway bridge near Craigiehall. The public road from Edinburgh to Queensferry crosses the Amon at Cramond Bridge, on the west side of which was a toll bar, let in 1789 for £142, but in 1790 the rent fell to £130.

Cramond Tower.—This tower is all that now remains of the palace of the bishops of Dunkeld, who possessed the lands known as "Bishops Karramond" as early as the twelfth century. It was only at the beginning of the fifteenth century that the then bishop exchanged the lands of Cammo for the lands of Cramond, and the tower is situated within the church town of Cramond, and this is supposed to be part of the tower referred to. It is a small structure 24 feet square, and, as it at present exists, about 40 feet high.

In front of Cramond House stands a spheri-angular sundial made in 1732. At Barnton are two sundials; one of them, an obelisk dial, which is dated 1692, stands twelve feet in height.

In Stark's 'Picture of Edinburgh' it is recorded that "a specimen of the rare opah had been taken near Cramond and preserved in the museum of Sir Patrick Walker. The short diodon or sun fish has also been caught at Cramond and preserved by the same gentleman. The sturgeon frequently enters the mouth of the Almond and is sometimes killed." The sturgeon is occasionally caught in the salmon nets west from Barnbougle Castle. A cinerary urn was found in December 1889 near Cramond. A fully illustrated account is given in the Proceedings of the Society of Antiquaries of Scotland, 1896-97, p. 244.

BIRDS.

Missel-thrush.
Song-thrush.
Redwing.
Fieldfare.
Blackbird.
Wheatear.
Stonechat.
Redstart.
Robin.
Hedge-sparrow.
Whitethroat.
Garden warbler.
Blackcap.
Sedge-warbler.
Grasshopper warbler.
Willow-wren.
Wood-wren.
Golden-crested wren.
Long-tailed tit.
Great tit.
Blue tit.
Coal tit.
Dipper.
Wren.
Pied wagtail.
Grey wagtail.
Tree-pipit.
Rock-pipit.
Waxwing.
Spotted flycatcher.
Swallow.
Martin.
Sand-martin.
Tree-creeper.
Greenfinch.
Goldfinch.
Siskin.
House-sparrow.
Chaffinch.
Brambling.
Lesser redpoll.
Bullfinch.
Corn-bunting.
Yellow bunting.
Reed-bunting.
Snow-bunting.
Starling.

Jay.
Magpie.
Jackdaw.
Raven.
Carrion crow.
Hooded crow.
Rook.
Skylark.
Swift.
Nightjar.
Great spotted woodpecker.
Kingfisher.
Cuckoo.
Barn-owl.
Long-eared owl.
Short-eared owl.
Tawny owl.
Tengmalm's owl.
Buzzard (rough-legged).
Sparrow-hawk.
Peregrine falcon.
Merlin.
Kestrel.
Cormorant.
Shag.
Gannet.
Heron.
Pink-footed goose.
Brent goose.
Barnacle goose.
Mute swan.
Bewick's swan.
Shelduck.
Wild duck.
Shoveller.
Pintail.
Teal.
Widgeon.
Pochard.
Tufted duck.
Scaup.
Golden-eye.
Scoter (common).
Goosander.
Merganser.

Wood-pigeon.
Stock-dove.
Turtle-dove.
Capercaillie.
Pheasant.
Partridge.
Landrail.
Water-rail.
Moorhen.
Coot.
Golden plover.
Grey plover.
Ringed plover.
Lapwing.
Oyster-catcher.
Turnstone.
Woodcock.
Snipe.
Knot.
Sanderling.
Dunlin.
Curlew sandpiper.
Redshank.
Bar-tailed godwit.
Curlew.
Whimbrel.
Sandwick tern.
Common tern.
Lesser tern.
Black-headed gull.
Common gull.
Herring-gull.
Lesser black-backed gull.
Great black-backed gull.
Kittiwake.
Richardson's skua.
Razorbill.
Guillemot (common).
Little auk.
Puffin.
Red-throated diver.
Great crested grebe.
Little grebe.
Stormy petrel.

PLATE XII.—ANTIQUITIES, ETC., OF CRAMOND DISTRICT.

NEST OF OYSTER-CATCHER.

NEST OF LAPWING.

MAMMALIA.

Cheiroptera—Bats.

Pipistrelle.
Long-eared.

Insectivora.

Hedgehog.
Common shrew.
Lesser shrew.
Water shrew.
Mole.

Carnivora.

Fox.
Otter.
Badger.
Weasel.
Stoat.
Common seal.

Rodentia.

Squirrel.
Water-vole.
Field-vole.
Bank-vole.
Brown rat.
House-mouse.
Wood-mouse or Long-tailed field-mouse.
Common hare.
Rabbit.

Ungulata.

Red-deer.

Cetacea.

Lesser rorqual (Granton, 1888).
Beaked whale (S. Queensferry, Sept. 1883).
Porpoise.
Pilot or caaing whale.
Common dolphin (Hound Point, Feb. 1887).

My list of birds numbers 136, and I shall now make a few comments on some of those most deserving of notice. These birds were observed during the last twenty-five years or so.

Grasshopper Warbler.—On 22nd June last I heard this bird in full song about 4.30 A.M. near the Drum Brae.

Dipper.—Not so plentiful in the district as formerly. I knew a nest with four eggs on 8th March 1889—a fairly early record.

Spotted Flycatcher.—For many years in succession a pair of these birds built their nest and reared their brood in the bushes growing up the wall of my father's house at Longgreen. The birds arrived in the beginning of May, and departed towards the end of August.

Goldfinch.—Is occasionally seen.

Siskin.—Seen usually in winter-time.

Starling.—Has increased enormously in recent years. About forty years ago this bird was so rare that when it was known that a pair were nesting in the ruins of Barnbougle Castle several local bird-fanciers betook themselves thither in the small hours of the morning to see these raræ aves.

Jay.—Has only been twice seen in this district to my knowledge, the last occasion being in 1896.

Magpie.—Plentiful in the locality. About twenty years ago I saw about seventy magpies together in a field at Lauriston Brae. The morning was rather stormy, and the birds were collected in the corner of a stubble field. The magpie is generally looked upon as a great egg-stealer. Its presence in this neighbourhood does not appear to diminish the number of song-birds.

Barn-owl.—Now very scarce.

Tawny owl.—Very common, especially in Dalmeny Park, where it is strictly preserved: although so numerous there, they do not interfere to any extent with the game, which is very plentiful.

Tengmalm's owl.—In December 1860 a specimen of this diminutive owl was caught alive on Cramond Island by Mr James Lumley, Cramond. Mr Lumley, along with his father and brother, had gone duck-shooting. On entering one of the out-houses on the island a small owl flew out. They succeeded in capturing it, and kept it alive for some time. After its death it was stuffed, and remained for many years in the collection of George Hutchison, Cramond House. Only three examples of this owl have been got in Scotland. This little owl inhabits Scandinavia and Russia. Measurement, 9 inches long. The tawny owl is 15 inches long.

Stormy petrel.—One picked up at Cramond about six years ago.

Wood-pigeon.—This bird has decreased greatly in recent years. Since 1895 the decrease has been very marked. Great numbers were killed during that severe winter. About twenty-five years ago these birds roosted, I may safely say in thousands, in Dalmeny Woods. Now it would be very difficult to count three hundred. One, and perhaps the principal, cause of the decrease appears to be the shooting of these birds in spring time, when they come readily to a decoy, and, being nesting time, the killing of the old birds very effectively prevents any increase.

Stock-dove.—While the wood-pigeon has decreased the stock-dove has increased during the last ten years or so, and its presence now does not attract attention.

Turtle-dove.—One example, October 1896, in Dalmeny.

Capercaillie.—First recorded 1878, and seen two or three times since.

Pintail duck.—A small flock seen near Barnbougle in 1901 (winter).

Water-rail.—Only two examples, the last one being February 1904.

Little auk.—Numbers were picked up dead in 1894-5. The last ones picked up on the shore were in February 1901.

Great crested grebe.—One example, February 1897, Cramond.[1]

Raven.—A dead raven was picked up on a field on the farm of East Craigie on 29th March last. This bird was presented to the Museum of Science and Art.

Woodcock.—A woodcock's nest was discovered in Dalmeny Woods this year on 5th April. It contained four eggs. This is the first record of this bird nesting in the district: there were at least five nests in Dalmeny Woods in 1904. I photographed the nest on 9th April under most unfavourable conditions,—a gale of wind with heavy showers of snow and sleet. (See Plate XIV.)

Waxwing.—One shot at Cramond in November last, and exhibited at our meeting in February 1904.

Peregrine falcon.—Occasionally seen; last record September 1903. Act 31, Henry VIII., c. 12, made it felony punishable with death for a person wrongfully to take or cause to be taken any egg or eggs of any "falcon, goshawk, or laner [the young female peregrine], or the birds [*i.e.*, the

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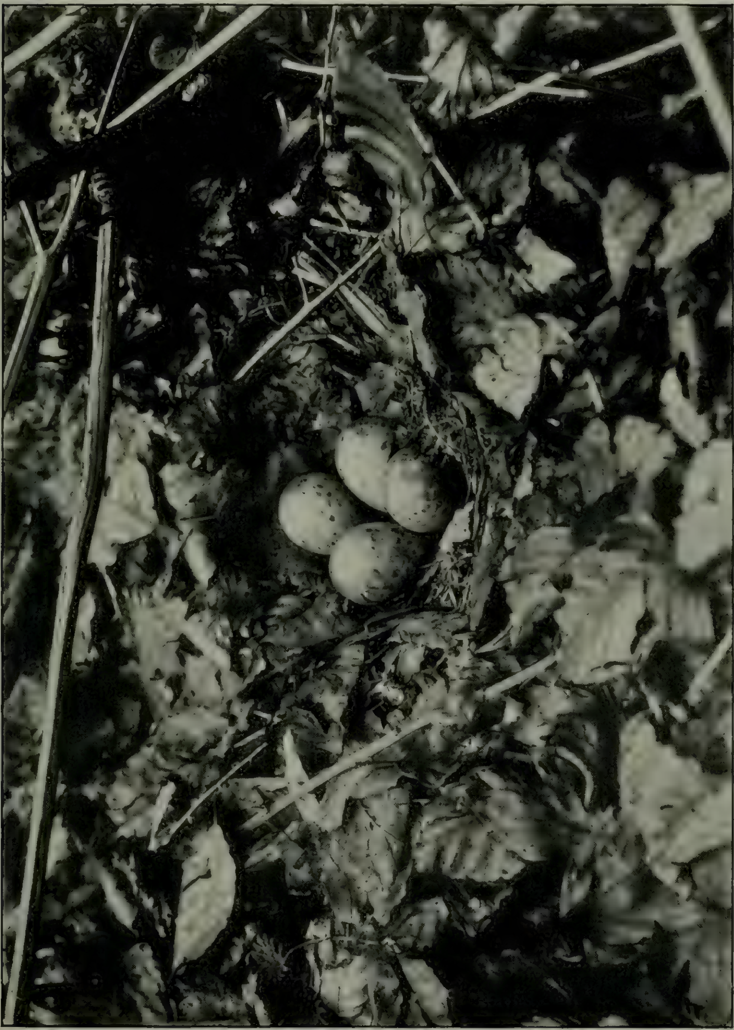
[1] Since this paper was read another example of the great crested grebe has been met with in Dalmeny Park, June 1904.

PLATE XIV.—ANTIQUITIES ETC., OF CRAMOND DISTRICT.



NEST OF WOODCOCK.

NATURAL HISTORY

young] of any falcon, goshawk, or laner, or lanaret out of the nest or nests of any falcon, goshawk, or laner, within any of the king's honours, castle, manors, lands, tenements, woods, or other grounds." Act 32, Henry VIII., c. 11, made it felony punishable with death for any persons unlawfully or wrongfully to take or cause to be taken any eggs of any falcon, goshawk, or laner, or the "birds" of any falcon, goshawk, or laner out or from any nest of any falcon, goshawk, or laner within any woods, ground, or place of any other person or persons within the realm.

Yellow wagtail.—This bird, I am informed by my friend Mr William Lumley, Broomhall Gardens, was very common at Cramond about thirty years ago.

MAMMALIA.—*Bats.*—The pipistrelle is, of course, the common bat of the district. I have only seen one long-eared bat, and that was many years ago, in Cramond School, when a class-mate produced one from his pocket.

Insectivora are all common here.

Carnivora.—With the exception of the otter, all those mentioned are fairly common. The badger has already been described by another member of our Society. The stoat, although by no means rare, cannot be said to be common.

Rodentia are all common.

Otter.—As far as I know, not seen here for about fifteen years.

Red-deer.—In 1888-89 a red-deer frequented this district for some weeks. I saw it on several occasions in the early morning standing in the Firth of Forth a few yards from the shore munching sea-weed. It had eventually to be shot owing to the damage it wrought among the cottage-gardens. This animal was supposed to be an "escape" from Hopetoun.

Foreign Birds.—A cockatoo flew about Dalmeny Woods during the winter of 1894. Several times parrots, paroquets, and cockatoos have been captured. Of course these were all "escapes."

The botany, geology, &c., I leave for some other member to describe.

[The above paper was illustrated by upwards of fifty slides of antiquities, scenery, birds' nests, &c., from photographs by Mr Bruce Campbell. Three photographs of birds' nests are here reproduced—viz., Plate XII., Nest of the Oyster-catcher; Plate XIII., Nest of the Lapwing; and Plate XIV., Nest of the Woodcock.]

A communication was read at this meeting from Mr Allan A. Pinkerton, stating that, with seven other members of the

Society, he had in the spring of last year commenced a study of the local Flora, with the object of making a record of the plants occurring in the county of Edinburgh. During the summer of 1903 two orders were taken in hand, the Cruciferæ and the Labiatæ, and the lists collated by him; and although nothing remarkable was brought out, the results were encouraging. Next summer, in addition to continuing the study of these two orders, it is proposed to take in hand two others, the Scrophulariaceæ and the Geraniaceæ. Mr Pinkerton will be glad to hear from members of the Society who may be desirous of joining in the work.

XII.—*REMARKS ON GLŒOCAPSA.*

By G. T. WEST.

(*Read Oct. 26, 1904.*)

There is always a fascination in the study of microscopic life, animal or vegetable,—perhaps because it is only by aid of the microscope that we are able to recognise their forms, admire the exquisite beauty of their symmetry or sculptured tracery, or philosophically to study the economy of their life-history and minute anatomy. Or perhaps it is that among the lower organisms we think we can approximate more closely to an answer to the question, Of what consists life? From whatever direction we approach, it is with a feeling akin to reverential awe that we meander in that borderland of life, whence on the one hand is given off vegetable and on the other hand animal existence.

Let us devote some attention to a plant form known as Glœocapsa crepidinum—one of the lowest forms of vegetable life. It occurs upon mud and other places in brackish and salt water. Similar species are also abundant in fresh water. It is a member of a group of unicellular chlorophyllous organisms whose green colour is masked by a blue-green pigment known as phycocyanin, which in aqueous solution is blue in colour with a red fluorescence. The cells of this Glœocapsa are surrounded by a gelatinous, hyaline, lamellated integument, which is formed by an excretion from the cell,—not by a gelatinous modification of the cell wall. There are no organs of reproduction in Glœocapsa, either sexual or asexual: multiplication takes place by simple vegetative cell-division. The cells immediately after division assume a globular form. Each individual cell is furnished with its own gelatinous integument. As each cell divides, the daughter-cells also secrete an integument, whilst at the same time they are surrounded by the integument of the original mother-cell. By this method two or four cells are produced, each with its own integument, forming a colony within the much-stretched integument of the primary mother-cell. This accounts for the peculiar lamellated appearance of the colonies. Finally, the primary integument ruptures, liberating the young cells. This process may be repeated continuously, but at certain periods some of the cells develop a spiny coat of cellulose in addition to the ordinary integument, forming a kind of resting-cyst. After a period of quiescence these resting-cysts reproduce new colonies by simple cell-division, after the manner of the genus. Occasionally large colonies will be observed with the remains of the spines upon the exterior integument, showing that they have developed from a resting-cyst. What takes place within the cell during this resting condition we do not know, but that this stage at intervals is necessary to them is certain. By it they gain renewed vigour. From it they emerge in a state of rejuvenescence. The size of a colony of two cells, including the integument, is in general $55\mu \times 45\mu$. A colony of four will be $85\mu \times 60\mu$.[1]

Species of Glœocapsa are found living in consortism with fungi to form lichens. In the lichen Bæomyces roseus the normal algal symbiont is a species of Cystococcus: this occurs in the upper strata of the lichen thallus, whilst in the lower portion the algal symbiont is Glœocapsa polydermatica. It does not, however, appear to be constant in the lichen thallus; hence this form of consortism may be termed contingent mutualistic symbiosis.

[1] A μ, or micron, equals the $\frac{1}{25400}$ of an inch.

The chlorophyll-grains in Glœocapsa are exceedingly minute and irregular. They are perhaps representative of the phylogenetic ancestors of the chloroplasts of higher plants. No starch of the ordinary nature occurs in Glœocapsa; neither is any nucleus to be found. The large central bodies imbedded in the cytoplasm cannot be looked upon as having close relationship to the nuclei of higher plants; they do not possess true chromatin, and any granulations that may be observed are simply collections of substances resembling glycogen. Whilst being quite aware of the mischievous results produced by assuming identity where only analogy exists, and of confounding analogy with affinity, yet it may be suggested that the nuclear substance in Glœocapsa is in a primitive form not at present perfectly understood,—ancestor, perhaps, to the so-called scattered nuclei, which occur undisputably in many Cyanophyceæ, in flagellate infusoria, and in Rhizopoda. Whilst we must avoid confounding analogy with affinity, yet we must also distinguish that affinity may be great without the existence of analogy. We become so inured to the usual form of nuclei in general that we are apt not to recognise the affinity of nuclear substance in an unorthodox condition.

For mounting, the gathering of Glœocapsa is placed at one end of a dish with water: a card is then placed over the dish, leaving the end opposite to the gathering open to the sunlight. After some hours the organisms will be found to have left the mud and congregated towards the light. They are then gathered with a pipette, and the process repeated until they are obtained clean enough for the microscope. The gathering freed from mud is allowed to settle in a tube, as much water as possible decanted and replaced with the following solution, which kills and fixes them. In the same fluid they may be preserved, either in a tube, or mounted as a slide for the microscope. The fluid preserves the colour for many years. Acetate of copper, 0·5 gram; distilled water, 100 cc. Mix, and add with stirring, at ordinary temperature, gum acacia, 65 grams. When dissolved, add pure glycerine, 55 cc.; mercuric chloride, 2 grams. Filter before use.

NATURAL HISTORY

PLATE XV. – REMARKS ON GLŒOCAPSA.

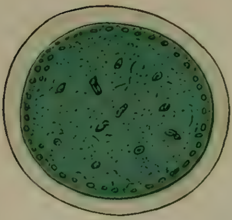


Fig. 1.

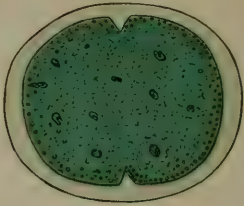


Fig. 2.

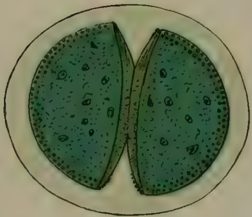


Fig. 3.

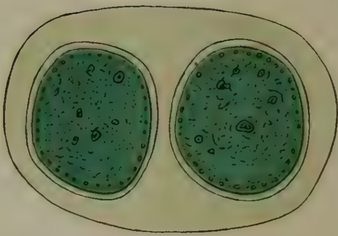


Fig. 4.

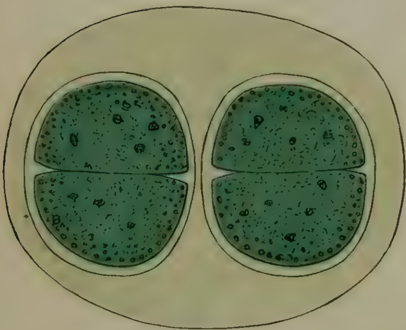


Fig. 5.

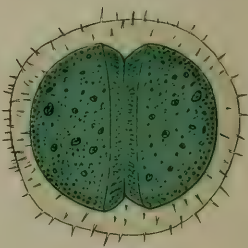


Fig. 7.

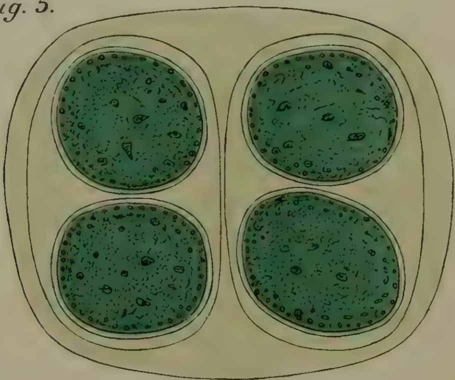


Fig. 6.

G T W del.

Mc Farlane & Erskine, Lith. Edinr

"The key to all ultimate biological problems must, in the last analysis, be sought in the cell." "That a cell can carry with it the sum total of the heritage of the species, that it can in the course of a few days or weeks give rise to a mollusc or a man, is the greatest marvel of biological science."—(Edmund B. Wilson.) To those students who devote themselves to the investigation of human diseases, to the ultimate betterment of our race, the knowledge gained in the investigation of these apparently useless organisms is of the utmost importance. Many important discoveries owe their origin to the study of these minute specks of life in which throbs protoplasm of a kindred nature to that in the cells of our own bodies.

EXPLANATION OF THE FIGURES.

All have been drawn at a magnification of 750 diameters by means of a $\frac{1}{8}''$ oil-immersion objective and "B" eyepiece.

SCALE—$\frac{1}{1000}$ths of an inch,—

Fig. 1. A single cell of Glœocapsa crepidinum with its integument, before the beginning of the first division.

„ 2. The cell beginning to divide.

„ 3. The first division nearly complete.

„ 4. Completion of the first division. Soon after division the cells assume a globular form, and the integument of the daughter-cells becomes visible.

„ 5. The two daughter-cells beginning to divide.

„ 6. Completion of the division of the two daughter-cells, each cell with its own integument similar to Fig. 4. After this stage is reached the two outer integuments rupture, and the four liberated cells with their own integuments quickly assume the form of Fig. 1, and begin the life-cycle over again.

„ 7. A cell that has been in a resting-cyst condition, beginning to divide (*vide* p. 131).

XIII.—*ALIEN PLANTS.*

List of "Introduced" or "Alien" Plants gathered by Members of the Society in the neighbourhood of Edinburgh during 1903 and 1904. Submitted to the Society at the meetings held on 27*th February* and 26*th October* 1904.

By Mr JAMES FRASER and Mr JAMES M'ANDREW.

The small letter "a" is placed after the names of plants gathered in 1903, and "b" after those got in 1904. The localities are represented by figures, thus: 1 is Slateford and Hailes Quarry; 2, Granton (including railway bank at Granton Road, nurseries on the north side of the city, and Craigleith Quarry); 3, Musselburgh; 4, Murrayfield; 5, Leith; 6, Craigmillar; 7, Inveresk; 8, Drylaw; 9, Comiston and Redford; 10, Colinton and Balerno; 11, Roslin and Bilston Glen; 12, North Queensferry to St David's; 13, Burntisland and Fife coast eastwards; 14, Linlithgowshire; 15, Haddingtonshire; 16, Blackford Hill; and 17 is attached to plants seen in the Seed Trial Grounds of Messrs Bell and Bieberstedt, Leith, having grown from impurities found in the seeds of commerce.

The mark of interrogation indicates that the specific name has not yet been determined, and the † that there is just the slightest doubt as to the identity of the species.

Plants not gathered by the compilers have the name of the collector placed after the number which represents the locality.

Ranunculaceæ.

Adonis æstivalis, *L.* †. b 5.
Delphinium orientale, *J. Gay.* b 5.
Helleborus fœtidus, *L.* b 2.
Nigella damascena, *L.* b 5.
Ranunculus arvensis, *L.* a 5; b 1, 5.
Ranunculus falcatus, *L.* b 5.
R. muricatus, *L.* a 5; b 1, 5.
R. parviflorus, *L.* a 5; b 1, 5.
R. sardous, *Crantz.* a 5; b 1, 5.

Papaveraceæ.

Chelidonium majus, *L.* a 2, 4; b 2, 4.
Corydalis claviculata, *DC.* b 1.
Eschscholtzia californica, *Cham.* b 1.
Glaucium corniculatum, *Curt.* a 5.
G. corniculatum *var.* **phœniceum**, *DC.* a 5; b 1.
Papaver Argemone, *L.* a 5; b 1, 5, 9.
P. Lecoqii, *Lamotte* (= P. dubium, *L.* with yellow juice). a 5.
P. somniferum, *L.* a 5, 13.
Rœmeria violacea, *Medic.* a 5.

Cruciferæ.

Alyssum calycinum, *L.* a 5.
A. incanum, *L.* a 5; b 1, 5.
Armoracia rusticana, *Gærtn.* b 5.
Barbarea præcox, *R.Br.* a 5; b 5.
B. vulgaris, *R.Br.* a 1, 5, 12; b. 1, 3, 5, 12.
Boreava orientalis, *Jaub. and Spach.*†. b 1.
Brassica alba, *Boiss.* a 1, 5; b 1, 5.
B. elongata, *Ehrh.* b 5.
B. Erucastrum, *L.* a 5.
B. juncea, *Coss.* a 5; b 1, 5.
B. Napus, *L.* a 5; b 5.
B. nigra, *Koch.* a 1, 5; b 1, 5.
B. oleracea, *L.* a 1, 2, 5; b 1, 2, 5.
B. Tournefortii, *Gouan.* b 1.
Bunias orientalis, *L.* a 5; b 5, 6.
Cakile maritima, *Scop.* a 5.
Calepina Corvini, *Desv.* b 5.
Camelina sativa, *Crantz.* a 5; b 1, 5.
Cheiranthus Cheiri, *L.* a 2, 6; b 2, 6.
Cochlearia officinalis, *L.* variety. b 5.
Conringia orientalis, *Dum.* a 5; b 1, 5.
Diplotaxis muralis, *DC.* a 5; b 5.
D. tenuifolia, *DC.* a 5, 12; b 5, 12.
Enarthocarpus lyratus, *DC.* a 1.
Eruca sativa, *Mill.* a 1, 5; b 1, 5.
Erucaria aleppica, *Gærtn.* a 1; b 1.
Erysimum cheiranthoides, *L.* a 5; b 5.
E. repandum, *L.* a 5; b 5.
Euclidium syriacum, *R.Br.* b 5.
Hesperis matronalis, *L.* a 9, 10; b 6, 9, 10.
Lepidium campestre, *R.Br.* a 5; b 5.
L. Draba, *L.* a 1, 3, 5, 7; b 1, 3, 5, 7.
L. perfoliatum, *L.* b 1, 5.
L. ruderale, *L.* a 5; b 5.
L. sativum, *L.* a 5; b 5.
L. Smithii, *Hook.* a 13.
L. virginicum, *L.* a 1, 5, [12 Miss B. Sprague]; b 1, 5.
Lunaria annua, *L.* b 1.
Malcolmia africana, *R.Br.* a 5; b 1, 5.
Matthiola bicornis, *DC.* b 1.
Myagrum perfoliatum, *L.* a 3, 5.
Nasturtium palustre, *DC.* a 5; b 5.
N. sylvestre, *Br.* a 5; b 5.
Neslia paniculata, *Desv.* a 5; b 1, 5.
Raphanus Raphanistrum, *L.* a 5; b 5.
R. sativus, *L.* a 1, 5; b 1, 5.
Rapistrum glabrum, *Host.* a 5; b 1, 5.
R. perenne, *All.* a 5.
R. rugosum, *All.* a 5; b 1, 5.
Senebiera Coronopus, *Poir.* a 5; b 1, 5.
S. pinnatifida, *DC.* a 5; b 5.
Sisymbrium altissimum, *L.* a 5; b 1, 5.
S. Irio, *L.* a 5; b 5.
S. orientale, *L.* a 5; b 1.
S. Sophia, *L.* a 1, 5; b 1, 5.
S. Thalianum, *J. Gray.* a 2, 5, 13; b, 2, 5, 13.

Resedaceæ.

Reseda lutea, *L.* a 5; b 5.
Reseda Luteola, *L.* a 5; b 5.

Violaceæ.

Viola odorata, *L.* a 2; b 2.

Caryophylleæ.

Cerastium dichotomum, *L.* b 5.
Gypsophila muralis, *L.* a [5 Mr A. Murray].
G. porrigens, *Boiss.* a 5; b 5.
Lychnis Githago, *Scop.* a 5; b 1, 5.
L. Viscaria, *L.* a 16; b 16.
Saponaria Vaccaria, *L.* a 1, 5; b 1, 5.
Silene Behen, *L.* b 1, 5.
S. conoidea, *L.* b 1.
S. dichotoma, *Ehrh.* a 5; b 5.
S. gallica, *L.* a 5; b 1, 5.
S. noctiflora, *L.* a 5; b 5.

Portulaceæ.

Claytonia alsinoides, *Sims* (=C. sibirica, *L.*) b 2.
Claytonia perfoliata, *Donn.* a 2; b 2.

Malvaceæ.

Malva ægyptia, *L.* †. b 1.
M. parviflora, *L.* b 1, 5.
M. parviflora, variety with glabrous carpels. b 5.
M. rotundifolia, *L.* a 1, 5; b 1, 5.
Malva sylvestris, *L.* a 1, 5; b 1, 5.
M. sylvestris, variety with pubescent carpels. b 5.
M. verticillata, *L.* b 1.

Lineæ.

Linum usitatissimum, *L.* a 5; b, 1, 5.

Aurantiaceæ.

Citrus Aurantium, *L.* a 5; b 1, 5.

Geraniaceæ.

Erodium ciconium, *Willd.* b 5.
E. malachoides, *Willd.* a 5.
E. moschatum, *L'Herit.* b 1.
Geranium lucidum, *L.* b 6.
Impatiens ——? b 1, 2, 6, 9.

Leguminosæ.

Astragalus bæticus, *L.* b 1.
A. glycyphyllos, *L.* a 5.
Ceratonia Siliqua, *L.* a 5; b 5.
Coronilla scorpioides, *Koch.* a [12 Miss B. Sprague]; b 1, 5.
Hymenocarpus circinnatus, *Savi.* b 1.
Lathyrus amœnus, *Fenzl.* b 1.
L. angulatus, *L.* b 1, 5.
L. Aphaca, *L.* a 1, 3, 5; b 1, 5.
L. blepharicarpus, *Boiss.* b 5.
L. hirsutus, *L.* a 5; b 5.
L. Ochrus, *DC.* b 5.
L. sativus, *L.* a 1, 5; b 1, 5.
L. sphæricus, *Retz.* b 1, 5.
Lens esculenta, *Moench.* a 5; b 1, 5.
Lotus edulis, *L.* b 5.
Medicago apiculata, *Willd.* a 3, 5; b 1, 5.
M. arabica, *All.* a 5, 12; b 1, 5.
M. denticulata, *Willd.* a 1, 3, 5; b 1, 5.
M. echinus, *DC.* a 5; b 5.
M. falcata, *L.* a 7; b 2, 5, 7.
M. lupulina, *L. var.* Willdenowiana. b 5.
M. orbicularis, *Willd.* b 1.
M. pentacycla, *DC.* b 1.
M. sativa, *L.* a 5, 7; b 5, 7.
M. scutellaris, *All.* b 5.
M. truncatula, *Gærtn.* b 1.
M. tuberculata, *Willd.* a 1, 3, 5; b 1, 5.
Melilotus alba, *Desr.* a 5, 12; b 5.
M. altissima, *Thuill.* a 1, 5, 12; b 1, 12.
M. arvensis, *Wallrh.* a 5; b 1, 5.
Melilotus indica, *All.* a 1, 5 [8 Miss B. Sprague]; b 1, 5.
M. messanensis, *All.* b 5.
M. sulcata, *Desf.* a 5; b 1, 5.
Onobrychis Crista-galli, *L.* b 1.
O. viciæfolia, *Scop.* b 5.
Ononis Alopecuroides, *L.* b 5.
Ornithopus compressus, *L.* b 1, 6.
Phaseolus vulgaris, *L.* b 5.
Pisum sativum, *L.* a 5; b 1, 5.
P. sativum, *sub-sp.* arvense, *L.* a 5; b 1, 5.
Scorpiurus sulcata, *L.* b 1, 5.
Securigera Coronilla, *DC.* b 5.
Trifolium arvense, *L.* a 3, 5; b 5.
T. fucatum, *Lindl.* b 1.
T. hybridum, *L.* form with abortive petals. a 5; b 5.
T. incarnatum, *L.* a 10.
T. lappaceum, *L.* a 3; b 5.
T. maritimum, *Huds.* a 5.
T. mutabile, *Portenschl.* †. a 3.
T. resupinatum, *L.* a 3; b 1, 5.
T. scabrum, *L.* a 3.
T. spumosum, *L.* a 3; b 1, 5.
T. stellatum, *L.* b, 1, 5.
T. supinum, *Savi.* a 3; b 1, 5
T. tomentosum, *L.* b 1, 5.
Trigonella aurantiaca, *Boiss.* †. b 5.
T. cærulea, *Ser.* a 1, 3, 5; b 1, 5.
T. corniculata, *L.* a [8 Miss B. Sprague]; b 5.
T. Fœnum-græcum, *L.* a 3, 5; b 1, 5.
T. gladiata, *Stev.* †. b 5.
T. monspeliaca, *L.* a 3; b 5.

Trigonella polycerata, *L.* b 5.
T. purpurascens, *Lam.* a 5.
Vicia angustifolia, *Roth.* variety. b 5.
V. calcarata, *Desf.* b 1.
V. Cracca, *L.* a 1, 3, 5; b 1, 5.
V. dasycarpa, *Ten.* a 5; b 1, 5.
V. Faba, *L.* a 1, 3, 5; b 1, 5.
V. gemella, *Crantz.* a 5.
Vicia hirsuta, *Gray.* a 5; b 5.
V. hybrida, *L.* a 5; b 1, 5.
V. lutea, *L.* a 5; b 1, 5.
V. Melanops, *Sibth.* b 5.
V. narbonensis, *L.* b 1.
V. peregrina, *L.* b 1.
V. sativa, *L.* b 1, 5.
V. sativa *var.* angustifolia. †. b 5.

Rosaceæ.

Potentilla norvegica, *L.* a 5; b 5.
P. recta, *L.* a 5.
Poterium polygamum, *W. and K.* b 5.
P. verrucosum, *Ehrenb.* b 5.

Onagraceæ.

Œnothera biennis, *L.* b 5, 6.

Umbelliferæ.

Apium graveolens, *L.* b 5.
Astrantia major, *L.* a 14.
Bifora testiculata, *Roth.* a 1, 5; b 1, 5.
Bupleurum croceum, *Fenzl.* b 1.
B. protractum, *Hoff. and Link.* a 1, 5; b 1, 5.
B. protractum *var.* heterophyllum, *Link.* b 5.
B. rotundifolium, *L.* b 1, 5.
Carum Carui, *L.* a 5.
C. Petroselinum, *B. and H. f.* a 5; b 5.
Caucalis daucoides, *L.* a 1, 5; b 1, 5.
C. latifolia, *L.* a 5; b 1, 5.
C. tenella, *Del.* b 1.
Conium maculatum, *L.* a 1, 2, 5, 12; b 1, 2, 5, 12.
Coriandrum sativum, *L.* a 2, 5; b 2, 5.
Daucus Carota *var.* gummifer, *Lam.* a [5 Mr G. West].
Fœniculum vulgare, *Mill.* a 5, 12; b 2.
Myrrhis odorata, *Scop.* a 1, 2, 5; b 1, 2, 5.
Peucedanum graveolens, *B. and H. f.* a 5; b 5.
P. sativum, *Bent. and Hook. f.* a 5, 12; b 5.
Scandix grandiflora, *De Vis.* b 5.
S. Pecten-Veneris, *L.* a 1, 5; b 1, 5.
Smyrnium Olusatrum, *L.* a 6; b 6.

Saxifragaceæ.

Tellima grandiflora, *R. Br.* b [3 Mr D. Bogie].

Crassulaceæ.

Sedum album, *L.* a 16; b 16.

Rubiaceæ.

Asperula arvensis, *L.* a 5; b 1, 5.
A. orientalis, *Boiss. and Hohen.* †. b 5.
Galium Mollugo, *L.* a 5.
G. tricorne, *Stokes.* a 1, 5; b 1, 5.

Valerianaceæ.

Centranthus ruber, *DC.* a 13; b 13.
Valerianella coronata, *DC.* b 5.

Dipsaceæ.

Cephalaria syriaca, *Schrad.* b 1, 5.
Dipsacus Fullonum, *Miller.* b 1.
Scabiosa prolifera, *L.* b 1, 5.

Campanulaceæ.

Specularia Speculum, *A. DC.* a [8 Miss B. Sprague].

Primulaceæ.

Anagallis arvensis, *L.* a 5 ; b 1, 5.
A. cærulea, *Schreb.* a 5 ; b 1, 5.
Androsace maxima, *L.* b 1.
Lysimachia punctata, *L.* b 2.
L. vulgaris, *L.* b 5, 6.

Polemoniaceæ.

Gilia achilleæfolia, *Benth.* a 5 ; b 5.

Compositæ.

Achillea Santolina, *L.* †. b 1.
Ambrosia artemisiæfolia, *L.* a 5 ; b 5.
A. trifida, *L.* a 5 ; b 5.
Anaphalis margaritacea, *B. and H. f.* b 5, 6.
Anthemis altissima, *L.* b 1.
A. arvensis, *L.* a 1, 5 ; b 1, 5.
A. Cotula, *L.* a 1, 5 ; b 1, 5.
A. maritima, *L.* a 5 ; b 5.
A. tinctoria, *L.* a 5 ; b 5.
Artemisia Absinthium, *L.* a 5 ; b 5.
A. annua, *L.* a 5 ; b 5.
A. biennis, *Willd.* b 5.
A. campestris, *L.* a 5, 12 ; b 5.
A. scoparia, *Kit.* a 5.
Aster —— ? b 6.
Calendula arvensis, *L.* b 1, 5.
C. officinalis, *L.* b 1, 5.
Callistephus hortensis, *Cass.* a 5.
Carbenia benedicta, *Adans.* b 5.
Carduus acanthoides, *L.* a 5 ; b 5.
C. argentatus, *L.* b 1.
C. pycnocephalus, *L.* a 5 ; b 5.
Carthamus tinctorius, *L.* b 1, 5.
Centaurea Calcitrapa, *L.* a 1 ; b 1.
C. calcitrapoides, *L.* a 1.
C. Cyanus, *L.* a 1, 5 ; b 1, 5.
C. depressa, *M.B.* b 5.
C. iberica, *Trev.* b 5.
C. melitensis, *L.* a 5 ; b 1, 5.
C. solstitialis, *L.* a 1, 5 ; b 1, 5.
Chrysanthemum coronarium, *L.* a 5 ; b 1, 5.
C. Parthenium, *Bernh.* a 5 ; b 1, 5, 6.
C. segetum, *L.* a 5 ; b 5.
Cichorium divaricatum, *Willd.* b 1.
C. Endivia, *L.* b 1, 4.
Cichorium Intybus, *L.* a 1, 5, 13 ; b 1, 5.
Cladanthus arabicus, *Coss.* b 1.
Cnicus arvensis *var.* latifolius, *Bab.* a 5; b 5.
C. arvehsis *var.* setosus, *Bab.* †. a 5 ; b 5.
Coreopsis tinctoria, *Nutt.* b 5.
Crepis alpina, *L.* b 1.
Cynara Scolymus, *L.* b 1.
Doronicum Pardalianches, *L.* a 14.
Erigeron canadensis, *L.* a 5.
Galactites tomentosa, *Mœnch.* b 5.
Helianthus annuus, *L.* a 5 ; b 5.
H. tuberosus, *L.* b 1.
Hemizonia Kelloggii, *Greene.* a 5.
H. pungens, *Torrey and Gray.* a 10 ; b 1, 10.
Hieracium aurantiacum, *L.* a 14.
H. umbellatum, *L.* a 5 ; b 5.
Lactuca sativa, *L.* b 5.
L. virosa, *L.* b 5.
Matricaria Chamomilla, *L.* b 1, 5.
M. disciformis, *DC.* a 7 ; b 1, 7.
M. discoidea, *DC.* a 5 ; b 1, 5.
M. inodora *var.* maritima, *L.* a [5 Mr G. West].
Onopordon Acanthium, *L.* a 5, 13.
Petasites fragrans, *Presl.* a 11.
Rhagadiolus edulis, *Gærtn.* b 1, 5.
R. Hedypnois, *L.*, *sub-sp.* R. tubæformis, *Ten.* b 1.
Sanvitalia procumbens, *Lam.* b 5.
Scolymus maculatus, *L.* b 1, 5.
Senecio ægyptius, *L.* b 5.
S. sarracenicus, *L.* b 9.
Silybum Marianum, *Gærtn.* b 1, 5.
Tragopogon porrifolius, *L.* a 5 ; b 5.
Xanthium spinosum, *L.* b 1.

Boragineæ.

Amsinckia lycopsoides, *Lehm.* a 1; b 1.
Anchusa arvensis, *L.* a 5; b 5.
A. italica, *Retz.* b 1.
A. officinalis, *L.* a 5; b 5.
A. sempervirens, *L.* a 6; b 6.
A. stylosa, *M.Bieb.* b 1.
Asperugo procumbens, *L.* a 1, 5; b 1, 5.
Borago officinalis, *L.* a 5; b 5.
Cerinthe minor, *L.* a 5; b 5.
Echinospermum Lappula, *Lehm.* a 5; b 5.
Lithospermum arvense, *L.* a 5; b 1, 5.
Symphytum asperrimum, *Donn.* a 15.

Convolvulaceæ.

Convolvulus tricolor, *L.* a 5; b 5.
Cuscuta planiflora, *Ten.* b 1.

Solanaceæ.

Hyoscyamus niger, *L.* a 5; b 5.
Lycopersicum esculentum, *Mill.* b 1, 2, 5.
Solanum Dulcamara, *L.* a 5; b 6.
S. nigrum, *L.* a 5; b 5.

Scrophularineæ.

Antirrhinum Orontium, *L.* a 5; b 5.
Bartsia Trixago, *L.* b 1.
Linaria chalepensis, *Mill.* b 5.
L. Cymbalaria, *Mill.* a 2, 5; b 2, 5.
L. purpurea, *Mill.* b 6.
L. repens, *Mill.* a 5; b 5.
L. viscida, *Moench.* a 5; b 5.
L. vulgaris, *Mill.* a 5; b 5.
Mimulus luteus, *L.* a 9, 10; b 9, 10.
Mimulus moschatus, *Dougl.* b 1.
Rhinanthus major, *Ehrh.* b 5.
Scrophularia vernalis, *L.* a 15; b 15.
Stachys annua, *L.* b 5.
Verbascum Thapsus, *L.* a 5, 6, 16; b 5, 6, 16.
Veronica Chamæpitys, *Griseb.* a 1.
V. peregrina, *L.* b 1.

Labiatæ.

Ballota nigra, *L.* a 5, 16; b 5, 16.
Calamintha acinos, *Clairv.* a 5; b 5.
C. graveolens, *Benth.* b 1.
Dracocephalum parviflorum, *Benth.* a 5; b 5.
D. Moldavica, *L.* b 1.
Galeopsis Ladanum, *L.*, *var.* latifolia. b 5.
Lallemantia peltata, *Fisch. and Mey.* b 1, 5.
Lamium amplexicaule, *L.* a 1, 5; b 1, 5.
Lamium maculatum, *L.* b 9.
Leonurus Cardiaca, *L.* a 5; b 5.
Marrubium vulgare, *L.* a 1; b 1, 5.
Mentha viridis, *L. var.* crispa. b 6.
Nepeta Cataria, *L.* a 5; b 5.
Origanum vulgare, *L.* a 5; b 5.
Salvia verticillata, *L.* a 5, 7; b 5, 7.
Sideritis lanata, *L.* b 7.
S. montana, *L.* a 5; b 5, 7.
Wiedemannia orientalis, *Fisch and Mey.* b 1.

Plantaginaceæ.

Plantago arenaria, *Waldst. and Kit.* b 1.
P. Lagopus, *L.* a 1, 5; b 1, 5.
P. lusitanica, *L.* b 1, 5.
Plantago ovata, *Forsk.* †. b 1.
P. patagonica, *Jacq.* b 17.
P. Psyllium, *L.* a 10; b 1, 5.
P. Rugelii, *DC.* b 17.

Illecebraceæ.

Herniaria glabra, *L.* a 5; b 1.
H. hirsuta, *L.* a 5.
Scleranthus annuus, *L.* a 5; b 5.

Amarantaceæ.

Amarantus retroflexus, *L.* a 5; b 5.

Chenopodiaceæ.

Beta maritima, *L.* a 5, 12; b 1, 5.
B. vulgaris, *L.* a 5; b 1, 5.
Chenopodium Bonus-Henricus, *L.* a 6; b 3, 6.
C. polyspermum, *L.* b 1.
Chenopodium rubrum, *L.* a 5; b 5.
C. Vulvaria, *L.* b 1, 5.
Salsola Soda, *L.* †. b 5.
Spinacia oleracea, *L.* b. 5.

Euphorbiaceæ.

Mercurialis annua, *L.* b 5.

Polygonaceæ.

Emex spinosus, *Camp.* b 5.
Fagopyrum esculentum, *Moench.* a 5; b 5.
Polygonum alpestre, *C. A. Mey.* a 5.
P. Bellardi, *All.* a 5; b 5.
P. cuspidatum, *S. and Z.* a 2; b 2, 10, 11.
Polygonum maritimum, *L.* b 1.
Rumex bucephalophorus, *L.* b 5.
R. obtusifolius, *L. var.* Friesii, *G. and G.* b 5.
R. scutatus, *L.* a 6; b 6.

Urticaceæ.

Cannabis sativa, *L.* a 5; b 5.
Urtica pilulifera, *L.* a 1; b 1.

Liliaceæ.

Asphodelus fistulosus, *L.* a 5.
Convallaria majalis, *L.* a 2; b 2.
Muscari racemosum, *Mill.* a 2; b 2.

Juncaceæ.

Luzula albida, *DC.* b 9.

Araceæ.

Arum —— ? a 11; b 11.

Gramineæ.

Ægilops Aucheri, *Boiss.* b 5. (=Triticum speltoides, a) Aucheri, *Aschers. and Grbn.*)
Æ. cylindrica, *Host.* a 1, 5; b 1, 5.
Æ. ovata, *L.* b 1.
Æ. triaristata, *Willd.* a 5; b 5.
Æ. triuncialis, *L.* b 1, 5.
Agropyron triticeum, *J. Gærtn.* b 5.
Aira capillaris, *Host.* a 5; b 4, 5.
Alopecurus agrestis, *L.* a 4, 5; b 4, 5.
Anthoxanthum odoratum *var.* villosum, *Dum.* a 5.
A. Puelii, *Lecoq and Lamotte.* a 2, 5; b, 1, 5.
Apera Spica-venti, *Beauv.* a 1 to 5, 13; b 1 to 5, 13.
Avena barbata, *Brot.* a 5.
Avena fatua, *L.* a 1, 5; b 1, 5.
A. sterilis, *L.* a 5; b 5.
A. strigosa, *Schreb.* a 5; b 1, 5.
Brachypodium distachyum, *Beauv.* a 5; b 1, 5.
Briza maxima, *L.* a 5.
B. minor, *L.* a 5; b 5.
Bromus arvensis, *L.* a 1, 4, 5; b 1, 4, 5.
B. erectus, *Huds.* b 5.
B. inermis, *Leys.* b 13.
B. macrostachys, *Desf.* a 5; b 1, 5.
B. madritensis, *L.* a 1, 5; b 1, 5.
B. madritensis, a form with compact panicle. a 5; b 5.
B. patulus, *Mert. and Koch.* a 1, 5.
B. racemosus. *L.* a 1, 4, 5; b 1, 4, 5.
B. rigidus, *Roth.* a 1, 5; b 1, 5.

Bromus Scoparius, *L.* b 1, 5.
B. secalinus, *L.* a 1, 4, 5; b 1, 4, 5.
B. squarrosus, *L.* a 1, 5; b 1, 5.
B. tectorum, *L.* a 1, 3, 5; b 1, 3, 5, 13.
B. unioloides, *H. B. and K.* a 5; b 1, 13.
Cynosurus echinatus, *L.* a 5; b 1, 5
Dactylis hispanica, *Roth.* a 5.
Echinaria capitata, *Desf.* a 5; b 1, 5.
Elymus Caput-medusæ, *L.* a 1, 5; b 1, 5.
E. sibiricus, *L.* a 5, 13.
Festuca ciliata, *Pers.* b 5.
F. ligustica, *Bert.* a 5; b 1, 5.
F. Myuros, *L.* b 1, 5.
F. sciuroides, *L.* a 1 to 13; b 1 to 13.
F. uniglumis, *Soland.* a 5.
Gastridium australe, *Beauv.* a [5 Mr A. Murray].
Gaudinia fragilis, *Beauv.* a 5; b 5.
Glyceria procumbens, *Dum.* b 5.
Hordeum bulbosum, *L.* a [5 Mr A. Murray].
H. distichum, *L.* a 5; b 5.
H. hexastichum, *L.* a 5; b 5.
H. jubatum, *L.* a 5; b 1, 5, 6, 13.
H. marinum, *Huds.* a 5; b 1, 5.
Kœleria phleoides, *Pers.* b 5.
Lagurus ovatus, *L.* a 5; b 5.
Lepturus incurvatus, *Trin.* b 5.
Lolium arvense, *With.* a 5; b 1, 5.
L. italicum, *Br. var.* muticum. b 5.
L. temulentum, *L.* a 1, 3, 5; b 1, 3, 5.
Panicum capillare, *L.* a 5.
P. Crus-galli, *L.* b 5.
P. miliaceum, *L.* a 5.
P. sanguinale, *L.* b 5.
Phalaris arundinacea, *L. var.* picta. b 9.
P. canariensis, *L.* a 1 to 5; b 1 to 5.
P. cœrulescens, *Desf.* a 1, 5; b 1, 5.
P. minor, *Retz.* a 5; b 1, 5.
P. paradoxa, *L.* a 1, 5; b 1, 5.
Phleum arenarium, *L.* a 5.
P. asperum, *Jacq.* b 5.
P. Bœhmeri, *Wibel.* b 5.
P. echinatum, *Host.* b 1.
P. Michelii, *All.* b 1, 5.
P. tenue, *Schrad.* b 1, 5.
Poa bulbosa, *L.* b 5.
P. Chaixii, *Vill.* a [9 Mr A. Murray].
P. palustris, *L.* a 1, 4, 5; b 1, 4, 5.
Polypogon monspeliensis, *Desf.* a 5; b 1, 5.
P. monspeliensis, variety. a 5.
Schlerochloa dura, *Beauv.* b 1.
Secale cereale, *L.* a 1, 5; b 1, 5.
Setaria italica, *Beauv.* a 5; b 5.
S. viridis, *Beauv.* a 5; b 5.
Triticum vulgare, *Vill.* a 1, 5; b 1, 5.
Zea Mays, *L.* a 5; b 1, 5.

REPORT OF THE MICROSCOPICAL SECTION.

By Mr JAMES RUSSELL, Convener.

Continuing the study of "Flowerless Plants," the members, during the months of November and December, had under consideration the Bryophyta. This section of the vegetable world comprises two large families—the Liverworts (*musci hepatici*) and the Mosses (*musci frondosi*).

The Liverworts.—The species studied was *Marchantia polymorpha*, a common plant found on damp ground. It produces a flat, dichotomously branched thallus having a dorsi-ventral structure. From the ventral side spring numerous unicellular rhizoids of two kinds—one with smooth walls, and the other with thickenings projecting into the internal cavity. It is not too much to say that in these thickenings we have a primitive vascular system. On the dorsal surface are numerous small cup-shaped outgrowths containing from four to eight flat stalked bodies called gemmæ. These gemmæ form the means of a vegetative reproduction of the plant. The sexual reproduction is formed by means of antheridia and archegonia produced on different individuals, the plant being diœcious. These sexual organs are borne on special erect branches which spring from the thallus—the male branch terminating in a lobed disc, and the female in a disc of nine rays. As in the pteridophyta, fertilisation takes place under water. In this family there is also a well-marked alternation of generation, the sexual being the more highly developed.

The Mosses.—These form a very numerous family, it being stated that there are upwards of fourteen thousand species spread over the face of the earth. The species studied was *Funaria hygrometrica*, a small plant growing on the ground or on old walls. Like almost all the other mosses, it has two modes of reproduction—an asexual and a sexual. The asexual arises from buds or gemmæ produced on the rhizoids, and the sexual by means of antheridia and archegonia. *Funaria* is diœcious,—that is, the male and female organs are borne on different plants. This, however, is not the case in all mosses, many genera of which are monœcious. The antheridia arise at the growing point of the male plant; they are club-shaped, and at maturity open on access of water, when the spermatozoid mother-cells are expelled. The mucilaginous cell-walls of these mother-cells disappear and the spermatozoids are thus set free. When the plants are covered with moisture the spermatozoids find their way to the archegonia of the female plants, and fertilisation is effected by the spermatozoids penetrating the neck-canals of the archegonium, and thus reaching the ovum, with which one of them unites.

The fertilised ovum begins at once to grow, and finally ruptures the archegonium, the upper portion of which is borne aloft on the top of the growing ovum, to which it forms a conical covering called the *calyptra*. When this fertilised ovum reaches maturity it consists of a long thin stalk, called the *seta*, bearing at its end a pear-shaped capsule. This is the fruit of the plant; and the whole fruit—seta and capsule—constitutes the asexual or spore-bearing generation. When the calyptra is removed the mouth of the capsule is found shut by a lid or *operculum*. Running through the whole length of the capsule is a solid pillar called the columella, and around the columella, between the inner and outer spore-sacs, is a mass of tissue called the archesporium, in which the spores or seeds of the plant are produced. Between the operculum and the body-wall of the capsule is a row of special cells called the *annulus*. When the fruit is ripe the cells of the annulus become ruptured and the operculum falls off. Although the lid of the capsule is now off, the way for the dissemination of the spores is not quite clear. As these spores can be properly scattered only in dry weather, provision is made that they shall be liberated from the capsule only in such weather. This is effected by a double row of teeth, called the *peristome*, which surround the mouth of the capsule. The cells of the teeth of the peristome are highly hygroscopic, so that in moist weather the teeth close tightly together over the mouth of the capsule and thus prevent the escape of the spores, while in dry weather they open and allow the spores to be disseminated. The spores thus scattered on the ground germinate, and produce a filamentous growth called the *protonema*, from which arise the young plants constituting the sexual generations.

During the period after the New Year Mr R. A. Staig of the Natural History Department, Glasgow University, gave a series of practical demonstrations in Zoology. His object was to show the gradual development of various types in the animal kingdom and their rise in the scale of existence. In pursuance of this object he chose the following types:—

Amœba.—Chosen as a type of the lowest class: animals composed of a jelly-like substance called by Dujardin *sarcode*. It has now been demonstrated that this sarcode and protoplasm have the same properties—that is, that animal and vegetable protoplasm are identical. The sarcode seems to consist of two layers—an outer, hyaline, and an inner, granular. The first was formerly called ectoplasm and the latter endoplasm, but the following names are now more generally used—hyaloplasm for the former and spongioplasm for the latter.

Owing to the gelatinous substance of the amœba, its form is continually changing. It protrudes part of its substance like a foot, and thus moves itself along. The parts thus protruded are called pseudopodia. The amœbæ feed upon minute algæ and reproduce themselves by fission.

Leech.—The next type was the Leech (*Hirudo medicinalis*). Dissection in invertebrates should be commenced from the dorsal side, while in vertebrates it should be commenced from the ventral side. As a rule, all such dissections should be done under water.

The external characters of the medicinal leech are—body with numerous rings; on the dorsal side a line of a brownish colour on each side of the median line; general colour olive-green. At the posterior end there is a large sucker which serves for the purposes of attachment, and at the anterior end a smaller sucker in the centre of which is the mouth. The biting apparatus in the mouth consists of three semicircular toothed plates.

Internal Organisation.—The alimentary canal extending the whole length of the body is provided with eleven dilatations or lateral pouches on each side. The gullet is very short, and the intestine slender. The male and female organs are in the same individual, but the leech is not self-impregnating.

The Earthworm (*Lumbricus terrestris*) was the next type studied. The dorsal side of the animal is of a purplish colour, while the ventral side is whitish. The body is divided into a number of constrictions or segments called *somites,* which correspond to internal divisions by *septa.* The mouth perforates the first segment, which is subdivided into a dorsal *prostomium* which overhangs the mouth; and a circumoral *peristomium.*

In sexually mature specimens there is a whitish saddle-shaped enlargement on the dorsal side called the *clitellum,* which is connected with the act of reproduction. The dark line on the dorsal side is the large dorsal blood-vessel.

The *locomotor organs* consist of four double rows (two ventral and two lateral) of bristle-like appendages called *setæ,* of a curved needle-shaped form.

The alimentary system is a straight tube running the whole length of the body. The followings parts may be distinguished :—

(*a*) The *buccal sac*, a thin-walled sac lying within the first two or three segments.

(*b*) The *pharynx*, a spacious thick-walled structure extending back to the sixth segment.

(*c*) The *œsophagus*, a tube continued back to the fifteenth segment.

(*d*) The *crop*, a large thin-walled sac lying within segments fifteen and sixteen.

(*e*) The *gizzard*, a whitish thick-walled sac in which the food is crushed.

(*f*) The *stomach* proper, surrounded by large yellow cells.

(*g*) The *intestine.*

The *segmental organs*, or *nephridia*, are delicate tubes opening externally upon the ventral side. They are excretory organs.

The earthworm is hermaphrodite, but not self-impregnating.

There are no special ganglia but simply swellings of the nerve-cord. At the anterior end of the nerve-cord there are two outgrowths—one on each side—at the end of each of which is a small jelly-like sphere inclosing a small particle of lime. These are called *otocysts*, and are regarded as elementary ears.

Along with the earthworm were considered the morphology and life-history of several Parasitic Worms, such as the Tape Worm (*Tænia solium*); the Fluke (*Distoma hepaticum*), the cause of the fatal disease in sheep known as the "rot"; and a singular nematoid worm called *Trichina spiralis.*

The Crayfish (*Astacus fluviatilis*) was chosen as the type of the Crustacea. Its external and internal morphology were fully described and the functions of the various organs explained.

Insect Morphology.—The principal characteristics of Insects were described as being—Exoskeleton composed of chitin; respiration by means of tracheæ; body with distinct head, thorax, and abdomen; head with compound eyes, and one pair of antennary organs; thorax bearing three pairs of legs and usually two pairs of wings; and abdomen limbless. The type studied was the Cockroach (*Blatta orientalis*).

On the head is one pair of long jointed antennæ and one pair of compound eyes; there is also on each side of the head a small transparent spot called a fenestra; by some these spots are supposed to be the remains of simple eyes.

The thorax consists of three parts—pro-thorax, meso-thorax, and meta-thorax.

The abdomen consists altogether of ten segments, of which the first six are quite distinct, the seventh, eighth, and ninth are telescoped into each other, and the tenth is split. The tracheæ communicate externally by means of pores called *stigmata*, of which two pairs are in the thorax and eight pairs in the abdomen.

When the tergal portion of the exoskeleton is removed the internal organisation can be studied. It consists of the—

Heart, a long slender tube lying immediately under the exoskeleton and above the alimentary canal.

Alimentary canal, consisting of the following parts: *Salivary glands*, which open into the mouth. Each gland is composed of two leaflike lobes, with a single duct; there is also a salivary bladder on each side. *Gullet*, slender at first, then dilating into the *crop*, which is large and situated in the abdomen. *Gizzard*, at the posterior end of the crop, provided with a thick muscular wall, and six large teeth and numerous smaller teeth between the large ones. *Stomach*, with pyloric cæca and Malpighian tubules, which probably function as a liver and kidneys. *Intestine*, small and large, ending in anus opening posteriorly.

On removing the alimentary canal the nervous system is exposed, as also the reproductive organs.

Molluscan Anatomy.—The "Common Snail" (*Helix aspersa*) was taken as the type. The Mollusca may be defined as "animals with a soft body, without segments, naked or covered with a shell of one or two valves composed of carbonate of lime secreted by a fold of the skin—the mantle." In the body there are three great divisions—shell, foot, and head. The Mollusca are generally sluggish, although some bivalves are spasmodically active. This sluggishness is favourable for the secretion of lime, of which the mollusc has need for the building up of its shell.

The *foot* in the snail is largely developed. It is, as its name indicates, the organ of locomotion.

The *head* is also well developed. It bears two pairs of retractile tentacles—a smaller lowermost *labial* pair situated at the sides of the mouth, and a longer dorsally placed *ocular* pair, at the summit of each of which there is borne a minute black eye.

When the shell is removed there is found the *mantle*, which is another feature of importance. It forms the roof of the pulmonary chamber or lung-sac. In the water-snail the lung-sac functions also as a hydrostatic organ.

The aperture of the mouth is bounded by soft fleshy lips. It leads into a spacious buccal cavity, the walls of which are excessively thick and muscular. A denticulate horny upper jaw or beak is present, and the floor of the mouth is raised up into a cushion-shaped odontophore, which is in turn surmounted by a dentigerous lingual-ribbon or radula. This ribbon has its posterior end in a sac called the radular sac, in which it is renewed as its anterior end is worn away.

The heart of the snail consists of a single auricle and ventricle, the valves between them being so disposed as only to admit of a current passing from the lung-sac to the body.

The snail is hermaphrodite, and the sex-organs are highly complicated. It is not self-impregnating.

As a type of the Vertebrates the Frog (*Rana temporaria*) was taken, but want of space prevents any description.

EXHIBITS IN NATURAL HISTORY.

During the past session the following objects were exhibited at the evening meetings: A collection of Australian shells, by Mr M. H. Speedy; specimens of radio-active substances, by Mr W. C. Crawford; specimen of radium bromide, by Dr Davies; petrological micro-slides, shown under the microscope, by Mr A. G. Stenhouse; goatsucker, by Mr Chas. Campbell; devices used in securing, rearing, mounting, and preserving moths and butterflies, by Mr Gloag and Mr Ganaway; preparations illustrating the early stages in the life-history of an ascidian, by Mr W. J. Pierce; lichens, by Mr James M'Andrew; pieces of fir branches damaged by squirrels, by Mr Stewart Archibald; live waxwing and crossbill, by Mr Robt. H. Tait; Bohemian waxwing, by Mr Tom Speedy; caterpillar destroyed by fungus (*Torrubia Robertsii*), from New Zealand, by the Secretary; young form of common octopus (*Octopus vulgaris*), sea-mouse (*Aphrodite aculeata*), sea-pen (*Pennatula phosphorea*), gaper-shell (*Lima hians*), and a crab (*Eupagurus Prideauxii*) and a sea-anemone (*Adamsia palliata*) living together as commensals, by Mr John Lindsay.

ADDRESS BY THE PRESIDENT

ARCHIBALD HEWAT, F.F.A., F.I.A.

TO THE ANNUAL MEETING OF THE SOCIETY ON THE 26TH OCTOBER 1904.

In closing another Session, as we now do on the eve of opening a new one, the thirty-seventh, I congratulate the Society upon its continued success and its increasing usefulness. As we have just heard from the Secretary's report, the membership has now reached 241—the highest number we have ever had on record. Our finances, too, are in that healthy condition of which a substantial balance on the right side is always a sure sign; and this we have accomplished, by care and economy, on what is little better than a mere nominal annual contribution. As you are aware, we do not canvass for new members. We prefer to attract them by a constant exhibition of good work done, pleasantly and profitably, in the study of what is undoubtedly the most interesting, most fascinating, and most elevating of all mundane subjects—the study of Nature, which leads us, if we walk aright, to the contemplation of the highest of all, even to the God of Nature who is not far from the humble and the reverent. We walk partly by faith and partly by sight, and in a Society like ours the more we investigate by close observation, microscopic or otherwise, by patient study, and in a teachable spirit, the more will our faith be strengthened, the less will we be led by a blind, baseless superstition. In the natural world as in the spiritual, what we know not now we shall know hereafter; Nature reveals herself, evolves herself, to the patient observer and ardent student who follows on to know her secrets and who is fascinated by the pursuit.

Henry Seton Merriman, in his 'Sowers,' says: "A Russian forest in winter is one of Nature's places of worship." "There are," he continues, "some such places in the world where Nature seems to stand in the presence of Deity; a sunrise at sea, night on a snow mountain, mid-day in a Russian forest in winter," and he adds—and this is what I desire to emphasise—"these places and these times are good for convalescent atheists and such as pose as unbelievers, the cheapest form of notoriety." Professor Masson, too, has said: "It is to the pale solitary; stretched by his cave in the desert or on the mountain, with his beechen bowl of simple water beside him, or meditating alone in his quiet watch-tower, that Nature whispers her sublimer secrets and that the lost knowledge of things comes once more in visions and in dreams."

Connected as we are with such a Society as ours, and doing work of the kind indicated, it well becomes each one of us to seek increasing knowledge, increasing proficiency, and an increasing desire to stimulate others in the good work by doing all we can to widen and deepen interest therein. While we cannot all be masters we may be disciples, taking in what we hear at our winter sessional meetings and what we see at our summer field excursions. The chair of the master is reached by way of the bench of the disciple. In our Society—in Nature itself—change is the evidence of life and progress. We pass on from one degree of knowledge, from one attainment, to another, with the comforting, stimulating assurance that our "little life" here is all too short in which to exhaust the subjects the study of which is the object of our Society. I would therefore urge each and all of you to do your best to bring forward communications, to attend our meetings as regularly as possible, to take part in the discussions, and to attract friends to our Society, to whom, as I may have said before, we may with all confidence say—as Moses did of old to Hobab—"Come thou with us, and we will do thee good."

As you are aware, ours is looked upon as one of the leading scientific societies in this city. We are represented on the committee which has been formed—and which is carefully watching all that is being said or done—to see what may be best for these societies in regard to the Royal Institution buildings at the foot of the Mound; societies which include the Royal Physical, the most ancient, the Royal, the most eminent, and the Royal Geographical, probably the most numerous. In this connection I would remind you that the Secretary of State for Scotland, in his place in the House of Commons on 9th August last, said he "was met in the winter by a most influential deputation of prominent scientific men in Scotland, who urged very strenuously, and with great force, that not only should the Royal Institution be allowed to remain where it was, but that the building which it occupied should be made the home of the learned societies. It was pointed out that it would be an enormous advantage if they had a central hall for lectures and discussions, and could house the other bodies so as to have the combined libraries of the various learned societies on one spot. That, again, secured a most admirable object." As you are aware, we had this matter, and our relation to it, fully and calmly considered at a largely attended meeting of our Society, on 27th January last, when we, very wisely as I think, resolved to take a sympathetic interest in the movement, at the same time keeping the door open for fuller discussion as the matter ripens, not committing this Society, as yet, to any definite promise or position in regard to the question. Mr Russell and I are your representatives on the committee. We have attended several meetings, but we always bear in mind that we have from you only what lawyers call "a watching brief"—*i.e.*, we are to hear all that is said, take part in discussions, watch the progress of the movement, and come back to you for instructions when the time for action on the part of this Society arrives, so far as its interests are concerned. Till then you will be committed to nothing.

I shall now refer, in a sentence or two, to another event of the past year which must be full of interest to naturalists —the return of the "Scotia" with the Scottish Antarctic Expedition, after an absence of more than a year and a half. As your President I was honoured with an invitation to join the company, headed by Sir John Murray, who went to meet her on her arrival in the Clyde, on 21st July last, and to welcome the returning party of adventurers. That expedition was, as we all know, a great success, and will add much to scientific knowledge and discoveries in which naturalists are deeply interested.

We hear a good deal in these days about "protection," and I would like to say a few words upon that this evening. But, please, do not be alarmed; it is not my intention to discuss with you any fiscal policy. Fortunately, we are here this evening as naturalists, and not as political partisans or what are called business men. It is to me—as doubtless to most of you—one of the charms of meetings such as ours that here, at least, we can with a clear conscience escape all responsibility for guiding the State or the Church in the way in which each and both should go, and that all the "business" we are called upon to consider can be disposed of by us in less than half an hour per annum, when our Secretary tells us how our membership stands and the Treasurer how our funds work out. The protection to which I would direct your attention is, in the first place, that which would see to it that when any rare bird, or beast, or plant—fauna or flora— is discovered, it should be spared, not shot or uprooted, and hidden away as a dead specimen in some mere museum, in a glass case, a wooden box, or between hard boards. Announcements of the visit of some rare and beautiful bird are too frequently accompanied by the sad intelligence that the visit has cost the welcome visitor its life. Here is a recent specimen: "A splendid osprey has just been shot at ——. This is believed to be the first of its species seen in Surrey;" and we hear of it in an obituary notice! Hear again from a recent paragraph: "There is some prospect that England may again become the England of a hundred years ago as a home for birds. Quails have this year been seen — and *shot* — in Buckingham, an osprey in Surrey, all sorts of rare birds round Yarmouth and in Norfolk. There is no reason why these should not nest in England to-day as they did eighty years ago. *Their chief enemy is the man with the gun*, but he is getting slowly trained in England. This should increase the recognition among birds that England is on the way to become an agreeable haven."

We can quite excuse, even justify, the killing of vermin, the keeping down of the enemies of the farmer, the forester, and the fisherman,—the sea-gulls, by the way, are under suspicion at present,—but the wanton destruction, the extermination, of rare and beautiful plants, beasts, and birds, merely to secure dead specimens for some miscalled naturalist, or to gratify the cupidity or the low ambition of some sportsman unworthy of the name, should be condemned by all true naturalists.

There is, further, statutory protection — that which is afforded by game and wild-bird laws, close-times, &c.; and we would be glad to see these extended and enforced. There has lately been a wish expressed to have the Wild Birds Protection Act extended to St Kilda so as to prevent the extermination of what, one time plentiful, are now becoming rare birds there, because of the too great run upon them by collectors and others. During the past summer the "Wild Birds Protection (County of Zetland) Order" was put in force for the first time—an English clergyman being fined £3 for taking a couple of the eggs of the great skua and one egg of the sea eagle in the islands of Unst and Yell. These would have been expensive eggs (at the rate of 240s. per dozen, besides expenses) for an English vicarage; but the unfortunate collector was not permitted to retain what he had paid for so dearly, the Sheriff having "ordered the eggs to be delivered to the procurator-fiscal to be handed over by him to the Professor of Natural History in the University of Edinburgh to be disposed of as he thought fit in the interests of science." The loss of two great skuas and of one sea eagle *in posse* thus contributed £3 to the local treasury and three valuable specimens to the museum of our metropolitan university — so magnifying the law and advancing the interests of science by one judicial pronouncement.

The close-times include Sabbath protection for much that lives and has its being. Fish, for example, can rest during six days of the week and safely make a rush for the upper reaches on the seventh. In our own city's silvery stream—the Water of Leith—the trout enjoy, or are supposed to do so, by Act of Parliament, an uninterrupted freedom from October till March, and the same from March till October except on Wednesdays and Saturdays. Even then their liberties and their lives are endangered only by the privileged few anglers who have armed themselves with a permit for the day from our town-clerk. In this connection I would suggest for one of our excursions a visit to the hatchery in the bed of the river a little way down-stream below the Dean Bridge—the existence of which may be news to most of our citizens who do not know that we there rear our trout, literally, "on the premises," and which may be caught, like boot-repairing, "while you wait." The disciples of St Crispin do not indicate how long one has to wait for boot-repairing, but the disciples of Izaak Walton will find by experience how long they may have to wait on the banks of the Water of Leith for—even a nibble! Here are a couple of trout—a half-pounder and a quarter-pounder—I myself caught one morning before breakfast in that stream as it passes through the gardens in front of my house in Eton Terrace, within ten minutes' walk of Princes Street!

Again, there is also the well-known protection of colour, that being in keeping with the environment of the living creature—the tiger with its stripes in the rank growth of the jungle, the grouse among the heather, and the caterpillar on the green stalk being familiar instances. The "snake in the grass" has become a proverbial way of indicating a sneaking fellow who, concealing himself until close up, stealthily and suddenly strikes the unexpected blow. Colour-protection is adaptable, as in the hare and the ermine, which have each his summer coat of yellow reddish-brown and his winter coat of snowy white. The flounder—a type of the flat-fish—affords an excellent example of Nature adjusting colour to suit environment. When born it is of one and the same whitish colour on both sides and an eye on each—upper and lower. As it grows it settles down one side bottomwards and the other upwards, the lower side remaining white while the upper gradually becomes brownish. The eye on the lower side, not being required *there,* gradually works round to the upper side. Examples of more or less speckled flounders are not unknown, but these are probably energetic, active specimens of a too restless disposition, undecided as to which side to lie on and so allow the pigment cells to operate on the one side or the other rather than scatter in patches on both.

I would now merely mention another item of protection which we, with pleasant memories of our field excursions, cannot ignore—viz., that of natural scenery. In this connection I was glad to see it reported lately that "the French Minister of Public Works has sent to the chief State engineers a circular which shows that, while naturally anxious to provide means for the development of the country, he nevertheless sympathises heartily with the society for the preservation of picturesque sites and beautiful landscapes. He tells the chief engineers that, as it is frequently their duty to prepare plans for bridges, &c., they should bear in mind that edifices of that sort, if judiciously placed and properly surrounded, often enhance the beauty of the spot, and that a misplaced detail as frequently mars its picturesqueness. He knows that these are commonplace platitudes, but, as they are sometimes lost sight of, he requests the chief engineers to instruct their subordinates that, in the construction of roads, railways, and tramways, and the planting and felling of trees, &c., they should not lose sight of a proper respect for natural beauties, and should try, if possible, to enhance their æsthetic value." Would that all our public and private works were directed towards this preservation of picturesqueness and to the avoidance of the marring of the beauty of natural scenery! Those of you who were of our party that visited Peebles on 23rd July would remember, as we walked along the banks of the Tweed to Manorfoot, the beauty of the stone skew-bridge which spans the river at one of the most beautiful of its many lovely reaches to carry the railway over it to the tunnel through which the trains run into Peebles. That bridge was purposely designed to be somewhat in harmony with the natural beauty of the district. Unsightly red-painted iron girder-bridges mar the scenery to such an extent that all lovers of the beautiful — including naturalists — should join in petitioning Parliament to prohibit the erection of such eyesores.

In closing, I am led to refer to one more form of protection. Patient observers tell us that wild birds of the genus *Anser* are protected in their long flights against missing their goal, through the possible failure of vision or alertness on the part of their leader, by changing him several times during their journey. This wise instinct has its counterpart in, and affords protection tò, our Society, where the leader, or President, is changed from time to time—to his relief and to the great advantage of the membership. My time for retirement from leadership—from the Presidentship—and return to the back benches is now fully come. By your courtesy I have been permitted to serve a term of nine years' easy labour—three years as a member of Council, three as a Vice-President, and three as President. In now vacating the chair I desire to thank you all for having made the discharge of my duties so pleasant and so agreeable to me. I can hardly recall a discordant note in our Council or in our sessional or field meetings. To you, and especially to our excellent secretary Mr Williamson, I owe my good fortune in being able to leave this chair with the Society in a happy and prosperous condition. My last word is—May it long continue so to prosper!

ANNUAL BUSINESS MEETING.

THE annual business meeting of the Society was held in the Hall, 20 George Street, on the evening of Wednesday, October 26th, 1904 — the retiring president (Mr Archibald Hewat, F.F.A.) in the chair. A paper entitled "Remarks on Glœocapsa" was read by Mr G. T. West (see *ante*, pp. 130-133); and a "List of alien plants gathered during 1903 and 1904 in the neighbourhood of Edinburgh by members of the Society" was submitted by Mr James Fraser and Mr James M'Andrew (see *ante*, pp. 134-141). The President exhibited specimens of trout caught by himself in the Water of Leith; Mr James Fraser, specimens of dodder found growing in the neighbourhood, and some Continental and Eastern grasses; and Mr James L. Gray, Natural History and other objects from Sumatra.

The Secretary then read his report, as follows:—

During the winter session 1903 and 1904 there have been held six indoor meetings of the Society, and the large attendances testify to the interest taken in these meetings. Through the good offices of Councillor David E. Young, an opportunity was given to members interested to visit the Cable Power Station, the Fire Brigade Station, the Electric Lighting Station, and the Gas Works at Granton.

For the summer session nineteen meetings were arranged, as follows:—

April	30.	Burntisland.
May	4.	North Queensferry.
"	14.	Culross.
"	18.	Pinkie.
"	24.	Holy Island (Lindisfarne).
"	28.	Longniddry to Aberlady.
June	1.	Carlowrie.
"	4.	Thornielee to Selkirk.
"	11.	Blairadam.
"	15.	Ravelston.
"	25.	Glencorse.
"	29.	Hunters' Tryst and Redford.
July	2.	West Kilbride to Fairlie.
"	9.	Gorebridge and Carrington.
"	13.	Cramond Island.
"	23.	Peebles.
"	27.	Craigmillar.
Oct.	1.	Penicuik.
"	8.	Hamilton Low Park.

Of these the excursion to North Queensferry had to be abandoned owing to unavoidable circumstances, and those to Longniddry and Carlowrie owing to very wet weather. The average attendance at these meetings was 29.

In addition to the foregoing, two special meetings were held—one on June 7, to visit the Canongate Tolbooth, Canongate Kilwinning Lodge Room, Canongate Church, and Moray House; and on July 6, to visit the Chapel of St Mary Magdalene, Bailie Macmorran's House, and the City Museum. 79 members attended these two meetings.

Since the last annual meeting five members have died — viz., Captain J. H. Fairley, Mr Allister Murray, Mr Lockhart Thomson, Mr Robert Gray, and Mr Frank Ross Mackenzie,—the last two, shortly after being admitted members. 22 members resigned and 35 new names have been added to the roll, making a total ordinary membership as at 1st October 1904 of 241,—an increase of 8 over last year.

One of the honorary members has died, and 1 new honorary member and 7 new corresponding members have been elected during the year.

Meetings of the Microscopical Section were held at the house of the Convener, Mr James Russell. Mr R. A. Staig, of the Natural History Department, Glasgow University, conducted the meetings devoted to zoological work, and instructed the members in dissection.

The Treasurer submitted his report and statement of income and expenditure for the past year, copies of which were already in the hands of members.

Mr Russell, Convener of the Microscopical Section, referred shortly to the work accomplished during the session, and expressed the great indebtedness of the Section to Mr R. A. Staig of the Natural History Department of Glasgow University, who had acted as Demonstrator during the greater part of the session.

A proposal from the Cryptogamic Society of Scotland for helping to diffuse a knowledge of local cryptogamic botany was submitted by Mr W. C. Crawford. The Cryptogamic Society, it was explained, is at present preparing a series of lantern slides to illustrate the genera and sub-genera of conspicuous fungi: they hope these will be of use to societies occupied with nature study, particularly before or after their autumnal fungus excursions. The Cryptogamic Society also suggests that joint excursions may be held with this Society. Later it is expected that other groups of cryptogams will be similarly illustrated.

The retiring President then delivered his address (see *ante,* pp. 148-155).

The election of office-bearers and councillors was then proceeded with, the recommendations of the Council being approved of. The following is a complete list, the names printed in italics being those of members elected to fill vacancies: President, *James Russell;* Vice-Presidents, John Lindsay, James A. Terras, B.Sc., and *William Williamson;* Secretary, *John Thomson;* Treasurer, Geo. Cleland; Editor of 'Transactions,' Dr Davies; Auditors, R. C. Millar and *Chas. Campbell;* also the following councillors: W. C. Crawford, Bruce Campbell, A. D. Richardson, David E. Young, Miss Mitchell, Miss E. M. H. Gray, James M'Andrew, *Rupert Smith*, *Miss M. G. Anderson*, *Miss Sprague*, *A. G. Stenhouse*, and *G. M. Brotherston.*

The newly elected President, having taken the chair, briefly thanked the Society for the honour conferred upon him; and the proceedings terminated with cordial votes of thanks to the retiring President and Secretary, and to the Convener of the Microscopical Section.

STATEMENT OF INCOME AND EXPENDITURE FOR YEAR TO 17th OCTOBER 1904.

INCOME.

To Balance from last Account			£23 15 2
" Annual Subscriptions for Session 1903-1904		£46 10	
" " 1904-1905		0 5	
" New Members, 1904-1905		4 10	
			51 5 0
" Arrears of Subscriptions— Amount outstanding, 16th Oct. 1903		£5 0	
" irrecoverable	£1 0		
" still outstanding	1 10		
		2 10	
			2 10 0
" Donation for Publication Fund			0 17 6
" 'Transactions' sold			1 6 0
" Interest			0 17 4
			£80 11 0

Arrears of Subscriptions outstanding—

Session 1902-1903	£1 10 0
Session 1903-1904	6 5 0
	£7 15 0

EXPENDITURE.

By Rent of Hall for Meetings, &c.	£6 2 6
" W. Blackwood & Sons—Printing 'Transactions,' Billets for Meetings, &c.	28 6 3
" Advertising Expenses	5 1 0
" Hire of Lantern, &c.	2 12 6
" Gratuities to Hall-keeper and at Excursions	0 14 0
" Stationery	1 11 11
" Secretary's Outlays and Postages	6 8 8
" Treasurer's " "	0 16 8
	£51 13 6
" Balance due by Bank of Scotland	28 17 6
	£80 11 0

PRIZE FUND.

To Balance from last Account	£5 0 0	*By* Balance due by Bank of Scotland	£5 0 0

GEO. CLELAND, *Hon. Treasurer.*

17th October 1904.—We hereby certify that we have audited the foregoing Statements of Income and Expenditure, and found them correctly stated and satisfactorily vouched, the balance in favour of the Society being Thirty-three pounds, seventeen shillings, and sixpence sterling.

R. C. MILLAR,
J. T. MACK, } *Auditors.*

PRESENTED
12 DEC. 1904

THE EDINBURGH FIELD NATURALISTS' AND MICROSCOPICAL SOCIETY.

COUNCIL, 1903-1904.

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241 Young, David E., 60-62 High Street.

VOL. V. PART III.

TRANSACTIONS

OF

The Edinburgh Field Naturalists' and Microscopical Society

SESSION 1904-1905

CONTENTS.

Published for the Society

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SESSION 1904-1905.

I.—*YARROW: ITS LITERATURE AND ROMANCE.*

By the Rev. ROBERT BORLAND, F.S.A.(Scot.)

(*Communicated Nov. 23, 1904.*)

There are two points of view from which we might survey the subject of our lecture this evening. We might deal with it from the historical standpoint, and trace the stream of the Yarrow literature and tradition from the earliest times down to the present day, paying special attention to the old ballads associated with the valley,—a body of literature unique of its kind. But I have thought it well on the present occasion to adopt what may be called the topographical standpoint. There will be thrown upon the screen views of many of the more interesting historical places, and around these I shall endeavour to weave the literary associations of the ballad-haunted Vale.

We begin at Philiphaugh, a house for generations intimately associated with the Murray family, of yore one of the most powerful on the Scottish Border, and of which more anon. The property is now in the possession of William Strang Steel, Esq., by whom it has been greatly improved. It was here the famous battle took place between Leslie and Montrose in the autumn of 1645. Montrose had at one time been an ardent Covenanter, but for some reason or another he joined the Royalists, and threw the whole weight of his influence against his quondam friends. He had raised a considerable army in the North, made up of Highlanders and Irish; and Leslie, who had been at the battle of Marston Moor, hearing that he was proceeding towards the Lowlands, hurriedly left England with a considerable body of troops, in order if possible to intercept him before he crossed the Forth. On coming into the neighbourhood of Edinburgh, he learned that Montrose and his men were encamped in Ettrick Forest. He crossed over Soutra Ridge and marched down the Gala Water, spent the night at Melrose, and early in the morning made all possible haste to Selkirk. The Royalist troops were completely taken by surprise, were thrown into disorder, and fled in all directions. Montrose arrived too late on the scene to save the day; hardly indeed was he able to save his own life. He galloped as fast as his horse could carry him up the Yarrow, and over Minchmoor to Traquair, where he found temporary shelter. Some of his troops were caught in a trap in the vicinity of Newark Castle, and put to death in cold blood. The only excuse that can be made for this wanton slaughter is that the Royalists would have served the Covenanters in the same fashion had the fortune of battle reversed the situation. Opinion may still be divided in regard to the Covenanting movement,—there were probably faults on both sides,—but the result, most unprejudiced critics must admit, has been favourable alike to religious and civil liberty.

> "The Solemn League and Covenant
> Cost Scotland blood, cost Scotland tears;
> But it sealed Freedom's sacred cause:
> If thou'rt a slave, indulge thy sneers."

Opposite Philiphaugh stands the modern mansion of Bowhill—"sweet Bowhill," as Sir Walter called it. Near the house an interesting experiment has been carried out that has a special interest for such a Society as this. Some seventy or more years ago there was a good deal of speculation as to whether trees would grow of their own accord on the hills in the district. The late Duke of Buccleuch, in order to put the matter to the test, enclosed 300 acres of a bare hillside. In a comparatively short time trees began to make their appearance, and now it is nearly all covered with beautiful specimens of the trees belonging to the district.

In the policies of Bowhill, close to the river bank, is the famous Newark Castle, for generations used as a royal hunting-seat. The present tower was built in 1466, but it is supposed that it took the place of one belonging to a much earlier period. It is a noble and massive pile, and is in excellent preservation. It is said that when the late Duke of Buccleuch was a minor his trustees took down part of this historic keep in order to build a farm-house in the immediate vicinity. It was a piece of unpardonable vandalism. But no sooner had his Grace come of age than he tore down the farm-house and had every stone belonging to the castle replaced with pious care. All honour to his memory! Could these walls speak, they would relate many a strange and stirring tale of Border feud and foray. Here Sir Walter Scott laid the scene of "The Lay of the Last Minstrel." The Harper

> "pass'd where Newark's stately tower
> Looks out from Yarrow's birchen bower:
> The Minstrel gazed with wishful eye—
> No humbler resting-place was nigh;
> With hesitating step at last,
> The embattled portal arch he pass'd,
> Whose ponderous grate and massy bar
> Had oft rolled back the tide of war,
> But never closed the iron door
> Against the desolate and poor."

"J. B. Selkirk," a name which will long live in Border literature, has also laid the scene of one of his best poems at Newark. In his "Song of Yarrow" he sings—

> "September, and the sun was low,
> The tender greens were flecked with yellow,
> And autumn's ardent after-glow
> Made Yarrow's uplands rich and mellow.
>
> Between me and the sunken sun,
> Where gloaming gathered in the meadows,
> Contented cattle, red and dun,
> Were slowly browsing in the shadows.
>
> And out beyond them Newark reared
> Its quiet tower against the sky,
> As if its walls had never heard
> Of wassail-rout or battle-cry.
>
> O'er moss-grown roofs that once had rung
> To reiver's riot, Border brawl,
> The slumberous shadows mutely hung,
> And silence deepened over all."

On the other side of the river, right opposite Newark, may be seen the ruined homestead where Mungo Park, the great African traveller, was born. He achieved world-wide fame by his gallant efforts to explore the Niger. He was born in 1771, and died in 1805. His wife, who survived him many years, could never persuade herself that he had perished, and looked for his return till her dying day. Park studied medicine, and practised his profession in Peebles, where he won the esteem and affection of the community in a singular degree. It is recorded that when he returned from his first visit to Africa, Sir Walter Scott, who was then living at Ashiestiel, on the Tweed, came over to see him, and found him standing on the banks of the Yarrow dropping stones into a pool. Sir Walter playfully remarked, "This is a fine occupation for a great African traveller." To which Park replied that it was in this way he discovered the depths of the streams in Africa, as owing to their muddy condition one could never see to the bottom of them. Park visited Scott before he set out on his last expedition to the dark continent, and spent a night at Ashiestiel. Next morning his host accompanied him homewards over the wild chain of hills between the Tweed and the Yarrow. Park talked much of his new scheme, and mentioned his determination to tell his family that he had business for a day or two in Edinburgh, and send them his blessing from thence, without returning to take leave. The autumnal mist floating down the valley of the Yarrow presented to Scott's imagination a striking emblem of the troubled and uncertain prospect which his undertaking had afforded. Reaching the spot where they had agreed to separate, Park's horse stumbled and nearly fell. "I am afraid, Mungo," said the Sheriff, "that is a bad omen;" to which he answered, "*Freits* follow those who look for them." In a few moments these two friends had parted for the last time on earth.

About half-a-mile beyond Park's birthplace we come to the mansion-house of Broadmeadows, standing on a plateau above the river, and commanding a magnificent view of Newark and of the country beyond. Before Scott built Abbotsford he had a great ambition to become the laird of Broadmeadows, but he failed to secure the much-coveted prize. It was unfortunate.

Here he would have been surrounded by large proprietors, and he would have found it difficult, if not impossible, to enlarge his boundaries; whereas at Abbotsford he was surrounded by small lairds who were only too ready to sell at the exorbitant prices Scott was prepared to offer.

A mile farther up the valley we come to Hangingshaw, where erst the Outlaw Murray lived in regal state. The story of the "Outlaw" is a fascinating one, but how much of it, as recorded in the well-known ballad, is authentic history, it is difficult to say. But tradition tells that the "Outlaw" ruled over a wide domain, and exercised his authority in a kingly fashion. In those days the Border chiefs were wont to set both king and government at defiance. They openly spoke of the monarch as "King of Fife and the Lothians," but refused to acknowledge his supremacy over the Border clans. They were a people by themselves, and resented everything in the shape of regal authority. They lived "in peace of mind,"—

> "For why?—because the good old rule
> Sufficeth them, the simple plan,
> That they should take, who have the power,
> And they should keep who can."

But the "Outlaw" had ultimately to reckon with his Sovereign. The king came down, attended by a large retinue, and summoned Murray into his presence to give an account of his stewardship. This, for a time, he resolutely refused to do.

> "'Thir lands are mine,' the Outlaw said,
> 'And I ken nae king in Christendie:
> Frae Soudron I this forest wan,
> When the king and his men were not to see.'"

By-and-by, however, he made his submission, and he and his heirs were appointed hereditary sheriffs of the county. It is an interesting incident, and, whether historical or not, reflects faithfully the social conditions of that period of Border history.

It is said that at the door of the castle a tub of good brown ale was placed, and replenished every morning, and every wayfarer was in honour bound to drink the contents of a capacious ladle with which the refreshing beverage was dispensed.

We pass now to another phase of the fascinating story. In the neighbourhood of Yarrow Kirk, near the picturesque "broken-down brig" (Plate XVI.), there stood a "keep" of the Outlaw Murray, and under its shadow and protection was the chapel of Deuchar. By some it has been supposed that it was here Sir William Wallace met the Border chiefs, and was by them recognised as the Warden of Scotland. Wallace's trench is on the Lewinshope ridge, not far away. It was a fitting place and convenient centre for such a meeting.

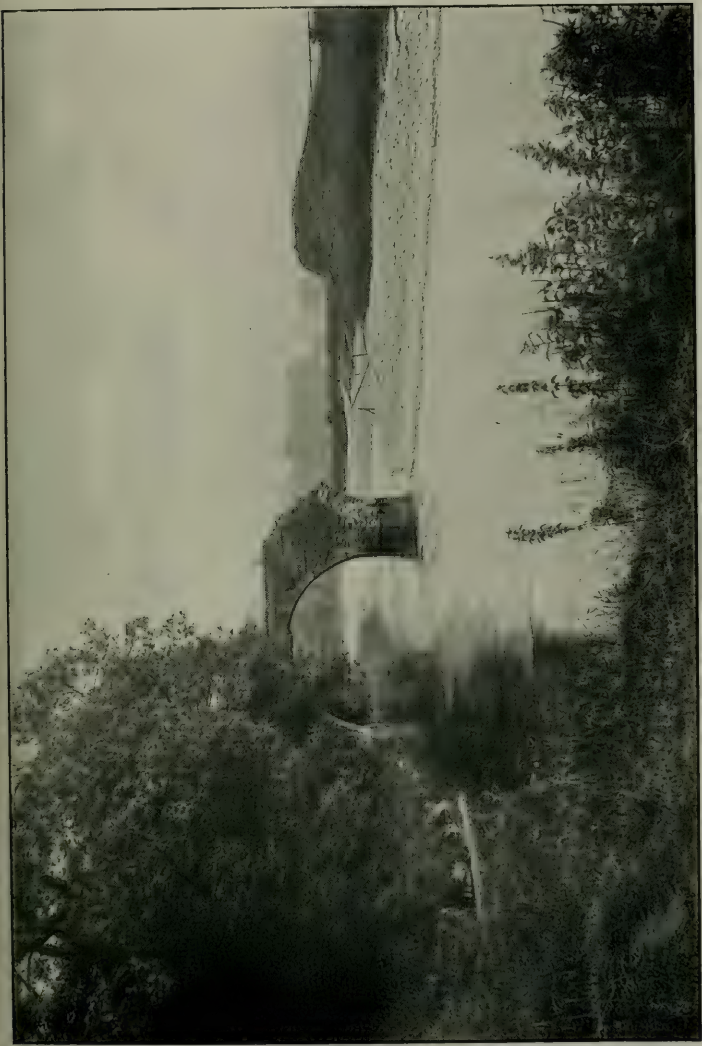
Yarrow Kirk is near by (Plate XVII.) It was removed from St Mary's, eight miles farther up the valley, in 1640, and the old bell of Deuchar Chapel was hung in the belfry of Yarrow Church, and to this day it calls the people to worship. This church has gathered around it, in the course of the years, many interesting associations. Sir Walter Scott's great-grandfather was minister of Yarrow for nineteen years: born 1641, ordained minister of Yarrow 1691, died 1710. His son, the famous Prof. Rutherford, familiarly known as "The Yarrow doctor," was one of the first men to bring the Edinburgh medical school into something like European fame. He composed the Latin inscription on his father's tombstone, which takes the form of a mural tablet in the north wall of the church. It may be translated thus:—

> "To the memory of the Rev. Dr John Rutherford, minister of Yarrow, most upright and most vigilant: And to Robert his son, in his fourth year. Christiana Shaw, his mourning wife, was careful to erect this monument. Died May 8, 1710, in the 19th year of his ministry, and 69th of his age.
>
> "Thou wast a faithful pastor, a beloved brother, a sure friend, a gentle master, a genial husband and father. Having laid aside the gift of an upright and pure life, thou hast yielded to the fates. Thy years passed happily. O, thrice blessed! thy fame is above the high hills and the green banks of Yarrow, thy soul above the stars."

Prof. Rutherford, the son of the minister, was the father of Mrs Scott, Sir Walter's mother.

After an interval Dr Lorimer, who was for twenty years minister of Mouswald, became minister of Yarrow, being succeeded in course of time by Dr Cramond, who died in 1791. In that year Dr Robert Russell became minister of the parish, being succeeded by his gifted son, Dr James

PLATE XVI.—YARROW: ITS LITERATURE AND ROMANCE.



THE "BROKEN-DOWN BRIG."

YARROW KIRK.

Russell, in 1847, who died 1883,—father and son having thus been ministers of the parish for the long period of ninety-two years.

A curious incident happened in the parish at the Disruption. At that time the shepherds brought their dogs to church with them, and as an old shepherd once remarked to me, "The dogs were desperately fond o' gaun to the kirk." An old elder, along with many others, joined the Free Church, but on Sundays he never could get his dog to go past the Auld Kirk! He tried all kinds of methods, but at last had to give it up. Laughingly I said to the son of this old man one day, when he told me the story, "It must have been a very foolish dog, John." Not noticing the twinkle in my eye, he replied, very seriously, "Na, man, it wasnae that. I think if it hadna been so wise my father would have shot it." Evidently dogs are sometimes very conservative.

Near Yarrow Kirk there are three druidical stones, or fanes; and in the fields, which now form part of the glebe, there were at one time some twenty cairns, probably also associated with the druidical worship, as the Celtic word for priest is derived from carn, or cairn.

But the "standing stone," or rather "inscribed stone," in a field about half a mile from the church, is an object of great interest to the antiquary. It was turned up on the hillside in 1803, and was carefully studied by Sir Walter Scott, Dr John Leyden, Mungo Park, and others, but they did not succeed in making much of the inscription. Scott had a theory of his own, which he published in the second edition of his 'Border Minstrelsy.' The place where the stone was found, and where it now stands, was known as Annan Street, the old Roman road to Annan. But Scott said this was a mistake. He was of opinion that the stone commemorated the tragedy of "The Dowie Dens," and that the place should be known as "Annan's Treat,"—a euphemism, I suppose, for the dastardly deed which put a period to the life of the hero of the ballad. My predecessor, Dr James Russell, was really the first to decipher part at least of the inscription, though it is only within the last year or two that the whole inscription has been made intelligible, thanks mainly to Principal Rhys of Oxford. The inscription runs thus:

"Here to the memory . . . of the most illustrious Prince Nudus of the Dumnogeni. Here also in the barrow lie the two sons of liberalis." The stone stands almost on the line of the Catrail, which is supposed, and on good grounds, to be the old boundary line between the Angles of Bernicia and the Britons of Strathclyde; and the tradition is that here a great battle was fought at the close of the sixth century between these two peoples. Roderick Hael, who was king of the Britons of Strathclyde at that time, was known as "the liberal" (and whose Welsh name is Nud), and it is supposed that this stone commemorates his two sons who here fell in battle. It is the oldest British inscribed stone in the country. A cast of it is in the Edinburgh Museum of Antiquities.

Again we pass to another phase of our story. Near the Gordon Arms is the site of the old farmhouse of Mount Benger. Here Hogg lived for several years, doing his best to earn a competency, but with indifferent results. To speak truth, he was but a poor farmer. His heart was not in the business. He had given himself to literature. Had he succeeded as a farmer we might not have known much of him as a poet. He dispensed a lavish hospitality. It was during Hogg's tenancy of Mount Benger that Wordsworth first visited Yarrow. This was in the year 1814. He had been at Clovenfords, but he would not turn aside at that time to view the far-famed valley. We are grateful, however, for his "Yarrow Unvisited," in some respects the best of his "Three Yarrows." It is often said that when Wordsworth first saw Yarrow from the height above Mount Benger he was disappointed.

> "And is this Yarrow?—*this* the stream
> Of which my fancy cherished,
> So faithfully, a waking dream?
> An image that hath perished!"

It is quite possible—nay, almost natural—that his first feeling should have been one of disappointment. Yarrow does not disclose her beauties to the first gaze, even of the poet. You must live in Yarrow; Yarrow must live in you, before you can appreciate its indescribable glamourie. But if Wordsworth's first impression was not altogether favourable, his final feeling was one of intense admiration and satisfaction.

> "But thou, that didst appear so fair
> To fond imagination,
> Dost rival in the light of day
> Her delicate creation."

In a poem which he wrote after Hogg's death, he makes beautiful allusion to the two visits which he paid to the valley—first in the company of Hogg, and on the second occasion, in 1831, under the guidance of Scott.

> "When first, descending from the moorlands,
> I saw the stream of Yarrow glide
> Along a bare and open valley,
> The Ettrick Shepherd was my guide.
>
> When last along its banks I wandered,
> Through groves that had begun to shed
> Their golden leaves upon the pathways,
> My steps the Border Minstrel led.
>
> The mighty Minstrel breathes no longer,
> 'Mid mouldering ruins low he lies;
> And death upon the braes of Yarrow
> Has closed the Shepherd-poet's eyes."

At the Gordon Arms Hogg and Scott met for the last time on earth. Hogg died at Altrive Lake in 1835, and is buried in Ettrick churchyard.

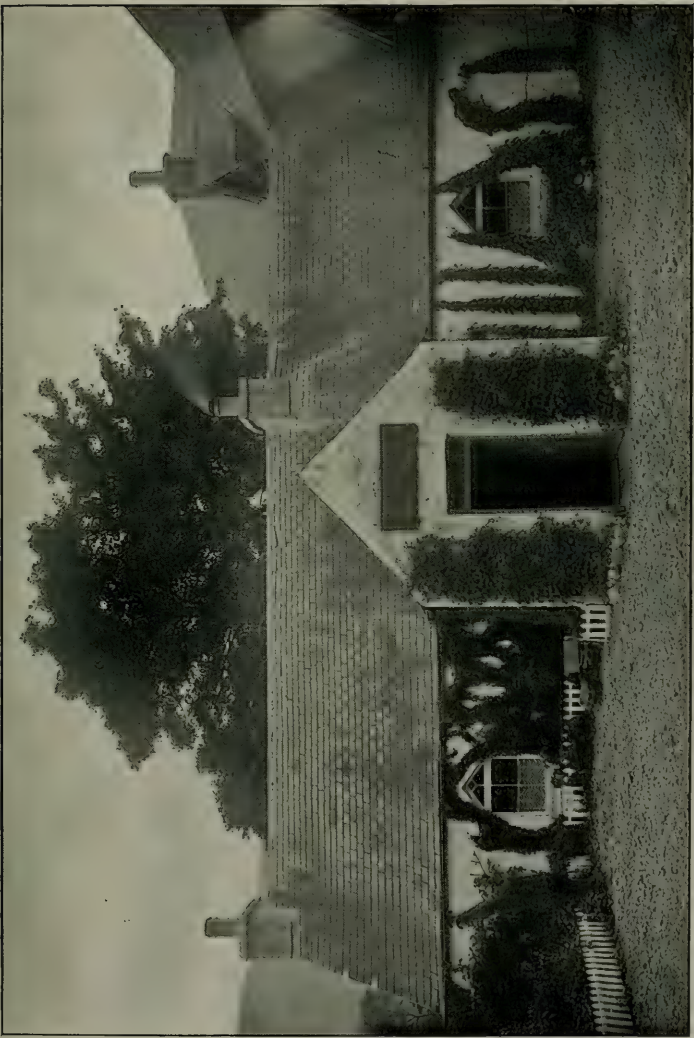
A mile beyond the Gordon Arms we pass the Douglas Burn, the scene of "Lucy's Flittin'." It was at Blackhouse, on the Douglas Burn, where Hogg was shepherd for a good many years, and where he first began to exercise his gift as a writer of verse. The associations of this part of the parish are full of interest, and well fitted to kindle the imagination of the budding poet. Dryhope Tower looks out from the hope under the hill, and suggests memories of feud and foray. Here Mary Scott, the Flower of Yarrow, was born and reared; and here Wat o' Harden woo'd and won her, stipulating with her father that he should keep him in horse meat and man's meat for a year and a day after the marriage as part of the dowry. And yonder, on the farther shore of "lone St Mary's silver lake," is Bowerhope, most pleasant of abodes. The old farmer, when dying, said to his minister, "Commend me to Bowerhope. I could tak' a lease o't to a' eternity," adding, after a short pause, "provided I got it at a reasonable rent." And what memories cluster around Tibbie Shiel's famous hostelry (Plate XVIII.)—the rendezvous of Hogg, Wilson, Edward Irving, and many another known to fame in the various walks of life! Well may we say, in the words of Principal Shairp,—

"High souls have come and gone,
And on these braes have thrown
The light of their glorious fancies,
And left their words to dwell
And mingle with the spell
Of a thousand old romances.

And we who did partake
By still St Mary's Lake
Those hours of renewed communion,
Shall feel when far apart
The remembrance at the heart
Keeps alive our foregone soul-union.

From this world of eye and ear
Soon we must disappear;
But our after-life may borrow
From these scenes a tone and hue
When all things are made new
In a fairer world than Yarrow."

PLATE XVIII.—YARROW: ITS LITERATURE AND ROMANCE.



TIBBIE SHIEL'S.

II.—*HYPOCREA RICCIOIDEA*, Berk.

By Mr JAMES M'ANDREW.

(*Read Dec. 21, 1904.*)

My object in exhibiting and directing your attention to this exceedingly rare and interesting fungus is that perhaps in our excursions some member may be fortunate enough to gather it. As there are many places round Edinburgh suitable for its growth, there is no reason why it should not be found. It grows on dead willow in damp marshy places, and when in vigorous growth forms conspicuous patches of a fleshy, orange, and lobed appearance like a Riccia. I gathered it near New Galloway in 1878, sent it to the late Rev. Dr Stevenson of Glamis, who, not knowing the species, forwarded it to the late Rev. M. J. Berkeley, who wrote to 'The Gardeners' Chronicle of April 27, 1878, the following note:—

"The Rev. John Stevenson has just sent from Glamis on a branch of willow the *Sphæria riccioidea*, Bolton, which has, we believe, not been found in this country since 1790. Both the Fig. and description of Bolton, as far as they go, are excellent, even to the greenish matter on the older portions of the fungus. It was found in the autumn of the same year by Tode, who gives a Fig. of it under the name *Acrosperma lichenoides* in his 'Fungi of Mecklenburg.' Mons. Lamy found it near Limoges, and a Fig. was given from his specimens by Dr Montagne in 'Annales des Sciences Naturelles' for 1836, who did not, however, identify it with the plant of Bolton. These, we believe, are the only occasions on which this rare and interesting species has been found, and its re-occurrence, therefore, is worthy of record. It belongs to the modern genus *Hypocrea*."

Dr Stevenson sent the above note to 'The Scottish Naturalist' of July 1878, and adds that I had sent him sufficient specimens to admit of its being included in the First Fasciculus of the Cryptogamic Society of Scotland.

Dr M. C. Cooke, in his 'Handbook of British Fungi,' gives Halifax as a locality for it, but whether of the date 1790 or not is not mentioned. I may say that I gathered it in four different localities in the neighbourhood of New Galloway, in the centre of Kirkcudbrightshire.

III.—*RECENT VIEWS REGARDING CORAL REEFS.*

By Mr GOODCHILD
of the Geological Survey, Royal Scottish Museum.

(*Read Dec. 21, 1904.*)

There is a very close resemblance between the animals that build coral structures and the common types of Sea-Anemone. Coral polyps, however, secrete some kind of hard matter out of the sea-water in which they live, and that structure remains after the death of the animal; whereas a Sea-Anemone leaves no such hard structure behind after death. In the best known types of corals (for there are at least four great groups of such organisms) the durable matter referred to consists mostly of carbonate of lime. In some of the less known groups the structures are horny, or even leathery, in consistency; but with these we have here no special concern.

The history of the carbonate of lime just referred to possesses many points of interest, some of which deserve notice here. In this connection it may be well to state at once that the carbonate of lime which forms the stony matter which is usually regarded as "coral" is not taken directly from the carbonate of lime in sea-water, as one might naturally have thought would be the case, but is made out of the sulphate. Some figures bearing upon this matter may usefully be given here. Most of them are taken from the results of the *Challenger* Expedition and from various papers by Sir John Murray. The quantity of carbonate of lime present in sea-water is extremely small. On the other hand, the quantity present in river-water, basing that estimate upon the average presented by nineteen principal rivers of the globe, is 326,710 tons per cubic mile of the river-water. It may be remarked here that, as regards the present-day source of that carbonate of lime, it is derived chiefly from the limestones on the land; though basic eruptive rocks, by their decomposition, still furnish part of the materials, and doubtless at an early period of the Earth's history they supplied nearly the whole of it. From both the limestones and the basic eruptive rocks the lime is being liberated now, as it was also in the past, through the action upon these rocks of surface-water charged with weak solutions of the humus acids. These acids originate through the action of bacteria upon decomposing vegetable matters.

The average percentage of salts held in solution by the nineteen representative rivers of the globe just referred to includes also 34,361 tons of sulphate of lime per cubic mile of the river-water. Comparing the sulphate with the carbonate,—*i.e.*, 34,361 to 326,710,—these stand about as one to nine. That is to say, river-water holds about nine times as much of the carbonate as it does of the sulphate. It may be well to add further that the percentage of magnesium to calcium in river-water stands about as one to three.

In striking contrast to the figures just given are those which relate to the relative percentages of the same substances as those mentioned when we have sea-water of average composition under consideration. There is practically no carbonate of lime in a cubic mile of sea-water. On the other hand, the percentage of the sulphate is enormously increased in proportion. Each cubic mile of sea-water holds in solution no less than 5,437,000 tons of the sulphate of lime, instead of the 34,361 tons in the same quantity of river-water. In the present case, therefore, the proportion stands thus: 34,361 to 5,437,000, which is as 1 to 158·22, or nearly as 160 to 1. The proportions of magnesium to calcium are also reversed, being in sea-water as 3·85 to 1, instead of the 1 to 3 as it is in river-water. I may perhaps be permitted to remark regarding this that, in a paper read before the Royal Physical Society in 1889 (see "The Paste of Limestones," 'Geol. Mag.,' III., vol. vii. pp. 73-78), Sterry Hunt's statement that "if a solution of carbonate of lime in carbonated water be mixed with a solution of sulphate of magnesia in water, double decomposition ensues, and carbonate of magnesia and *sulphate of lime* are formed," affords us the clue to what happens. The carbonate of lime, transported ceaselessly by rivers from the rocks of the land, does not reach the waters of the sea in that form, but is changed into the sulphate at the confluence of the two waters. It is therefore from this latter source that marine organisms, including coral polyps, secrete the carbonate of lime of which their hard structures mostly consist. I used to teach this in my geology classes in London in 1887-88, but it is only right to mention that the point was not definitely proved until Messrs Irvine and Woodhead conducted their now well-known experiments bearing upon this matter, which were published in the 'Proc. Roy. Soc. Edin.,' vol. xvi., to which the reader may well be referred. The authors just named show that marine animals which secrete carbonate of lime structures get that carbonate chiefly from the sulphate, as mentioned above. In the case of the coral polyp the animal pumps in sea-water into its body-cavity, sifts out of that water what is to be had in the way of food, extracts oxygen for respiratory purposes, and takes in some of the sulphate of lime. Within the animal this latter-named salt is converted into an emulsion, which forms a kind of lime-soap, and out of this there eventually is formed carbonate of lime. This collects within what may be termed the "skin" in the lower part of the body, close to the base of attachment to the rock. It accumulates at first as a mere film, whose shape is regulated by that of the animal's body at that part. But as time goes on this film thickens into a cushion,—still moulded on the plan of the basal parts of the animal,—and this, eventually, into a gradually lengthening column. This structure from first to last bears the impress of the structural characters of the polyp, of whose basal portion, indeed, this stony matter may well be regarded as a cast in carbonate of lime. Thus it is that the corallum of a coral polyp is formed. There are, of course, many modifications in matters of detail; but the general idea of the animal building up a steadily lengthening column of carbonate of lime, which separates the animal farther and farther from its original base of attachment, will quite suffice for the purpose here in view. It may be remarked here that a most admirable and simply worded description of the growth of a coral, by one who knew his subject well, will be found in Martin Duncan's edition of Cassell's Natural History.

So far as the larger divisions of corals are concerned, it may suffice here to group them into four chief categories. In the first of these the tentacles and the radiate parts of the animal run in sixes or multiples of six—whence these corals are referred to as the Hexacoralla. In an extinct group, abundantly represented by the corals found in rocks of Carboniferous age, there is more or less of what one may term right- and left-ness, and a front can be made out as distinct from the back. In these corals there is more or less tendency for the radiated parts to run in fours. So these are often referred to as the Tetracoralla. In another group, represented at the present day by the Sea Fans, the Precious Coral, the Organ-Pipe Coral, the Dead-men's Fingers, and some others less well known, the tentacles are eight in number, neither more nor less, and the tentacles are fringed. These corals are therefore referred to as the Octocoralla. Lastly, there is a group of corals of lower grade than these, in which the structure of the polyp resembles that of the Hydra more than the Sea-Anemone. These are called the Hydrocorallinæ. They are well represented by the existing Millepores. The first-named group and the last are those most concerned in building up coral reefs. The Millepores are of great interest from both a geological and a biological point of view.

Corals are all confined to marine habitats. So far as their relation to depth of water is concerned, it is well to remember that the several genera and species may range to various depths. Some are confined to the depth of quite a few fathoms, while others range to the deepest parts yet explored by the dredge. So far, again, as the temperature of the water is concerned, there are some corals which can live in water of almost icy coldness, while others cannot endure a temperature that falls below 68° Fahrenheit.

Again, so far as the mode of growth of corals is concerned, there is considerable diversity of habit. Some coral animals, like Sea-Anemones, never bud or branch, but remain simple or non-compound structures throughout their lives. Others—and these include the reef-building forms—branch to an almost indefinite extent, just as a tree buds and branches out of the parent plant. Both of these multiply by ova, regarding which more presently.

Adult coral animals are fixtures; but their ova are sent forth into the sea-water, where they hatch into fry endowed

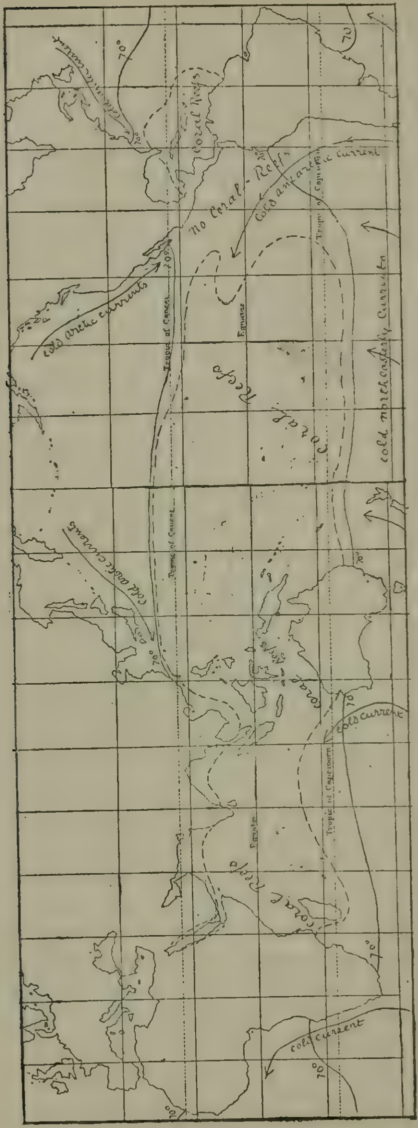


Fig. 1.—*Sketch-map of the areas occupied by coral reefs (which are enclosed within dotted lines). The isotherms of 70° F. are shown by the adjacent continuous lines; and the directions of the cold currents which affect the surface temperature of the sea-water are shown by arrows.—J. G. G.*, 1905.

with some small powers of locomotion. But their dispersion is accomplished chiefly by the action of surface currents, by which they are drifted hither and thither far and wide. The fry live mostly on minute vegetable organisms, which abound in the plankton of which the fry form a part. While in the immature stages they suffer a very high death-rate, which arises from many causes. To begin with, they are an important source of food to many other animals. They are liable to be drifted by surface currents to regions where the water is not salt enough, or not sufficiently free from muddy matter, or not warm enough, or not full enough of the food they need. The chief risk arises from their liability to be drifted into parts of the ocean where, at some time or other, the temperature of the water falls below 68° Fahr. It has to be remembered in this connection that, although the sun's rays at the same time of the year heat alike all the ocean water within the same latitudes, the final results are by no means uniform. The action of the prevalent winds in some cases, and of the Earth's easterly rotation in very many more, seriously affect the surface temperatures. It must be remembered that the great Antarctic basin is always chilling the sea-waters there to icy coldness, and that these waters slowly creep along the sea-bottom, flowing northward far beyond the Equator. As they travel they tend to rise to the surface. So nearly all the lower waters of the ocean have a temperature but little above the freezing-point, even where the surface-waters may receive all day the burning rays of a tropical sun. Now the Earth's rotation tends to bank up the surface-waters on the east side of the great land masses, and to make these surface-waters on the west side drift westward from the land. This latter cause facilitates the slow uprise of the nether waters. So there are cold Antarctic currents rising on the south-west of Australia, on the south-west of Africa, and on the south-west (or even all the west) of the continent of America. Consequently there is not a foot of the ocean surface on the west of either Africa or America where, at some time of the year or other, the temperature of the water does not fall below 68° Fahr. There are therefore no coral reefs on the west coast of either Africa or America. Nor are there any within several hundred miles of those coasts, for the reasons that have already been given. (See Sketch-map, p. 174.)

Then again, owing to the very slow rate at which heat travels downward through water, it is usually only in the first few fathoms of water well within the Tropics that the sea-water is warm enough for coral reefs to occur. There are certainly some few areas where a temperature exceeding 65° Fahr. extends to a depth of one hundred fathoms; but these cases are exceptional.

We may now follow the history of the young coral polyp to a later stage. Such of the fry as have successfully run the gauntlet of all the dangers above referred to reach the stage when they are to change to the adult form, and they begin to descend to the sea-floor. If they touch bottom on a submarine mound, well and good: there they will perch and grow up into coral reefs in due course. But the chances are ten to one against their being so fortunate, and they may find themselves on the way down to one of the great deeps, in which case no more is heard of them. Several individuals may be lucky enough to find the right spot together; in which case they begin to grow, at first upwards and outwards, until they get into touch with each other. Then their growth is limited to an upward direction. Arrived at the plane of high-water mark, they can grow no farther in that direction. Then begins a bad time for the corals near the centre of the colony. It is all very well for those on the outer edge of the reef, where myriads of hungry mouths are open ready to intercept what food the waves bring them. But those less fortunately situated have to be content with what they can get. The sea surf and the clouds of spray cast over them by the breakers bring them some food; but as the reef grows seaward these sources of supply become more and more precarious, and eventually get so much reduced that the corals can no longer hold out. So one by one the centrally situated corals die, while the vigorous young corals on the outer fringe of the reef thrive and constantly push seawards.

But the seaward extension of the reef soon experiences a check. The coral reefs extend seaward below the surface, and above a certain depth, which is regulated by the temperature of the water and by the food-supply. So they grow outward after a time as a shelf or rocky ledge, which cannot well extend very far seawards without some support beneath. This support is furnished by the blocks of coral that are frequently broken off by the heavy seas which pound and batter the outer edge of the reef. This destructive work of the sea is much facilitated by the fact that the reef is riddled through and through in all directions by the tunnels driven by various boring animals, which make their way into the solid substance of the reef in order to obtain shelter from their numerous enemies. So large blocks of coral are from time to time broken off, and they fall on to the slopes beneath the edge of the reef, where they help to form what one may term stepping-stones, upon which the growing corals gradually make their way farther out to sea.

The growth of a coral reef is only in part effected by corals. Much coral sand is cast up by the waves into the reef. The tiny shells of foraminifera accumulate there from the same cause. Numerous lime-secreting animals of various kinds live and die on a reef. All these contribute more or less to the accumulation of carbonate of lime, and the solvent action of surface-waters helps to reduce much of this matter to a fluid state, in which it serves to bind the loose parts of the reef into one hard compact mass, which may eventually become even crystalline in texture, and as close-grained as one of the limestones of the Carboniferous rocks. But the chief agent concerned in this cementing and compacting process, and therefore in the conservation of the reef, is that of the Millepores. These are lime-secreting algæ, belonging chiefly to the Florideæ, and they are represented mostly by the algæ of the genus *Lithothamnion.* Enormous quantities of carbonate of lime are fixed upon each reef by the action of these rock-forming plants. Indeed the Millepores may be regarded as taking a part in the construction of the reef but little inferior in importance to that played by the corals themselves.

The seaward growth of a reef tends, as time goes on, to leave the earlier formed corals farther and still farther removed from the source of food-supply. Hence these older portions of the reef after a time come to consist of little else than dead coral, unless, of course, subsidence lowers the reef and permits of the growth of a layer of new coral on the top of the old. Now a reef is a porous structure,—at all events in its earlier stages,—so that water, both rain-water and sea-water, readily finds its way into the reef. The sea-water, indeed, surges up and down with each great undulation of the sea outside. So a solvent action commences, and soon begins to make its action manifest upon the parts of the reef that have been longest open to attack. By slow degrees these older corals rot and go to pieces, and crumble away to such an extent under the chemical action of these waters that the fragments are easily washed out during a storm, or may even be removed by the winds. So in time it happens that a pool is formed over the part where the ancestral corals of the reef first came to the surface. It follows, therefore, that while the outer corals are steadily building their way seaward, the margins of a gradually enlarging and deepening pool or lagoon of sea-water follow up in their rear. The process forcibly reminds one of the growth of the well-known fairy-rings of our pastures. If the initial stages of the coral reef were commenced as a fringe to a large mass of land, the lagoon becomes a long strip parallel to the coast. If, on the other hand, the reef started on a submerged mound, the reef itself will grow into the shape of a ring, and the central pool will be roughly circular. It is this latter case which most people have in mind when thinking of the coral reefs of our story-books.

One of the commonest features noticeable in connection with coral reefs is the presence of masses of coral, in every respect like those which are forming now below the sea, at various levels high and dry above those which are now living. The elevated position of these upraised coral reefs is due, not to any fall in the level of the sea, but to intermittent uprises of the sea-floor upon which the corals grew. Our Scottish raised beaches, which are so well seen on the West Coast, or at Elie, or at Granton, are records of similar changes of level here within geologically-recent times. In Scotland the rise has been intermittent, with long pauses between each uplift. This appears to be the rule in most cases of the kind. But the uplift in some parts may be continuous—*i.e.*, without any stationary pauses between. This appears to have been the case in the south of England, where the evidence of uplift is quite clear, but where there are no rocky shelves carved on the shore-line, such as happen when the sea works for a long time on a coast-line not undergoing any elevation. Some coral islands which have been carried above sea-level by these terrestrial movements fail to show any trace of the terraces in question. But the majority show long lines of cliff, with their bases one above another, and with lines of sea caverns now situated far above the plane at which any such caverns could be wrought by the sea now. The importance of these terrestrial movements may be judged of from the fact that reefs of coral in no respect different from those now forming in the seas adjacent occur hundreds of feet above the level at which they were found, and in some few cases even more than a thousand feet up. The frequent association of these upraised banks of coral rising tier above tier to considerable elevations above the sea is a fact of considerable importance in connection with the modern views regarding the history of coral reefs in general. It is becoming quite clear to most persons who have thought well over the facts, that coral reefs, as a rule, are most common where the sea-bottom is undergoing elevation. There is no reason why corals should not grow in a stationary area, or even in one that is subsidiary, provided that the other conditions are suitable. But elevation, as a rule, seems to prevail.

There are many areas of upraised coral reefs in which the base of the reef is exposed, and in which, therefore, the nature of the foundation upon which the reef started can be examined. In several cases, as might be expected, the base consists of volcanic material, and it is evident that the corals perched upon the summit of a submarine volcano, which, with its crown of corals, has afterwards been upheaved into land. This coincidence of upraised coral reefs with volcanoes is not accidental, for there is a growing belief that volcanic action is chiefly caused by the heat generated by movements of upheaval of the Earth's crust; and further, access of sea-water to these heated areas supplies the other factors needed for the generation of eruptive rocks. But in the majority of cases that have been carefully investigated, the base of the reef has been found to consist of calcareous ooze—now a limestone—which has been formed on the sea-floor, and, in many cases, in deep water. The age of these deposits can be readily determined by means of their included organic remains, and the majority of them prove to be of comparatively recent origin. Most of them are of earlier date than the Age of Snow, but of later date than the volcanoes of Skye, Mull, Rum, Antrim, &c. This is to say, they are of Miocene, or even Early Pliocene, age. From this it is evident that the slow pulsations of the Earth's crust, which appear to be always in progress in one part or another, have gradually thrown the ocean-floor into parallel ridges and hollows; and upon the crests of the ridges, as soon as the elevation brought them high enough to reach the surface films of water at 68° Fahr., the corals have perched, and then built up their reefs in the way described.

It may be pointed out, in conclusion, that the evidence of recent upheaval of the ocean-floor applies especially to the Pacific Ocean. There is no need to advance any further arguments against the idea that the ocean basins and the Continental masses are in any sense permanent.

At this meeting Miss Beatrice Sprague contributed an interesting paper on "Flints from a Workshop of Neolithic Man," which was illustrated by a large number of specimens.

IV.—*SOME CHANGES IN THE AVIFAUNA OF THE SOLWAY AREA.*

By Mr ROBERT SERVICE, Corresponding Member.

(*Read Jan. 25, 1905.*)

The student of the faunal areas of Scotland finds it of interest and value to take stock from time to time. Such a balance-sheet will show in the course of even comparatively short intervals how great, and often how unexpected, is the amount of ebb or flow in the numbers of some particular bird. Such changes may be merely temporary, as, for instance, in the case of the garden warbler and the blackcap warbler during that gloomy season of 1903 when both species were everywhere with us in Solway in such numbers as had never before occurred in my experience. During that year of dark and dripping skies, there was a lucid interval in early June when the songs of these two birds formed a charming chorus of song which I am not ever likely to forget. So unaccustomed were folks to such an outburst of music, that to this cause must be attributed the strong allegations made from more than one district that the nightingale himself had crossed the Borders. On the present occasion, however, I do not wish to do more than mention such merely temporary changes,—what I am to describe are those of more permanent character.

First and foremost stands the very serious upsetting of the faunal balance caused by game-preserving. To it we have to attribute the entire disappearance of our native stock of the harriers, the golden eagle, and the osprey, none of which is ever likely to recolonise many most suitable spots in the south-west country; while many generations of the merlin, the sparrow-hawk, and the peregrine falcon, have probably been entirely killed out from time to time, the vacant places being filled from other areas. From some rather inexplicable cause we have had for some time past a decided recrudescence of the buzzard, kestrel, tawny owl, and long-eared owl. There can be little doubt in their case of a visible increase in numbers. The barn owl, one of the most interesting members of our native avifauna, has been slowly withdrawing from inland localities, and at present is to be found hardly anywhere else than along the cliffs of the shore-line. This bird never was to be reckoned as common with us, and was hardly so subject as the other owls to the attentions of the keeper, owing to its semi-domesticated habits which gave it a certain amount of immunity, but it is now gone from the precincts of most of the old mansions that it formerly frequented. An analogous change is that of the house martin, which has behaved in a precisely similar way. Formerly it was no uncommon sight to see from 20 to 30 pairs nesting on the walls of a single farmhouse and its adjacent steading, and that at the most remote inland localities. Nowadays, many such farm walls are tenantless, or at most have one or two pairs only. The diminution at places situated near the coast is not so marked, and at the great rock colony on the precipices of the Burrow Head the martins seem to be as numerous as ever. Perhaps some slow and obscure change of climatic conditions may be the reason for the withdrawal of the barn owl and the house martin shorewards. The chough, once comparatively numerous on the Galloway coast, has now, with perhaps a solitary exception now and again towards the Portpatrick direction, entirely disappeared. At one time I believed that the gun was the cause, but later and riper information induces me rather to lean to the opinion that here again we have some climatic reason at work. The jackdaw has been blamed, but so far I do not see the connection. In my own experience there has been an enormous extension of the jackdaw population along-shore. Numbers of them breed in rabbit-burrows, on hillsides, in hedgerow banks, and even on the flattest of merse fields, so that here again game-preserving comes in, by having provided lodgings for the jackdaws in the unfettered increase of the rabbit. Here might be mentioned some curious, and now well known, facts in the latterday life-history of the jackdaw's congener—the rook. We are all aware that the rook has come under the ban of the game-preserver. Formerly the rook was a staid and respected, if not respectable, member of the bird community. The rook used to attack grain- and root-crops, but these were the days of craw-herdin', and it was only by the exercise of unusual circumspection, or taking rapid advantage of the rare occasions when the youthful herds became drowsy and slept at their posts, that the sable-coated gentry had a chance of doing damage. At other times the rooks were destroying untold quantities of grubs and noxious insects.

Then about the advent of the early 'Seventies the whole rook population came under the influence of a great change of habits. Eggs of all kinds, young birds, small rodents, young rabbits, chickens, and ducklings were devoured as greedily as ever the carrion-crow did the same thing. So, of course, the gamekeepers were everywhere up in arms against the rooks, with the usual result. The whole subject of this curious change of habits and its consequences might easily provide facts for a lengthy communication, but it may suffice to say at present that our rook population in Solway has been reduced by considerably more than one half,—many of the largest rookeries are without a single nest left, and all remaining have been reduced in numbers.

One of the reasons given for this singular assumption of bad habits is the very probable one (in fact, it may be taken as proven), the taking of the rook's usual food of insects and vermiform animals by the immense hordes of starlings that now everywhere exist. Since I can remember, the starling was a very scarce bird indeed, and those not much older than myself remember it as very rare or altogether unknown. By about 1870 it began to increase at a rapid rate, and one wonders now where all its vast numbers find a living. Some interesting modifications in its habits are being evolved as it gradually adapts itself to new conditions. Once it would not nest anywhere except in a hole in a tree, or a crevice of a building. Now it will build its nest, sparrow-like, in ivy, and I have even seen its home made in a laurel bush, a couple of feet from the ground. There seems little doubt that pastoral farming, which has succeeded so largely to arable cultivation, has favoured the remarkable extension of the species.

During my boyhood a bird that was never seen with us was the stock-dove. I happened to be present when a nest of the stock-dove was taken in Southwick in 1876 amongst the ivy on the cliffs at the shore. Since then the stock-dove, previously only a rare visitant to Scotland, has spread all over the country; and in our area especially, a flock of thirty or forty strong is by no means uncommon, and causes no remark now.

The turtle-dove visits us very rarely indeed now. Thirty years ago it was a not infrequent summer visitant to at least the border district of Dumfriesshire.

The next species to be noticed is the black-game. There has been a most noticeable falling-off for years past. The total area under heather is slowly but surely diminishing, and the peat lands show a serious amount of denudation year after year.

Once an annual and abundant visitor, the quail comes now at longer and more uncertain intervals.

Water-rails and coots are evidently increasing in numbers, while the opposite has to be said of the golden plover and the lapwing. We rarely see now the huge flocks of these birds that some thirty or more years ago were almost an everyday sight during the autumnal migration. Oyster-catchers have, however, increased to a marked extent.

Woodcock breed in fair numbers annually, but there is a marked fluctuation in the numbers present. During my experience I am certain that more remain on an average than formerly. The dunlin breeds now with greater frequency, and redshanks are found nesting all over our area to an extent that was very far from being the case previous to about the year 1882.

Robert Gray remarks on the scarcity of the knot when he used to visit our coast. That has not been the case for more than twenty years past, for annually they may be seen in autumn in huge clouds that literally darken the air. These are, however, to be found only in the vicinity of Southerness Point.

The black tern was once a very frequent spring and summer visitant, but now is very rare and intermittent only. The Sandwich tern has at least one small colony now, formerly a visitant only. For a good many years past the common tern has had some considerable extension and augmentation of its breeding flocks. The little tern shows a slight increase.

The black-headed gull has increased enormously, and many of its habits have been modified to suit the overcrowding of the species that seems imminent.

On the Galloway coast we have breeding-stations of the common gull that are the most southerly on the west coast of Great Britain, and these are getting more populous than they used to be. All the gulls are certainly on the increase, and this may be attributable to protection, to the effect of the gun tax, and some other less evident causes. A new breeding species with us is the great crested grebe, which has at least three breeding-stations. Strange to say, the little grebe has only remained to breed with us in comparatively recent years. Not many do so yet, but it is of fairly general distribution in the nesting season.

After a lengthy series of years, during which the resident cormorant population was either stationary or going back in numbers, one of their large breeding-places that had been deserted for almost forty years has again been taken up very numerously.

One of the prettiest bird sights we have in spring and summer is the great abundance of the beautiful sheldrakes scattered in pairs or small flocks over the vast sandy expanses that fringe the firth. This pretty duck is certainly increasing to a rather remarkable extent, and far more of them nest at inland localities than formerly.

Ducks in general have more than recovered from the down-grade that threatened the tribe so seriously some thirty or more years ago. The long-tailed duck is creeping around from the west coast, and the capture or sight of individuals in the waters of the firth is not so unusual as it was in very recent years. Then there is the tufted duck, of which the first nest was only found so recently as 1887, and now it would be difficult, if not impossible, to find a piece of water of sufficient size to which they do not resort to nest.

Specially interesting is the small colony of pied flycatchers that have within the past twelve to fifteen years put in an appearance each season in Nithsdale and Annandale respectively. These are increasing very slowly, and indications are not wanting that we may see some established offshoots before long. Our Dumfriesshire pied flycatchers have doubtless originated from those that have long been known to frequent the Lake District.

Let me also mention the fairly regular appearance now in spring of the white wagtail, a species which the field naturalists of Clyde have proven to be a very regular migrant there.

One more example of a striking change, and my list of species to be noticed on this occasion will finish. I allude to the missel-thrush, which, when I began bird-nesting, was a very scarce bird indeed. Nowadays it is probably one of the first nests that a boy adds to his spoils.

V.—*WORK IN A CANADIAN ORCHARD.*

By Mr JOHN PURSELL.

(*Read Jan. 25, 1905.*)

It was my good fortune to have an opportunity of paying a visit to Canada in the autumn of last year. I sailed from Glasgow in the s.s. *Corinthian* on the 10th of September. By the 19th we were sailing up the Gulf of St Lawrence. On the 20th we got our first real view of New Brunswick. The coast line is high, and clothed all over with trees, which come down close to the water's edge. The maple tree is everywhere in abundance, with its marvellously beautiful foliage shading from golden yellow to blood-red. We took 12 days 7½ hours to reach Montreal. When I arrived I noticed a large quantity of apples at the docks for shipment, and it was very interesting to watch the Government fruit-inspectors at their work. They are most particular as to the qualities packed under the different brands. It was at Morrisburg that I first saw a real Canadian orchard, but as my view was only from the steamer, I cannot say much about it, except that the trees were heavily laden with beautifully coloured apples. It was on board the *Spartan* steamer on Lake Ontario that I ate the first Canadian grapes I had ever seen. I had previously heard they should be swallowed whole, and I always thought that it was a joke, but find that when one breaks the skin the inside comes out like a tough piece of gelatine, and they have a very peculiar flavour, and are, in my opinion, not worth eating. It also seemed strange to me to see the people eating boiled heads (cobs) of Indian corn or maize. The cobs are held in the hand and buttered, then sucked and bitten at.

When I arrived at Burlington, near Hamilton, I was shown a large field of tomatoes of 4 acres where the crop was simply enormous. It was estimated that this field would produce 1000 bushels. I now saw and closely inspected an orchard in which were splendid crops of apples, pears, and peaches quite beyond anything I had ever expected to see,—confirming me in my impression that this is a most wonderful country. The severe winter of 1903 had, however, left traces of its effects, for there were many peach trees quite dead. One of the things that struck me much was the continuous chirping of the innumerable crickets everywhere present. The Burlington Canning Factory employs 200 hands: they can various fruits in season. At the time I was there they were putting up tomatoes, which were pouring in on them from all the growers around. I counted 4000 bushels of this fruit standing in their yard, where an Indian was emptying box after box on a revolving apparatus like a steamer's paddle-wheel, which conveyed the fruit into the works through a tank, where they were scalded; and this went on day and night. Apple-packing is done by all the farmers' families, and is pretty hard but pleasant and healthful work, and I am bound to say that a fruit-grower's life is a most delightful one. They are well off, and live in stylish houses, but they work like labouring people in the fields. Other fruits and vegetables are abundant, such as egg-fruit, melons, pumpkins, and squashes. The climate at this time of year is very variable, the temperature sometimes as low as 26° F., and again as high as 74° F. On the 10th October we experienced a severe thunderstorm, with a brilliant display of lightning.

The cultivation of the apple-tree is one to which the Canadian Government has given much attention, and it has established several experimental farms throughout the dominion. The Central Experimental Farm is at Ottawa, and the apple—the fruit which is by far the most useful and important one in all civilised parts of the north temperate zone—is carefully studied. Probably the apple sprang from the wild apple of Europe, but there is no means of knowing when or where its improvement began to take place. All we know is that improvement has been much accelerated of recent years, notwithstanding the fact that at the beginning of the Christian era the Romans cultivated a few varieties, which might compare favourably with some grown at the present time. The tree has a wonderful power of adaptability to soil and climate, but it is beyond doubt most at home in the temperate climate of North America. Named varieties are becoming very numerous, so that at present there are probably over 2500 of these. Every taste, no matter how eccentric, may be satisfied. The season during which the apple may be had in perfection is of long duration, some varieties being ready early, others late; and now that cold storage is so successfully adopted, apples may be had all the year round. To the farmer the profit on the crop depends much on whether the varieties he produces suit the market in which he offers his fruit, and it most of all depends on the skill of the grower himself. A considerable time, however, must be allowed between the planting and the reaping. The better the sort, the longer the tree takes to come into a fruitful condition. Once it has become fruitful, a healthy apple-tree will remain so for a very long period,—even up to a hundred years or more.

Ontario, the province of which I write, began to assume a position of much importance as an exporting centre for apples about forty years ago. In 1900 the yield reached the grand total of about 36,993,017 bushels, and there were 6,518,048 trees of bearing age, and beyond that 3,430,670 young trees in the province. The best flavoured, most highly coloured, and longest keeping fruit is produced in Canada. The lines of work at the Central Experimental Farm include the testing of the hardiness, productiveness, quality, and freedom from disease of the different varieties of apples: also the different methods of propagating and grafting have been tested. During these experiments, which were begun in 1887, nearly a thousand varieties have been tested. It may be asked, How are there so many varieties? The answer is that there are three ways of producing varieties: first, from fortuitous seed; second, by cross-fertilisation and hybridisation; and third, by bud variation. Doubtless the accidental growth of seedlings is accountable for many of the varieties. Emigrants brought apple seeds with them from our own land, which the Canadian usually lovingly refers to as the old country, and these occasionally produced trees which bore in time fruit of merit. Other seeds grew up in fence corners. From seeds of apples grown in Canada, and from these spontaneous growths, have come some of the finest fruits, such as Northern Spy and Baldwin. When scientists took the matter in hand and endeavoured to produce varieties, their efforts were only partially crowned with success. One great apple-seed grower publishes the results of his efforts over a period of thirty years. He began by planting one bushel of apple seeds, and during each successive year, for eleven years, he planted enough apple seeds to produce 1000 trees, gaining as a net result of all this effort only two varieties worthy of note. One of these is the famous apple called "Wealthy," which is thought at present to be the best early apple the country produces. Since the end of that first eleven years of the thirty years' period, however, as many as forty first-class varieties have been produced by the same experimenter. Much devotion is required to produce such a result. In fact, it has been calculated that on an average it takes from 300 to 500 seedlings to give one new first-class variety of apple.

There are usually five or six buds in a cluster on apple-trees, but generally only the strongest of these sets fruit, and it occasionally happens that an apple is produced quite different from all the others. This is called a "bud variety," and the skilful grower looks out for these, and propagates either by bud- or branch-grafting. In grafting, a cutting of the variety desired is taken and united by wax and tying to the tree on which it is desired to grow the fruit. The branch so united does not thereby lose its individual characteristics, except to the extent that it may be modified by the vigour of the tree on which it is grafted. If a variety is grafted on to a dwarf or slower growing tree than itself, the result is that the stock tends to reduce its vigour, as the amount of sap natural to it is reduced; and as a lessening of vigour tends to the development of fruit, this kind of stock is often used.

Sometimes root-grafting is adopted, and consists in taking pieces of a root and carefully uniting them to a branch. In this way young trees are produced rapidly. The farmer naturally chooses a position for his orchard in close proximity to his house. It is not necessary that the orchard should be on any particular slope, as no matter what the slope, there are drawbacks peculiar to it. On a slope to the north, for example, trees suffer from root-killing, whereas scorching of the trunk of the tree is a common calamity when the orchard slopes to the south; but given good drainage, perhaps a level piece of land is best. To have an orchard protected by forest trees from prevailing winds is another thing of importance. The kind of soil is not, perhaps, very important, although whatever nature it possesses, it should be worked well, and properly broken up, so as to allow of the free access of air. If the land is not properly prepared before the trees are planted, it cannot be done after. Each tree must be so set that it will not be overshaded by its neighbour, but must have abundance of light and air. The popular tree in the past has been one with a trunk five or six feet high, on account of the advantage thus gained in the growing of other crops on the same land along with the trees. The grower was also able to work the land with the aid of horses. This idea is perhaps now gradually giving place to the newer order of things, where the orchard is for fruit-trees only.

As already said, there are now probably over 2500 kinds of apples, and one of the things for which the grower has to thank his Government is the help he has received in determining what kinds to plant in his district. The fruit-growing part of Canada has been divided out into sections, and lists have been compiled, giving the names of the varieties found, after years of experiment, to be most suitable for each of thirteen of these. It does not exhaust a tree to bear a good crop of fine fruit, so much as it does to produce a heavy crop of small fruit. The exhaustion of the tree is in proportion to the number of the seeds matured and not to the size of the fruit. Unfortunately pruning is much neglected, partly because of the time it takes and partly through want of confidence on the part of the grower in his own ability,—the subject being one on which very much has been written, but on which there is so much contradictory opinion. There are three ways of dealing with the ground in the orchard. One is to keep it in grass; another is to keep it cultivated or well tilled, and free from all vegetation; and another is to grow what are called cover crops. These cover crops are for the purpose of keeping the frost out of the ground, or, as is often necessary, to shade the stems of the trees from the hot sun, and they are of much value in being a means of forming humus and supplying nitrogen to the soil.

Spraying is a most necessary part of a fruit-grower's work, and the Government has set itself, through the Board of Agriculture, to discover the best insecticides and fungicides, and gives all necessary help and information on the subject to the farmers. To keep the trees clean and healthy is a duty which requires a watchful eye, besides considerable knowledge, skill, and personal application.

The principal crop of apples is ready to pick in October. Picking should be done at that particular time when the fruit is almost ripe—that is to say, not mellow, but just at the time when the seeds are turning brown. With this in view, the grower having a large orchard begins with those kinds which ripen earliest, and arranges his work so as to be finished with gathering the latest fruit just before being stopped by winter frost. The fruit must be in all cases handled with the utmost care if it is expected to reach the distant destination in perfect condition. A bruised apple deteriorates very rapidly, whereas an unbruised one remains perfect for a long time. When the apple-picker ascends his ladder, he takes with him a small basket with a hook on the handle, by which he suspends his basket from one of the branches, and so leaves both of his hands free. The basket should be lined with some soft material. An important thing, and yet one often neglected, is to take care not to break the stem of the apple. When this is broken the fruit is not only disfigured, but the keeping of the fruit is endangered. Some growers sort their fruit and pack it immediately, and I think that this is the best way, as I have seen it done with great success. There is much less danger of injury to the fruit when there is little handling; and it has also to be remembered that the fruit, after being picked, continues to part with moisture as it did when on the tree, especially if light strikes upon it,—with this great difference, however, that now it receives none to make up for the evaporation, and so shrivels. A sorting-board, covered with some soft material, is set up at a convenient height, on which the apples are emptied from the pickers' baskets. The sorting is then most carefully done, and the qualities are set aside in three grades—namely, firsts, seconds, and thirds. The firsts and the seconds are packed in boxes or barrels and prepared for export. The thirds are either sold in the district at a cheap figure or put into the grower's own cellar for household use, or they are sent to the cider mill.

When packing, it is the usual practice to face the end of the barrel with two layers of apples placed neatly and tightly in it with the hand. These should, of course, always be fair samples of those which are in the middle of the barrel. The other apples are now filled in, and the whole rocked so as to cause the fruit to settle down closely; but it is always a somewhat difficult matter to finish off, as the apples are either too high to allow of the lid being put in, or too low, in which case the barrel would be slack filled. Some packers gain considerable skill, however, and seem to have quite a knack in getting the right quantity into the barrel. The barrel having been properly filled, the last layer should come just slightly above the lid groove, and then a little pressure is applied with a special press to put the lid in its place. Doubtless the best fruit should always be packed in boxes, as when in barrels the fruit is subjected to considerable pressure. All fruit which falls during the process of picking or packing should be set aside, and not used for export.

The Government has conferred a great benefit on the trade generally by the Fruit Marks Act, which has recently come into operation. Many of the fruit-growers think that its terms are a little too strict, but it cannot be doubted that it has done great good in the way of giving confidence to those who buy Canadian fruit; and in this way the farmer will benefit when his fruit is sold in competition with States producers, who have no such Act, for it operates in the end as a guarantee of quality. The Act insists that the package of apples be marked with the full name and address of the owner, with the name of the variety of the fruit, and with a designation of the grade. Thus fruit of the best quality must be marked × × ×, fruit of the second quality must be marked × ×, and if there is a lower quality it can only be marked with ×.

In conclusion, I would like to suggest that every person buying or eating fruit should ask the name of the variety, and should if possible make himself acquainted with the characteristics of the same. He will thus help greatly in the effort which many scientists and growers are to-day making to produce a better apple than the world has yet seen. These are a few brief notes of the things I saw and heard of when visiting the Canadian orchards. They were interesting to me at the time, and I trust that I have made them interesting to you.

At this meeting a paper entitled "Notes on the Whortleberries," by Mr W. Wilson of Alford, Aberdeenshire, was communicated by the Secretary.

VI.—*LINNÆA BOREALIS*, Grounov.

By Mr WILLIAM WILSON.

(*Communicated Feb. 22, 1905.*)

As the occurrence of this plant on moors seems to be more or less overlooked in present-day botanical literature, it seemed to me desirable that something might be said on the subject. I happen to reside near the spot where it was first known to be found altogether outside any proximity to fir woods, and so have opportunities of seeing how it develops. The patch is near the Clistic rivulet, on the Coreen hills, about 1000 feet above sea-level, and facing an easterly direction. The other habitats in this neighbourhood have a similar exposure. I find that this plant has maintained its position since it was first pointed out to me. It is capable of filling up any vacant space caused by digging any part of it. This, I may mention, is a process which I have frequently put to the test, and so can speak with experience of the result. There is thus complete establishment of a habitat, and not only so, but there is also a vigorous form of development which shows itself in readily filling up the vacancies. I also find that a certain number of flowers every year vary much, in accordance with the earliness or lateness of the season. But so far as the fruit is concerned, I have only seen in an occasional season any berries at all, and never a properly matured one. It is in the colder seasons that stray flowers are enabled to form a berry. The peculiarity is, that after flowering the peduncle breaks through, and the fading flower or partially formed berry falls off.

I hope that botanists will take a careful look in other places to see whether they can find this plant upon other moors, as well as in this county.

At this meeting Mr Hippolyte J. Blanc, R.S.A., gave a lecture on Melrose Abbey, illustrated by a large number of very beautiful lantern slides.

VII.—*THE UTILITY OF THE TIT TRIBE.*

By Mr A. B. HERBERT, Honorary Member.

(Read March 22, 1905.)

We have four species of these pretty and extremely useful little birds constantly around our country houses—viz., the great tit (*Parus major*), the blue tit (*Parus cæruleus*), the cole tit (*Parus ater*), and the marsh tit (*Parus palustris*),—the two first named the most common, the last the rarest; and all, being insectivorous, well deserve every protection we can give them. They are fed by us during the winter mainly by sawing off the two ends of a cocoa-nut and suspending it in the garden in sight of our windows, and when the nut itself is eaten we fill the shell with suet or cheese, both equally acceptable to the birds. It is not unusual to see a tit feeding at each end of the nut. To encourage them to build near us, I fixed a small box in a Virginian creeper growing against the house, having a circular side-hole $1\frac{1}{8}$ inch diameter bored into it. I found a hole of this size would admit *Parus cœruleus*, but not sparrows. A pair of these pretty birds built in it last summer, and I observed them for some time carrying food in for their numerous young. To give some idea of their utility to gardeners, I may mention that I have observed one or more green caterpillars carried in by the old birds eight times in five minutes; and when we consider the number of hours this daily goes on, and the number of days taken to rear the young, which are fed for some time after leaving the nest, we can form some idea how useful these birds are in our gardens, and how well they merit every protection we can give them. I noticed seven young ones sitting in a neighbouring plum-tree being fed by their parents, and there may have been more. They have been accused of killing worker-bees; but this I believe to be a pure mistake. They will eat dead worker-bees and living drones, but will not attack a live stinging-bee. I have kept the great and blue tits in a large aviary for many months, in which I have repeatedly put living worker-bees, but never could induce them to touch one. It is said that they peck the hives to induce the bees to come out in the winter, and then devour them. I have kept bees for fifty years, and do not consider tits as enemies. We know that when these insects come out on a fine day in winter, their first act is to carry out all dead ones from the hive, which are eagerly devoured by the tits, and this may have been the origin of the error. I have seen them, and also fly-catchers, and even sparrows, catch and devour drones, but not live worker-bees, and venture to think it an unjust accusation.

There is in the north of Europe a pretty species of tit, the azure tit (*Parus cyanus*), which I have often thought might be successfully introduced into this country by some one having landed property in Scotland or Norfolk. Its predominant colour is blue, as its name implies. This would in some measure compensate us for the becoming scarcity—owing to the objectionable collectors—of that very pretty bird, the bearded tit (*Calamophilus biarmicus*). Happily a few landowners in Norfolk are now doing their best to prevent the entire extinction of the pretty bearded tit, which I have only once seen in a wild state, and this was in Oxfordshire. I send herewith a coloured illustration of the azure tit, enlarged by my son from the 'Skandinaviska Foglar' of Körner (Plate XIX.): the introduction of this would be a pleasing addition to our avifauna. The book is merely a collection of illustrations of the Scandinavian birds, without any letterpress; but the bird seems about the size of our *P. cæruleus.*

We have here a nut walk or avenue about eighty yards long, the nut- and filbert-trees meeting overhead. This is frequented in the autumn by nuthatches (*Sitta europæa*), and some of the produce is always left ungathered purposely for them. They are interesting birds in their habits, taking the nuts away and fixing them in the rough bark of an acacia, where they peck out the kernels. They will also eat hempseed and beech-nuts. We have a small bird table, consisting of a square board suspended in the garden, on which is placed every morning in the winter food for the tits and other birds, and a few nuts for the nuthatches, and we always welcome the cheerful whistling call-notes of the latter, which can be heard from some distance. They are not shy birds, and will break their nuts within a few yards of us. Woodpeckers and creepers use their tails as a fulcrum in climbing trees; nuthatches never do, but with their tenacious claws run up or down the stem of a tree with equal facility—as Yarrell says, more like a mouse than a bird. I have never seen a nuthatch in Scotland, but they are not uncommon in Switzerland. Kingfishers frequent the small stream running through Campden, Gloucestershire (where I am writing), and we have also nightingales and the red-backed shrike.

PLATE XIX.—THE UTILITY OF THE TIT TRIBE.

AZURE TIT (PARUS CYANUS, PALLAS).

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VIII.—*AN ACCOUNT OF SOME COPEPODA THAT LIVE AS PARASITES ON, OR MESSMATES WITH, OTHER INVERTEBRATA.*

By THOMAS SCOTT, LL.D., F.L.S., Honorary Member.

(*Read March 22, 1905.*)

The study of animal or vegetable parasites is of never-failing interest. In the course of such a study we meet with organisms very different from each other, yet associated in various relationships, either as friends or foes. The causes that have brought about these associations, the purposes they serve in the economy of nature, and the effects they may produce on other living creatures that in any way come into contact with them, are problems that may well engage our attention. So varied and strange are the relationships one meets with from time to time, that the attempt to arrange and classify them is no easy matter; and we soon find that any system yet devised is at best but a convenient makeshift.

The term "parasite," as used here, includes various kinds of relationships. In some, the species associated together may be nearly akin; in others, widely divergent. The relationship may be that of a true parasite living on the body of its host, or that of a commensal or messmate doing useful service in return for food and shelter received.

In a paper read to this Society two years ago I incidentally directed your attention to some interesting Copepoda found parasitic on several of our common fishes. In the present paper I propose to give an account of a number of species found for the most part associated with other invertebrates, and I have arranged the species selected into six groups, as follows:—

1. Copepoda usually found on sponges as commensals or messmates.
2. Copepoda found only on Alcyonium or allied species.
3. Copepoda found on various Echinoderms.
4. Copepoda associated with Annelids.
5. Copepoda found on other species of Crustacea.
6. Copepoda that are associated with various species of Mollusca.

Copepoda, including some curious species, are also associated with Ascidians of various kinds, but they are so numerous that the consideration of them would require a separate paper. I may also state that the remarks which follow will, for the most part, be restricted to species that have come under my own observation.

1. *Copepoda usually found on sponges as commensals or messmates.*—The two sponges on which I have most frequently found Copepoda are *Chalina oculata,* a soft, branching species, not uncommon on the pier at Granton; and *Suberites domuncula* Olivi, or *Hymeniacidon suberea* as the name is in Bowerbank's monograph. The Copepoda found on these sponges appear to belong exclusively to the family Asterocheredæ. *Asterocheres Boecki* (Brady) is the species common on *Chalina.* I usually obtained these Copepods by washing the sponge in moderately strong methylated spirit. Two different species of *Asterocheres* are found on the Suberites—viz., *Asterocheres echinicola* and *Asterocheres suberea. Suberites domuncula* is a moderately common sponge; it is massive and compact in structure, and is frequently somewhat globular in form. In a large proportion of the sponges examined a molluscan shell—usually a univalve of some kind—was enclosed within their substance, and they also contained a cavity in which a hermit-crab found shelter. The sponge, therefore, has not always an evenly rounded surface, but frequently presents the appearance of a potato; and so closely do many of them bear this resemblance that I have sometimes heard them spoken of as "Sea-potatoes." Numerous water-passages penetrate the substance of the sponge, and it is in the largest of these that the Copepods live. If one of the sponges be cut so as to expose a longitudinal section of these passages, the Copepods may be seen adhering to their sides or partly filling the openings of smaller passages branching off from the main ones. As the Copepods are small and of the same colour as the sponge, they require to be carefully sought for. I am not certain whether the Copepods are found only in the excurrent or in the incurrent passages, or in both, but it would be interesting to ascertain if there is any limitation in this respect. If it is in the *incurrent* passages that the Copepods live, they

might be regarded as messmates, claiming a share of the food carried along these passages to the various parts of the sponge. If, on the contrary, they live chiefly in the large *excurrent* passages, they may then be rightly regarded as commensals or mutualists, paying for their shelter by assisting in the removal of the waste and effete matter which it is the purpose of these passages to carry to the outside.

Chalina and this *Suberites* are the only two sponges I have examined thoroughly, but it is highly probable that if others were examined, they too might be found to harbour these minute crustaceans.

2. *Copepoda found only on Alcyonium or allied species.*—Though Alcyonium is usually considered higher in the scale of life than the sponges, the copepods associated with it and its allies are decidedly lower than the commensals of the latter. The *Asterocheres* of the sponge belongs to one of the more highly organised groups of the Copepoda; but *Lamippe proteus*, the species so common on *Alcyonium digitatum*, if not a true parasite itself, is very closely related to species that are. *Lamippe proteus* varies to some extent in its general appearance, as implied by the name, but usually it is of a narrow, elongated form; the body exhibits very little segmentation, and the limbs, which appear to be rudimentary, are only one-branched, and fitted merely for crawling or grasping. Two species of *Lamippe* have been obtained in Scottish waters—viz., *Lamippe proteus* Claparède, mentioned above, and *Lamippe Forbesi* T. Scott, both being parasitic on *Alcyonium digitatum*. The first is apparently very common, but the other is rare.

The first species of *Lamippe* to be recorded was *Lamippe rubra*, obtained on *Pennatula rubra*, a species of Sea-pen which occurs in Bohus Bay, off the Bohustan coasts of Norway and Sweden. The species was described by Bruzelius in 1859 in 'Archiv für Naturgeschichte.' The Sea-pen on which this *Lamippe* occurs is apparently absent from our seas, but *Pennatula phosphorea* is moderately common in some places, and I have examined many examples of that species without finding a single *Lamippe*. The species to be recorded next in point of time was the *Lamippe proteus* mentioned above. This was described by Claparède in 1867. Then came *Lamippe Duthiersii* and *L. alcyonii*, both described in 1882; and lastly, *Lamippe Forbesi*, which was described and figured as *Lamippe* sp. in Part III. of the 14th 'Annual Report of the Fishery Board for Scotland' (1896).

It is seldom that moderately big pieces of Alcyonium, when properly examined, fail to yield examples of the parasite; and the quickest and surest way to find these parasites is to cut or break the Alcyonium into pieces and shake each piece vigorously in a bottle containing methylated spirit: the parasite will then be found in the bottom of the bottle.

3. *Copepoda found on various Echinoderms.*—During the years from 1851 to 1858 Sir John Dalyell published in three volumes his interesting work entitled 'The Powers of the Creator displayed in Creation.' This work contains descriptions of many curious and interesting animals. Not the least interesting of these is the description and drawings of a copepod that was found living on a kind of star-fish belonging to a group commonly known as Brittle-stars. This description, which was published in the first volume in 1851 (p. 233, pt. lxii., figs. 1-5), is one of the earliest records we have, if not the first, for the British Islands, of a copepod living as a parasite or commensal on Echinoderms. The name which Sir John gave to this copepod was *Cancerilla tubulata*—probably because of some resemblance it has to a crab (*Cancer pagurus*)—*cancerilla* meaning a small crab. This copepod, though rare, has apparently an extensive distribution. The late I. C. Thompson of Liverpool obtained *Cancerilla* in the vicinity of Port Erin, Isle of Man, on *Ophiocoma nigra* (?) and *Ophiothrix fragilis* (?); Prof. Giard in 1887, and Dr Canu in 1891-92, obtained it at Wimereaux (Boulogne-sur-Mer) and elsewhere on *Amphiura squamata*; and in 1897 Dr Giesbrecht obtained it on the same species of star-fish at Naples and at Bohustan. I have only seen the female once in some dredged material collected off Aberdeen.[1] A species described by Claus under the name of *Caligidium vagabundum*, and of which I obtained a specimen in the Moray Firth, is said to be the male of *Cancerilla*.

Scottomyzon gibberum T. and A. Scott, the species I am now

[1] Described in the 20th F.B. Report, Part III., p. 473, pl. xxv. fig. 7 (1902).

to refer to, was discovered amongst some material dredged near the Bass Rock in 1893, and was described by my son and myself in the 'Annals and Magazine of Natural History' for February 1894. By our examination of it we were convinced that it was not a free-living Copepod, but it was not till 1895 that we knew its habitat. During the summer of that year the Fishery Board for Scotland carried out some line-fishing experiments, when various things were found hanging to the hooks every time the lines were hauled up. One of the things most frequently thus found was the common five-finger star-fish (*Asterias rubens*), so I took the opportunity to put a number of these into a large bottle containing fairly strong methylated spirit. After the star-fishes had been vigorously shaken to wash off anything adhering to them, the sediment in the jar was carefully examined, when close on a hundred specimens of this new copepod were obtained, and very little else. Later on other star-fishes of the same kind were treated in a similar way, and gave like results, sometimes even more successful than at first. The subsequent examination of numerous examples of *Asterias rubens* has shown me that one is more likely to obtain specimens of the copepod on star-fishes brought up on fishermen's lines than on those taken in the trawl-net. Those captured by the trawl are usually considerably knocked about, and the copepods seem to get shaken off. A considerable number of those obtained were adult specimens, and several of the females carried ovisacs. The adult specimens are nearly globular, and are of a brick-red colour on the back, which harmonises so well with the colour and the rough skin of the star-fish that it is difficult to detect the parasites unless they happen to move about.

When my son and I described this species we placed it provisionally in the Genus *Dermatomyzon* Claus, but as it differed somewhat from the characters of that genus, Dr Giesbrecht instituted a new one—*Scottomyzon*—for its reception. The species is now known to have a fairly extensive distribution.

Parartotrogus Richardi T. and A. Scott, a curious little copepod, was first observed in 1889 but not described till 1893, as previous to that year we had seen no specimens that appeared to be fully adult, and we were therefore doubtful of the species being really "new." The discovery of one or two females with ovisacs, however, removed some of the doubts we had concerning the genuineness of the species; and a description of it, with figures, was published in the 'Annals and Magazine of Natural History' for March 1893. Though the structure of the mouth-appendages of *Parartotrogus* indicates parasitic habits, we have not ourselves been able to locate the host on which it lives; but Dr Giesbrecht, who records it from Naples, states that it is probably parasitic on *Ophioglypha lacertosa* = *Ophiura texturata* of Forbes' 'British Star-fishes,'—a moderately common species in the Firth of Forth.

Pseudanthessius Sauvagei Canu is another rare species obtained during the line-fishing experiments already alluded to. It was discovered in the following manner. During the experiments several specimens of the common Sea Urchin (*Echinus esculentus*) were among the things brought up on the hooks, and they were treated to a methylated-spirit bath in the same way as the star-fishes, care being taken, of course, to see that the bottle used for each experiment was thoroughly cleaned. After the Sea Urchins had been steeped and washed in the spirit, the sediment was, as usual, examined, with the result that quite a number of this rare *Pseudanthessius* were obtained—the first time the species had been found in Scottish waters. Several other species of copepoda are known to live on Echinoderms, and if methods similar to those mentioned were employed to catch them, the number of species might be still further increased.

4. *Copepoda associated with Annelids.*—*Lichomolgus hirsutipes* T. Scott, a fine species, is another of the trophies captured during the line-fishing experiments carried out in the summer of 1895. Among the various objects brought up on the hooks there was occasionally a long tube formed of blackish mud by a large Annelid—a species of Sabella. These tubes were usually encrusted more or less throughout their entire length with a layer of Alcyonium, but there happened to be one which had its anterior end free from that organism; and on this one a few white specks were observed scattered over the dark surface of the tube, and big enough to be easily noticed without a lens. Curiosity led me to examine these white objects, when I found them to be copepods belonging to an

undescribed species. Though this species has been obtained on several subsequent occasions, and more often free than otherwise, I am inclined to believe that its true habitat is the tubes of the Annelids referred to. For should the dredge pass across any of these tubes it may easily dislodge the copepods and bring them up "free" amongst the material collected.

If the copepod I am now to speak of—*Sabelliphilus Sarsi* Claparède—were endowed with the sense of what is beautiful, it could hardly have made a better choice of a dwelling-place, for it lives among the lovely plumes that adorn the heads of certain marine Annelids, and especially of those belonging to the genus Sabella. To see the copepods running about among these feathery plumes reminds one of the free happy life of the squirrel in its native forest.

In Part III. of the Nineteenth Report of the Fishery Board I have described a curious copepod found in a gathering of small crustacea sent to me from Loch Fyne by Mr F. G. Pearcey. It was at the time entirely unknown to me, and I gave it the name of *Cancerina confusa.* I had found only a single female, which carried ovisacs, and it was the unusual position these occupied that made the species somewhat puzzling. Shortly after the description and drawing had been published, Canon Norman informed me that this was a species which Levinson had described in 1877 under the name of *Selioides Bolbroëi*, and he kindly let me see a specimen that Levinson had sent him, and which I found to correspond exactly with that from Loch Fyne. Levinson describes the species as living on *Harmothoë imbricata*, one of a group of Annelids nearly related to the Sea-mouse (*Aphrodite aculeata*), and found on our shores at the roots of sea-weeds between tide marks and a little beyond. I may add that the Sea-mouse itself is said to afford shelter and food to another copepod, but this one I have not yet seen.

Nereicola concinna T. Scott and *Nereicola ovata* Keferstein are two species which, though different, have such a general resemblance that they may easily be confounded unless carefully examined. Several specimens of the first were found adhering to a fragment of a moderately common Annelid, *Eulalia viridis*, that lives on rocky shores between tide-marks, and also in moderately deep water. This species is described and figured in Part III. of the 'Twentieth Annual Report of the Fishery Board for Scotland,' p. 455, pl. xxv., figs. 8-15. *Nereicola ovata* is a species which Professor M'Intosh of St Andrews obtained on the shores of the Channel Islands adhering to specimens of *Nereis cultrifera* Grube. The Professor very kindly sent me his specimens of *Nereicola* that I might myself compare them with those from the *Eulalia*, and also indicated where he thought the two forms differed. The fragment of *Eulalia* with the *Nereicola* adhering to it was obtained in a gathering of dredged material from Loch Etive, Argyleshire.

In the 'Annals and Magazine of Natural History' for March 1898 a curious copepod was described in a paper by my son and myself under the name of *Eurynotus insolens*. *Eurynotus*, which means broad-shouldered, was given to this copepod because the cephalo-thoracic segment was somewhat larger than usual. The specimens were not attached to any host, but an examination of the mouth-appendages led us to remark that "the species appeared to be either a parasite or a commensal." We were therefore not greatly surprised when a considerable time afterwards Dr Steuer, Trieste, informed us that he thought the species we had described was probably identical with *Eunicicola Clausi* Kurz, a parasite on *Eunice* sp., —an opinion we also now share. This copepod seems to be rare. It has been observed on one or two occasions in the Clyde, but has not yet been noticed on the east coast.

Before passing on to consider some of the copepods associated with other crustaceans, there is another example of a copepod and an Annelid living together that I shall briefly refer to because of their habitat. This copepod is called *Hersiliodes latericius* (Grube), and its host is known as *Leiochone clypeata*. Two species of *Hersiliodes* are found in the Forth, *H. littoralis* (T. Scott) and *H. aberdonensis*, but *H. latericius*, which has not yet been observed in Scotland, has, together with its host, been discovered by Mr Arnold T. Watson at Hunstanton, on the coast of Norfolk. The same copepod (or one very closely allied to it), with what appears to be the same worm as host, are found together at Cherbourg, in France, and at both places there is a submarine forest. Mr Watson, in his remarks on the species, states that the

Leiochone "is a very rare worm on our English coast, and seems to have been unrecorded" previous to his discovery of it at Hunstanton; and he suggests that a search might be made for the worm and its parasite where any remains similar to those referred to were known to exist. It would no doubt be interesting if it could be satisfactorily shown that there was any real connection between the remains of submarine forests and this particular worm and its copepod lodger.

5. *Some Copepoda found on other species of Crustacea.*—The claim which these copepods make on their larger and well-to-do relatives for shelter and food is more in harmony with the nature of things than are some of the examples already mentioned; and, curiously enough, genuine parasitic habits are more frequently observed among the Copepoda living with other crustaceans. A peculiar group that forms the subject of a most interesting monograph by Dr H. T. Hansen, of Copenhagen, are all true parasites. In this monograph nearly fifty species have been described and figured, and the number is still being added to. They have been found on various crustaceans, including those belonging to the Carida, the Schizopoda, the Cumacea, and the Isopoda. But it is on the Amphipoda that the largest number have been observed. Of the species already described, over thirty have been found on amphipods, and it is in the marsupium of these crustaceans that they are usually met with. The following species occur in the Forth estuary: *Aspidoëcia Normani* infests the Schizopods, *Erythrops elegans* and *Erythrops erythrophthalmus* (sometimes recorded as *Erythrops Goësi*). *Sphæronella minuta* variety, found in the marsupium of the Amphipod *Megamphopus cornutus;* and the closely allied *Salenskya tuberosa*, which occurs in the marsupium of another Amphipod, *Ampelisca spinipes.* These parasites are for the most part very small, of a globular form, and rather difficult to diagnose satisfactorily. But the species to which I am now to refer is a considerably larger one, and belongs to a more highly-developed group. Its name is *Sunaristis paguri*, because it is found in the same shell with, and is supposed to be a commensal of, the common hermit crab (*Eupagurus Bernhardus*). I have found it in the Cromarty Firth, and my son has taken it in the estuary of the Mersey. When searching for specimens, the method adopted

by my son is very simple. All the hermits brought up in the dredge or trawl are, with their shells, dropped into a jar containing methylated spirit, and left till there is sufficient leisure to wash thoroughly both the crab and the shell. The sediment in the bottom of the jar is afterwards collected and examined. *Sunaristis* does not appear to be very plentiful.

6. *Copepoda that are associated with various species of Mollusca.*—Quite a number of copepods are known which, in one way or another, are associated with Mollusca; a few of these will now be referred to. The large clam-shell (*Pecten maximus*) and the smaller (*P. opercularis*)—the latter very common in some parts of the Forth estuary—afford accommodation for probably more than one copepod. The name of the one best known to me, however, is *Herrmannella maxima* (I. C. Thompson). This is one of the species discovered by the late I. C. Thompson of Liverpool. It was first observed in *Pecten maximus*, and was described as a *Lichomolgus;* but in the rearranging of genera and species another place had to be found for it, and so it has for the present been transferred to the genus *Herrmannella*. It is just possible, however, that it will not get leave to remain there, but may have to seek another home.

Herrmannella rostrata Canu.—There used to be, and no doubt there still is, a large cockle-bed between Cramond and Cramond Island. The cockles there are the common edible species (*Cardium edule*). A considerable proportion of the specimens are small, but fairly large ones may be obtained. It was in the larger specimens that the copepod mentioned above was most frequently observed, as many as sixteen specimens having been found in a single cockle. In these researches two methods were employed. The more exact of the two was to open the shell by inserting a knife and cutting the muscles, meanwhile holding the shell so that one at least of the valves would retain a portion of the fluid. If copepods were present, they might then be seen swimming about in this diminutive lake. The second and quicker method was to put a number of shells into a basin, and then pour in methylated spirit sufficient to cover them—having previously opened the shells to allow the spirit to enter freely. The sediment could then be examined, and the copepods picked out.

We found this copepod in 1892, and, believing it to be a new species, my son and I published a description of it under the name of *Lichomolgus agilis*, but we afterwards learned that it had been described by Dr Canu of Wimereaux, Boulogne-sur-Mer, the year previous, so we were again too late. Dr Canu has obtained *Herrmannella rostrata* in *Mactra stultorum* and *Pecten opercularis*, as well as in the cockle.

Another species which Dr Canu records from *Pecten opercularis* is *Modiolicola inermis*, but this I have not seen. I have at various times, however, found specimens of another very pretty *Modiolicola*—viz., *M. insignis* Aurivelius. This species is not uncommon in the large horse-mussel (*Mytilus modiolus*, or *Modiola modiolus* as it is sometimes called). The distribution of the copepod seems to be coextensive with that of the mollusc.

A small but very neat species—*Lichomolgus agilis* Leydig—not the species my son and I described under that name—lives on the branchial plumes of *Doris tuberculatus*, and has been found in the Firths of Forth and Clyde. Another fine species, *Artotrogus orbicularis* Boeck, which I have taken in the Clyde, and which the late Mr I. C. Thompson also obtained in the Irish Sea, though not found by either of us attached to any host, is reported as living on a species of *Doris*. Boeck is said to have found the species on a *Doris* at Farsund, in the south of Norway. Another curious species, *Anthessius solecurti*, is found on the common "spoot-fish" (*Solen siliqua*). Several other species might be mentioned; but enough has been said to show that there may still be work to do even in such a limited field of Natural History study as that I have now been dealing with. In any case, the day is yet far distant when the student of Natural History will have to sit down and mourn, like Alexander, because he has no more worlds to conquer.

At this meeting Mr R. A. Staig read a paper entitled "Nature-Study and the Citizen."

IX.—*LARGS AND ITS SURROUNDINGS.*

By Mr D. A. BOYD, Corresponding Member.

(*Read April 26, 1905.*)

The parish of Largs consists of the extreme north-western portion of the county of Ayr. Its length, when measured from Fairlie Burn on the south to Kelly Burn on the north, is about 9 miles, while its breadth may be reckoned at about 3¾ miles. A level and comparatively narrow plain extends along the line of the sea-coast, widening considerably in Kelburne Bay, and still more between the mouths of the Gogo and Noddsdale valleys, where it forms a somewhat crescent-shaped plateau upon which most of the town of Largs has been built, and from which it is said to derive its name. With these exceptions, the parish is mainly occupied by a range of hills, which increase in height towards the watershed between the shires of Ayr and Renfrew, where they attain an elevation of from 1500 to 1700 feet. Towards the seashore, and in the neighbourhood of the glens, the hillsides afford good pasturage for grazing, while the higher moorlands abound in marshes and peat-bogs. The configuration of the hills is generally bold and impressive, thus imparting to the scenery a character which is much more suggestive of a highland than a lowland type. This is well displayed in the two valleys above-mentioned, whereby the two main streams—the Gogo and the Nodd (popularly known as the "Noddle Burn") —descend through highly picturesque glens to the sea.

When Largs is approached from the south, by way of the main road leading from Ayr and Irvine to Greenock, the visitor obtains a view of the islands and Firth of Clyde which can hardly fail to attract his admiring notice. At Fencebay, about a mile south of Fairlie, the road, which for nearly five miles has been passing inland behind the bold headland of Portincross, once more touches the seashore. On the left hand lie the blue waters of the Firth, so hemmed round about with islands, peninsulas, and promontories as to appear altogether land-locked, thus presenting scenery suggestive of the characteristics of an inland lake rather than of a marine estuary. When seen bathed in the golden light of one of those magnificent sunsets for which the West Coast is justly famed, with every island and distant headland presenting its own peculiar shade of rich purple, the scene is one which will not readily be forgotten. At this part of the coast, and southwards round the sweep of the shore-line by Hunterston Bay, a wide expanse of muddy sand is left exposed at low water. Perhaps the most striking feature of this region is the remarkable abundance of the common and lesser grass-wracks (*Zostera marina* and *Z. nana*), which grow in such plenty as to cover hundreds of acres. The flats thus left bare at low tide, and shoals covered by the returning water, are frequented by multitudes of sea-birds; the soft sand contains many interesting species of mollusca and crustacea; the zostera-beds afford a congenial habitat to various algæ, &c., peculiar to such places; the pools of brackish and fresh water, just above the ordinary tide-mark, abound with ostracoda, copepoda, and other minute crustaceans; while the shore itself yields a considerable variety of maritime plants, including *Samolus Valerandi*, *Scirpus Caricis*, *S. rufus*, *Carex extensa*, *Lepturus filiformis*, &c.[1] On the right hand, the most conspicuous feature in the landscape is Kaim Hill, the loftiest summit in the parish of West Kilbride, which rises to a height of 1270 feet. On the western side of the hill is situated the quarry where are obtained the millstones for which the place was formerly widely famed. The material used for their manufacture consists of a grey sandstone rock containing abundance of quartz pebbles. A large trade, both local and export, was long carried on here; but the demand for Kaim Hill millstones has gradually declined to much smaller proportions. Among the plants which have been noted as occurring on the hill are *Vaccinium Vitis-Idæa*, *Hymenophyllum unilaterale*, *Oligotrichum hercynicum*, *Dicranella secunda*, *Leptodontium flexifolium* (c. fr.), *Plagiobryum Zierii*, *Lecanora tartarea* (c. fr.), *Sphærophoron coralloides* (c. fr.), &c.

On Diamond Craig, a spur of Kaim Hill in the vicinity of

[1] Some idea of the richness of the district between Hunterston and Fairlie may be formed from a perusal of the Lists of Marine Algæ, Crustacea, &c., contained in the 'Handbook of the Fauna, Flora, and Geology of the Clyde Area,' published by the Local Committee for the Glasgow Meeting of the British Association in 1901.

Southannan Mains farm-steading, an outcrop of sandstone rock bears some specimens of those archaic sculpturings known as "cup-and-ring-markings." They have suffered greatly from weathering, and are by no means so extensive as the series at Blackshaw, near West Kilbride. In one interesting example the ring surrounding a cup has been interrupted by a quartz pebble, but the obstacle seems to have merely been passed over, and the incision of the circle resumed immediately beyond it. Near by, too, was discovered a cist containing an urn of a much more ornate type than those usually found in the district.

The estate of Southannan, of which the modern mansion may be seen nestling at the foot of the bank, about half a mile beyond Fencebay, recalls memories of the Lords Sempill by whom this property was formerly possessed. The most eminent of these was Robert, third Lord Sempill (sometimes referred to as "the great Lord Sempill"), who took a notable part in public affairs during the reign of Mary, Queen of Scots, and died in 1572. The estate passed from the Sempills more than two centuries ago, and afterwards came into the possession of the Earl of Eglinton. It is now the property of Lady Sophia Montgomery, eldest daughter of Archibald-William, fourteenth Earl.

With the exception of a few houses situated south of the Fairlie Burn, the village of Fairlie lies wholly within the parish of Largs. Stretching up the stream for nearly half a mile is "Fairlie Glen," the sweet sylvan beauty of which has inspired several poems in its praise. It is a favourite resort of excursionists and picnic parties, of whom there are often enough and to spare. A short distance up the glen stands Fairlie Castle, a square tower, once the abode of the Fairlies of that Ilk, but now roofless and partially covered with ivy. Writing in the early part of the seventeenth century, Timothy Pont, the topographer of the Cuninghame district of Ayrshire, notes that "Fairlie Castell is a stronge toure and werey ancient, beutified with orchardes and gardins. It belongs to Fairlie de eodem, chieffe of ther name." Like the family to whom they belonged, the "orchardes and gardins" have long since disappeared from the scene. The property was acquired from the last of these Fairlies by David, first Earl of Glasgow, with whose successor it now remains.

In addition to its well-merited repute for charming scenery, the village of Fairlie enjoys a reflected glory as the seat of Fife's boat-building yard, long famed for the excellence of its racing yachts. So many prize-winners have been turned out here, that the place has acquired a world-wide reputation. Fairlie Railway Station at the south end of the village and Fairlie Pier Station at the north end are connected by a railway tunnel, which runs parallel with the road all the way.

Between Fairlie and Largs, the most attractive feature of the landscape is the beautiful park which surrounds Kelburne Castle, enclosed within a semicircle of verdant hills. A view is obtained of the mansion itself, the seat of the Earl of Glasgow, which lies embosomed among fine old trees, in proximity to a wooded glen and picturesque stream. The Boyles of Kelburne trace their descent from a certain Richard de Boyle, who is said to have held these lands as early as the reign of Alexander III. The earldom of Glasgow was created in 1699, and the present peer is the seventh of his line.

The views from the neighbourhood of the castle are very beautiful, while the mansion and its immediate surroundings afford many features of great interest. The structural details of the house have been described by Messrs Macgibbon and Ross, in their well-known work on 'The Castellated and Domestic Architecture of Scotland.' It consists of two distinct portions, bearing respectively the dates 1581 and 1700. There are two fine sun-dials in the grounds; also a small garden divided into four little plots. On these plots, traced out with an edging of box, have been preserved the initials of the four children—the family of John, third Earl of Glasgow—for whose delectation the little garden was made. As the youngest of the four (afterwards George, fifth Earl) was born in 1766, it is evident that the boxwood initials must have occupied their present position for about 130 years, remaining as a somewhat pathetic memorial of bygone days.

Pont refers to Kelburne Castle as "a goodly building, weill planted, hauing werey beutifull orchards and gardens, and in one of them a spatious rome adornid with a christalin fontane, cutt all out of the liuing rock." The description is still appropriate, except that the spacious room and crystalline fountain no longer charm the visitor's eye. The salubrious nature of soil and climate is evidenced by the number of beautiful and uncommon shrubs and herbaceous perennials which are successfully cultivated in the gardens. On a small terrace or platform, situated in the romantic dell behind the house, is a handsome monument commemorating John, third Earl of Glasgow, who died in 1775, in the 69th year of his age. The most impressive feature of the monument is a female figure in white marble, placed in a niche, and supposed to represent "Virtue lamenting the loss of one of her favourite sons." There is also an inscription appropriately describing the public and private character of the deceased earl, who was deservedly held in high esteem by his contemporaries.

The north-western extremity of the Kelburne policies is used as the Largs golf-course (9 holes), where that popular pastime is pursued in the midst of very pleasant surroundings. Between Kelburne and Hailie the road from Largs to Kilbirnie and Dalry is carried up the hillside, in zigzag fashion, by a somewhat heavy gradient. Close to the roadside is the beautifully situated cemetery, the making of which is said to have been resolutely opposed by a section of the inhabitants of Largs, and to have led to a costly action in the law courts. From any part of the ascent, but particularly from the summit of the steepest part of the road, a panoramic view is to be had which affords ample compensation for the labour expended in obtaining it.

A large tumulus, known as "Margaret's Law," formerly existed near Hailie House, but was removed about the year 1780 by the proprietor, Mr James Wilson. Having required some loose stones for dyke-building, he proceeded to avail himself of the vast store accumulated in Margaret's Law, which is said to have extended to upwards of 5000 cartloads. In the centre of the tumulus were found five "stone coffins," two of which contained five skulls each, with other human bones, and several urns. The earth and small stones at the bottom were calcined. It is stated by Robertson that the quantity of bones found in the tumulus was immense, but on exposure they soon crumbled into dust.[1] One of the central chambers of the mound still remains, and consists of a large flat slab of stone, supported by two others placed on edge. According to the popular

[1] George Robertson: 'Topographical Description of Ayrshire, more particularly of Cunninghame' (1820), p. 112.

ideas of the district, this tumulus and its contents, with indeed almost every other relic of prehistoric times found in the country for miles around, have been assigned to the period of the Battle of Largs. The memorable conflict between the forces of Haco, King of Norway, and the victorious army of Alexander III., took place on 2nd and 3rd October 1263. The mound is supposed to have covered the remains of some of the unfortunate chiefs and warriors who fell in battle. It is not impossible that the tumulus, already in existence, may have been used in the manner indicated; but the construction of chambered barrows or cairns and the use of urns in burial-mounds must, of course, be assigned to a period not only many ages anterior to the Battle of Largs, but even long prior to the introduction of Christianity into our island.

Although the more modern or residential portion of Largs now extends southwards for nearly a mile along the Fairlie road, the town itself is approached by a bridge across the Gogo Water. Looking upwards from the bridge, a glimpse is obtained of the mansion of Halkshill, lying at the entrance to the fine valley down which the river pursues a somewhat turbulent course. About a mile above Halkshill the scenery along the course of the stream becomes wildly picturesque. Its Highland features may be said to attain their grandest development near the junction of the Gogo and Greeto, and for some distance along the steep banks of the latter stream. The Greeto here flows through a narrow rocky channel, fringed with mountain-ash and other trees, and rapidly descends by a series of beautiful cascades and dark pools. The moist rocks along the stream-sides abound in mosses, among which are several interesting species. The plants which have been noted as occurring from Halkshill upwards include *Geranium lucidum, Saxifraga hypnoides, Doronicum Pardalianches, Bartramia Halleriana* (c. fr.), *Breutelia arcuata* (c. fr.), *Brachythecium glareosum, Orthothecium intricatum, Eurhynchium Teesdalei* (c. fr.), &c. A short distance above the Falls of Greeto the stream is crossed by a wooden bridge, from whence a road is carried along the hillside towards Largs. From this elevated point a beautiful view is obtained of the hills above the Gogo valley, with a pleasant survey of the Firth and its islands. The road descends at Flatt farm-steading, on the north side of the Halkshill policies. Still nearer Largs, and situated between the Halkshill and Flatt roads, is a little hill or mound supposed to have been artificially constructed. It is surmounted by three stone pillars, which were erected by the late Sir Thomas Makdougall Brisbane, F.R.S., for purposes of astronomical observation. This mound, locally known as "the Green Hill," is conjectured to have been a "moot-hill," or place where justice was administered prior to the period when the feudal system of government was introduced.

At various places along the course of the Gogo, a considerable amount of concrete work has from time to time been required to repair the ravages wrought by the stream when in high flood. In this respect the Gogo may be described as an old and incorrigible offender. More than 250 years ago the turbulent rush of its waters, when in full spate, occasioned serious inconvenience to the kirk-session and parishioners of Largs, as well as some trouble to the Presbytery of Irvine. During the brief ministry of Mr William Smith (1644-1647), the ecclesiastical affairs of the parish had attained a position of remarkable prosperity. The communicants exceeded 2000 in number, and the old church was insufficient to accommodate half the people who flocked thither. Accordingly, in the summer of 1647, steps were instituted to have the parish divided. In an application by the Presbytery to the Lords Commissioners for the Plantation of Kirks, the reverend court set forth, among other reasons, "the great hazard and danger that many people are now in by coming to the present place of meiting throw reason of a water callet Gogo, running throw the midst of the paroch, whilk after raining any space becometh impassable even to horses, and it runneth with sick violence that ther is no possibilitie to get a bridge upon it." As the outcome of the movement, about the year 1650 the lands of Southannan, belonging to Lord Sempill, and Corsbie, belonging to the Laird of Auchinames, were detached from the parish of Largs and annexed to that of Kilbride, because (among other reasons) "of their neirness to that kirk and farrness from ther owne," and also "because of ane impassable water betwene them and the

Larges." It was not, however, till long afterwards that a stone bridge was successfully carried from one side of the Gogo across to the other.

It is by no means improbable that the earliest Christian place of worship at Largs may have been founded by St Columba, the patron saint of the town, in the course of his frequent missionary journeyings on the west coast of Scotland. A church seems to have existed at Largs during the reign of David I., and is occasionally referred to in documents from the thirteenth century onwards. At the period of the Reformation the rectory and vicarage of Largs, which then belonged to the Abbey of Paisley, were valued at £40. The ancient edifice was taken down in 1812, but a fragment of the south wall contained a monument to the Boyles of Kelburne, and was on that account allowed to stand. The building was of unknown age and of great strength, the portion remaining being about four feet in thickness, and of the most compact solidity. It is therefore not improbable, as has been suggested, that the demolished edifice may, in whole or in part, have formed the original church of Largs.[1]

With the exception of its somewhat quaint gateways, and a few tombstones bearing metrical epitaphs, mostly of a gloomily didactic type, the churchyard itself is not marked by any features of special interest. It is to the structure known as the "Skelmorlie Aisle" that the attention of visitors is mainly directed. The aisle was formerly attached to the north wall of the old parish church, and has been preserved intact. It was erected in 1636 by Sir Robert Montgomerie of Skelmorlie, to contain the burial-place and monument of himself and his wife, Dame Margaret Douglas, daughter of Sir William Douglas of Drumlanrig, ancestor of the Marquesses of Queensberry. Sir Robert's name is associated with the great feud which was long carried on between the families of Montgomerie and Cuninghame, at a period when that deplorable quarrel had assumed one of its most sanguinary phases. On 13th April 1586, Hew, fourth Earl of Eglintoun, was murdered near Stewarton by

[1] J. Shedden Dobie: 'The Church of Largs.' Archæological and Historical Collections relating to Ayrshire and Galloway, vi. (1889), 55.

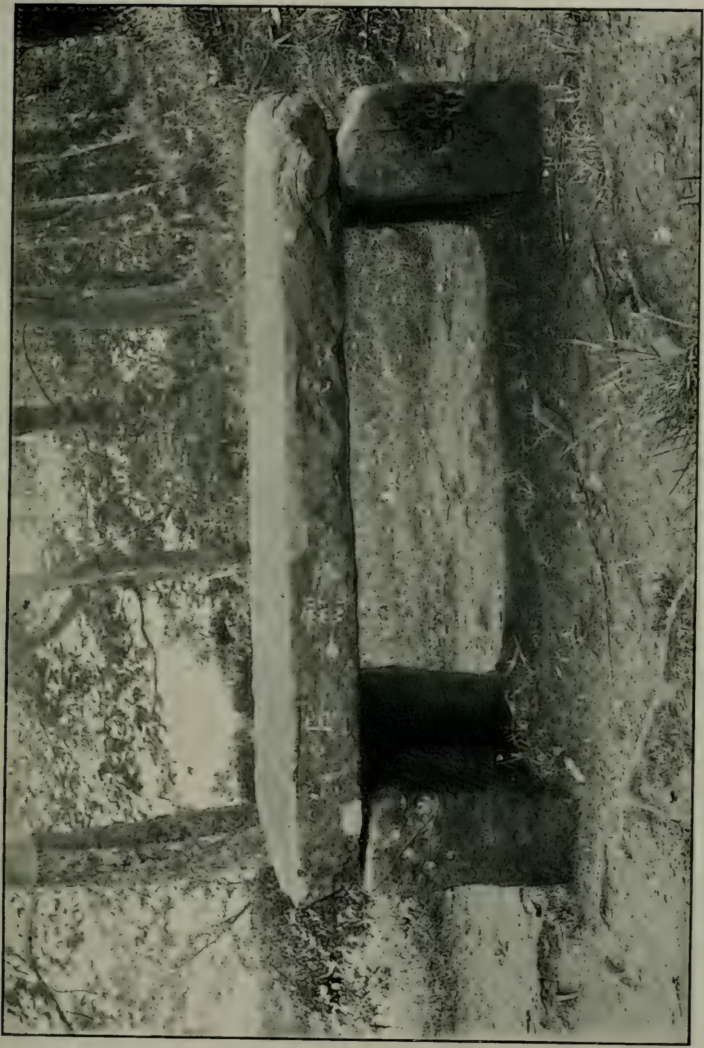
a party of the Cuninghames. In seeking to avenge the foul deed, the kinsmen of the deceased nobleman adopted no less culpable measures of retaliation. Their policy of wholesale slaughter is said to have been pursued by Sir Robert "with such eagerness as to occasion very much bloodshed of his enemies"; but his most notable act of vengeance was the assassination of Alexander Cuninghame of Montgreenan, Commendator of Kilwinning Abbey. The Commendator, who was the third son of the fifth Earl of Glencairn, was regarded by the Montgomeries with special hatred as having been accessory to the murder of the Earl, and accordingly he was waylaid and mercilessly shot by Sir Robert at his own gate at Montgreenan, on 1st August 1591. In his later years, however, Sir Robert is said to have been seized with remorse for the bloodshed of which he had been guilty; and he therefore constructed the "Aisle," with its finely carved monument, and its gloomy burial-vault into which he was accustomed to descend at night and spend long hours in solitude and penitential devotions. He died in 1651 at an advanced age. In the vault immediately beneath the monument are deposited two leaden coffins bearing appropriate inscriptions, and containing the remains of Sir Robert and his lady.[1]

Close to the west wall of the churchyard is an artificial mound, popularly assigned to the period of the Battle of Largs, and supposed to contain the remains of the Norwegian slain. It was excavated in 1873 by Mr John S. Phené, Chelsea, who regarded his discoveries as confirmatory of the popular theory. "Gallowhill," the modern name of the mound, is suggestive of its use as a place of public execution during the period of government by the feudal barons.

The Noddsdale or Brisbane Glen, which extends in a north-easterly direction from Largs, is traversed by a road which crosses the hills to Greenock. This valley affords pleasantly varied scenery. A range of steep and lofty green hills gives boldness to the landscape, while in the glen the Noddsdale burn meanders peacefully through grassy meadows and copse-covered slopes. A distant view is obtained of Brisbane

[1] A full description of the Skelmorlie Aisle, illustrated with views of its most interesting details, will be found in Mr Shedden Dobie's paper, already cited.

PLATE XX.—LARGS AND ITS SURROUNDINGS.



THE PROPHET'S GRAVE.

From Photo by *Dr A. E. Davies.*

House, which occupies a beautiful site in the valley. Until the latter part of the seventeenth century the estate was known as Kelsoland, and was the property and residence of the ancient family of Kelso, whose pedigree has been traced back as far as 1296. In the year 1671 these lands were acquired by James Brisbane of Bishoptoun, whose ancestors had been in possession of other property in the parish of Largs from a period prior to 1400. The family claim descent from William de Brisbane, who was chancellor of Scotland in 1332.

But the most interesting traditions of the valley are those associated with a visitation of the plague or pestilence, which ravaged Largs about the middle of the seventeenth century. In its ecclesiastical affairs, as we have seen, the parish had at that time attained a position of remarkable prosperity under the brief ministry of Mr William Smith. Multitudes flocked to listen to his discourses. The church was overcrowded, and proposals were made to relieve the parochial congestion. But the congregation was soon reduced in numbers, not through any device of presbytery or synod, but by the hand of the destroying angel himself. The town became plague-stricken. Death spread from house to house with awful rapidity. It is said that in their dire distress the affrighted people fled from the town, and retired to a distant part of the glen, where they inhabited hastily constructed huts, formed of the rudest materials. In the course of faithful ministrations upon his afflicted people, the young pastor contracted the fatal disease, and died in September 1647, at the early age of twenty-eight years. His resting-place—known as "the Prophet's Grave" (Plate XX.), and a favourite resort of visitors—is situated in a lonely part of the glen. Tradition affirms that the dying minister requested that two holly trees should be planted, one on either side of his grave; and he prophesied that so long as the branches of the two trees were kept from meeting, the plague should never revisit Largs.

There are several fine waterfalls in the glen. In its upper course the burn branches into several streamlets, each of which descends through a deep and picturesque ravine, the moist sides of which afford a congenial habitat to many interesting plants. The following species may be mentioned as indicative of the botanical richness of the Noddsdale valley: *Saxifraga stellaris, S. hypnoides, Parnassia palustris, Sedum villosum, Carum verticillatum, Vaccinium Vitis-Idæa, Melica nutans, Asplenium viride, Hymenophyllum unilaterale, Equisetum maximum, Andreæa alpina, Encalypta ciliata, Anæctangium compactum* (c. fr.), *Meesia trichoides* (c. fr.), *Bartramia Œderi* (c. fr.), *Plagiobryum Zierii* (c. fr.), *Mnium stellare, Cryphæa heteromalla* (c. fr.), *Neckera crispa, Plagiothecium pulchellum, Heterocladium heteropterum* var. *fallax, Hypnum vernicosum, Gibbera vaccinii,* and *Peltidea apthosa.*

Between Largs and Kelly Burn (6 miles), the road is carried close to the seashore all the way. It passes many interesting places, but to these only a very brief reference can now be made. Netherhall (½ mile from Largs Church) is the coast residence of Lord Kelvin of Largs. Knock Castle (2¼ miles) was long possessed by the Frasers of Knock, a branch of the Lovat family. A fine modern mansion occupies a commanding site near a picturesque fragment of the ancient abode of the Frasers. Knock may be approached either by the shore road, or by another (locally known as "the Red Road") which diverges at Netherhall and passes along the hill-top, thus affording one of the best views of Largs, as well as a magnificent prospect of the Firth. Skelmorlie Castle (4¼ miles) was long the seat of the Montgomeries of Skelmorlie, a branch of the Eglinton house, who acquired it about the year 1461. The ancient castle was erected in 1502, added to in 1636, and reconstructed in 1852. Skelmorlie consists mainly of handsome villas, situated in pretty gardens close to the roadside, completely sheltered from the east wind, and commanding an unbroken view of the blue waters of the Firth. The village of Upper Skelmorlie, extending along the heights above, offers great attractions to visitors. A handsome hydropathic establishment occupies a prominent site on the hillside. At the north end of Skelmorlie is the Kelly Burn, which here forms the boundary between the counties of Ayr and Renfrew. Immediately beyond the bridge is the entrance to the commodious station and pier of the Caledonian Railway at Wemyss Bay. From this point to Greenock or Gourock the distance is 8 miles, and the road, especially by the Gourock or coast route, passes through delightful scenery.

X.—*THE AIMS OF FIELD-CLUB EXCURSIONS.*

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

(*Read April 26, 1905.*)

We hear not infrequently the remark that Field-Club Excursions are unsatisfactory,—that they do little to encourage the study of local natural history, or that they might do a great deal more than they do. I use the words Field-Club Excursions for all kinds of excursions of local Natural History Societies,—botanical or zoological,—shore walks or mountain climbs, dredging excursions and fungus forays, here and elsewhere. I do not include at present geological excursions, because open-air geology has a more definite field than botany or zoology. The problems of geology are, on the whole, less complex and much more mechanical than the problems to which living organisms give rise. Besides, we have in geology great local guide-books in the 'Memoirs of the Geological Survey,' from which, by taking trouble, we can understand the tectonic structure of a district and the views of the best-informed for the time regarding its geological history. In biology it is quite different: hardly any biological surveys have been made in this country—none systematically by Government, as they have been made in the United States under Hart, Merriam, and others.

In the excursions about which I am to speak, I do not mean to include those organised for a biological survey: such a survey must be systematic and thorough,—it must be like a geological survey, and can hardly be carried out without paid workers, because a great deal of the work is not much more than scientific book-keeping. A great deal can be done by enthusiastic, unpaid men—in fact, often the best of all work and the most epoch-making has been done by such investigators. Take the biological survey of fresh-water lakes begun by a single observer, Forel, thirty years ago, in the Lake of Geneva. Fifteen or twenty years later systematic investigations were made in Plönersee, in Holstein; in Müggelsee, near Berlin; in the large Hungarian lake, Plattensee, and in Finland; and lately in Scotland the survey of the fresh-water lakes has been taken up by Sir John Murray and his staff. Such surveys can only be well done under the best scientific direction by a number of observers giving a large part of their time to the work. They are beyond the capacity and reach for the most part of Field Clubs or local Natural History Societies. Still, these societies can do much to aid biological surveys in supplying materials for them and in the study of particular groups of organisms. It is to be regretted that local societies do not generate more enthusiasm for the study of living things, and for the creation of specialists: we have had in the past Dr Greville, the author of the 'Flora Edinensis,' and we have still a few very admirable field-naturalists amongst us. When such men, however, make excursions, they prefer to go almost alone; and when members are devoted to particular groups, say to fresh-water algæ, or microscopic fungi, or flies, or mites, they do not want more than a companion or two. What I want to talk about are the larger excursions of from 20 to 50, or even more. What is the aim of the excursions? and how could they be improved? Every year in this and other societies an excursion committee meets and arranges a programme, generally without any definite ideas of ends to be aimed at. New members do not know what previous committees have attempted, and the arrangements are haphazard. That is the defect of democratic rule in general,—there is no continuous policy. Could we not think out some of the things to be aimed at when a party of a score or two of intelligent people go out together into the country for the purpose of increasing their knowledge of natural phenomena and laws? I believe we could, and it is with the intention of laying before you some considerations for our guidance that I have written this paper.

Let me repeat, it is not excursions connected with biological surveys, and it is not excursions made up of two or three specialists, that I am going to speak about; it is the larger excursions of Field Clubs. I would make two remarks at the outset—they are axiomatic, I mean self-evident:—

1. Excursions are for *nature study*—that is, their ultimate aim is to cultivate the habit of observing things and of reasoning from what is observed. They should also keep us in touch with nature.

2. Every excursion should have a *definite aim.* A walk in the country, a visit to some old castle, with or without tea afterwards, is not a field-naturalist's excursion. It is desirable for convenience to consider one subject, or small number of connected subjects, at a time.

I read Goethe often—Goethe is the ideal nature-student: he looked upon open nature as one of his muses. "Es ist," he writes to Eckermann, "als ob der Geist Gottes dort den Menschen unmittelbar anwehte, und eine gŏttliche Kraft ihren Einflusz ausübte." Goethe's excursions through the fields and forests were never without reward. When a student at Leipzig, he tells us that he wandered along the brooks and through the woods: he was frequently teased by his friends about these solitary walks. The celebrated poet Ewald v. Kleist, from whom Goethe received much inspiration, took his part, maintaining that Goethe was not morose, but went simply on *picture-hunts* ("auf die Bilderjagd"). I have told this about Goethe because it is to my mind the ultimate aim of all field-naturalist excursions,—they are a hunt for pictures, for ideas, for thought-models of nature's operations.

Let me now give a score of subjects suitable for Field-Club excursions:—

(1) *A shore walk*—(*a*) Above high tide: xerophyte societies of plants, shore grasses, folding of leaves to prevent loss of moisture, &c. (*b*) Below high water: rock-pools, different types of worms, crustaceans, &c., might be studied during separate walks.

(2) A most interesting study is a *peat bog:* the kind of vegetation in it—the lack of bacteria—the nature of peaty water—pectin combinations, their decomposition by a bacterium, and much else.

(3) *A woodland walk:* effect of shade on plant life—deciduous trees and conifers—effects of physiological drought—saprophytes on fallen leaves, &c.

(4) *A hill top, heath, moor,* &c. The Pentlands should always be included once a-year in Edinburgh excursions.

(5) *Trace a stream along its course.* Amongst other things look for molluscs,—get young transparent *Cyclas* on gill of old one, &c. Difference in growth of algæ might be noticed, where stream flows quickly or slowly. Look for *Vaucheria* in conjugation on wet rocks.

(6) *Visit to pond or swamp.* Fresh-water insects,—try to get some gnat larvæ in summer. Fresh-water algæ, conjugation in various forms.

(7) *Shore walk for marine algæ.* At Musselburgh, the parasitic worm in cockles might be found: consider formation of pearls.

(8) *A tow-netting excursion*, by which means enormous numbers of organisms and larvæ of many kinds may be obtained: *Plankton.*

(9) An excursion to illustrate biology of microscopic fungi, summer and winter quarters on different hosts, &c. Look for *mycetozoa:* try to grow some at home.

(10) *Excursion to look for galls*—changes of tissue due to irritation. Notice also witches'-brooms. Galls may be taken home and gall flies caught when they emerge.

(11) Many biological facts should have excursions devoted to their illustration—*e.g.*, parthenogenesis, aphides, ants and their cows, social and solitary insects. Daphnias and their eggs (winter female; summer unfertilised).

(12) Having most fortunately this winter learned much of the structure of insects, an excursion or two might be devoted to *insects.*

(13) An afternoon might be well spent in studying *weeds.* I don't mean by weeds simply wild plants, but wild plants which appear in our cultivated fields and gardens, occupy the soil we till and prepare for crops and flowers, and enter into the struggle for existence with these for food and sunshine. Heath and rock-roses are not weeds. Where do the weeds come from? Seeds wind-carried, like dandelions; seeds ripened earlier than the crops (poppies and wild mustard); brought by human agency (finger-and-toe disease with manure); introduced with cereals.

We have, in studying a garden or a farm, a fine thought-model for human society. Human society, unlike animal communities, can plan its own development—a thing which it rarely does in any efficient way. Garden cities are a spendid idea,—only, to be really successful, human society must adopt some means of keeping down human weeds within them, and it should have clear ideas about what weeds are.

(14) If we could see cheese-making on scientific principles

it would be most illuminating,—it would show us how much in ordinary life is possible only through the action of microscopic organisms. It has been said that there are as many such organisms in, say, a cubic inch of good old ripe cheese as the human population of Europe!

(15) In this city of breweries we should surely be able to arrange an excursion to a brewery, and see how much depends on the tiny yeast plant, and how different results are produced by different varieties, even if we might not find pure cultures.

(16) A visit to a bacteriological laboratory could perhaps also be arranged. I don't mean, where pathogenic bacteria are cultivated, but where economic bacteria are studied, and we might get a glimpse into the vital processes continually going on in the soil.

(17) Few more informing excursions could be made than occasional visits to experimental agricultural institutions. We should try to get some idea of the important work that is being done there in giving a scientific basis to the cultivation of the plants and animals on which human civilisation chiefly depends. There is such an experimental farm at Kilmarnock.

(18) An excursion which would furnish material for much prolific thought would be a visit to the fruit-farms near Blairgowrie, if such an excursion be practicable. In summer some hundreds of women-workers are employed: they have country air in one of the most beautiful parts of Perthshire, good food, and healthy dwellings. It is altogether a social work of great interest and importance.

(19) In speaking of rearing crops and fruits, a visit might be paid to the institution at Corstorphine, which aims at developing the well-instructed female gardener.

(20) At some of our excursions a few practical demonstrations might be given to the more philosophical aspect of the field-naturalist's studies: for example, a little study of species-making might be taken up. I saw once one of our members make a very interesting and quite unprepared attempt of this kind. It was in May or June, when many plants of the Ranunculus family were in flower. He gathered a handful of different kinds,—*R. Lingua*, *Flammula*, *repens*, *bulbosus*, *sceleratus*, and *acris*. I don't remember whether he

had examples of allied genera, such as wood-anemone and meadow-rue and the like; but he pointed out the characteristics on which each species was founded. We may remember Asa Gray's saying, "Species are judgments."

(21) Could we not take up the study of some single genus? Take, for example, the commonest of roadside weeds, *Capsella Bursa-pastoris*. In the neighbourhood of Landau, Salms-Laubach found it in mutation—found it producing new varieties, suddenly and discontinuously. Near Amsterdam, De Vries found it in a state of stable equilibrium, and not in mutation. Could we not find some plants here in mutation? Even if we did not succeed in that, if we got a vivid idea of the new aspect the origin of species is assuming, it would be worth much trouble. An epoch-making change is taking place, the intellectual horizon is widening since Darwin lived, and it becomes us as field-naturalists to understand the newer views, and to try to find facts to support them or the opposite. Species, according to the more recent investigations, are like great poets, great musicians, great mathematicians,—born, not made; and that change of view should have vast future significance for human society.

This list of subjects for Field-Club excursions might, by giving the matter thought, be greatly extended. What I have written has been hurriedly done,—it should have been more logically arranged. The aim of my communication has been to indicate that excursions should grow out of ideas—as rain-drops are formed round particles of dust; and that excursions, like genial showers, should in turn help to make new, prolific ideas grow. Members should make suggestions. Finally, the most important social requirement is *co-operation*. Many are quite able to co-operate who do not do so: every member would do good to his society and to himself by trying.

At this meeting Mr J. G. Goodchild gave an interesting paper on "Some Animals in the Upper Elf Loch," which was illustrated by views of larvæ and other forms of aquatic animals, projected from life by the lantern microscope.

REPORT OF THE MICROSCOPICAL SECTION.

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

The Microscopical Section met regularly twice a-month during the winter session, each meeting occupying nearly three hours. The meetings were well attended and enthusiastic. We were again fortunate in having, as demonstrator, Mr Staig of the Natural History Department of the University of Glasgow, and the Section studied zoological subjects. We began with the earthworm; and after spending a couple of evenings over it, we devoted attention to several other worms, free and parasitic. That great group of animals commonly spoken of as Worms shows well how organisms on a common plan adapt themselves to very different conditions of life,—frequently to marvellous environments. From the free planarians we proceeded to the liver-fluke (*Distomum hepaticum*), and studied its structure. It has no heart and no blood, and it directs itself to the organs in the host where the most nutritive food is to be found. In course of time, and by regressive evolution, it will probably be able to do without a mouth: in that case the mouth will disappear. Every organism, to speak anthropomorphically, tries to live as easily as it can, and when it is prevented from accomplishing that, it may rise to higher things. Amongst men we have the almost universal approval of cheapness and disregard of its effects on the social organism. We had a very pretty demonstration of that large parasitic nematode, *Ascaris*. As usual, our procedure had three stages: we dissected the worm first; then we examined parts of it microscopically; and finally, we philosophised about what we had seen. Parasitism is associated with regression, but every young mammal is a parasite at first, though the parasitism here is only temporary.

Then we examined some curious Arthropods, amongst others the so-called skeleton screw (*Caprella*), with its gymnastic, attenuated body, and the parasitic *Sacculina*, become by degeneration almost a tumour. We had an example of the curious *Phronima*, which lives commensally in the body of a pelagic tunicate; and we spent some time over that most interesting of water-fleas, the archaic *Apus*, the modern representative of some extinct ancestor of the Crustacea. In fact, last winter we visited often what might be looked upon as a historic picture-gallery, where we saw representations of the ancestors of great races: we had a king crab, representing its relatives the trilobites; and we examined carefully one of the most interesting of animals, which connects the annelids with the centipedes and millepedes,—these in turn leading to simple wingless "white fish," the most ancient of insects. The ancestral form of animal life which delighted us so much was the *Peripatus.* It makes all the difference in the world to read about a thing, or to see something in a glass bottle in a glass case, and to handle it and put it under the microscope oneself; and so that hour spent with the *Peripatus* in our hands left a lasting impression in our minds.

Insects are so very numerous, both individually and in kind,—they have such interesting life-histories and mental powers,—that Field Naturalists should know something about them, almost above all other organisms, and so we devoted several evenings to the study of Insect anatomy, beginning with the cockroach and going on to some others.

We had an instructive evening on the *Amphioxus*: we went over the rough anatomy carefully, and were shown how to remove the nervous system virtually entire by steeping an *Amphioxus* in 10 per cent nitric acid and shaking it. We examined the notochord and other structures, and pictured to ourselves the shapes they took in higher forms of life.

Our last evening was spent in a fascinating way over bones. There was a significance and life put into that usually very dry subject. We understood from their development something of their structure and functions. We could see how important it was for the organism to economise waste-products for its advantage,—consider the case of a worm, the exoskeleton of a lobster, the wing of an insect, the skeleton of a vertebrate. It would not be too much to say that it is by using up waste-products that the organism is protected and built up for higher things.

In this report I have avoided the details of our work, the most of which is to be found in ordinary text-books. The chief function of the Microscopical Section is practical nature-study. It is by keeping continually in touch with natural objects that we hope to arrive at wider views of things biological. We want more intellectual co-operation amongst us, —that has been always our somewhat ineffectual aspiration. We must not lose sight of that ideal. Supplied with rich intellectual food, we have to avoid imitating the *Distomum* or the *Sacculina*, and, adopting a very general tendency of the age, fall into intellectual parasitism.

A microscopical section, in a word, is the nursery for philosophical Field Naturalists: we trust there will be a vigorous growth in it both of stable varieties and of sports.

A FEW RICCIAS FROM THE PENTLANDS.

By Mr JAMES M'ANDREW.

(*Read Oct. 25, 1905.*)

For some time the Pentland reservoirs have been, and still are, very low. Large expanses of dried or partially dried mud have in consequence been exposed, forming, especially along the courses of the burns which feed the reservoirs, very suitable habitats for that curious genus of Hepaticæ called *Riccia*. Mr William Evans and I have found, almost simultaneously, at least five species, and also *Fossombronia cristata*, which grows in similar situations. I have brought specimens of these Riccias for the inspection of members, and I may mention that a like abundance of these plants has occurred in other parts of Scotland, and from much the same cause. We have not gathered all the five species from any one reservoir, and, curiously, no species has been found in Bonaly reservoir. A Chara growing on the bottom may have something to do with this.

The following is a list of the species gathered: 1. *Riccia sorocarpa*, the smallest of the five species. 2. *Riccia glauca.* —This plant is larger than the preceding, and has a peculiar frosted appearance. 3. *Riccia crystallina.*—In the fronds of this species are found many large air-spaces. Mr Macvicar mentions that he has not before received this species from any part of Scotland. In the Glencorse reservoir it covers spaces measuring several yards in diameter. 4. *Riccia glaucescens*, or *Lescuriana*, occurs in the Clubbiedean reservoir, but only very sparingly. 5. *Riccia fluitans.*—This species is found floating in water, but fruit is only got on plants growing on the earth, at the margins of pools. It is very plentiful, along with *Fossombronia cristata*, on the bank of the burn connecting Threipmuir and Harlaw reservoirs.

EXHIBITS IN NATURAL HISTORY.

During the past session the following objects were exhibited at the evening meetings of the Society:—

A collection of plants from the Flannan Islands; by Mr Eagle Clarke. Specimen of Sirex gigas found suffocated in a gas-pipe in Dunfermline, with the piece of pipe showing the circular hole bored in it; by Mr James Adams. Specimens of plants from Caithness, including the Holy Grass (*Hierochloë borealis*), Ajuga pyramidalis, &c.; by Mr R. A. Calder. Scorpion (*Arachnida Scorpio*), tarantula (*Mygale Henzii*), horned toad (*Phrynosoma*), centipede (*Scolopendra morsitans*), and trap-door spider (*Cteniza californica*); by the Honorary Secretary. The rare fungus, Hypocrea riccioidea (Berk.), and five species of Riccia from the Pentlands; by Mr James M'Andrew. Living Canadian owl; by Mr John Pursell. Beekites, being chalcedonised fragments of fossiliferous limestone from a conglomerate cliff at Torquay; by Miss Beatrice Sprague. A water-colour sketch of the azure tit (*Parus cyanus*), Scandinavian forests; by Mr Herbert. Giant beetle, from Dominica, West Indies, and humming-bird's nest; by Miss E. Elliot. A nest of living ants (*Formica flava*); by Mr W. C. Crawford. White lark (*Alauda arvensis*), redwing (*Turdus iliacus*), starling (*Sturnus vulgaris*), siskin and greenfinch hybrid; by Mr G. M. Brotherston.

ADDRESS BY THE PRESIDENT,

Mr JAMES RUSSELL,

October 25, 1905.

It is only in mythology that Athena springs fully equipped from the cleft brain of the Olympian Zeus. In actual life things are very different,—knowledge has to be gained by slow and laborious processes. The secrets of Nature do not lie upon the surface; they must be searched for earnestly and diligently, but to those who do so they offer a rich reward. In the physical world as in the spiritual, it is true that they who seek shall find, and that to those who knock it shall be opened. In the past much knowledge of the secrets of Nature has been gained by diligent searchers, and their gains, which have become the common property of humanity, form a starting-point for others. At the present day there is hardly a conceivable branch of human knowledge which has not its earnest workers, and I would wish you one and all, and especially the younger members of the Society who have life's heyday still before them, to become co-workers in one or other of these branches of knowledge. You may perhaps ask,—What branch? That is a question which every one must answer individually to himself or herself. I am addressing the members of a Field Club and Microscopical Society, and of course my remarks will be more particularly applicable to the subjects cognate to the objects of such a Society; but I am far from thinking that such objects are those which should chiefly occupy your attention, or that they are those which can most fully satisfy the longings of every mind, although the fact of your becoming members shows that you have a certain inclination towards them. Each one must choose the branch of research from which it is thought the greatest satisfaction will be derived, and work at it with a whole-heartedness. Nothing is to be gained unless you bring your mind and energy to bear upon the subject you have chosen. Some—in a Society such as this I would think the number would be few—may, however, ask, *Cui bono?* My answer is,—For the good of yourselves and your fellows. You have tasted of the fruit of the tree of knowledge, and there is now no drawing back: on the contrary, you feel an impulse, which is almost irresistible, driving you forward in the quest of fuller knowledge. You feel there are on every side of you mysteries which you wish to unravel: you desire to know the *why* and the *wherefore* of the things around you. Hence this striving after knowledge, and as you are indebted to the labours of those who have gone before, so there is an obligation upon you to hand on your own quota to those who come after, and thus to work for the common good. But, for yourselves individually, there should be an aim higher, infinitely higher, than the acquisition of knowledge,—I mean, the *formation of character*. Never forget that there may be much knowledge and very little nobility of character, and as this latter is the principal thing for the individual, see you do nothing which would injure it in your search for the former. In comparison with nobleness of character the world's highest possessions are poor. Your strivings, then, should be for the formation of a noble character: in your search for knowledge, to love the true and the good and to despise the false and the mean, and to follow its pursuit in the true scientific spirit—the search after truth. In so doing you will no doubt encounter many prejudices, and experience many failures, but do not be disheartened : all true labour is never lost. You may not be able to add much, or anything, to the sum of human knowledge, but you will have your reward in the consciousness that you have tried to do your duty.

Having by these preliminary remarks succeeded, I hope, in freeing myself from the imputation of one-sidedness, I will endeavour, in a few sentences, to give some suggestions as to the manner in which I think the objects of our Society may be most practically and beneficially pursued. These objects are set forth in the rules of the Society as "the Study of Natural History in all its Branches." Now the term "Natural History" here, as I understand it, is employed in its widest sense, and as the words themselves imply, "to designate the study of all natural objects indiscriminately, whether these are endowed with life, or exhibit none of those incessant vicissitudes which collectively constitute vitality." If I am right, then the objects of our Society embrace the study of the three great kingdoms or divisions of nature—animal, vegetable, and mineral. The mere statement of the case shows, then, that to enable the study to be taken up seriously there must be a division of labour,—separate workers in many different departments. To carry this out, the members should form themselves into small sections, with a convener to each, for the study of those branches of the subject to which they are more particularly inclined. A place of meeting could be found at the house of one or other of the members of each section, or at such other place as might be arranged. Papers from the workers in these various sections would be communicated to the Society at its monthly meetings, and would thus appear in the 'Transactions.' This would prevent the sections from drifting apart, and would constitute a bond of solidarity and an *esprit de corps* among the members as a whole. Again, members would change from one section to another, which would tend to broaden their knowledge and increase their sympathies with each other. The following are some of the subjects for the study of which sections might be formed:—

ANIMAL KINGDOM: (1) *Sub-kingdoms Protozoa and Cœlenterata.*—Under these sub-kingdoms the following divisions would furnish many interesting subjects for the study of the lower forms of life—viz., Amœba, Infusoria, and Hydrozoa. The following are books bearing upon these divisions:—

'Fresh-water Rhizopods of North America,' Leidy.
'Manual of the Cœlenterata,' Greene.
'Manual of the Infusoria,' Saville Kent.
'British Zoophytes,' Pennington.

(2) *Crustacea.*—Under this division, and particularly under the sub-class Entomostraca, there are a very large number of genera, specimens of which are easily obtainable, and having this additional advantage, that the life-histories of many of them can be studied without much difficulty. Reference to the following books may be made:—

'Natural History of British Entomostraca,' Baird.
'Report on the Present State of our Knowledge of Crustacea,' Spence Bate.
'The Crayfish,' Huxley.

(3) *Arachnida.*—These include the spiders, mites, &c. The following books may be consulted:—

'British Spiders,' Staveley.
'British Oribatidæ,' Michael.

There are also some in German on special genera.

(4) *Insecta.*—You have under this sub-kingdom endless subjects for study, and the literature upon the various families and genera is ample and various. The following books may be consulted:—

'Introduction to Entomology,' Kirby and Spence.
'Guide to the Study of Insects,' Packard.
'Origin and Metamorphosis of Insects,' Lubbock.
'British Beetles,' Rye.
'British Butterflies and Moths,' Stainton.
'The Structure and Life-History of the Cockroach,' Miall and Denny.
'The Anatomy and Physiology of the Blow-Fly,' Lowne.

It will be observed that I have confined myself to the Invertebrata, because I wished to bring under your notice those subjects of study which are practicable, and, speaking generally, the literature upon which is easily obtainable. To those who wish to pursue their studies among the Vertebrata, there can be no better subject for a beginning than the Common Frog (*Rana temporaria*). For this the 'Practical Biology' of Huxley and Martin may be followed.

VEGETABLE KINGDOM.—In this kingdom sections could be formed for the study of the following divisions:—

(1) *Fungi.*—Under this division you have some of the lowest forms of vegetable life: specimens of the various families are, as a rule, easily obtainable, and their life-histories can be traced. The tracing of these life-histories, especially in many of the microscopic fungi, is extremely interesting. You will observe the higher plants on which they are parasitic, and in some cases you will find that in the course of their life-history they become parasites on plants belonging to entirely different orders. As an instance of this, the rust of wheat (*Puccinia graminis*) may be mentioned. It develops two kinds of spores—uredospores and teleutospores—on the green parts of certain of the *Gramineæ*, especially wheat, barley, and oats, to which it is extremely injurious; while a third form of spores—æcidia—is found on the leaves of the barberry. The following books will be useful:—

'British Fungus-Flora,' Massee.
'Introduction to the Study of Fungi,' Cooke.
'Microscopic Fungi,' Cooke.

(2) *Algæ.*—Another well-defined division are the Algæ: here also you have got some of the lowest forms of vegetable

life, and here, perhaps better than in any other division, you can study the processes of fertilisation and reproduction. Here you have reproduction by means of fission, by conjugation, and by spores. As instances of the first mode, there are the genus Chroococcus, which consists of isolated rounded cells enveloped by a thin wall of a blue-green colour; and the genus Nostoc, which forms a chain of cells. As an instance of reproduction by conjugation, there is the genus Spirogyra, in which two filaments come together, when the contents of some of the cells of one of the filaments pass into cells of another filament and coalesce with the contents of these cells; and not only so, but sometimes the contents of the cell of a filament pass into a neighbouring cell of the same filament. As instances of reproduction by spores (swarm-spores), you have the genera Ulothrix and Œdogonium, but in these it may be mentioned there is also sexual reproduction. You will find another very peculiar form of sexual reproduction in the genus Vaucheria. These are, speaking generally, terrestrial and fresh-water algæ, but, as you are all aware, there are numerous families of marine algæ which form interesting objects of study. The following books treat of these:—

'A Treatise on the British Fresh-Water Algæ,' West.
'British Seaweeds,' Gatty (Mrs Alfred).

(3) *Bryophyta and Pteridophyta.*—These include the liverworts and mosses and the vascular cryptogams, and they form an excellent division for study. You can trace the gradual development of the vascular system from what appears to be its beginning in special rhizoids of some of the liverworts to its beautiful form in the bracken (*Pteris aquilina*). In the vascular cryptogams, and especially in the ferns, you can trace very clearly that form of reproduction called alternation of generation. You can sow the spores of the fern, and thus obtain the prothallus on which the antheridia and archegonia arise, and from the fertilised archegonium of which the young fern plant grows. In this study the following books will be of use:—

'Handbook of British Hepaticæ,' Cooke.
'The Student's Handbook of British Mosses,' Dixon and Jamieson.
'Flowerless Plants,' Scott.

(4) *Phanerogams.*—The foregoing remarks apply only to the Cryptogams; there is, in addition, the great sub-kingdom

of the Phanerogams or flowering-plants, and it is likely that it is to these plants the majority of you will turn. In doing so you should carry on the study of them in a systematic manner, taking up the various orders in succession, and thus mastering their distinctive differences. As a guide to the localities where the various specimens may be found, you would find Sonntag's 'Pocket Flora of Edinburgh' useful.

In naming the various books which I have done, I do not at all mean that they are the only ones in the different subjects, but only that I think you would find these sufficient for your purpose.

It may be that some of you would wish to apply yourselves to the more recondite subjects of study: if so, you will find a most interesting one in the fertilisation of plants. You can study the changes which take place in the sperm-cell and the egg-cell respectively, before the final coalescence of the two. So far as has been established, there is in each of these cells (sperm-cell and egg-cell) a definite number of what are called chromosomes for each plant, and also for each animal. If, then, these cells united without any previous change, there would be a number of chromosomes in the daughter-cell resulting from this coalescence, double those in the original cells. This is, however, provided against in a most remarkable manner. In each of the sperm-cells and egg-cells preliminary divisions—called maturation divisions—take place, by which the original number of chromosomes in each is reduced by one-half, so that when coalescence actually takes place there is in the daughter-cell the definite number of chromosomes appropriate to the particular plant or animal. Here, then, is a study fitted for the highest powers of observation and the best glasses of your microscopes. A writer on this subject says:—

> "We thus know now what 'fertilisation' is. Through the labours of the last decade the veil has been torn from a mystery of nature which for thousands of years confronted humanity as unapproachable; a riddle has been solved for the solution of which a few centuries ago man did not even dare to hope. Not a few have taken part in these labours."

Some of you may wish to take a part also in carrying on such labours,—there is ample scope in the field,—and to those who do I wish all success.

In your study of Nature I would, however, not wish that you should be one-sided. I have spoken of what may be called the animate side of nature; there is another side—the inanimate—which I would not wish you to overlook. Here also may be found influences which appeal to our higher feelings. I would not wish your mind to be entirely engrossed with somites and tracheæ, with ovaries and chromosomes. Admire the sheen on the elytra of the beetle and the velvety down on the petal of the flower before you subject them to the scalpel. There is beauty in the gentle rivulet winding its silent course through the flowery mead; there is grandeur in the mountain torrent in its wild leap down the rocky gorge; and there is sublimity in the raging storm as it hurls the ocean's billows against the cliffs, driving their spray far across the fields. I wóuld not have you miss the glint of the slanting sunbeam on the ripple of the brook by your eye being fixed on the bottom in search of a fresh-water mollusc; nor the glorious suffusion of the glow of light as the foam-covered steeds of Helios, with their fire-engirdled chariot, pass from view beneath the western horizon, because you are peering into a rock-pool looking for a sea-anemone. In all these sights of nature, inanimate though they be, there are influences impelling us on to things higher and better, and I would not wish that you should stop your ears or shut your eyes to them.

During the year there have been changes in the membership of the Society. We have lost several by death and resignations, but there have also been admissions of new members, so that, upon the whole, our numbers have not fallen below those of the previous year. I think you will pardon me if I allude specially to one member who has been removed from us by death—I mean Dr Andrew Semple. His extensive knowledge and varied experience, and withal his modest and kindly disposition, endeared him to all who knew him. He was a very constant attender at our indoor meetings, but his age precluded him from taking much part in our excursions. He told me, however, that he was looking forward to be able to join in some of them this season, but it was not to be; the word was spoken—"Return,"—and he has gone from us.

Perhaps I should also mention that one of the last of the original members of this Society has passed away in the person of Patrick Neill Fraser, of Rockville, Murrayfield, who died on the 27th of February 1905, in his seventy-eighth year. Mr Fraser was all his life a keen botanist, and a frequent attender of the botanical excursions of this Society in its earlier days. At the time of his death, however, Mr Fraser was not a member, he having severed his connection with the Society some years ago. On July 25, 1900, the members visited Rockville to see the magnificent collection of British and exotic ferns brought together there, and were most cordially received by Mr and Mrs Fraser.

In the introduction of new members I would like to see a little more formality observed. At present the ballot is taken, and the President declares them duly elected, and there is an end of the matter. Probably they are not known even by sight to the majority of the members, and they may feel themselves isolated units. I would like, however, that they should feel on becoming members they are entering a brotherhood or sisterhood in which they will find kindred hearts beating in sympathy with their own. To in some degree attain this object, I would venture to suggest that new members on their first appearance at our meetings be introduced to the chairman for the time who could welcome them, and thus make them feel that not in name only but in reality they are in the midst of friends.

I now beg respectfully to tender my most sincere thanks to the members generally for the kindly manner in which they have overlooked any of my shortcomings in the chair or at the excursions; to the members of Council, and especially to our Secretary, for the manner in which they have supported me in the performance of my duties. To me the meetings have been a source of great pleasure.

And now one word in concluding: if any of you who are engaged in microscopical investigations think that I can be of any assistance to you, it will give me much pleasure to do what I can in the way of such assistance.

ANNUAL BUSINESS MEETING.

THE annual business meeting of the Society was held in the Hall, 20 George Street, on the evening of Wednesday, October 25, 1905—Mr James Russell, President, in the chair. Mr James M'Andrew exhibited specimens of, and read a short note on, five species of Riccia found in the Pentland reservoirs (*ante*, p. 227).

The Secretary then submitted his report, as follows:—

During the session 1904-5 six indoor meetings of the Society were held. It is pleasing to state that the attendances have been in all respects highly satisfactory, and that there was no difficulty in obtaining communications and exhibits for these meetings.

For the summer nineteen meetings were arranged, as follows:—

April 29. North Berwick.
May 3. Elf Loch and Blackford Hill.
" 13. Inverkeithing and St Davids.
" 17. Carlowrie.
" 23. Lake of Menteith.
" 27. Longniddry to Aberlady.
" 31. Davidson's Mains.
June 10. Penicuik.
" 14. Colinton Glen.
" 17. Millport.
" 24. Auchendinny.
" 28. Swanston.
July 8. Binns and Linlithgow.
" 12. Currie to Colinton, by Clubbiedean and Torduff reservoirs.
" 15. Pressmennan Loch.
" 22. Peebles and Innerleithen, by Traquair.
" 26. Balerno to Currie, by Malleny and Lymphoy.
Oct. 7. Cadzow High Park.
" 14. Roslin to Polton.

The average attendance at these meetings was 22.

In addition to the foregoing, one special meeting was held to visit Restalrig Church and Craigentinny House: 40 members attended this meeting.

Compared with last year, the membership is increased by 5,—the total number of ordinary members being 246. Of new names 22 were added to the list, while 17 names were withdrawn. Of these latter, 14 resigned; 1 died (Dr Andrew Semple); and 2 were elected Honorary Members.

Ten meetings of the Microscopical Section were held at the house of the Convener, Mr W. C. Crawford. The syllabus for the session 1905-6 will be issued next month, on the return of Mr Crawford, and it is hoped there will be a much larger attendance than last year.

The Treasurer submitted his report and statement of income and expenditure for the past year, copies of which were already in the hands of members.

In the absence of the Convener, Mr Crawford, the report of the Microscopical Section was held as read.

The President then delivered his address (*ante*, pp. 229-236).

The election of office-bearers and councillors was next proceeded with, the nominations of the Council being agreed to. The following is a complete list, the names printed in italics being those of members elected to fill vacancies: President, James Russell; Vice-Presidents, James A. Terras, B.Sc., William Williamson, and *W. C. Crawford*; Secretary, John Thomson; Treasurer, Geo. Cleland; Editor of 'Transactions,' Dr Davies; Auditors, R. C. Millar and Charles Campbell; Councillors, Miss Mitchell, Miss E. M. H. Gray, James M'Andrew, Rupert Smith, Miss M. G. Anderson, Miss Sprague, A. G. Stenhouse, G. M. Brotherston, *E. Denson*, *John Laidlaw*, *D. S. Fish*, and *Jas. B. Stewart*.

The proceedings terminated with the usual votes of thanks.

PRESENTED
27 DEC. 1905

THE EDINBURGH FIELD NATURALISTS' AND MICROSCOPICAL SOCIETY.

COUNCIL, 1904-1905.

President.

JAMES RUSSELL, 16 Blacket Place.

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STATEMENT OF INCOME AND EXPENDITURE FOR YEAR TO 18th OCTOBER 1905.

INCOME.

To Balance from last Account			£28 17 6
" Annual Subscriptions for Session 1904-1905		£48 15	
" " 1905-1906		0 15	
" New Members, 1904-1906		1 15	
			51 5 0
" Arrears of Subscriptions— Amount outstanding, 17th Oct. 1904		£7 15	
" irrecoverable	£1 15		
" still outstanding	3 0		
		4 15	
			3 0 0
" Donation for Publication Fund			0 10 0
" 'Transactions' sold			1 17 11
" Blocks sold			0 15 0
" Interest			0 14 4
			£86 19 9

Arrears of Subscriptions outstanding—

Sessions 1902-1904	£3 0 0
Session 1904-1905	4 10 0
	£7 10 0

EXPENDITURE.

By Rent of Hall for Meetings, &c.		£6 7 10
" W. Blackwood & Sons— 'Transactions'	£25 10 5	
Billets for Meetings, &c.	11 17 1	
		37 7 6
" Advertising Expenses		4 1 0
" Hire of Lantern		2 2 0
" Gratuities to Hall-keeper and at Excursions		1 15 3
" Stationery		1 0 0
" Secretary's Railway Fares to Excursions		0 18 1
" " Postages, 'Transactions'	£0 8 4	
" " " Billets	3 4 6	
" " " Ordinary	2 12 3	
		6 5 1
" Treasurer's Postages		1 0 7
" Secretary's (W. Williamson) Final Expenses		1 14 7
" Millport Marine Biological Association		1 1 0
		£63 12 11
" Balance due by Bank of Scotland		23 6 10
		£86 19 9

PRIZE FUND.

To Balance from last Account	£5 0 0
By Balance due by Bank of Scotland	£5 0 0

GEO. CLELAND, *Hon. Treasurer.*

18*th October* 1905.—We hereby certify that we have audited the foregoing Statements of Income and Expenditure, and found them correctly stated and satisfactorily vouched, the balance in favour of the Society being Twenty-eight pounds, six shillings, and tenpence sterling.

CHARLES CAMPBELL, } *Auditors.*
R. C. MILLAR, }

61.

VOL. V. PART IV.

TRANSACTIONS

OF

The Edinburgh Field Naturalists' and Microscopical Society

SESSION 1905-1906

BRITISH MUSEUM NATURAL HISTORY

CONTENTS.

Published for the Society

BY

WILLIAM BLACKWOOD & SONS

MCMVI

Price to Non-Members, Four Shillings.

SESSION 1905-1906.

I.—*A CONTRIBUTION TO THE HYDRACHNID FAUNA OF SCOTLAND.*

By Mr WM. WILLIAMSON.

(*Read Nov. 22, 1905.*)

The only list of Scottish Hydrachnids that I know of is that which was submitted to the Quekett Microscopical Club in November 1900 by Mr Chas. D. Soar, F.R.M.S.,—now one of the Corresponding Members of this Society. In that list 40 species, belonging to 20 genera, were enumerated as having been found in the district near Oban by Mr Taverner. Since that time I have been collecting Hydrachnids, chiefly in the neighbourhood of Edinburgh, Glasgow, and West Kilbride, Ayrshire, and a list of those collected is now put on record. After being named by me, all the specimens were submitted to Mr Soar and verified by him; and it is due to him to acknowledge the constant courtesy and kindness with which he has helped me in this branch of zoological study. The classification and nomenclature which I have followed are those of Dr Piersig's 'Deutschlands Hydrachniden' (Zoologica, Heft 22, 1897-1900), supplemented by 'Hydrachnidæ und Halacaridæ,' Piersig and Lohman (Das Tierreich for 1901). Since these works were published numbers 2 and 18 in this list were described by Mr Soar as new species. An asterisk marks those species which do not appear in Mr Soar's list of 1900. These number 14, so that now 54 species of Hydrachnids are recorded by Mr Soar and myself as found in Scotland. Further systematic work will doubtless add to the list in the future. One of the specimens of Piona conglobata was found to have an abnormal development of one of the limbs. About half way down, the limb bifurcated, but unfortunately the specimen, when found, had been somewhat mutilated by the other inhabitants of the pond, although sufficient evidence remained to show that it was a freak.

In a communication made to this Society on 28th April 1897, Dr Thos. Scott and Mr John Lindsay report Diplodontus as fairly common in the Upper Elf Loch. Curiously enough, I have never taken specimens of this genus in my collecting anywhere, although it has been reported also by Mr Soar as occurring in Scotland. I may here observe that, owing to changes in nomenclature, the water-mite recorded by Messrs Scott and Lindsay, 23rd March 1898, as Arrenurus buccinator is now known as Arrhenurus caudatus *De Geer.*

HYDRACHNIDÆ.

Sub-Family HYDRYPHANTINEÆ.

Genus I., THYAS C. L. Koch.

1* Thyas venusta *C. L. Koch.*
2* " extendens *Soar.*

Genus II., HYDRYPHANTES C. L. Koch.

3* Hydryphantes prolongatus *Karl Thon.*

Sub-Family HYGROBATINEÆ.

Genus III., ARRHENURUS Ant. Dugès.

4 Arrhenurus maculator *Müller.*
5 " zachariæ *Koenike.*
6* " neumani *Piersig.*
7 " crassicaudatus *Kramer.*
8* " caudatus *De Geer.*

Genus IV., BRACHYPODA Lebert.

9 Brachypoda versicolor *Müller.*

Genus V., LEBERTIA Neuman.

10 Lebertia tauinsignita *Lebert.*

Genus VI., LIMNESIA C. L. Koch.

11 Limnesia koenikei *Piersig.*
12 " histrionica *Hermann.*
13 " maculata *Müller.*
14* " connata *Koenike.*

Genus VII., HYGROBATES C. L. Koch.

15 Hygrobates longipalpis *Hermann.*
16 " nigro-maculatus *Lebert.*

Genus VIII., PIONACERCUS Piersig.

17* Pionacercus leuckarti *Piersig.*
18* " pyriformis *Soar.*

Genus IX., LAMINIPES Piersig.

19* Laminipes ornatus *C. L. Koch.*

Genus X., PIONOPSIS Piersig.

20* Pionopsis lutescens *Hermann.*

Genus XI., NEUMANIA Lebert.

21* Neumania vernalis *Müller.*

Genus XII., PIONA C. L. Koch.

22 Piona nodata *Müller.*
23* " aduncopalpis *Piersig.*
24 " carnea *C. L. Koch.*
25 " rufa *C. L. Koch.*
26 " circularis *Piersig.*
27* " uncata *Koenike.*
28 " fuscata *Hermann.*
29 " conglobata *C. L. Koch.*
30* " paucipora *Sig. Thor.*

Addendum.

It may be as well to record here that a specimen of Torrenticola anomala *Piersig* was sent to me from Callander. I have a note of three mites, not mentioned in Mr Soar's list or in the foregoing list, which have been found in Highland lochs, but these will doubtless be recorded in due time.

At this meeting Mr T. C. Day read an extremely interesting paper entitled "A Geological Ramble on Arthur's Seat." The paper was illustrated by a large number of beautiful lantern-slides.

II.—*SOME FEATURES OF INTEREST IN SCOTTISH MOUNTAIN PLANTS.*

By Mr D. S. FISH.

(*Read December 20, 1905.*)

Mountainous countries are usually far more interesting than those that are low-lying and flat. The climate varying with altitude favours much variety of life. Many features, foreign to the lowlands, crowd upon the observation. If charming scenery or dreary solitude is wished for,—whether interested in natural history, climbing, or sport,—mountains offer rich ground for careful inquiry and keen observation. While noting some of the more prominent features of mountain plants in Scotland, it may be well to point out a few matters of interest in connection with mountain vegetation generally.

The floras of high mountains are usually very diversified. The range of vegetation met with is, of course, widest on mountains situated in equatorial countries, for there plants occur from the tropical forest or plain up to the edge of the summer snow-line. Between the extremes of a tropical and a frigid temperature, a series of varied zones occur which may, for illustration, be considered analogous to the zones traversed in travelling from the equator towards the poles, the poles being represented on high mountains by their snow-covered summits. The features of a whole continent—its different climates, the rocks and soils, the forests, grassy steppes, meadows, marshes, lakes, and deserts, its fauna and flora—may all be epitomised upon a mountain.

Subject to a remark made above, it will be obvious that the vertical range of vegetation upon any particular mountain largely depends on the latitude, a difference of three degrees being about equal to a thousand feet in elevation. In Europe, as the Arctic region is approached, there is a very rapid falling away of this vertical range. The flora of the lowlands of Northern Europe is repeated with but slight differences upon the hill summits of that country. In Scotland, the range of plants is not nearly so marked as in equatorial countries, or even in the European Alps or other like mountain-ranges. There the vegetation frequently extends from the Vine and the Olive region, not far above sea-level, to the borders of perpetual snow. Here we commence with grassland or woodland of a more or less Northern type, and end where stragglers from subalpine regions, and even from the lowlands, combine with characteristic plants of the higher parts of mountains to form a dwarf vegetation.

As islands, Great Britain and Ireland are exposed to influences which do not affect the mountains of large continents. The influence of the sea, with its varied currents, must account in part for the wide difference of levels to which plants ascend in the two islands.

Comparative Purity of Mountain Floras.

The changes that take place when virgin ground is devoted to agricultural purposes effect a very considerable influence on the flora. For instance, some of the indigenous plants are quite likely to perish, owing to the breaking up of land by the plough, by irrigation, or draining. If certain plants disappear, however, it is likely enough that others of exotic origin will make an appearance, for amongst the seeds of plants cultivated are sure to be those of foreign weeds, which speedily grow. In some cases the aliens usurp the places of native plants. Such changes as these here indicated have no doubt taken place extensively, especially in such countries as Switzerland, where many of the valleys and lower slopes to-day are highly cultivated vineyards.

While these changes take place, mountain floras, however, are usually isolated from interferences due to land cultivation and traffic, and may be peculiarly instructive in instances where the lowland floras have become much altered by civilisation. If any portion of a fertile country is likely to hold what is called a virgin or indigenous flora, it is most likely to be found in a mountainous part. But, of course, even mountainous districts are not always free from lowland traffic. Such plants as the Holly appear in isolated plants in very out-of-the-way districts, brought probably by fruit-eating birds. In Scotland the Nettle not infrequently ascends with the cattle or sheep—in fact, this social plant is seldom absent from the track of man, as M. Lavallée has pointed out. On the Continent goats are the principal carriers of lowland plants to mountain heights, and colonies of weeds are not infrequently to be found in the vicinity of their mountain shelters. Occasionally man himself is the introducer, sometimes as a designing rather than an accidental one, as when the Continental Primula Auricula and Erinus alpinus were found—planted or sown by hand, of course—near Glen Shee.

There are certain plants which, if introduced, might play havoc with an indigenous mountain flora. Such an occurrence is actually taking place to-day in New Zealand. Some of the most vigorous mountain plants of these islands, such as the large New Zealand Flax (Phormium) and the enormous Wild Spaniards (Aciphyllas), which form huge rosettes of rigid sharp-pointed leaves, are, according to Mr T. Kirk, being ousted from their haunts by the vigorous growth and competition of introduced Grasses and Clovers. The pressure that sturdy aliens of the lowlands can exert on even a mountain flora may be particularly well observed from their beginnings in New Zealand, where large tracts of the country have only within recent years been opened up.

Mountains as Plant Asylums.

From the preceding it may be gathered that a mountain flora is less liable to change than a lowland one. The exact *rôle* that mountains have played as places of refuge for plants driven from the lowlands by land cultivation, &c., would form an interesting subject—if known! Little, however, need be said, as the matter is largely conjecture. The majority of plants are herbaceous, and leave no remains which can be identified in geological strata.

Since our present types of flowering-plants existed on the earth, mountains, it may be assumed, have played a part in their history and distribution. Were the vegetation to be gradually destroyed by untoward circumstances, it does not seem improbable that the last plants to remain, so far as land forms are concerned, would be those of mountainous regions. Some plants may even owe their existence to-day to the varied range of the mountain climate, &c., these plants having been able to spread towards the positions better fitted for their life.

Scottish Mountain Flora: The Arctic Character.

The vegetation of the mountains of Northern Britain resembles in many respects that of the North of Europe. Those familiar with the plants of the latter region find in Scotland a fair replica—in some details scanty or wanting, it is true—of the Farther North flora. The migration of many Arctic plants into Britain is believed to have taken place during the Glacial Period, when the greater part of Britain was submerged, its higher land appearing as islands above the water. These islands—now our mountains—were approached from the north by vast ice sheets, their *débris*-covered surfaces serving as a means of plant-transportation between the two countries. The ice-scratched rock-surfaces and various deposits of glacial drift, together with the living plants left on the high lands or the ice, remain with us to this day as striking relics of that Period. The greater number of these plants that did reach Britain find their most extensive and congenial home in Scotland. Some occur in England, especially in the Northern counties, and some also in Wales, while a few penetrate farther south—for example, the Crowberry (Empetrum nigrum), a relic in Sussex. The majority of such plants have, however, fallen off long ere the Thames is reached.

Of some of these plants, plentiful farther north, Britain received, or anyway has to-day, a scanty allowance. The remarkable Bulbous Saxifrage (Saxifraga cernua) and the Blue Sow-thistle (Sonchus alpinus) of the Grampians, also Bryanthus taxifolius, may be cited as examples of plants scarce and restricted in distribution here, but comparatively frequent in Northern Europe. It is noticeable, too, that a number of plants, although found in Scandinavia, &c., did not reach Britain. A charming Pasque-Flower (Anemone vernalis), the Arctic Raspberry (Rubus arcticus),[1] Silene rupestris, two Ericaceous genera, Cassiope and Ledum, are among those that might be expected to occur in Scotland, but apparently do not.

Notwithstanding the non-occurrence of certain North-European plants, the presence of others here is quite sufficient to give reasons for the belief that a portion of our mountain flora is derived from the larger ones of Northern and Arctic Europe. The general appearance of the vegetation of the Scottish Highlands, especially in the predominating presence of xerophilous plants with small "heathy" foliage (as Calluna and Empetrum), is strongly akin to that which prevails in many parts of Norway, &c. It is unlike the general type of vegetation of the Swiss Alps. Other distinctive plants of northern origin, in addition to those named above, are several Saxifragas, the Dwarf Birch (Betula nana), Salix Lapponum, the Scottish Asphodel (Tofieldia palustris), the Bog Asphodel (Narthecium ossifragum), Luzula arcuata, &c.

The Scottish and the Swiss Mountain Flora.

Comparisons have been made between the mountain floras of Scotland and Switzerland, and the tabulated results show what might naturally be expected—namely, that a number of the same plants occur in both countries. Many of these species are ubiquitous, or widely distributed over the northern or temperate regions of the Old World, while others are confined to considerable areas in Europe. Many of the most conspicuous plants of the Alps are, however, entirely wanting

[1] Said to have been gathered in Scotland by Don, but if a native, unknown as such to-day.

in Britain: the favourite Edelweiss (Leontopodium alpinum), the Soldanellas, Androsaces, many perennial Gentians and Campanulas, groups of Primula, the Cortusas, several sections of Saxifraga, Pulsatillas and other Anemones, and many species of Dianthus, may be instanced as examples. Regarding the non-appearance of many such plants in Scotland, it has been ingeniously stated that they might probably have been present had our mountains been rather more compact and higher. This, however, does not seem likely. Had our Highland peaks been higher or closer together, they could hardly have held greater attractions for the absentees than exists at present. More probable is it that many Swiss plants do not occur in Scotland to-day simply because they were never enabled to reach this country. Had they done so, it is likely that they would still have remained on one or other of our mountain-ranges.

Characteristics of Mountain Plants.

Lowland plants not infrequently ascend to high altitudes, and by comparing examples from different elevations an idea may be gained of the influence of the mountain climate upon plant growth. Moreover, for the purpose of obtaining comparative results plants have been carefully grown in Continental experimental gardens situated both at low and high levels. Some of the more noticeable features of plants from the higher mountain regions may be here mentioned.

Dwarf Habit.—Mountain plants are usually dwarfer than lowland ones, and their leaves smaller. Although the aërial portion of the plant is reduced, the roots are, as a rule, considerably longer than in lowland examples. Good Scottish illustrations of these features are seen in the Dandelion and in the Buttercup (Ranunculus acris), both of which ascend to high altitudes,—at the upper stations the plants reaching only a few inches in height. Lowland and upland specimens of such plants as the Marsh Marigold (Caltha palustris), Golden-rod (Solidago Virgaurea), and Alchemilla vulgaris, &c., may also be compared. None, however, show the shortening of plant, stem, and leaf, and the elongation of root, better than the Dandelion, which often occurs in a miniature condition near and at the tops of our highest mountains.[1] Even plants that are confined in Scotland to the higher parts of mountains show very considerable variation in size, as may be seen by comparing the plants of Saxifraga stellaris, &c., at the summits of the Breadalbane Mountains with the examples that occur, say, a thousand feet below.

Shrubby plants, when they occur, are likewise compact and bushy, owing to their branches being numerous and short.

Xerophilous Features.—The general stunted character of mountain plants is due to the nature of their environment. The stormy winds, the sudden extremes of temperature, and the rarefaction of the mountain air, all tend to favour a dwarf growth. Many of these plants have to undergo a period of drought,—drought not produced so much by heat as by winter cold and the desiccating effects of winds. To prevent death taking place from loss of water, many mountain plants are found with adaptations which check transpiration. Thus the leaves may be stiff and leathery, with a reduced surface (Lycopodium), succulent or fleshy (Saxifraga oppositifolia, Sedum roseum), with stomata partially concealed (Empetrum), hairy on the under surface (Dryas, Plate XXIV., Fig. 1), waxed on the under side (Vaccinium Vitis-Idæa, Salix reticulata), densely covered with hairs (Antennaria, Salix Lapponum, S. lanata), rolled up and strongly cuticularised (Grasses and Sedges, as Festuca ovina, Nardus, Carex rupestris, &c.).[2] Loiseleuria (Plate XXIII.) has rigid leaves with revolute margins, and downy beneath.

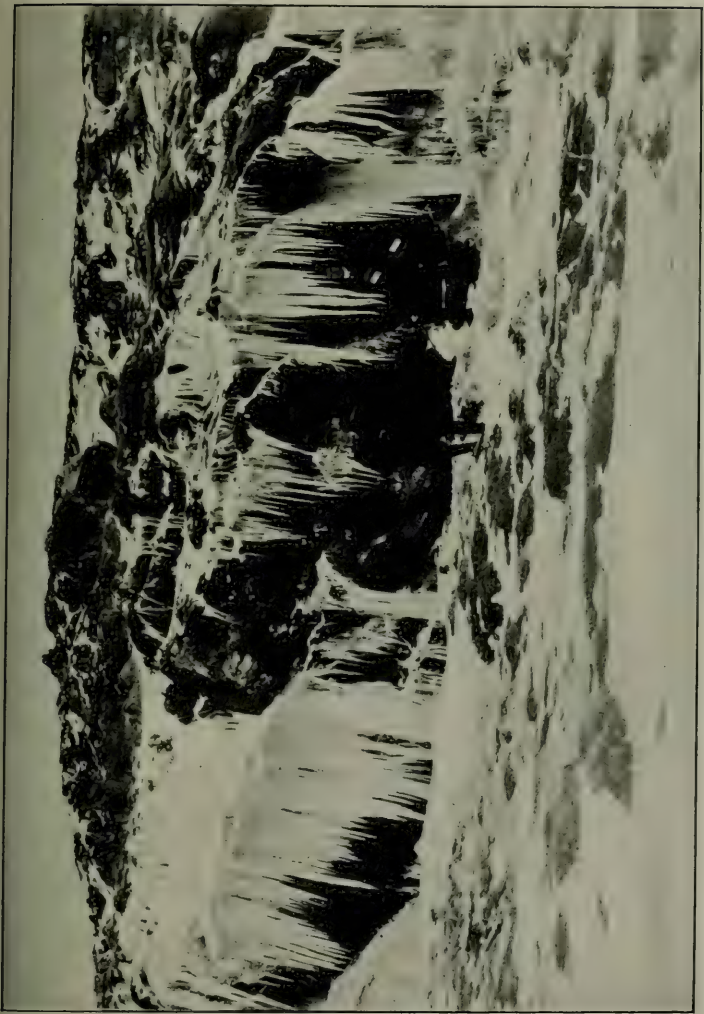
Plate XXI. shows the half-exposed mountain rocks during spring, when the plants are most liable to suffer owing to insufficient moisture; for it is when oft-repeated winds and sunshine accompanied by frost occur that desiccation is liable to take place, owing to the loss of water from the shoots—water which, if lost, cannot be replaced, owing to the roots being frozen in.[3] At one time it was supposed that the

[1] The Dandelion was one of the plants that the late Mr Ball found in flower on the Aletsch Glacier, 10,700 feet above sea-level.

[2] See Schimper's Plant Geography, p. 679.

[3] Many plants, upland and lowland, which do not die below-ground in autumn, are liable to this danger, especially in spring when the air is warm and in rapid motion, while the soil is frozen. The injury done is usually, but erroneously, put down to the direct action of frost.

PLATE XXI.—SCOTTISH MOUNTAIN PLANTS.



MOUNTAIN SCENE (EARLY SPRING), PERTHSHIRE.

PLATE XXII.—SCOTTISH MOUNTAIN PLANTS.

FIG. 1.—DWARF SHRUBS: CALLUNA AND VACCINIUM VITIS-IDÆA.

FIG. 2.—CUSHION GROWTHS OF SILENE ACAULIS.

hairs, &c., on leaves were protections against cold, but it has been clearly proved that their purpose is to prevent undue loss of water from the shoots. By means of these protective measures against drought, the plants are enabled to live in situations where they could not otherwise do. Mountain plants are generally xerophilous in structure. In a few instances some prominent plants are found even more plentifully on the sea-shore, where, owing to the presence of saline matter in the soil, the plants meet with a similar though not the same difficulty of safeguarding the water-supply, and thus assume a like character. In Scotland, Armeria maritima, the Thrift (so called because it grows readily under varied circumstances), and the Scurvy Grass (Cochlearia officinalis), occur both on the coast and on mountains.

Conspicuous Flowers.—Although smaller than lowland examples, the flowers of mountain plants are usually quite as large, and perhaps larger. Often they are more conspicuous, owing to the sparse foliage; and in the cushion type of plants they may occur so plentifully as to hide the leaves from view.

The intensity of colour exhibited by native mountain flowers is marked in the case of the Alpine Forget-me-not (Myosotis alpestris), a Pansy (Viola lutea var. amœna) variously coloured, &c. If wild flowers of Oxytropis campestris be compared with those obtained from garden plants, the difference in purity of tone is usually appreciable.

Barren and Viviparous Forms.—Some plants cease to flower as they approach the height limit. For instance, the Heather occurs as a stunted flowerless plant in some of its higher stations in Scotland. In the same way the London Pride (Saxifraga umbrosa) is flowerless on some of the summits of Irish mountains. The barrenness of such plants is of little consequence; there are always plenty of recruits in a normal fertile state at a lower elevation. These supply the higher unfavourable ground with seed, easily wind-blown.

Certain plants produce little bulbils or plantlets, these either supplementing or replacing the usual flowers. Such plants are termed viviparous. In Polygonum viviparum—not infrequently found in subalpine pastures—flowers occur towards the top of the spikes, while bulbils occupy the lower portion. Each bulbil, readily detached from the stem, is capable of becoming an independent plant. A rarer plant, Saxifraga cernua, seldom flowers in its Scottish station, and increases by little bulbils in the axils of the leaves, which become detached and sow themselves around the older plant. S. stellaris is not infrequently viviparous in Norway. Among grasses, viviparity is not uncommon, Aira cæspitosa, Poa alpina, and Festuca ovina being found in this condition in the Highlands.

Mountain Plants: Prominent Groups.

The principal features, at least, of mountain floras are usually well distinguished from lowland ones; and apart from the mountain flora, the country surrounding the base of mountains has often a distinct character in its vegetation, different from the outlying district. The mountain presence often ensures a more abundant rainfall and a more regular amount of surface moisture, which is favourable to the growth of trees and to the plants that are associated with forests. The ground at the foot of many mountains is often largely made up of marsh or bog, owing to the copious supply of water draining from the mountain slopes.

The vegetation of mountains will be found to vary much. Where hard rock prevails (as in Skye, &c.), the plants are very few, owing to insufficient rooting material; while on crumbling micaceous slopes and cliffs, as in Breadalbane, the vegetation is plentiful. Then the amount of atmospheric moisture present influences the vertical range of plants. To the moist climate of Ireland must be attributed the low elevation—often at sea-level—to which alpine plants descend in that island. Many Highland plants occur in Ireland at a much lower altitude. To a less degree the same occurs in the extreme Northern counties of Scotland, &c. In Skye, Alchemilla alpina descends to sea-level.

A great many observations have been taken in order to deal with this vertical range of alpine and other plants. The principal records are given in the 'Cybele Britannica.' In this work, by the late Mr Watson, the zones given that concern us just now are—the Super-agrarian zone, characterised by the Bracken (the higher limit of this fern is usually the limit of cultivated ground); the Infer-arctic zone, Erica Tetralix without Bracken; Mid-arctic zone, Heather (Calluna) without Bell Heath (Erica Tetralix); Super-arctic zone, a dwarf Willow (Salix herbacea) without Heather. The exact height reached by any particular plant may vary even on the different slopes of the same mountain, for the height attained on the southern side is often greater than on the northern. Aquatic plants are by no means so easily affected by the mountain climate as are land forms, and therefore afford little criterion of elevation. In the higher zones climbers are conspicuous by their absence. The Wood Vetch (Vicia sylvatica) and the Stone Bramble (Rubus saxatile) scramble over rock ledges, but the former occurs in greater abundance lower down. Annuals (as Gentiana nivalis) are rare.

It may be interesting to group together informally some of the more conspicuous types of our native mountain plants, making no aim at completeness, and always remembering that mountain floras are usually as heterogeneous in composition as lowland ones, and cannot be divided up into a few strictly defined groups.

Forest Trees.—The lower slopes are frequently covered with woods of Scots Pine, Larch (not indigenous), Birch, &c. The rearguard of such forests is usually the Pine, as this tree withstands wind and cold comparatively well. Where isolated clumps of trees occur, their growth is often stunted. Beneath the woods or forests of mountainous districts such plants as Vaccinium Myrtillus, Linnæa, Pyrola, Goodyera, various Ferns, &c., may occur. In Continental woods similar plants are found, together with the Lady's-slipper Orchid (Cypripedium Calceolus) and others. The growth of forests is encouraged by a considerable amount of atmospheric and also surface moisture.

Tall Herbaceous plants are more commonly observed at low elevations, but they also occur at considerable heights, especially where there is more shelter than usual. They then form a noticeable feature, among a herbage so generally dwarf. The most frequent plant of this description in Scotland is the beautiful Melancholy Thistle (Cnicus heterophyllus) or "Cluas an fheidh" of Highlanders, by some believed to be the original Stuart badge. Its flowers are purple, and its leaves, of which the basal are different in shape from those on the stem, are white beneath. The plant is unarmed. Cnicus palustris and two umbelliferous plants — Angelica sylvestris and the Cow Parsnip (Heracleum Sphondylium)— not infrequently are seen on high mountain cliffs.

On the Continent similar plants are met with in the proximity of mountain slopes. Centaurea Rhaponticum, the Medicinal Gentian (Gentiana lutea), and Veratrums, form conspicuous objects from their size of leaf and inflorescence.

Dwarf perennial plants, including many of lowland origin or little removed from lowland species, are usually frequent. Needless to say, the plants that might be included under such a heading are varied in habit. Ranunculaceæ is represented by the very conspicuous Globe Flower (Trollius europæus), by Alpine states of the several Buttercups (Ranunculus acris, R. Flammula, &c.), and by the small Thalictrum alpinum; Polygonaceæ by Polygonum viviparum, alluded to elsewhere, and the Mountain Sorrel (Oxyria), a very characteristic mountain plant. Its winged seeds are wind-carried, and consequently the plant is plentiful, often descending to comparatively low levels. Rosaceæ gives us the prominent Alchemilla vulgaris, Potentilla Tormentilla, and others confined to higher levels. The Golden Saxifrage (Chrysosplenium oppositifolium) frequently lines moist cavities. In Crassulaceæ, both the frequent mountain representatives are somewhat anomalous in preferring wet situations,—Sedum villosum ascending high on wet ground, and the more conspicuous Rose-root (Sedum roseum) frequently giving a remarkable appearance to wet mural precipices. A variable Pansy (Viola lutea var. amœna) is one of the most charming mountain flowers. Viola palustris and the Wood Sorrel (Oxalis Acetosella) grow in moist places, as they do lower down; and Geranium sylvaticum, dwarfed, displays its purple flowers here and there over the turf. Several Composites are conspicuous, as Saussurea alpina, Erigeron alpinus, Solidago Virgaurea, Antennaria dioica, and Gnaphalium supinum, the Scottish Edelweiss, with noticeable small silvery leaves:

also lowland plants, as Dandelion. The charming Alpine Forget-me-not (Myosotis alpestris) is famous. Among other plants, the Harebell (Campanula rotundifolia), which ascends high, and the distinct Bartsia alpina, may be mentioned. The Scottish Asphodel (Tofieldia palustris) and the Bog Asphodel (Narthecium ossifragum) are the only liliaceous plants found on Scottish moors and mountains.

Grasses, Sedges, and Rushes.—These frequently occur from the base to the summit of high mountains, but are sometimes very scarce, or even absent, where the rock is of a hard, uncrumbling nature. Representatives of various genera are seen, and frequently the lowland species ascend high, forming with the mountain grasses, &c., a turf which is dotted with both lowland and typically mountain species of other Orders. Viviparous forms are not infrequent among mountain grasses. In some instances a single species may form an almost exclusive covering. Juncus squarrosus, one of the Rushes, and Nardus stricta, the Mat-weed grass, are examples of such monopolists. Many of the scarcer Sedges (Carices), and also certain species of Rush (Juncus), are found only on wet ground at high altitudes. Luzula arcuata is confined to the area near the summits of some of our highest mountains. Alpine grasses have usually shorter leaves than lowland species.

Ferns.—The Mountain Fern (Nephrodium montanum), with fragrant fronds, is especially noticeable on the banks of many mountain streams. Polypodium alpestre is found near streams in certain districts. Many ferns are partial to rocky places in alpine districts. The Holly Fern, Aspidium (Polystichum) Lonchitis, is usually associated with large rocks and boulders, while Asplenium viride likes moist and shaded mossy places. Woodsia hyperborea and W. ilvensis, also Cystopteris montana, are rare in Scotland. The Parsley Fern (Cryptogramme crispa or Allosorus crispus) is partial to loose stony places. The Bracken (Pteris aquilina) is usually abundant on the lower slopes, and before it disappears is very dwarfed.

Lycopodiums.—Two of the Club Mosses—Lycopodium clavatum and the rarer L. annotinum—are conspicuous plants, their trailing shoots covering a considerable area among heath, &c. L. Selago is found in many positions, and from low to high elevations. It is usually present on the summits of the Scottish mountains. The upright shoots give it a somewhat conifer-like aspect, hence the name of Fir-tree Club Moss. L. alpinum is less noticeable, although spreading; while L. inundatum and Selaginella selaginoides are so small that they are still less conspicuous.

The mountain species of the true Mosses and other Cryptogams are numerous. They cannot be mentioned here.

Mountain Shrubs.—Where grasses and sedges are scanty, these shrubs not infrequently are the leading feature in the mountain vegetation. The most plentiful of such plants are the Heaths and Heathers. The Heather (Calluna vulgaris), the Fine-leaved and Bell Heaths (Erica cinerea and E. Tetralix), are frequent monopolists of the ground. They are enabled to grow in the poorest of soils, and seed abundantly. These three plants, so characteristic of Scottish scenery, are given in Watson's 'Cybele Britannica' as typical test plants of elevation, the heights reached by them being given by him as 3300, 2190, and 2370 feet respectively. E. Tetralix is usually the most abundant of the three where the ground is boggy or Sphagnum-covered. White-flowered forms of all the three occur.

Another conspicuous evergreen shrub is the heath-like Crowberry (Empetrum nigrum), conspicuous in autumn by its black fruit. Like the Heather or Ling, it varies a good deal in stature, &c., according to the environment. Frequently the Crowberry is very plentiful, its long branches often extending downhill. In some cases the branches hug the ground as closely as the shoots of the Bearberry (Arctostaphylos Uva-ursi). The branches of all the erect-growing evergreen shrubs are sufficiently flexible to remain unbroken when pressed to the ground by many weeks of snow.

Dwarf or pigmy forms of coniferous trees do not occur in Scotland, with the exception of the Juniper. The wonderful little Japanese trees of great age which are grown in vases, are illustrations of what may be done in gardens to produce a similar result to that obtained naturally at Alpine heights.

Willows are the most important deciduous shrubs of mountains, Salix Lapponum and S. lanata forming much-branched bushes that are noticeable from a distance, owing to the light-green of the woolly foliage. S. arbuscula and S. Myrsinites are other characteristic mountain Willows. Three genera which, so far as the Lowlands are concerned, are plants of considerable size, are represented in the Highlands by diminutive species (Cornus suecica, Rubus saxatilis, R. Chamæmorus, and Betula nana).

Several Vacciniums are conspicuous subjects in the formation of the dwarf shrubby vegetation of mountains. The native evergreen-leaved species (V. Vitis-Idæa) is illustrated (Plate XXII., Fig. 1).

Mat Growths.—Several plants form a dwarf layer of interlacing, much-branched, woody shoots, which spread over rocks. Some mentioned under shrubs must at times be included here, for under certain conditions, and especially when growing in exposed places, they become very dwarf, spreading over, rather than rising from, the ground. Empetrum nigrum and the Heather are plants thus varied in habit. The mountain form of the Juniper, Juniperus communis var. nana, is smaller than the ordinary form. Not infrequently the Juniper occurs on rocks around which coarse Grasses and Sedges luxuriate. Starting as a seedling, perhaps in a very small crevice, the roots strike down into the slit, while the branches spread over the surface of the rock. Here it is quite safe from competing plants around. No seed can grow on the rock covered by the branches, and the crevice where the Juniper received its first start of life having been filled up with the plant's growth, is inaccessible to other plants.

Loiseleuria procumbens (Plate XXIII.), known as the Scottish Azalea, has a somewhat similar growth to that of the Dwarf Juniper. So flat and interlaced are its wiry-like branches, that a plant may be lifted from the ground, rolled up, placed in the pocket, and unfolded without breaking or straining a shoot. The carpets of Loiseleuria sprinkled with rose-coloured flowers in summer form one of the most charming features of Scottish Alpine plant-life. It is perhaps best seen in the Grampian range, where the conspicuous mat growths occur amongst Heather or on stones.

Of non-evergreen mat growths none are more striking in certain districts than Dryas octopetala, a well-known rosaceous plant with prostrate branches and large, white, eight-petalled flowers (Plate XXIV., Fig. 1). Among other mat plants the Dwarf Birch (Betula nana) is characteristic, as are also the following two Willows. Salix reticulata forms large sheets, usually on rock ledges, and its branches creep chiefly above ground or through a tangle of moss, &c. It is easily known by its reticulated leaves. Salix herbacea has the distinction of being the smallest shrub indigenous to Britain, and it is frequently found on the barer and higher ground of mountains. Its shoots spread beneath the surface of the soil, and the leaves usually rise to less than one inch high. This Willow can withstand much drought.

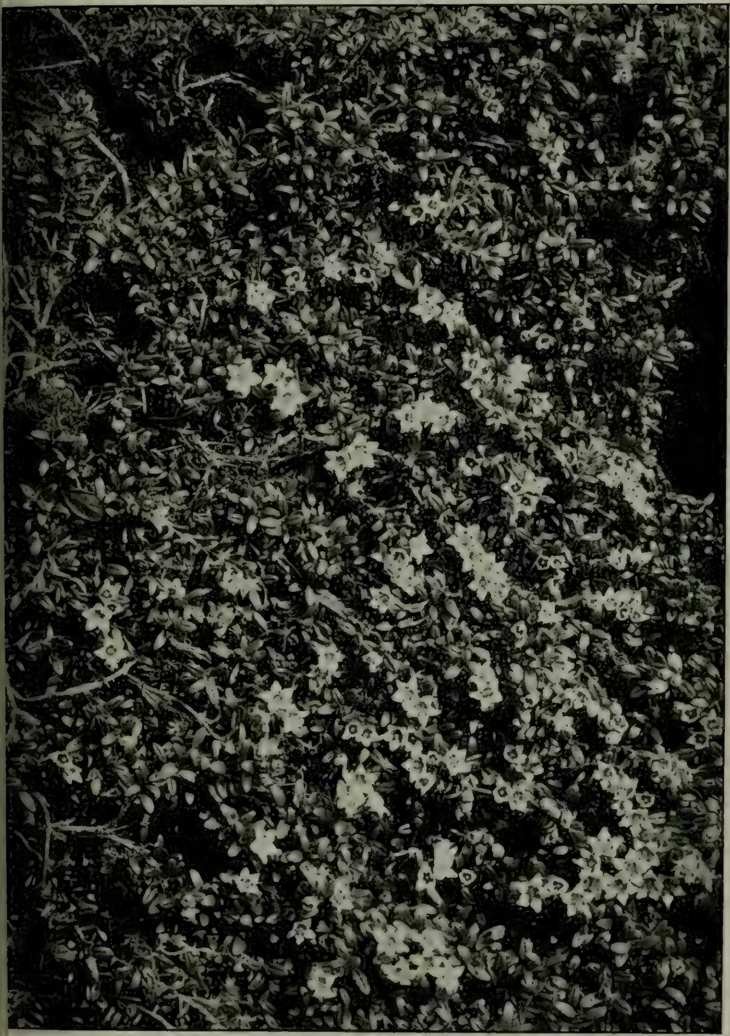
All these mat growths prefer comparatively dry places, and are not frequent where much surface-water is present. As a rule, they occur on barren slopes and rocky ledges, and shun the vicinity of rills and streams. They ascend to higher altitudes than any other shrubby or woody forms.

Rosette forms are represented on Scottish mountains by such plants as Arabis petræa, Saxifraga nivalis, S. stellaris (Plate XXIV., Fig 2), Draba incana, and D. rupestris. This growth is more noticeable if the plant consists of a single or of few rosettes. Generally found in stony places, although not strictly confined to these.

Trailing Alpine herbs are not infrequent on the higher slopes and screes. The two most conspicuous are the white-flowered Cerastium alpinum and Saxifraga oppositifolia, a plant with charming purple flowers produced early, even when surrounded by the snow. Saxifraga aizoides, with brilliant yellow flowers, ascends high, preferring damp positions. The common white-flowered species, S. hypnoides, is likewise found over a long vertical range. This Saxifrage is very variable in habit: on screes or slopes of loose stones it often occurs in small flakes. The small Epilobium alpinum is often abundant on wet ground, sometimes with Sedum villosum, Veronicas, &c. As a rule, these dwarf plants chiefly affect moist situations.

Cushion growths give a peculiar aspect to much of the high mountain vegetation throughout the world. The cushion habit is not confined to plants of any particular Natural Order, nor is it believed that those forms originated in any

PLATE XXIII.—SCOTTISH MOUNTAIN PLANTS.



MAT GROWTH OF LOISELEURIA (AZALEA) PROCUMBENS.

PLATE XXIV.—SCOTTISH MOUNTAIN PLANTS.

FIG. 2.—SAXIFRAGA STELLARIS: ROSETTE PLANT.

FIG. 1.—DRYAS OCTOPETALA: FLOWER AND FRUIT.

one place, afterwards migrating. They rather appear to have been evolved in response to environment, and form striking illustrations of the influence of the mountain climate upon the growth of plants differing widely in affinity and distributed over many countries.

The cushions, often very regular in outline, are composed of densely ramified branches so thickly placed that they press each other on all sides. The shoots all reach to about the same length, and are furnished with living leaves at the tops only. The withered foliage of previous years on the lower portion of the stems serves to absorb and retain moisture in the cushion. In Scotland two good cushion plants are not uncommon, the Cyphel (Arenaria Cherleria) and the Moss Campion (Silene acaulis), the latter with small pink flowers expanded just above the level of the leaves. (Plate XXII., Fig. 2, shows a small plant in flower, and a larger one with ripening capsules.) These two plants often grow side by side both on the summits of many mountains and on the higher parts generally.

Cushion growths (except certain mosses) are absent from the lowland floras of most countries,—hence the ground where these forms are seen is likely to be either at a high elevation or far north where many plants descend to sea-level. Cushion plants also occur at low levels in the South Temperate and Antarctic regions—*e.g.*, Scleranthus biflorus, living plants of which may be seen at the Royal Botanic Garden, Edinburgh.

[Thirty-three slides were shown in illustration of the above paper. The photographs here reproduced from the author's negatives illustrate some of the more prominent types of native mountain vegetation.]

EXPLANATION OF THE PLATES.

Plate XXI. Mountain scene (Perthshire). Early Spring. The snow has disappeared from portions of the rocks, leaving many plants exposed.

Plate XXII., *Fig.* 1. Mountain shrubs : Heather (Calluna) with the Red Whortleberry (Vaccinium Vitis-Idæa), the latter creeping through sheets of a hoary Lichen.

Plate XXII., *Fig.* 2. Moss Campion (Silene acaulis). Note the compact "cushions" or "hummocks."

Plate XXIII. Loiseleuria procumbens. Portion of plant showing dense mat growth.

Plate XXIV., *Fig.* 1. Dryas octopetala in flower and fruit. Portion of a large plant. The under sides of leaves are conspicuous—whiteness due to a covering of fine hairs.

Plate XXIV., *Fig.* 2. Saxifraga stellaris. Rosette plant.

At this meeting Miss Beatrice Sprague made a communication on "The Flora of a Shingle Island." Miss Sprague's paper will be found in full at p. 290.

Dr Watson also contributed a very interesting and instructive paper on "Fungus Diseases of Trees."

III.—*THE GREAT GULF:*

An Interesting Point in Evolution.

By Mr J. J. MACDONALD.

(*Read Jan. 24, 1906.*)

To enable the human mind to grasp and memorise a mass of facts which otherwise it would be impossible for it to do, it has been found necessary from the earliest times to adopt some system of classification of such facts, whereby they might be pigeon-holed in the brain, as it were, ready and accessible at any time when required. No doubt in very early times this classification was of an elementary character. As time went on, however, and human knowledge increased, it became necessary to adopt more thorough and more complete classifications. We find, therefore, that all knowledge came gradually to be divided into departments, which were again divided and subdivided as was found most convenient and useful. A distinction was thus early drawn between plant and animal life, giving rise to the sciences of botany and zoology.

For long ages the classification of plant life was little studied and less understood. Indeed it is not till we come down to comparatively recent times that we find any serious thought given to the matter. It is to Linnæus, the great Swedish botanist, who lived A.D. 1707 to 1778, that we are indebted for the first serious effort to cover this region of knowledge. His system was no doubt a highly artificial one, but it was unquestionably the foundation of that enormous mass of knowledge which we now possess in botanical and biological science. His system was, as I have said, an artificial one, but Linnæus quite understood and grasped the fact impressed on him by his study of botany, that there existed a *natural* system of classification of plants, based upon their mutual relationships to one another.

From the study of this natural system of classification in plant and animal life grew one of the most brilliant theories ever propounded, and one which has completely revolutionised the science of biology. In studying the relationships of plants and animals, it was soon discovered that these were in the form of a ladder, the first step of which consisted of life in a very lowly form—a single independent cell; while, as one mounted upwards, the steps increased in complexity and variety of form till one reached the top. This fact appears to have suggested to the minds of philosophers the great theory of evolution. Broadly stated, the theory avers that such a ladder with its numerous steps did not always exist, but that the first life known on our planet consisted of the low forms only, and that from these the more complex forms were gradually evolved step by step. This theory has been a hard one to prove, or even to maintain. The first great upholders of it—Darwin (A.D. 1809-1882) and Wallace (born in 1822)—were met with a perfect storm of opposition from all sorts and descriptions of people. Whatever truth there may be in the theory, however, one important point has been brought to light in the course of its investigation. This point is, that there are a good many steps awanting in the ladder of life as we know it at the present day, which recalls to mind what was for a time a most burning question—that, namely, of the missing link between man and the other animals. It is such a missing link, or more than one, in fact a great hiatus, between two sections of the vegetable kingdom, that forms the subject of this paper.

In classifying the vegetable kingdom, we find that it first of all naturally divides into two great groups of plants, named (1) the Phanerogams, or plants with more or less conspicuous flowers, and (2) the Cryptogams, or plants devoid of flowers,—

the latter being lower in the scale of life than the former. These groups are again divided—the Cryptogams into two, namely, (1) the Vascular Cryptogams, or those partly composed of vascular tissue; and (2) the Cellular Cryptogams, or those composed of cellular tissue entirely. The Vascular Cryptogams divide into several well-marked Natural Orders, the most distinctive of which are (1) the Lycopodiums, or club-mosses; (2) the Equisetums, or horsetails; and (3) the Filices, or ferns. The Cellular Cryptogams break up into a large number of Natural Orders, at the head of which we find the Bryaceæ, or mosses, followed by a long list of other Orders. Here, then, between the Vascular and Cellular Cryptogams we find the great gulf,—an arch, or several arches, being required to bridge the chasm that lies between them. Let us see exactly how wide this chasm is.

For our present purpose we cannot do better than take the ferns as a type of the Vascular Cryptogams. Here is Nephrodium Filix-mas, the common male fern, which is familiar to everybody who takes an interest in our native flora. This fern consists of a short brown stem surmounted by a cup-shaped crown of beautiful green fronds, much divided. It derives its nourishment, like most other plants, partly from the soil by means of its roots, and partly from the air by its fronds. With the question of nourishment we have nothing to do. What concerns us is the reproduction or life-history of the plant. On the back of the fronds you will see a number of small brown heaps named sori, each with a covering called an indusium. This is shaped like a kidney, and hence the generic name of the plant, derived from the Greek *nephros*, a kidney. Under the indusium the heaps are composed of a number of small brown cases, termed sporangia or thecæ, and these again are filled by a vast number of minute round bodies called spores. How minute they are may be judged from the fact that it would take at least 250,000 of them to cover a square inch of surface!

When they arrive at maturity, the sporangia, or spore-cases, burst, and the spores are set free. If they fall on, or are carried to, a suitable place, these spores germinate and begin to grow. Now, one would naturally suppose that from the spore grown upon a fern would grow another fern, but this is not so. Our friend the fern leads a double life, a sort of Jekyll-and-Hyde existence. From the spore grows what is called a prothallus—a flat, heart-shaped, green object, not unlike a piece of the frond of Pellia epiphylla. The under side is attached to the ground by rhizoids, and on this side also are found sexual organs termed antheridia and archegonia. The antheridia, or male organs, consist of minute rounded protuberances, composed of a number of cells, each containing a spermatozoid. These latter are excessively minute spirally-coiled bodies like corkscrews, but thicker at one end than the other. Near the thin end a number of exceedingly fine cilia are attached. When the antheridia are ripe they burst on contact with water, the spermatozoids are set free, and at once begin swimming about in the water with the aid of their cilia.

The archegonia are minute sacs buried in the prothallus, with an opening to the exterior by means of a hollow neck projecting slightly beyond the surface. At the bottom of the sac is found a cell containing an ovum. When the ovum is ripe the spermatozoids are attracted to the opening at the end of the neck, down which they make their way until they reach the ovum, which is thus fertilised. The ovum immediately begins to develop and grow, eventually becoming a male fern, with fronds and spores ready to repeat the life-cycle once more.

Here, then, is a deeply interesting and strange life-history. First we have the spore-bearing plant, or sporophyte, being the ordinary male fern, which has no sexual organs and does not reproduce itself, but from a spore of which grows the prothallus, being the oophyte or ovum-bearing plant. The prothallus in turn does not reproduce itself, but by means of sexual organs produces the fern or sporophyte.

Stepping now across the gap between the vascular and cellular cryptogams, let us take an example from the family in the latter group, nearest allied to the ferns, namely, the mosses. A good one is found in a very common moss, Funaria hygrometrica, an acrocarpous moss growing gregariously in large patches, especially where wood has been burned on the ground. Another example, and a very handsome moss, is Hylocomium splendens, one of the hypnoid group of pleurocarpous mosses. From these specimens it will be observed that mosses roughly consist of two main types—first, one with an upright, leafy stem, bearing one or more capsules at the top of the stem; and, second, one with a prostrate, creeping stem, bearing capsules at various points of the stem. Those two types have, however, practically the same life-history, which we will now follow out.

As we have seen, a moss plant consists of a stem with leaves, bearing capsules usually supported on a stalk or seta of varying length, but sometimes quite sessile. This capsule, like the sporangium of a fern, produces spores which, when the capsule is ripe and the lid falls off, are scattered abroad in dry weather. Falling on a suitable nidus, the spores germinate and give rise to a mass of fibrous matter called the protonema, consisting of green cellular fibres. These fibres in turn give rise in varying numbers to young moss plants similar to the parent. Such plants on attaining maturity produce, sometimes on the same plant, sometimes on different plants, (1) antheridia, consisting of club-shaped bodies containing mother-cells, each of which produces a spermatozoid. On the rupture of the antheridia and breaking up of the mother-cells the spermatozoids are set free. The moss plant bears (2) archegonia, which are bottle-shaped bodies with a long neck, an ovum being contained in the body of the bottle. This ovum is fertilised by a spermatozoid from the antheridia, and from the fertilised ovum grows the seta, carrying the capsule with spores on the top of it. The sexual process is practically the same as in the ferns.

Here again we have a wonderful life-history. First, we have the spore which, on germination, produces the protonema. From the protonema grows the moss plant, producing in its turn sexual organs, from the fertilised ovum of which arises the seta, and capsule, producing spores once more. This is a very different state of matters compared with what we found existing among the ferns. Here the oophyte or ovum-bearing generation is the moss plant itself, while the sporophyte or spore-bearing generation is not a separate plant at all, but is parasitic on the oophyte in the form of a seta and capsule.

In many ways allied, we yet see a great differentiation in the life-history of ferns and mosses,—a great gap, indeed, in the chain of evolution, with how many links awanting who can say? Where are these links? Have they been lost in some prehistoric cataclysm? or did they ever exist? Did nature by some strange freak make a huge bound from the Cellular to the Vascular Cryptogams? A most unheard-of thing for old Mother Nature to do. She does not generally walk *per saltum*, but much more usually takes a very small step at a time. Then where to look for the missing links? Among fossil plants? It is quite possible some may be found there, as our knowledge of fossil botany is still very small. There is also another possible explanation, however, and that is, that the missing links may still be in existence, perhaps undiscovered, or perhaps, from insufficient knowledge of the history of the lower forms of plant life, they may be misplaced in the chain of evolution. In this event, it may be that a closer study of biology will some day reveal them. In any case, we have here a most interesting point in evolution. To those who study nature like myself—not as their life work, but as a relaxation for a leisure hour,—it opens up wonderful vistas into the depths of creation, and glimpses under the veil of Isis. You know it is said that the following inscription is engraved over the Temple of Isis: "I am, whatsoever is—whatsoever has been—whatsoever shall be; and the veil which is over my countenance no mortal hand has ever raised." The smallest peep under that veil fills the thinking mind with wonder.

At this meeting Mr W. C. Crawford exhibited specimens of two kinds of grain from tombs in ancient Egypt. He obtained them at the Egyptian Museum in Cairo. The one was barley from a tomb of the fifth dynasty (about 2400 to 2300 B.C.); the other, wheat from the tomb of Thothmes III. of the eighteenth dynasty. It may be remembered that the Pyramids of Gîzeh were built in the time of the fourth dynasty; and Ramses II., who is said to be the Pharaoh of the Exodus, belonged to the nineteenth dynasty (1324-1258). So the barley was as old as the accepted time of Abraham, and the wheat older than that of Moses. The barley had very rough glumes; the wheat was much more modern in appearance. These grains found in the tombs of ancient Egypt do not germinate: those that are said to have done so have been found to belong to modern varieties.

IV.—*SOME OF THE RARER PLANTS OF THE GOREBRIDGE DISTRICT.*

By the Rev. D. W. WILSON, M.A.

(*Read Feb. 28, 1906.*)

The district of Gorebridge supplies a variety of conditions providing a diversity of habitat for plant life. The soil varies. There are belts of clay,—stretches of a light and friable mould,—sandy beds, mossy lands, and marshy tracts. There is a river like the South Esk, streams like the Gore, and big sheets of water like Gladhouse and Edgelaw. There are railway banks whose sunny slopes favour vegetation, and which by means of artificial causes furnish a deposit for plant-life new and hitherto unknown to the district. There are meadows, sheltering woods, deep bosky glens, and mountain-ranges such as the Moorfoots and the outlying spurs of the Lammermoors. The variety of soil, situation, elevation, and exposure is very great indeed. These conditions perhaps form the explanation why the district of Gorebridge has long deserved a well-merited fame for wealth of plant-life. There the botanist can roam, sure that many things will present themselves to his observation which are full of interest, and if he be patient and arduous he may even discover more than one floral treasure. This last summer I was led to search our district more thoroughly than I had ever done, and I now proceed to give you the benefit of my labours. I select the rarer plants, and propose to make a few remarks concerning their more interesting and distinctive features.

Eranthis hyemalis flowers with us in February. The flowering-season of different flowers varies greatly. The necessities of fertilisation determine the length of the season. Some species are ephemeral, open only for a single day, and then fade and fall, such as the Spergula arvensis. Others open in the morning, close in the evening, and open again the following morning, but wither away in the course of the afternoon. Of this, the poppies furnish a characteristic example. But the Eranthis, owing to the season of its blooming, requires a longer life, and its flowers nominally endure for at least eight days. It is a flower well worth an exact study. It furnishes an example of movement of stamens. You know its construction. Yellow sepals, tubular petals filled with honey, then in successive whorls a multitude of stamens surround the pistil. When the golden sepals have opened and the bright colour has attracted the fertilising insect, the anthers of the outermost whorl open to dehisce. But before doing so their filaments have elongated, and twisted themselves round so as to bring the anthers exactly over the mouths of the trumpet-shaped nectaries. When insects, therefore, are sucking the honey, they brush against the anthers, and carry away the pollen to fertilise the pistil of another plant. Before another day has come round these stamens have moved farther outward towards the sepals, and the next innermost whorl have taken their place over the nectaries; and so on until all the whorls have occupied that position. It is a wonderful provision, which, like the unusual duration of the flowering-period, no doubt owes its existence to the plant's great desire to perpetuate its species. The Coronilla varia has a curious movement of its leaflets. By day they lie expanded in the usual horizontal position. At night the opposite leaflets close together like the two slices of a sandwich. This is to prevent loss of heat by night-radiation. Two other leguminous plants possess a wonderful sort of piston apparatus by which they expel the pollen from their anthers. A bee alighting on the wings of the flower presses them down on the heel, and thereby pumps the pollen through a hollow cone at the apex of the heel on to its belly or its legs. It may have taken toll of the flower's honey, but in return the flower compels it to perform the function of a flower marriage.

The Arum maculatum grows in Arniston Glen. All three varieties are to be found there. That with the leaf a uniform green, most numerous; the variety with the black spots on the leaves, about a third of the whole; and the variety with pale white spots is also represented. This is an interesting plant. Tiny midges are the cross-fertilising agents, especially the Psychoda phallanoides. In the cavity of a single spathe hundreds of these insects may be found. The leaves are large, full of chlorophyll, and so spread out as to catch the faintest ray of sunlight percolating through the trees. It is growing on the sloping banks of a brook rippling through the shady wood; and near it there is another smooth, flat-leaved plant, a variety of Allium. Both have the same characteristic leaves—the leaves best adapted to catch any sunlight going. Both are thick-rooted plants, tuberous or bulbous. Both are fond of the woods, because the fallen leaves shelter their roots from winter's frosts. Both flower early, because only thus can they obtain their needed measure of light and heat ere the summer's foliage has constituted an almost impenetrable shade. Their life-histories are in many ways pretty much the same, just as they have selected their home in this definite spot.

The Poterium sanguisorba, not common in Scotland, is abundant in England. It grows on the railway embankment near Gorebridge. I think I know how it has come thither. When the seeds were ripe, chance placed covered waggons near a bed of this plant. The wind blew the seeds on to the covers. The seeds enjoyed a free railway passage to Scotland. Chance again stopped these waggons opposite this spot. A favourable breeze blew the seeds on to this embankment. They rooted themselves. And now the plant is not only established but flourishing. For one plant discovered by the writer some summers ago, there is now at least a dozen.

Growing not far from the burnet is the Caucalis daucoides and the Hieracium aurantiacum. Another whose habitat is very different is the Epipactis latifolia. This is a plant of wide distribution, though rare in our district. It is much frequented by wasps, who are the agents of cross-fertilisation. The lip of the perianth is deeply grooved, and resembles a boat filled with honey. When sipping up the honey with their short proboscis they press their head against the two pollen-masses attached to a viscid rostellum. These pollen-masses are shaped like the arms of a windmill; then away the wasp goes. Through contact with the air the pollen head-dress becomes dry, slips forward on the head, and assumes such an angle that on visiting another flower it comes to be pressed right on to the quadrangular stigma. This is one of the many curious arrangements made by plant-life for successful cross-marriages. Here is another, furnished by a typical though somewhat rare carex—the

Carex lævigata. The flowers of the carices are neither fragrant nor bright-coloured. They yield no honey, as they have no perfume. They require no visitors for cross-fertilisation, and so they produce nothing to attract a visit. The wind is the pollen-carrier, and of all winds a dry gentle breeze is best. If the wind be charged with moisture, the pollen becomes soaked, and, carried down to the ground, the purpose of its existence is baffled. Again, if the wind be violent the pollen is apt to be whirled away, so that little of it reaches its natural goal. But when the wind is soft and steady, such as the summer evening breeze, which just stirs the leaves of the trees into a sibilant whisper, or ripples the corn of the fields into golden wavelets, then the pollen rises like a dust-cloud that gradually distributes itself over an ever-widening area, and many plants are fertilised. The stigmas ripen at a different time from the anthers to obviate side-marriages. Aliens have found their way out to our district,—such as Echinospermum lappula, with tiny blue flowers, and Amsinckia lycopsioides, with blooms of a lovely orange. These are a few of the rarer plants occurring in our district. But what a pleasure was associated with the finding of them! Hours in the open air, with the blue sky overhead and the sunshine touching all with gold, and the thrill of joy in discovering something never found before, and which, the more closely it is examined, reveals new features of interest and new subjects for wonder.

V.—*THE "WATER-FLEA" SCARE IN OUR CITY.*

By Mr JOHN LINDSAY.

(Read Feb. 28, 1906.)

For the past few weeks the citizens of Edinburgh have been constantly provided by the daily press with paragraphs and letters and editorials—generally alarming, though now and then reassuring—as to the condition of the city water-supply. Not a little of what has been written on this subject is, of course, either absurd or beside the mark. Numerous "facts" have been adduced fitted to terrify timid citizens into abjuring water-drinking, as well as to confirm others in the wisdom of their conduct regarding their choice of fluids. The days of the St Mary's Loch scheme have been vividly recalled to many, with this important difference, that the "horrid creatures" with which we were then simply threatened are said to have now arrived from classic St Mary's, but by the roundabout way of the Megget and the Talla, and are being served out every day, and all the day long, to the sorely perplexed and over-burdened ratepayers.

This particular branch of nature-study has suddenly become of some importance, and has already secured a considerable following. All sorts of possible and impossible denizens of fresh water are alleged to have been detected and duly noted by numerous observers. One writer, for example, dating from Gilmerton, has given a most minute but utterly unscientific account of not fewer than eighteen "wriggling things," each half an inch long, which he discovered in a water-meter. A newspaper paragraph descriptive of this wonderful creature was headed "Terrible monsters at Gilmerton." These "monsters" were said to be light-brown in colour, to wriggle along broadside on, to possess jointed scales on their back, to be bent like part of a circle, and to have "a good number of legs." "They are great cannibals," the writer adds. "My lot ate one another till only one was left and a few legs." Any number, we are informed, were in the pipes in the Gilmerton water-district before the introduction of the Talla water, so that they are no new importation. Their presence is accounted for by this budding naturalist because of their spawn—"if spawn there is," he cautiously adds—being so minute as to pass through the filters. It need not be very difficult in all this to perceive a glimmering of the truth, and to detect our well-known friend the fresh-water shrimp (*Gammarus pulex*).

It has not yet been substantiated, however, that this familiar amphipod has at any time found its way into our water-cisterns. On the other hand, some microscopists have been fairly revelling in the "hauls" they have lately been securing. From different parts of the city have come reports of such organisms as desmids, diatoms, rotifers, and vorticellæ having been found, as well as animal, vegetable, and mineral fragments, and, above all, "water-fleas." It is safe to say that most, if not all, of these are to be found now and then in the water-supply of many large towns,—in some cases, in far greater number and variety than we in this city can boast of.[1]

As to what exactly is meant, however, by the term "water-fleas," there has been a singular lack of unanimity. One observer informs us that he kept his water-tap running for three hours, and was rewarded by capturing three Daphnias, the species not recorded. It seems that only one species of Daphnia is the real Simon Pure, and entitled to the designation "water-flea." 'The Scotsman' lately engaged a member of the Scottish Lakes Survey to write a scientific account of the water-flea for its columns, in order to furnish enlightenment to the citizens in this time of panic and scare. This writer, who modestly signs as "J. M.," states in his article that the water-flea *par excellence* is *Daphnia pulex.* In this connection Dr Thomas Scott writes me to say that "the name 'water-flea' is usually applied to *all* the species of Daphnia, and not specially to *D. pulex*, although that one, being sometimes an abundant form, is commonly regarded as *the* 'water-flea.' Even an expert, however," Dr Scott adds, "would sometimes have a difficulty in discriminating between the species; and one good way to test this would be to place a few *D. pulex* and, say, *D. longispina* together (living) in a tube of water, and ask any one who may be a stickler for *D. pulex* being the only 'water-flea' to say if all those you show him are so, and if not, which are." *D. pulex*, however, is said by this writer in 'The Scotsman' to be common in ponds only, while the Daphnia of our lochs and reservoirs is the smaller, more graceful, and more transparent *D. hyalinus.* This is the "flea," we are informed, that is found in all the Highland and Lowland lochs examined by the Lake Survey, including St Mary's. But, after a good deal more to the same effect, there comes the following inconclusive statement: "Talla Reservoir enjoys for the present, if it were any recommendation, an

[1] In illustration of this, see 'Trans. Edin. Field Nat. and Micro. Soc.,' vol. iii. pp. 283, 284, where some rare and curious forms of microscopic life are noted as having been found in the domestic water-supply of Dundee and of Birmingham.

almost total freedom from animal and plant life. *There were no fleas in Talla Reservoir.*" This reminds one of the celebrated chapter on snakes in Iceland. We are, besides, left completely in the dark as to what the precise "flea" of the present invasion is, though we have learnt that, whatever it may be, it has not come from the Talla Reservoir, which, strangely enough, is said to be almost destitute of life of any kind,—a state of matters which is a very doubtful good. That it will not long remain so, but become in course of time like all other lochs and reservoirs as regards the presence of animal and plant life, may be regarded as certain.

It is beyond dispute, however, that what are popularly termed "water-fleas" are frequently found in the domestic water-supply of some towns. Dr Scott has very kindly furnished me with the following personal observations, hitherto unpublished, regarding this. He says: "When I was at Rothesay in 1886-87, somebody spoke of having seen minute living creatures in the drinking-water, so I got a piece of clean thick flannel, fixed it on the tap in our laboratory, and allowed the water to run for a while. I then washed the flannel in a tumbler of clean water, and found a splendid collection of Entomostraca, *Bosmina* being the most common. So numerous were they, that millions of them must have gone down the throats of the dwellers in Rothesay, including ourselves. . . . On another occasion a friend sent me a small sample of water from Campbeltown, collected from a tap, and containing some interesting Entomostraca. I sent him the names, but counselled quietness, so that little was heard of the affair, and, so far as I learnt, neither in the one case nor in the other had the medical men any extra work on hand because of the occurrence of these harmless crustaceans. Why, not so long ago Professor Herdman recommended furnishing ships destined for long voyages with a number of large townets, so that should those on board be shipwrecked, or should provisions run short, bagfuls of Copepods and other minute crustaceans might be collected, and used partly or wholly as food until a ship appeared or land was reached; and I reckon that a fresh-water Copepod or Cladocera is just as good in this way as a marine one." This opens up a new source of food-supply!

But now, to come to the point, what is the "flea" of the present invasion? Amid the multiplicity of organisms said to have been found of late in the water-cisterns of the city, one mysterious visitant in particular has been largely in evidence. This is the so-called "water-flea" which has been the innocent cause of so much alarm and so many columns of print. Descriptions of it, scientific and otherwise, have not been wanting. Some of these descriptions furnish rather amusing reading. Thus a Southside doctor, who had specimens sent to him from the Sanitary Department, says: "They are of a yellowish-white colour, with four legs, two abortive wings, and a peculiarly-shaped head. The body is semi-developed, is of a hard substance, glossy and shiny in appearance." Further, to show these strange creatures do not favour any particular situation, the writer adds, "They have been discovered in new cisterns, old cisterns, area cisterns, and cisterns situated in house-tops." The same insect was observed in Edinburgh water, it appears, about ten years ago, and the rather remarkable statement is made that "this time they are larger in size than they were on the former occasion"! Then we have the one "scientific" observation added, that "when treated with ammonia vapour or sulphurous acid vapour, they die almost instantaneously." Yet this learned observer does not venture to give the "flea" a name. We now know, however, that it is the spring-tail with which we have to do. Numerous specimens have been seen by those able to identify it.

There is not much mystery about spring-tails, as they are common enough, and their life-history is fairly well known. In the 'Monograph of the Collembola and Thysanura,' by Sir John Lubbock—now Lord Avebury—published by the Ray Society in 1873, the first attempt in this country to classify the group was made. The result, however, has not been quite satisfactory: minute structural differences, on which classification frequently so much depends, are, unfortunately, scarcely noticed; the nomenclature is often very puzzling; while the localities given are almost wholly English—one reference only to Scotland being made! Following upon the excellent later work of a few North-European scientists, we owe much to Messrs Carpenter and Evans for the valuable observations made by them regarding the Collembola and Thysanura of Scotland in general and of the Edinburgh district in particular. These observations are eminently useful at this time, when attention is being so largely drawn to this little-studied group.[1]

The spring-tails belong to the lowest group of the class Insecta, namely, the Aptera or wingless insects—sub-division Collembola. They are hatched from eggs, cast their skin, and undergo no metamorphoses. Extremes of heat and cold seem to have little or no effect on them. Their springing apparatus, which is very curious, and found in no other insects, consists of "a forked appendage bent under the body, and which, when the insect leaps, is forcibly extended, so that it strikes against the surface-film of the water, or against the solid object on which it happens to be stationed, thus lifting the body into the air." The largest of them are only about one-eighth of an inch in length. Yet, with their grub-like appearance, their leaping habit, their three pairs of legs and one pair of antennæ, they are rather uncanny-looking creatures to the non-scientific observer. The leaping apparatus, possessed by most of them, gives the name Collembola or "spring-tail" to this sub-division of the Aptera, in contradistinction to the term Thysanura, or "bristle-tail," applied to the other and much smaller sub-division.

As already mentioned, spring-tails are by no means uncommon. According to Lord Avebury, one cannot shake a heap of moss over a handkerchief without seeing them running with agility and springing with considerable force. Of one form—*Isotoma fimetaria* (Linn.), Tullb.—Messrs Carpenter and Evans state that Dr R. S. MacDougall sent them a great many, "obtained amongst sawdust at the Edinburgh Botanic Garden," where, in March 1899, there are said to have been "swarms." Of another form—*Achorutes viaticus* (Linn.), Tullb.—at Aberlady Bay, in September 1896, there are reported by the same authors to have been "immense numbers on the sands for a distance of several hundred yards on the east side of the bay towards Gullane Point. And it is added, "In some places there could not have been less than 20,000

[1] See "The Collembola and Thysanura of the Edinburgh District," by George H. Carpenter, B.Sc., F.E.S., and William Evans, F.R.S.E., in 'Proc. Roy. Phys. Soc. Edin.,' vol. xiv. (1899); and "Some Spring-tails new to the British Fauna, with Description of a New Species," by the same writers, ibid., vol. xv. (1904).

to 30,000 in the space of a square yard, so that they were literally present in millions." They are found by the sea-shore, in woods, moors, and mosses, on garden gravel-paths, in greenhouses, under flower-pots, and in numerous other situations. In all these places they act very much the part of Nature's scavengers, living on decaying vegetable (and animal ?) matter. I can always secure a supply from a Japanese Hare's-foot fern (*Davallia bullata*) grown as a hanging plant, without a pot, and having the long rhizomes of the fern plaited outside to enclose the soil. This form of plant, known as a "design" by the nurserymen, when plunged into water, liberates the spring-tails in dozens, which then float off and congregate in little knots or groups on the surface.[1]

The important question now remains, How has this "degraded" insect—or perhaps this "ancestral form" of insect, as some scientists consider it to be—found its way into the water-supply of our city ? To this there seems to be but one answer, namely, that the eggs have been blown by the wind or carried by rain-spates into the fire-hydrants of our streets, and have there found a congenial breeding-place. We have just seen how numerous and widespread the insects themselves are; and that their eggs should be carried, along with street-refuse, into these inviting hiding-places, need form no cause of wonder. The type of hydrant known as the "ball" form, which has been largely in use in our city for some fifty years, is defective in this respect, that when the pressure necessary in order to close it is taken away, an opening is at once left in the hydrant box into which any foreign matter may readily enter. To complete the mischief thus done, as soon as the pressure returns any refuse which may have found its way into the box enclosing the hydrant is swept through the water-pipes, and so enters the cisterns. How much of this semi-liquid mixture may have gone down the throats of the citizens during the last half-century, no one can tell. The appearance of these little scavengers in numbers has at length saved the situation. "Collembola," says Lord Ave-

[1] Mr Evans has very kindly examined some specimens of this spring-tail which I sent him, and has pronounced them to belong to the genus *Lipura*—a genus very closely allied to *Isotoma*.

bury, "can only live in moist situations," and in these iron boxes are the requisite conditions of damp, dirt, and darkness for their propagation and multiplication. Why they did not appear as an invading army long ago should be the question, rather than how they have come at this time.

The further question has been mooted, Are the spring-tails which have now been found in hydrants and water-cisterns all of the same species or kind? Certain "experts" have answered that they are, and they have even been named as *Podura aquatica*. Indeed, some science teachers, who ought to know better, have spoken and written lately of poduras and spring-tails as if the two terms were synonymous. All poduras are spring-tails, but all spring-tails are not necessarily poduras. Messrs Evans and Carpenter recorded in 1904 having collected and examined in all no fewer than sixty-one species of spring-tails in the "Forth" district alone. Many of these are, of course, rare; but others, as we have already seen, are very common. That *Podura aquatica* is now found in our domestic water-supply is very doubtful. The authors already cited say of it, "Locally common on the surface of stagnant water: as yet we have met with it only in East Lothian." Of the numerous specimens of spring-tails taken from water-cisterns which I have seen, the great majority were yellowish-white in colour, and totally unlike the blue-black *Podura aquatica*. Probably there are more species of these insects than one with us at present, and what these are we may learn, with other interesting details, from the Report of Dr Williamson, when it at length makes its appearance.

A few words in closing on the subject of water-cisterns. The Sanitary Department continue to iterate, "Keep your cisterns clean." These cisterns, however, are often so awkwardly situated, and so difficult of access, that it requires no small amount of courage and exertion to reach them. A space of twelve or eighteen inches is all that is usually allowed for the entrance to a cistern; and struggling from the top of a long ladder, it may be, to enter through such an aperture, is a difficult and delicate performance, worthy of an acrobat. It may be hinted, too, that far more dangerous foes to the health of the community than harmless spring-tails are now and again discovered in cisterns. Thirsty rats and mice at times find there a watery grave, and dead birds have been got in the bottom of Edinburgh cisterns. If our domestic water-supply, therefore,—no longer, it is to be hoped, intermittent and insufficient,—cannot now be drawn in every case direct from the street mains, it is very important that all cisterns in which that supply is stored should be so placed and constructed as to be easily accessible.[1] And it is just as important that the Water Trust should do their part, and see to it that our drinking-water, on the purity of which the health of the citizens so largely depends, is protected throughout its way to our homes from all contaminating influences.

[A day or two after the above paper was read to the Society, the Report of Dr Williamson, Chief Sanitary Inspector of the city, was issued. This Report embodies a communication on the purely zoological aspect of the subject from Dr Traquair, who, again, called in the services of Mr William Evans for purposes of identification. As a result, the insects in question are authoritatively declared to be spring-tails; and these are stated to have been found in about 30 per cent of the ball-hydrant boxes examined. It is also said to have been demonstrated that the liquid contents of these hydrant boxes could, in a few seconds, be transferred to the house cisterns by a simple increase of pressure. Mr Evans identified the particular species of Collembola found in the hydrants or in the cisterns as being three in number: *Isotoma fimetaria*, Tullb., *I. minuta*, Tullb., and *Templetonia nitida* (Templ.),—the first being by far the most numerous, and none of them being in any sense aquatic. It is added, however, that other

[1] The following passage from the Sanitary Inspector's last Annual Report gives some idea of the number of cases in which the domestic water-supply is still stored within the dwelling, and points out at the same time the undesirable condition of many of these sources of supply: "Over 13,000 cisterns have been examined; and that more than 1500 of these have been found by the Inspectors in a dirty condition is an evidence of an absence of ordinary precautionary care on the part of so many persons in regard to this very important matter. Indeed, the Inspectors specially charged with this work report that many householders are unaware where cisterns are situated; and in such cases, as may be supposed, the conditions found present are frequently far from satisfactory."—'Annual Report of the Sanitary and Markets Departments of the City of Edinburgh, for the Year 1905,' by A. Maxwell Williamson, M.D., B.Sc., pp. 3, 4.

species may be present. Mr Evans concludes his part of the Report in these words: "So far as the insects themselves are concerned, they may safely, I think, be considered as quite harmless; but their presence in such numbers in the hydrants is evidence that they find an ample food-supply there, and herein lies the danger." The ball hydrant, Dr Williamson states, has been for some years past in process of abolition, being replaced, as opportunity occurred, by the superior valve hydrant; but some 2300 of the old form were said to be still in use. These it was proposed to get rid of "within a period of about six years"! This dilatory mode of procedure, it is understood, has been now departed from, and the old ball hydrant will soon have disappeared altogether from our streets. Dr Williamson's Report furnishes very instructive reading, and from it various conclusions may be drawn.]

VI.—*A TRIP TO THE ISLAND OF HOY.*

By Mr TOM SPEEDY.

(*Read March 28, 1906.*)

Among the wealthy classes in America it is nowadays considered fashionable to rent a Highland shooting-box and to spend the latter part of summer and the months of autumn in Scotland. Among the American middle classes, again, the person is regarded as a nobody who has not visited this country, and especially the scenes depicted by Sir Walter Scott. It is surprising that, as far as my experience goes, the Waverley Novels are much more read and appreciated in America than they are in the country in which their great author first saw the light. Why people should wish to see any part of another country before they have seen what is best worth seeing in their own is, to my mind, difficult of explanation. Surely one's own land ought to be dearest to all. Perhaps in no part of the world is there a greater variety of beauty and sublimity than in the northern and north-western parts of Scotland. Yet many in our own city have visited places on the Continent and elsewhere who have seen but little of the country to which they owe their birth.

Where to spend one's holidays is a question which nowadays exercises the minds of many in the spring months, creating an excitement resembling in some degree the restlessness of birds on the approach of the period of migration. A lady acquaintance of my own characterises it as "the periodical fever." In accordance with my conviction that every one should see and know his own country, I may be excused for saying that the Orkney Islands can be strongly recommended. They are sufficiently removed from the great centres of life to ensure relief from the overcrowding which prevails at many of our modern summer resorts, yet, with the greatly improved steam communication of recent years, they are comparatively easy of access. The travelling expenses are so moderate that, combined with the cheap rate of living, they afford to almost every one an opportunity of a thoroughly recuperative period of relaxation somewhat out of the run of the more frequented haunts of the tripper and beyond the bounds of the city week-ender. To the lover of nature in particular, few places possess so many attractions as the Orkney Islands. The ornithologist, the botanist, the geologist, the admirer of cliff scenery, and the antiquarian will there find much to interest them. It is, however, chiefly to Hoy that I wish at present to direct your attention. This island—the largest, excepting Pomona, of the group which constitutes the Orcadian Archipelago—is certainly the most interesting to the naturalist.

Having a delicate daughter, I was advised by the doctor to give her a sea-voyage round the north of Scotland. It seemed to benefit her so much that the following year I resolved to spend a few days with her at the Longhope Inn. I acquainted the proprietor of the island as to my intention, and asked his permission to walk round the shore with a rifle to try and shoot a seal. I expected his reply on my arrival at Longhope Inn. Nor was I disappointed, for on the steamer reaching the pier the factor was awaiting us with a trap, and proffered a request from the laird that we should stay at Melsetter. As the inn at that time was rather primitive—there is a fine hotel now—the invitation was gladly accepted, and the hospitality displayed towards us will not readily be effaced from my memory. Not only was I authorised to shoot seals but was invited to shoot grouse: and, having the factor and gamekeepers at my disposal, I could inspect the places of interest on the island at my own sweet will. To most people these places are generally regarded as the Enchanted Carbuncle on the Ward Hill, the Old Man of Hoy, the Dwarfie Stone, and the Kame Rock, whose echo gives back shout for shout and scream for scream. To me, however, the wild cliff scenery and the long list of the feathered tribe which haunt their stupendous precipices, the plants found in that wild region, and even the shells on the shore, constituted an irresistible attraction. The island is over a dozen miles in length by about six miles across. Near the south end it is all but severed by an arm of the sea, the Longhope, which is one of the finest natural harbours of the world. Two years ago the part called Walls, south of the Longhope, was at high water completely isolated, constituting an island. The present proprietor, however, at great expense formed a road across the neck of the peninsula, so that the inhabitants of this part, which is thickly populated, are no longer dependent on the tides. Generally speaking, however, the commerce of Walls is carried on by sea, a pier having been recently erected there. At the west end of the Longhope stands the seat of the proprietor, Melsetter House, which commands a magnificent view down the loch.

By the time we had lunched the afternoon was wearing away, so we walked up to the top of the Berry, which overlooks a stupendous cliff of sheer descent into the sea. The tide was coming in with a fury deafening to the ears, the surging waves rolling in their wrath against the bottom of the precipice. The melancholy grandeur of the scene, the billows of the broad Atlantic in all their varied forms, the rocky precipices that echo the ceaseless roar of the raging sea, and the screaming of the thousands of seafowl, are all indelibly riveted in my memory. From the top of the Berry a splendid view is got of the Sneuk-head, which is the highest part of the perpendicular precipice in sight, the home of the peregrine falcon. Beyond the Sneuk-head the cliff gradually lowers to the township of Rackwick, which is beautifully situated in the extremity of a valley closed in on two sides by tremendous precipices,—one the Sneuk-head already mentioned, and the other Rora Head, near the Old Man of Hoy. The sun, like a ball of fire, had sunk beneath a shoreless horizon, which warned us to retrace our steps homewards. In that northern latitude, however, light does not fade till long after the setting of the sun. The fiery-red gleam lingered in the western sky, and it was some time ere darkness set in. Earlier in the season it is scarcely ever dark. On the way home white heather, stag's-horn moss, and other plants were gathered to take to Edinburgh. I have traversed many moors in Scotland, but nowhere have I seen such a profusion of white heather as in the Island of Hoy. This freak of nature is greatly prized since the publication of the novel 'White Heather' by the late William Black, and is gathered and sent to friends in all parts of the world.

During the next few days I explored most parts of the island, and was chiefly interested in the very large variety of bird-life which came under my notice. It is impossible to dwell at length on the numerous species of the feathered tribe found in this island, but some of them call for more than a passing remark. When grouse-shooting I was interested in coming upon the nesting-place of a colony of Richardson's skua. The young birds were able to fly, but somehow did not seem to leave the locality where they had been hatched. The parent birds also flew round regardless of our presence, as if wondering why we had intruded on their solitude. The habits of the skua are rather interesting. For hours I watched them on the sea in search of their prey, but in no case did I observe them take the trouble to fish for themselves. No sooner, however, did one notice a common gull successful in catching a fish, than the skua dashed after it and pursued it like a hawk, till the frightened bird disgorged its recently-swallowed prey. With the rapidity of lightning the skua then darted after the fish, and in most cases secured the prize before it reached the water.

The following is the list of birds found on and around the island of Hoy:—

Brambling.
Bunting.
" Snow.
Buzzard, Common.
" Rough-legged.
Cormorant.
Crow, Carrion.
" Royston.
Curlew.
Diver, Red-throated.
Duck, Eider.
" Golden-eyed.
" Long-tailed.
" Mallard.
" Scaup.
" Teal.
" Widgeon.
Dunlin.
Eagle, Golden.
Falcon, Peregrine.
Fieldfare.
Goosander.
Goose, Brent.
Grebe, Little.
Grouse, Red.
Guillemot.
" Black.
Gull, Common.
" Glaucous.
" Great Black-back.
" Lesser Black-back.
Harrier, Hen.
Hawk, Sparrow.
Heron, Common.
Jackdaw.
Landrail.
Lapwing.
Merganser.
Merlin.
Moor-hen.
Owl, Long-eared.
" Short-eared.
Oyster-catcher.
Pipit, Meadow.
Plover, Golden.
" Ringed.
Puffin.
Raven.
Razorbill.
Redshank.
Redwing.
Robin.
Rook.
Shag.
Sheerwater, Manx.
Sheldrake.
Skua, Richardson's.
Snipe.
Song-thrush.
Sparrow, House.
Starling.
Stonechat.
Tern, Common.
Turnstone.
Wagtail, Pied.
Water-rail.
Wheatear.
Woodcock.

No one can realise the grandeur and sublimity of the cliff scenery of Hoy except by sailing round its base. Care must, however, be taken that only safe boats and practical boatmen are employed, as even in fine weather strong currents and heavy swells are frequently encountered. Sailing close under these precipices for miles, the rocks range from 400 to 1200 feet in height, and, being of Old Red Sandstone formation, are very rich in colouring, with tints of bright red and yellow. In some places the rocks are apparently perpendicular and smooth; at others rent, riven, and worn by the heavy breakers into long, deep, vertical chasms and caverns, split and worn by the huge rolling breakers dashing their weight on the rock-bound coast. At such places as Rackwick Little, where the cliff lowers, and where the great white-crested waves come tumbling shorewards, it is surprising the distance limpets and other shellfish are propelled across the moorland in a storm. These soon become a prey to the hoodie-crow and other predatory birds.

On the west coast stands the "Old Man," a gigantic pillar of rock rising 450 feet out of the sea,—a sight in itself, not to speak of the grandeur of the coastline which it fronts. Sir Archibald Geikie, in his 'Scottish Reminiscences,' says: "The 'Old Man of Hoy,' which has been left standing as an isolated column in front of this great cliff, is the grandest natural obelisk in the British Islands, for it rises to a height of 450 feet above the waves that beat against its base."

So much has been written about the Old Man of Hoy, and so many photos and picture post-cards of him have been scattered broadcast, that it would be superfluous for me to say more, except, perhaps, that it is asserted the "Old Man" at one time had another tier or support, but which has long since been washed away by the fury of the Atlantic surges. A local poet has described the "Old Man" in verse, which, though not of high rank as poetry, is yet not without a considerable amount of humour. Some of the verses may here be reproduced:—

"Upon Orcadia's rocky strand
There stands a man alone,
One foot amongst the briny weed,
The other one is gone.
Old people yet remember it,
Although 'tis many years
Since it was lost by winds and frost,
And the old man dropped some tiers.

When this man was created,
We have no dates at hand:
I think it must have been before
Old Adam delved the land.
There are some others of the clan
Of the same date and day;
They stop somewhere near John-o'-Groats,
And are called the 'Men of Mey.'

. . . .

If you wish to see this wonder,
This man who had no birth,
You must steer your bark for Stromness town,
North from the Pentland Firth:
And when you land ask for the man
Who never was a boy,
And any one will tell you where
To find the Man of Hoy."

Though best seen from below, I climbed the hill and looked down on the head of the "Old Man." Long may he stand as a landmark on the coast of Hoy. We know, however, that such obelisks sometimes succumb to the winds and waves of centuries. Only the other day it was announced in the newspapers that "Stand Alane," a well-known landmark on the Cockburnspath coast, was brought to the ground, owing to decay and the severity of the weather.

From the eminence above the "Old Man" we wended our way down to the valley, and then ascended the highest mountain in Orkney, the Ward Hill, which rises to an altitude of 1555 feet. It was a beautiful day, and on gaining the summit a magnificent panorama was spread out before us. The entire islands which constitute the Orcadian Archipelago lay around, sparkling in the bright sunshine "like emeralds chased in gold,"—Papa Westray, North Ronaldshay, Eday, and Sanday being easily discernible. Though the tidal currents flow among the islands like mighty rivers, yet looking down from this eminence the billows of the broad Atlantic dwindled into mere ripples, and gave the appearance of the sea being perfectly calm. Gazing southward, the coast of Caithness is distinctly seen, with Dunnet Head and John-o'-Groat's standing out conspicuously. The Morven and Benhope hills are also observable, and the fact of our having traversed the heather in that district of Caithness added interest to the scene. Verily the view from the summit of the Ward Hill, if once obtained, will not readily be forgotten.

Descending the mountain, we followed the stream down to the township of Rackwick. As already said, this village is beautifully situated in the valley; and though closed in on two sides by lofty precipices, it possesses a fine bay, opening towards the Pentland Firth. Conversing with one of the inhabitants, he informed us that great hawks from the Sneuk frequently carry off their domestic poultry.

Retracing our steps, and following up the burn through a long swampy valley on the south side of the Ward Hill, with its wild corries furrowed with ravines and scarred by the storms of centuries, we came to the "Dwarfie Stone." This is one of the wonders of the Orkney Islands, and it is interesting to find the name of Hugh Millar on it, carved by himself. It is a great fragment of rock, which possibly by the action of frost became detached from a belt of the same material high up the mountain side, and rolled down the declivity till it found its present resting-place. The rocky face cresting the eminence above where the stone now lies is a breeding-place of the peregrine falcon, and is designated in the ordnance map as the Dwarfie Hammers. The stone is about twenty-two feet long, seventeen feet broad, and seven feet high. I measured it carefully with my foot-rule, but having lost my notes, have had to copy the measurements from other writers, who, I observe, vary considerably. The upper end of the stone has been hollowed out by iron tools into an apartment containing two beds. The largest bed is 5 feet 8 inches long by 2 feet broad, and is the one supposed to have been used by the dwarf himself. The other one is shorter; and though I tried to stretch myself in the former, I did not attempt to do so in the latter. To my mind the stone has been hewn out by some half-witted mason, of kinship to the "crank" who excavated the Gilmerton subterranean cave. Sir Walter Scott, however, has woven round this place such a halo of romance that, as already observed, it is one of the wonders of the Orkney Islands, and is visited yearly by numbers of people. Readers of 'The Pirate' are familiar with the words of Norna of the Fitful Head in reference to this stone. She says: "I was chiefly fond to linger about the Dwarfie Stone, as it is called—a relic of antiquity which strangers look on with curiosity, and the natives with awe. . . . The inside of the rock has two couches, hewn by no earthly hand, and having a small passage between them. The doorway is now open to the weather; but beside it lies a large stone which, adapted to grooves still visible in the entrance, once had served to open and to close this extraordinary dwelling, which Trolld, a dwarf famous in the northern Sagas, is said to have framed for his own favourite residence. The lonely shepherd avoids the place; for at sunrise, high noon, or sunset, the misshapen form of the necromantic owner may sometimes still be seen sitting by the Dwarfie Stone."

Dr Wallace, in his 'Description of the Islands of Orkney,' published in 1700, and quoted by Sir Walter Scott in 'The Pirate,' says that from the Dwarfie Stone may be seen at midnight, in the months of May, June, and July the "enchanted carbuncle" near the summit of the Ward Hill. It is "something that shines and sparkles admirably"; and though many are said to have climbed the hill and searched for it, nobody has ever yet found it. It is supposed to be caused by water sliding down the face of a smooth rock. Again to use the words of Norna of the Fitful Head: "Often when watching by the Dwarfie Stone with mine eyes fixed on the Ward Hill, which rises above that gloomy valley, I have distinguished among the dark rocks that wonderful carbuncle which gleams ruddy as a furnace to them who view it from beneath, but has ever become invisible to him whose daring foot has scaled the precipice from which it darts its splendour."

Facing the sound of Hoy is the Kame Rock, of echo-haunted fame, already referred to. This precipice is 1160 feet in height, and almost perpendicular, and here the eagle used to build her nest. Many stories are recorded of the ravages of eagles in Hoy. One is, that an eagle carried off a child to its nest in the Kame Rock. Happily, the eyrie being known and the bird instantly pursued, the child was found uninjured playing with the young eagles. The absurdity of such a story is apparent, and it is surprising how it ever came to be recorded. Those who have seen an eagle seize its prey, or have looked on the tremendous precipice in question, must admit that the story may be safely consigned to the region of romance. Stories of a similar nature have from time to time been recorded — oral tradition and superstition being both difficult to eradicate from the minds of the Scottish people. So recently as Saturday last a paragraph appeared in the 'Peeblesshire Advertiser' to the following effect:—

"ATTACKED BY AN EAGLE.—Mr James Sneddon, Elcho Street, Peebles, states that while walking on the hills beyond the Drove Road, in the direction of The Glen, on Sunday forenoon, a large eagle made a determined attack upon him, swooping down three times in quick succession. Fortunately he had with him a stout walking-stick, with which he was able to ward off the bird, which afterwards flew off in the direction, as far as he could judge, of Manorhead. It is said that the eagle has been seen in the district several times recently."

It will be interesting to know if this eagle has been seen by any practical ornithologist.

Eagles have long since deserted Hoy as a nesting-place, though it is on record that they used to breed both on the Kame Rock and on the breast of the "Old Man." Half a dozen years ago, however, I introduced seventeen mountain hares from Perthshire to Hoy. Being very prolific, the hares soon increased to considerable numbers, when a pair of eagles made their appearance and again nested on the Kame Rock. Whether it was owing to the scarcity of food or on account of their persecution by the farmers for the protection of their lambs, that caused the eagles to forsake their breeding-haunts, it is impossible to say. The fact remains, however, that with the increase of mountain hares, a pair of eagles, as already mentioned, returned and bred on the Kame Rock.

How vultures discover their prey has long been a controverted question among naturalists, and by what mysterious agency birds are guided to where food-supplies are abundant passes the wit of man to understand. The vole plague on the Border pasture-lands some years ago affords a familiar illustration. Short-eared owls, it may be remembered, then came upon the scene in hundreds, and nested among the heather in the vole-infested districts. With the disappearance of the voles, the owls, as is well known, also took their departure.

In conclusion, our trip to Hoy was voted a great success. The people whom we met were most kind and affable; the scenery was both grand and picturesque, with a mingling of the weird and awe-inspiring; while the natural history, especially the bird-life, was extremely interesting. When, joined to all this, there were the invigorating sea-breezes, and the free open-air life, with its constant changes and varied delights, enough has been said to recommend to any in search of a holiday resort this island of the Orcadian Archipelago.

VII.—*A FIELD NATURALIST'S RAMBLE IN SOUTH AFRICA:*

With some Sociological Inferences therefrom.

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

(Read March 28, 1906.)

Last summer the writer visited South Africa with the British Association. It was a splendid opportunity of seeing a country very different physically and socially from lands many of us are familiar with in Europe or America. South Africa shows us many things from a new point of view,—it supplies so much food for reflection on subjects geological, biological, sociological—problems of the past, the present, and the not distant future. Our tour was informing in the highest degree.

The large official party arrived at Capetown on the very day the meetings began: that gave no time to see the country and attend meetings too; so we started fully a fortnight earlier, and had thus some time to see Capetown, with its beautiful environs, and a little of Cape Colony. Then we did not wish to add another 800 miles to our long voyage by going by sea from Capetown to Durban,—we preferred to travel by rail to Johannesburg through the Karroo, the backbone of South Africa, and to stop at different places on the way to get a better impression of the country. Then we wanted to return by the east coast, and to break our journey in Egypt. The most satisfactory way of doing all that was to take a circular ticket by the German East-Africa Line: besides, we had as much German conversation as we liked, and some well-informed, calm, philosophic views of South African affairs.

After leaving England our first stop was for a few hours at Las Palmas, picturesquely situated on a steep hillside amongst volcanic mountains and luxuriant vegetation. Our next stop was at Schwakopmund — not far from Walfisch Bay — in Damaraland. There is no harbour, only an open bay and a long line of sandhills about a couple of hundred feet high: the country is entirely desert, so much so that drinking-water is regularly imported from Capetown, 700 miles away. We coasted along, keeping within sight of land without a green leaf for a hundred miles or so. That was our first impression of South Africa. From Schwakopmund a railway goes inland some 300 miles to copper mines.

It was a bright sunny morning when we arrived at Capetown. Table Mountain was draped in delicate clouds like pillars around its perpendicular sides. It was a sight not to be forgotten. We had many walks around Capetown. There was during our visit a remarkably interesting exhibition of wild plants, arranged in floral regions. It was the queerest collection of wild plants I ever saw, very many being adapted to live through the dry season. One of our excursions was to False Bay to visit the Marine Biological Station there. Then we had a shore walk,—a disappointing one, because while there are plenty of rocks, the rock-pools are almost barren of life, and there are very few seaweeds—that is due to the heavy waves. False Bay is 6° Fahr. warmer in summer than Table Bay, and we saw some of the green mud or sand full of foraminifera, and green from phosphate of lime, which is supposed to arise from vast numbers of fish killed where the warm and the cold currents meet.

One evening during our stay at Capetown we were fortunate in hearing a discussion at a Literary Society on the most important of all questions in South Africa,—"Natives as Citizens." The recently published "Report of the Commission on Native Affairs" was largely quoted, and it was most interesting to hear how the white man regarded the black, socially and politically. The majority of the speakers thought that the blacks should have collective representation.

Several visits to the Museum gave us a good idea of the South African fauna: its richness in antelopes strikes every one.

In some of our excursions we met with the Pre-Cape rocks,—the oldest rocks of South Africa. They are highly metamorphosed, and resemble much the rocks found in the West Highlands: schists, sandy clay-slate dipping at great angles, granites, and veins of quartz are common. Above these archæan rocks are the rocks of the Cape system—said to be 10,000 feet in thickness. The Table Mountain series are likely of Lower Devonian age. Above the Cape system comes the Karroo, and the lowest member of it is the Dwyka Conglomerate, consisting of mud, sand, and pebbles derived from glaciated land to the north of it. It is more than 1000 feet thick, and extends over some thousands of square miles. This shows that glacial conditions prevailed over a large extent of land and for a long time. The Dwyka belongs to late Palæozoic times. The mountain-ranges seem to have been raised between the Dwyka and the Cretaceous times by a thrust from the south. Sheets or outliers of dolerite often form a cap on softer rocks, and so flat kopjes with steep sides are a feature of South African scenery.

As we crossed the Karroo we saw some scorpions, many ants, and some queer insects. Some 40,000 species of insects found in South Africa have been described. We met several flocks of locusts in different places.

When we were in the Transvaal we paid a visit to the Agricultural Experimental Station. Amongst a number of investigations going on there, two interested us much. The one was a method of growing peach-trees without watering them, by keeping the soil about the trees continually hoed loose: the loose soil hinders evaporation. The other was raising a maize to ripen in three months—that is, to germinate in the season when the rains can be depended on, and to ripen before the early frosts which occur in these elevated regions.

At Heidelberg we saw a dust-storm: a friend there drove us round the environs, and for some time we could not see beyond the heads of the horses. It lasted a couple of hours, —red dust, how it sticks!

When we travelled in the trains we found our Colonial fellow-travellers most communicative. There was a great difference of opinion on economic and social questions. One thing they were almost unanimous about was that the late war was a mistake, and the reason sometimes given was almost amusing,—it did not bring the advantages anticipated!

We visited gold mines, both worked by Kafirs and by Chinamen. Of course, our visits were all arranged before-hand. At Johannesburg we were struck with the magnificence of its buildings and its 800 miles of streets, built while white workmen's wages were about 30s. a-day!

From Klerksdorp we trekked to Mafeking in Cape-carts: thence we visited Victoria Falls, and stayed there several days. We returned by Salisbury and Umtati, where we saw some small mediæval ruins. We met our steamer at Beira, and stopped at several places on the east coast. Finally, we spent three magnificent weeks in Egypt.

Omitting the most serious of problems, the conflict of races —white, black, and yellow—and the servile problem, in its newer phases, the sociological conclusions to be drawn may be summed up as follows. On account of the aridity of South Africa—the east and south coast belt being excepted,—shown by its flora and fauna, it has been long in developing, and the population must always be scanty. From the scattered population, markets for produce are few. The richer gold mines of Witwatersrand will be wrought out in a dozen years or so: will Johannesburg then be like Bulawayo now and Zimbabwe later? Prices are so high that the country has nothing to exchange with other countries, except diamonds, gold, ostrich feathers, and a little wool and hides,—besides, of course, bonds. Almost everything, including food, has to be imported. To bring down prices and help to make the country self-supporting, a great financial reconstruction seems sooner or later to be inevitable.

[The above paper, which is here much abbreviated, was illustrated by about a hundred original lantern views.]

VIII.—*NOTES ON THE FORMATION AND FLORA OF A SHINGLE ISLAND IN THE RIVER ORCHY, DALMALLY, ARGYLL.*

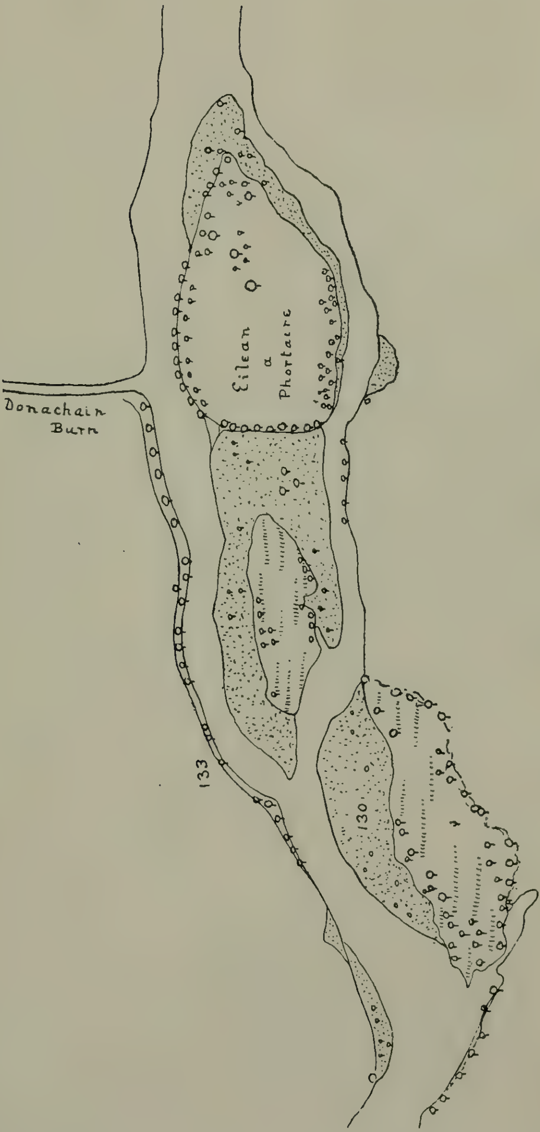
By Miss BEATRICE SPRAGUE.

(*Read Dec. 20, 1905—Revised Sept. 1906.*)

Course of the Orchy.—Before describing our Shingle Island, we shall glance at the course of the Orchy itself, and at one or two of its larger islands, noting what changes have taken place in recent years. On flowing out of Loch Tulla, the Orchy runs rapidly and turbulently through Glen Orchy proper, in a narrow channel, forming some striking rock scenery on its way; but as soon as Dalmally Vale is reached, the fall of the country becomes very gradual, and the river spreads into wide shallows, heaping up great banks of shingle, now on one side now on the other. A mile or so above Inverlochy is a large wooded island; just below Dalmally bridge is another, Eilean a Phortaire, still larger, and also wooded; and immediately below the latter lies the Shingle Island with which we are concerned. The Orchy here flows through a cultivated strath, half a mile wide or more; and the island, lying in a curve of the right bank, is separated from the fields only by the six-foot drop of the steep sandy bank, and by the stony bed of the winter stream (which, though dry in summer, has still rushes and other water-loving plants growing here and there). Immediately above our island a tumble-down wall runs out obliquely from the bank, deflecting the current of the river and thus acting as a slight protection to the bank. This wall, or breakwater, is overgrown with young trees and other plants; in summer it is continuous with the island and the mainland (down-stream), but is separated from them in winter by a backwater of the river.

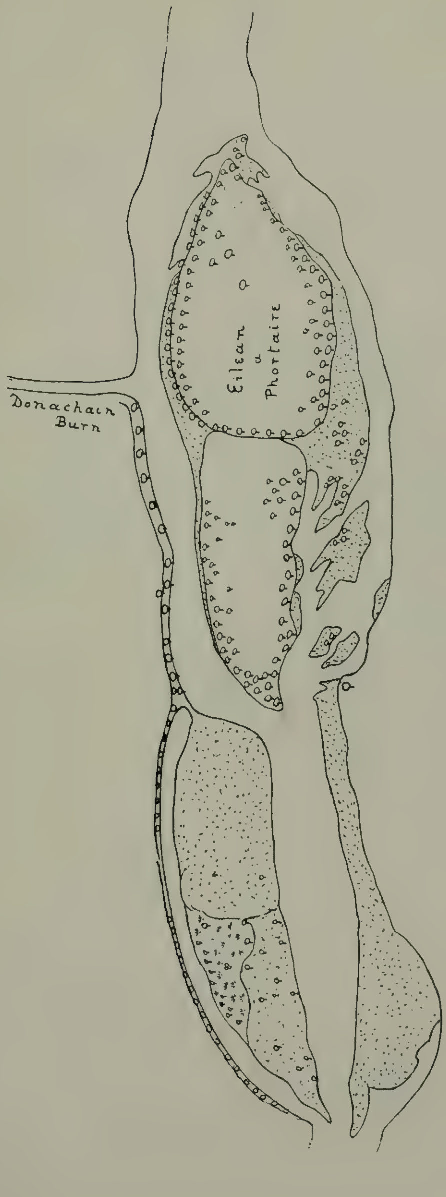
Changes in recent years.—Great changes have taken place in the river's course during the last forty or fifty years; and the two following maps will give some idea of what has

MAP I.



COURSE OF ORCHY IN 1870.

MAP II.



COURSE OF ORCHY IN 1906.

happened. Map I. is copied and enlarged from the Ordnance Survey map drawn in 1870: and Map II. shows the same stretch of the river, as nearly as I have been able to give it from rough sketches made on the spot. There are doubtless inaccuracies in this map, but the general proportions are correct. I made no drawings of the right and left banks of the Orchy east of the middle of Eilean a Phortaire; and those two outlines (which I have copied from the Ordnance map) may now be slightly different. It will be noticed that the altitude of the fields is 133 feet; that of the island itself ranges from 127 to 133 feet.

Forty or fifty years ago the river-banks were carefully protected, and the Orchy ran through Dalmally Vale in a comparatively narrow channel, with hardly a shingle bank in its course. At that time Eilean a Phortaire had already assumed its present appearance; but the island immediately to its west was a mere shingle bank, very little overgrown. The two are now continuous, and at first glance appear to be one large wooded island of uniform age; but the junction is very clearly seen on visiting the island. Map I. shows these islands in an intermediate stage.

As recently as twenty-four years ago, the fields on the northern river-bank extended much farther south; and our Shingle Island was then a comparatively narrow strip of gravel, cut in two by a small stream, and level with the fields, from which it was separated by the main body of the river. When proprietors grew careless and left off protecting the banks, these fields received the full force of the current; and a large curve has now been cut away from them. The river is still eating farther and farther into them; and great lumps of turf and sand are continually being undermined, and may be seen dropping down all along the edge of the bank. About eleven years ago the rough breakwater above mentioned was built; and this has diverted the current, and retarded, though it has not stopped, the wearing away of the banks. The diverted current has since swept the gravel to right and left, piling it up both on our Shingle Island and in the bay immediately opposite on the south. Seven years ago this bay was full of water, but it is now completely filled up with gravel, as shown in Map II.

Eilean a Phortaire.—Eilean a Phortaire is slightly over 200 yards long and 140 yards wide, if we include the broad shingle belt on the south; and it rises gradually from east to west till it reaches a height of 6 feet above the river. All along its margin there are trees, forming a narrow belt of woodland round a wide open space of a pastoral character. This woodland belt contains numbers of alder and ash, with a good many hazel and bird-cherry, a few sycamores, and one or two birches and rowans; and some willows are growing on the extreme edge and on the shingle. The trees are mostly large and well-grown, except at one corner on the S.E. Underneath the trees are quantities of dog's-mercury and wild hyacinth, a good deal of wood-sage, here and there a patch of red campion or creeping buttercup (R. repens), some primroses, a fair sprinkling of wood-sorrel and self-heal, and a little wood crane's-bill and wood loosestrife. There are several lady ferns and one or two male ferns; also a few lemon-scented ferns (Lastræa Oreopteris), and one or two tiny hard ferns: but these last two species do not seem to be thriving well.

The central open space is only broken by four large ashes near the eastern end. In August and September it is ablaze with ragwort, underneath which are quantities of wild pansies, creeping buttercup, and self-heal, and a good deal of sheep's-sorrel. There are also many grasses; but these form only short turf, the flowering stems having been eaten off, I imagine, by rabbits. One well-defined oval area at the eastern end, 75 yards by 30, is rather different in character, having scabious (S. Succisa) as the dominant plant, with a sprinkling of golden-rod and primroses; and here the ragwort is almost entirely absent.

We were told that Eilean a Phortaire has been a wooded island as far back as could be remembered; and the largest of the trees appear to be about 100 years old. It was for a time under cultivation, crops of potatoes, turnips, corn, rye-grass, and hay having been raised there, and cows sometimes pastured, up till 1903. But the last crop (corn) was destroyed by rabbits, and since then the island has not been used.

The western island is more recent: 40 or 50 years ago it was little more than a gravel bank, and the river flowed between it and Eilean a Phortaire proper. Nowadays the two are continuous, but there is a sudden drop of two feet from the high western end of Eilean a Phortaire to the low eastern beginning of the newer island. In flood-time the stream still flows between the two. This western island is 200 yards long by 70 wide; and, like the other, it rises westwards (that is, down-stream) to a height of six feet. A thick belt of trees clothes the southern and western edges; and on the northern edge young trees are growing up fast. The central space is open and pasture-like, but a good deal interrupted here and there by trees. The island begins on the east as almost pure shingle; but as one goes west, scattered tufts of moss (Grimmia fascicularis) are seen on every tiny sand-drift, and at last the ground is covered with luxuriant moss tufts, interspersed with little sandy spaces. Among the moss are flat-growing plants of grass, scabious, ragwort, and golden-rod; but these are mere rosettes, mostly without a flowering-stem, and are, I suppose, all quite young. Still going eastwards, vegetation quickly becomes continuous; the moss now forms a thick carpet, but is half hidden by tiny heather-plants (Calluna Erica), then by quantities of golden-rod, scabious, grasses, and tormentil. The soil is still very sandy, but darker in colour. Under the trees vegetation is ranker, and we have meadow-sweet, wood-sage, brambles, and dog's-mercury; with golden-rod and scabious still persisting. There is a little raspberry and wood crane's-bill, lady fern and male fern, dog-violet and speedwell (V. Chamædrys). In one spot Ranunculus repens is growing, and in another wild hyacinth. The trees are nearly all alder, with a few sycamore, willow, and ash; and one or two birch, bird-cherry, rowan, and hazel.

The moss on this island appears to play a very important part, acting as pioneer for the other plants, by helping to retain the sand and to form humus. We pulled up a good many pieces to see whether the sand beneath was affected by the moss; and, as far as we could judge, the sand underneath was becoming slightly finer and darker coloured.

This western island has had cows pastured on it, and hay has once been cut there; but it has never been under cultivation.

The Shingle Island.—As already mentioned, the shingle island formerly consisted of two portions; and a well-marked channel can still be easily seen, where a stream rushes through in flood time.[1] (See Map III.)

At ordinary times the island is now one long continuous bank, 350 yards long, with a maximum width of 85 yards; but it is roughly divided into three distinct areas, as follows:—

(1) The large main body of shingle, which forms the eastern half of the island. This rises gradually from east to west till it reaches a height of six feet, when it ends abruptly with a drop of two or three feet to the low-lying western half. Much shingle has been deposited lately on this bank, and it is only within the last two years that it has reached its present high level.[2]

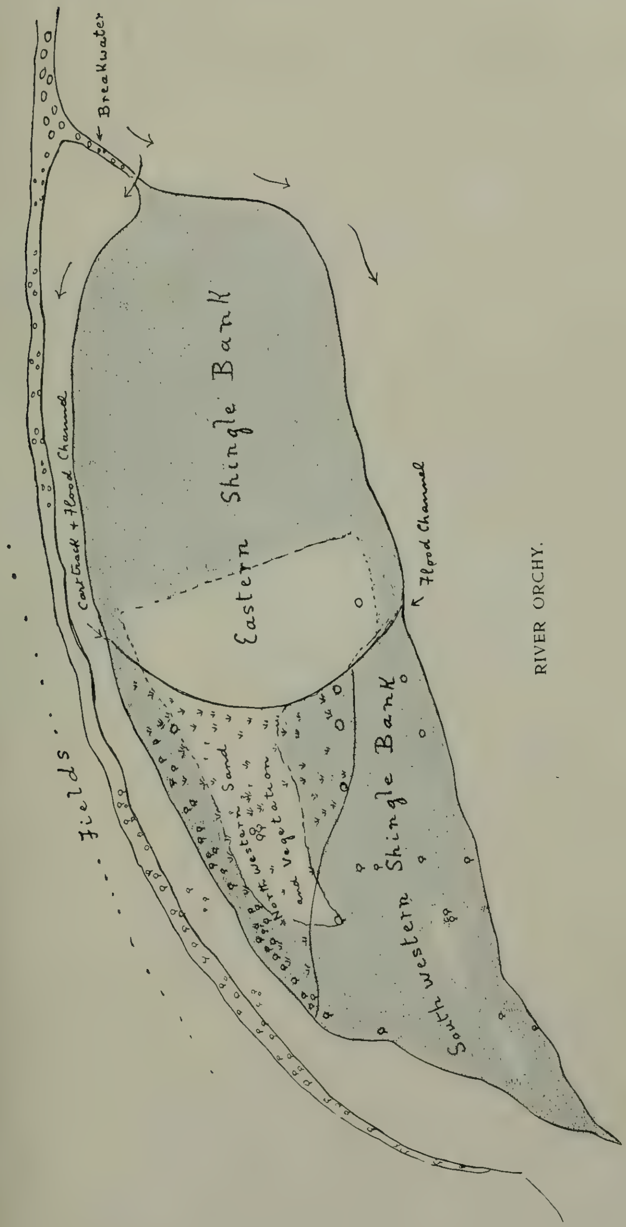
(2) The south-western part—another well-defined body of shingle, but smaller, and lying at a lower level. These two parts, the eastern and south-western, are practically mere barren stretches of stones, with here and there a small bush and a few scattered plants, to be noted later. The stones are well-rounded pebbles of all sizes up to six inches long, but mostly not more than four inches; nearly all are fragments of a micaceous schist or quartzite; but a few are quartz or granite. The larger stones lie on the surface, and underneath are smaller stones and coarse grit.

(3) The north-western part, which is quite different in character. It consists of low-lying shingle, covered with drifts of pure sand a foot or more deep; and the greater part of it is thickly covered with vegetation,—a noticeable feature being a hundred or so very tiny bushes. It is rather difficult to understand how this part of the island assumed its present form. The river formerly deposited shingle here, but afterwards carried it away again. A crofter friend of ours, who has lived on the spot for many years, and has watched with interest the changes in the river, made two suggestions

[1] The southern branch of the channel is purely natural, but the northern one has been used as a cart-track. Here the sand has been loosened by the carts passing over, and then scoured out by the flood-water; so that this part of the channel is now deeper than it was originally.

[2] Several years ago shingle was carted away from this large eastern bank for road-making.

MAP III.


Breakwater
Cart track + Flood Channel
Eastern Shingle Bank
Flood Channel
North western Sand and Vegetation
South western Shingle Bank
Fields
RIVER ORCHY.

to account for the presence of the sand-drifts. First, that the river, by the time it reaches this part, has already dropped all the heavier shingle on the eastern bank, and has nothing left but small shingle and sand to deposit here. Some colour is given to this theory by the fact that at the junction of the two parts a good deal of small shingle is deposited; and also by the fact, already mentioned, that the eastern bank is receiving fresh accumulations of large shingle. On the other hand, why should not the *south*-western bank be sandy too? His other suggestion is that, as the north-western part is some feet lower than the eastern, the water in flood-time lies comparatively deep and still over it, and can therefore deposit the sand it is carrying; whereas in the shallower parts there is a stronger current, and the sand is swept along. Perhaps the north-western part gets the benefit of an eddy, in which the south-western part does not share. But the river is constantly shifting its course and its currents, and it is not easy to form a definite opinion on the subject.

This overgrown north-western part is much less regular than the rest of the island, being full of large clumps of vegetation, deep holes, scattered sand-drifts, and depressions. On rushing over a clump of vegetation in flood-time, the river pours down beyond it with added force, and so scours out a hole immediately below. It is perhaps twenty years ago that plants *began* to grow here, but only within the last five or six years that the vegetation has become noticeable.

All these islands—Eilean a Phortaire proper, its western continuation, and the Shingle Island — reach a maximum height, westwards, of 6 feet, which is the same level as that of the adjoining fields.

Floods and flood-drift.—In summer the Shingle Island is left high and dry, and one can walk to it dryshod from any part of the adjoining river-bank. In fact, owing to fresh shingle having lately been piled up near the breakwater, it is now (September 1906) less of an "island" than when we first visited it in the summer of 1905. In rainy weather, however, it is isolated by a good-sized stream; and it is subject to frequent floods, which occur chiefly in autumn and spring. Sometimes it is completely submerged, together with the low-lying fields close by; this has been known to happen several times in one month, but such high floods do not occur every year.

The following tables give some idea of the annual rainfall and temperature of the district: exact figures were not available, and we drew up these tables ourselves from maps in the 'Journal of the Scottish Meteorological Society.' The rainfall maps are in the Third Series, No. X., and the temperature maps in Third Series, Nos. XIII. and XIV. We had some difficulty in estimating the rainfall figures.

Rainfall (1866-90).

January	above 6 inches.	July	6 inches.
February	above 6 "	August	6 "
March	above 6 "	September	above 6 "
April	3–4 "	October	above 6 "
May	3–4 "	November	above 6 "
June	4–6 "	December	above 6 "

Mean annual rainfall 80 inches (?).

(Dalmally is just on the line between the 60–80 area and that above 80.)

Mean temperature (1856-95).

January	under 40	July	55–60
February	under 40	August	55–60
March	under 40	September	50–55
April	40–45	October	45–50
May	50–55	November	40–45
June	55–60	December	under 40

Mean annual temperature 45–50.

On 15th Sept. 1906, we saw the island half submerged after ten days' heavy rain (see Map III., where the light parts correspond to what was showing above the water); and on 17th Sept., when the water had subsided, we examined the flood-drift carefully, in order to see what bearing it had on the flora of the island. The following is the list of our finds:—

Leaves.—Sycamore, bird-cherry, rowan, ash, birch, alder, oak.

Twigs.—Raspberry, bramble, heather (Calluna), ash, alder, oak, willow, larch; the alder predominating. Nearly all these twigs, however, were old and dead, and none seemed capable of growing. There were probably twigs of other trees, too, but we found them hard to identify.

Fruits.—A good many rowan-berries; rose-hips,[1] young alder fruits, an unripe hazel nut, a broken Spanish chestnut burr, dead cones of Scotch fir and larch, a few seed-vessels of an umbellifer (? Heracleum Sphondylium), a head of Dactylis glomerata, a seed of some composite, a piece of corn-spurrey in seed, seeds of a rush, and some small brown seeds which we could not name. The rush and corn-spurrey, however, were most likely derived from plants growing close by on the island itself. Probably many seeds brought down by the floods were so small as to escape our notice; and the only satisfactory way of investigating these would be to collect portions of drift and try to grow the seeds they contain.

Roots.—Several healthy-looking roots of the lesser celandine, which appeared likely to grow. Several fern roots, including one with minute fronds (? Lomaria Spicant). One or two entire plants of Rumex crispus, which, however, looked as if they had been pulled up by hand and thrown into the river. These dock plants, and a few potato tubers, some of which were decaying, did not seem at all likely to live. Numerous fragments, large and small, of moss; sometimes regular mats several inches square. These included two of the true mosses (? Grimmia fascicularis and Polytrichum urnigerum), and at least three species which I think belonged to the Jungermanniaceæ; there was also one rather large piece of Fontinalis sp., and a scrap of sphagnum. All of these except the last two seemed likely to live.

Lastly, great lumps of turf, sometimes more than a foot square, torn presumably from the river-bank or from the banks of Eilean a Phortaire. They consisted chiefly of grasses, with one or two roots of heather (Calluna) and clover; and were good solid pieces of turf with two or three inches of sandy earth containing live worms and other creatures. All these various kinds of drift were sorted out by the river; the twigs were deposited along the sloping western edges of the high shingle bank, and on the low western part of the island, and were often half buried in sand. The leaves were mostly collected into layers some inches deep, which will help to form good soil; these also were on the western part. On the large eastern shingle bank, and in fact wherever there was bare shingle, practically nothing had been able to lodge, except

[1] Found in Sept. 1905.

tiny accumulations of sand and grit with a few fragments of moss and scale-moss, which had collected in the crevices underneath flat stones, &c. A lot of *débris* — leaves and grass stems, &c.—gets wound round the heads of such plants as hard-heads, plantains, and rushes; but the bushes on the island collect by far the largest part. They already have curious mounds of grass growing up high round their roots; and the fresh pieces of turf brought down by the river lodge there, and have every chance of growing. Large collections of twigs also lodge in the bushes; and much small *débris* is entwined round their leaves. These bushes also play another important part, as they protect the shingle from being washed away. We noticed several instances where a regular ridge of shingle extended westwards (*i.e.*, down-stream) from a bush, the shingle on both sides having been carried away by the stream. It appears, then, that as soon as any bushes have established themselves on a shingle bank, it has a much better chance of becoming permanent, and its prospects of getting covered with vegetation are perhaps improved.

Chief aim of our investigation.—Our chief aim, in all these investigations, was to record the entire flora of the Shingle Island, and to ascertain as far as possible the sources from which it was drawn. It became clear, at the outset, that besides the island itself we should have to take into account its immediate surroundings, namely, the adjoining fields, and the narrow strip of land between them and the river, which, for the sake of clearness, I shall call the *riparian strip.* We thus found ourselves with three distinct tracts to study, each with a character of its own and certain plants peculiar to itself. After indicating the general characteristics of all three tracts, we shall give the complete list of the island's flora, and note how it differs from that of the fields and the riparian strip.[1]

Fields adjoining the Shingle Island.—The fields immediately alongside the island have been cultivated for at least a hundred years. Judging from the surroundings, they were origin-

[1] We have followed the nomenclature of the 'London Catalogue of British Plants,' 9th edition, 1895, wherever possible; but in some cases—*e.g.*, Valeriana officinalis—we have used the older aggregate name, because we did not discriminate further when identifying our specimens.

ally part of the marshy grass moor common in this neighbourhood. The southern slope of Ben Donachain, immediately to their north, is chiefly mountain pasture.[1] When we first saw the fields, in the summer of 1905, they were long narrow strips, running down almost to the edge of the river-bank. There were three hayfields close by the island; and a little farther off (and farther inland) a strip of oats and a potato-patch. The hayfields contained quantities of the following grasses:—Anthoxanthum odoratum, Agrostis vulgaris, Holcus lanatus, Sieglingia decumbens, Lolium perenne; a good deal of Arrhenatherum avenaceum, and a few scattered plants of Deschampsia cæspitosa and Agropyron repens; also a good deal of Festuca ovina, and a few plants of a viviparous form of this species. The commonest wild flowers in these fields were Viola tricolor, Lychnis Flos-cuculi, Trifolium repens, T. pratense, T. dubium, Anthyllis Vulneraria, Lotus corniculatus, Potentilla silvestris, Scabiosa Succisa, Chrysanthemum Leucanthemum, Crepis virens, Hypochœris radicata, Campanula rotundifolia, Rhinanthus Crista-galli, Plantago lanceolata, and Rumex Acetosella; and there were a fair number of Orchis mascula, Habenaria conopsea, H. bifolia, and Equisetum sylvaticum. The oats and potato patches being farther off, we did not examine them so thoroughly; there was a good deal of Spergula arvensis and Polygonum Persicaria in one or other of them, and the oats were full of Chrysanthemum segetum.

The riparian strip.—The riparian strip, although rather narrow, is varied in its nature. Opposite the island it is a steep sandy and stony bank [2] with a few small bushes; while higher up stream it consists of a grassy and well-wooded border some yards wide, dividing the fields from the river. This upper part contains a variety of trees:—

Upper part.—Acer *Pseudo-platanus,* Prunus Padus, Pyrus Aucuparia, Fraxinus excelsior, Alnus glutinosa, and Salix aurita (?). In the shady grass below them, Mercurialis perennis and Athyrium Filix-fœmina are growing well, together with a few plants of Anemone nemorosa, Hieracium crocatum,

[1] See map in 'Scottish Geographical Magazine,' vol. xxii. No. 6.

[2] This bank is formed of sand overlying a layer of shingle. Opposite the eastern end of the island, this layer of shingle rises to within a foot of the surface; but it dips down westwards, and opposite the western end of the island there is visible only the six-foot river-bank of sandy earth.

Primula acaulis, Teucrium Scorodonia, Luzula maxima, and Lastræa Filix-mas.

Breakwater.—From this corner of woodland runs out the breakwater already mentioned, which contains a number of young trees, up to 10 feet in height. It is distinguished from the rest of the riparian strip by the presence of Stellaria Holostea, Geranium Robertianum, Epilobium montanum, Volvulus sepium, Urtica urens, and one or two young Betula alba.

Lower part.—The lower part of the riparian strip contains chiefly Sagina procumbens, Hypericum pulchrum, Anthyllis Vulneraria, Lotus corniculatus, Vicia Cracca, Spiræa Ulmaria, Potentilla silvestris, P. Anserina, Heracleum Sphondylium, Galium boreale, G. palustre, Valeriana officinalis, Scabiosa Succisa, Solidago Virgaurea, Tussilago Farfara, Senecio aquaticus, Centaurea nigra, Hieracium vulgatum, Euphrasia officinalis, Thymus Serpyllum, Plantago lanceolata, P. maritima, Rumex crispus, R. Acetosa, and Equisetum arvense; and the stony bed of the winter stream was full of Ranunculus Flammula. At the extreme edge of the fields, immediately above the sandy bank, was a sturdy, though stunted, border of Calluna Erica.

The Shingle Island.—On visiting the island, the first thing that struck us was how amazingly certain plants were flourishing. By far the most conspicuous was Plantago maritima, which was growing in dense cushions a foot or more across, and flowering splendidly, over a great part of the island, including the bare eastern shingle-bank.[1] Less ubiquitous, but very much at home, were Ranunculus acris, Lathyrus pratensis, Alchemilla vulgaris, Heracleum Sphondylium, Centaurea nigra, Rumex Acetosella, and Oxyria digyna; there was also a good deal of Geranium sylvaticum, Vicia Cracca, Achillea Millefolium, Hieracium vulgatum, Hypochœris radicata, and Equisetum arvense. Less widely spread, but forming conspicuously fine clumps, were an Aster hybrid of the Michaelmas daisy type,[2] Tanacetum vulgare,[2] Cnicus hetero-

[1] This was in June 1905. On revisiting the island in September 1906, we were astonished to find hardly any trace of this plant. There were only a few tiny rosettes left, and one very large cushion two feet by three. Possibly the plants had reached their limit of growth, and exhausted their remaining stock of vitality in the final magnificent effort of last summer.

[2] Garden escapes.

phyllus, Mentha sylvestris,[1] and Polygonum cuspidatum.[1] All these plants were growing on the north-western fertile part of the island;[2] and in this same area are springing up many bushes and young trees, chiefly along the northern margin. We counted 55 willow, mostly Salix aurita (?), 17 alder, 16 wild rose, 12 bird-cherry, and 6 ash. Most of these are quite tiny, but several of the willows and alders are larger, the tallest being a ten-foot alder. The ashes are all tiny, and do not look healthy. The sycamore, birch, beech, oak, hazel, and red currant of our list are the merest seedlings —one seedling of each kind.

Over part of the island, where little else grew, Grimmia fascicularis was flourishing.[3] This was on a stretch of bare shingle, and on an adjacent sandy corner that unites it with the north-west overgrown area. But for this moss and Plantago maritima, the large stretches of shingle on the island are the merest barren wastes, with here and there widely scattered roots of grasses, Centaurea nigra and Plantago lanceolata; and more locally, Lotus corniculatus, Tussilago Farfara, Oxyria digyna, Rumex Acetosella, and Equisetum sylvaticum. These last five plants tend to form colonies.

Complete list of Shingle Island flora.—One of our special aims was to ascertain where the island flora originally came from; and to this end we made a thorough search of the land immediately adjoining — namely, the right river-bank, both directly opposite the island and for some distance up-stream. Lack of time prevented our studying Eilean a Phortaire so thoroughly. The left river-bank we did not examine; and, judging from its position, it hardly affects the problem. The following list gives the whole of the Shingle Island flora, as far as we ascertained it, and attempts to show the sources from which that flora is drawn:—

[1] Garden escapes.

[2] Oxyria digyna was thriving both on the bare shingle and in the sand.

[3] This observation was made in the summer of 1905. In September 1906 we found that though Grimmia fascicularis was still flourishing in the sandy corner mentioned (which is in process of being overgrown with other plants), it had almost disappeared from the shingle. Tiny pieces were to be found pretty frequently on close search, but they did not look at all healthy. Possibly the time of year had something to do with it. All the moss on the shingle consisted of creeping stems without fruit; I do not know whether this was Grimmia fascicularis in a young stage, or whether it was another moss altogether.

	Mainland.	Riparian strip.	Mountain.	Garden.	Eilean a Phortaire.	Untraced.
Anemone nemorosa, Linn.		×				
Ranunculus Flammula, Linn.		×				
R. acris, Linn.	×					
R. repens, Linn.	×	×			×	
Trollius europæus, Linn.		×				
Cardamine pratensis, Linn.		×				
C. hirsuta, Linn.	×				×	
Viola palustris, Linn.		×				
V. canina, Linn.	×	×			×	
V. tricolor, Linn.	×	×			×	
Polygala vulgaris, Linn.	×					
Silene acaulis, Linn.[1]			×			
Lychnis dioica, Linn.					×	
L. Flos-cuculi, Linn.	×	×				
Sagina procumbens, Linn.		×				
Cerastium triviale, Link.	×					
Stellaria media, Cyr.	×	×				
S. graminea, Linn. (?)						×
Spergula arvensis, Linn.	×	×				
Montia fontana, Linn.		×				
Hypericum humifusum, Linn.		×				
H. pulchrum, Linn.		×				
Acer *Pseudo-platanus*, Linn.		B[2]			×	
Geranium sylvaticum, Linn.	×	×			×	
G. Robertianum, Linn.		B				
Cytisus scoparius, Link.		×				
Trifolium repens, Linn.	×	×				
T. pratense, Linn. (?)	×	×				
Anthyllis Vulneraria, Linn.	×	×				
Lotus corniculatus, Linn.	×	×				
Vicia Cracca, Linn.	×	×				
V. sepium, Linn.	×					
Lathyrus pratensis, Linn.	×					
L. montanus, Bernh.	×					
Prunus Padus, Linn.		×			×	
Spiræa Ulmaria, Linn.	×	×			×	
Rubus idæus, Linn.		B & DB[3]		× (?)	×	
R. fruticosus, Linn.		DB			×	
Geum rivale, Linn.		×				
Potentilla silvestris, Neck.	×	×			×	
P. Anserina, Linn.		×				
Alchemilla vulgaris, Linn.		×				
A. alpina, Linn.		×	×			
Rosa canina, Linn.	×	×				
Pyrus Aucuparia, Ehrh.		×			×	
Cratægus Oxyacantha, Linn.		DB				
Œnothera biennis, Linn.				×		
Saxifraga aizoides, Linn.			×			

[1] We found several blooms on one of the island plants of Silene acaulis on 17th September 1906. [2] B=Breakwater. [3] DB=Donachain Burn.

	Mainland.	Riparian strip.	Mountain.	Garden.	Eilean a Phortaire.	Untraced.
Ribes rubrum, Linn. (? var. sativum)				×		
Conopodium denudatum, Koch	×					
Heracleum Sphondylium, Linn.	×	×				
Galium boreale, Linn.		DB	× (?)			
G. palustre, Linn.		×				
Valeriana officinalis, Linn.		×				
Scabiosa Succisa, Linn.	×	×			×	
Solidago Virgaurea, Linn.	×	×			×	
Bellis perennis, Linn.	×	×				
Aster hybrid of the Michaelmas daisy type				×		
Achillea Millefolium, Linn.	×					
A. Ptarmica, Linn.	×	×				
Chrysanthemum segetum, Linn.	×					
C. Leucanthemum, Linn.	×					
Tanacetum vulgare, Linn.[1]				×		
Tussilago Farfara, Linn.		×				
Senecio Jacobæa, Linn.	×				×	
S. aquaticus, Huds.	×	×				
Cnicus heterophyllus, Willd.			×			
C. arvensis, Hoffm.	×					
Centaurea nigra, Linn.	×	×				
Crepis virens, Linn.	×					
Hieracium Pilosella, Linn.	×					
H. vulgatum, Fr.		×				
H. crocatum, Fr.		×				
Hypochœris radicata, Linn.	×					
Taraxacum officinale, Web.		×				
Campanula rotundifolia, Linn.	×	×				
Primula acaulis, Linn.		×			×	
Lysimachia nemorum, Linn.		DB				
Fraxinus excelsior, Linn.		×			×	
Volvulus sepium, Junger		B		×		
Solanum tuberosum, Linn.	×					
Veronica Chamædrys, Linn.	×				×	
Euphrasia officinalis, Linn.	×	×				
Pedicularis sylvatica, Linn.		×				
Rhinanthus Crista-galli, Linn.	×					
Mentha sylvestris, Linn.				×		
M. arvensis, Linn.	×					
Thymus Serpyllum, Linn.	×	×				
Prunella vulgaris, Linn.	×	×			×	
Stachys hybrid		S. palustris B				
Galeopsis versicolor, Curt.		×				
Ajuga reptans, Linn.					×	
Plantago lanceolata, Linn.	×	×				
P. maritima, Linn.	×	×	× (?)			
Polygonum Convolvulus, Linn.						×

[1] This is of course a wild flower; but in this particular instance it came from a garden.

	Mainland.	Riparian strip.	Mountain.	Garden.	Eilean a Phortaire.	Untraced.
Polygonum aviculare, Linn. . . .	×					
P. Hydropiper, Linn.	×					
P. Persicaria, Linn.	×	×				
P. cuspidatum, Sieb. and Zucc. . .				×		
Oxyria digyna, Hill			×			
Rumex crispus, Linn.	×	×				
R. Acetosa, Linn.	×	×				
R. Acetosella, Linn.	×				×	
Mercurialis perennis, Linn. . . .		×			×	
Urtica dioica, Linn.						×
Betula alba, Linn.		B			×	
Alnus glutinosa, Medic. . . .		×			×	
Corylus Avellana, Linn. . . .		DB			×	
Quercus robur, Linn. . . .		DB				
Fagus sylvatica, Linn. . . .		×				
Salix aurita, Linn. (?) . . .					×	
S. phylicifolia, Linn. . . .						
S. viminalis, Linn.						
Tritonia crocosmiflora, Nichols. . .				×		
Scilla festalis, Salisb. . . .					×	
Juncus effusus, Linn. . . .						×
J. lamprocarpus, Ehrh. . . .						×
Luzula maxima, DC. . . .		×			×	
Phalaris arundinacea, Linn. . .						×
Anthoxanthum odoratum, Linn. . .	×					
Phleum pratense, Linn. . . .						×
Agrostis vulgaris, With. . . .	×					
A. palustris, Huds.						×
Deschampsia cæspitosa, Beauv. . .	×					
Holcus mollis, Linn. . . .	×					
H. lanatus, Linn.	×					
Avena sativa, Linn.	×					
Arrhenatherum avenaceum, Beauv. .	×					
Sieglingia decumbens, Bernh. . .	×					
Molinia varia, Schrank . . .						×
Dactylis glomerata, Linn. . . .		×				
Glyceria fluitans, R. Br. . . .						×
Festuca ovina, Linn. . . .	×					
F. ovina, Linn. (a viviparous form) . .	×		×			
F. elatior, Linn.						×
Lolium perenne, Linn. . . .	×					
Agropyron repens, Beauv. . . .	×					
Lastræa Oreopteris, Presl. . . .		×	×		×	
Equisetum arvense, Linn. . . .	×	×				
E. sylvaticum, Linn. . . .	×					
Polytrichum urnigerum, Linn. . .					×	
Grimmia fascicularis, C. M. . .					×	
Lycoperdon sp.					×	

Chief sources of the flora.—As shown in this list, out of 143 species on the Shingle Island, 68 were also growing in the adjoining fields, 76 in the riparian strip, and 33 on Eilean a Phortaire; 9 belong to mountainous situations, and were doubtless brought down from the hills by tributary streams; and 9 are escapes from gardens a little way upstream.[1] Of the 11 untraced species, I believe that 3,—Juncus effusus, J. lamprocarpus, and Phalaris arundinacea,—though not recorded from the riparian strip, were probably growing there in the bed of the winter stream;[2] so there are really only 8 which have not been referred to any definite source.

Disregarding for the moment those plants which occur in more than one of these sources, we find that the fields by themselves supply 31 species, the riparian strip supplies 28, and Eilean a Phortaire 7. From these figures it would appear that the fields and the riparian strip are the main sources of the flora, and are of equal importance; but we had not time to examine Eilean a Phortaire nearly so completely as the other two localities; and we imagine that a thorough search would show this island to be almost as important a source as the others. In any case, the list shows that an overwhelming proportion of the plants come from the immediate neighbourhood, as only 7 or 9 out of the 143 species appear to have travelled any great distance.[3]

Comparison of the floras of the fields, the riparian strip, and the Shingle Island.—On comparing the floras of the fields, the riparian strip, and our Shingle Island, it was noticeable that each had certain plants peculiar to itself, besides others growing there in abundance, while almost lacking in the other two places.[4]

[1] *Œnothera biennis* we did not actually trace to a garden, as we did the other 8 species; but there can be little doubt that it *was* a garden escape.

[2] We investigated the Juncaceæ last; and the autumn floods unfortunately prevented our completing them, or making any record of the purely aquatic plants in the bed of the winter stream.

[3] That is, the mountain plants. Two of these, Galium boreale and Plantago maritima, are not so exclusively mountainous; and the latter was growing plentifully in the neighbourhood of Dalmally, even along the roadsides.

[4] In the succeeding pages we have not taken into consideration the Gramineæ, because we were not familiar enough with them to form a fair estimate of the abundance of many of the species.

Plants peculiar to the fields.—The fields had Orchis mascula, Habenaria conopsea, and H. bifolia almost to themselves; there being only one or two odd plants of these in the riparian strip, and not one on the island. There were also quantities of Viola tricolor, Lychnis Flos-cuculi, Trifolium dubium, Crepis virens, and Euphrasia officinalis, quite close to the island; a little farther off was a potato-patch, and a field of oats containing quantities of Chrysanthemum segetum; and in the potatoes or the oats occurred a good deal of Spergula arvensis, Galeopsis versicolor, and Polygonum Persicaria. All these plants were very scantily represented both in the riparian strip and the island.

Plants peculiar to the riparian strip.—The riparian strip was the sole possessor of Teucrium Scorodonia, Calluna Erica, and Athyrium Filix-fœmina; and had also 8 other species all to itself, though only a few plants of each, namely, Caltha palustris, Alchemilla arvensis, Sedum anglicum, Epilobium montanum,[1] Myosotis cæspitosa, Digitalis purpurea, Urtica urens,[1] and Lastræa Filix-mas.[1] It contained plenty of Mercurialis perennis, of which the island had only one or two stunted specimens, and the fields none at all; and also, at its foot, plenty of Ranunculus Flammula, which was absent from the fields, and poor on the island.

Plants peculiar to the island.—The island had Alchemilla vulgaris and Oxyria digyna in abundance; the former being scanty in the fields and riparian strip, and the latter entirely lacking. In addition the island had the following 21 species entirely to itself: Silene acaulis, Stellaria graminea (?), Saxifraga aizoides, Ribes rubrum, *Œnothera biennis*, Aster hybrid, Tanacetum vulgare, Cnicus heterophyllus, Mentha sylvestris, Polygonum Convolvulus, P. cuspidatum, Urtica dioica, Tritonia crocosmiflora, Juncus effusus, J. lamprocarpus, Phalaris arundinacea, Phleum pratense, Agrostis palustris, Molinia varia, Glyceria fluitans, and Festuca elatior (many of these, however, were only odd specimens); besides Cnicus arvensis, which was represented on the mainland by only a few specimens a good way off.

Why certain plants, thriving in the fields and riparian strip, are absent or poor on the island.—In trying to account for

[1] These were on the breakwater.

these differences of flora, it will serve our purpose best to omit strays and restrict ourselves to those plants that are growing really well. First, then, why are the following 20 plants flourishing in the fields or the riparian strip, and missing or very poor on our island?—Ranunculus Flammula, Viola tricolor, Lychnis Flos-cuculi, Spergula arvensis, Trifolium dubium, Chrysanthemum segetum, Crepis virens, Calluna Erica, Solanum tuberosum, Euphrasia officinalis, Galeopsis versicolor, Teucrium Scorodonia, Polygonum Persicaria, Mercurialis perennis, Orchis mascula, Habenaria conopsea, H. bifolia, Avena sativa, Athyrium Filix-fœmina, and Lastræa Filix-mas.

Of these 20 species, Solanum tuberosum and Avena sativa are cultivated plants; and Viola tricolor, Spergula arvensis, Crepis virens, Chrysanthemum segetum, and Galeopsis versicolor may fairly be considered weeds of cultivation; Lychnis Flos-cuculi, Trifolium dubium, Calluna Erica, Euphrasia officinalis, Mercurialis perennis, Orchis mascula, Habenaria conopsea, H. bifolia, Athyrium Filix-fœmina, and Lastræa Filix-mas grow either in pasture, meadow, heath, or wood. All these 17 species, then, are accustomed to very different soil from that provided by the coarse shingle or pure sand of our island, which would clearly be an unsuitable habitat for them at present.

There is probably too little moisture for Ranunculus Flammula, Lychnis Flos-cuculi, Orchis mascula, Habenaria conopsea, H. bifolia, Athyrium Filix-fœmina, and Lastræa Filix-mas; and too little shade for the two last named, and for Mercurialis perennis.

Six of our 20 species — Spergula arvensis, Chrysanthemum segetum, Solanum tuberosum, Galeopsis versicolor, Polygonum Persicaria, and Avena sativa—were rather far removed from the island; and it may be that, in the absence of special facilities for dispersal, they were really too far off to reach it.[1] In their case, then, difficulty in reaching the island *may* be the true explanation of their absence from

[1] We are told, however, that "corn" was grown close to the island three years ago; and that fact would probably have enabled Spergula arvensis, Chrysanthemum segetum, Galeopsis versicolor, and Avena sativa to establish themselves on the island had it been a suitable habitat.

it; but in the case of the other 14 species there is apparently no such difficulty.

We have not accounted for the absence of Teucrium Scorodonia.

Summing up, then, the various circumstances responsible for the absence of these 20 species from the island, we find that unsuitability of soil seems to be a factor in 17 cases; lack of moisture or shade in 8; and perhaps difficulty of access in 6 cases.

Why certain plants thriving on the island are absent or poor in the fields and the riparian strip.—We come now to the 11 species more or less peculiar to the island—namely, Silene acaulis, Alchemilla vulgaris, Saxifraga aizoides, Aster hybrid, Tanacetum vulgare, Cnicus heterophyllus, C. arvensis, Mentha sylvestris, Polygonum cuspidatum, Oxyria digyna, and Tritonia crocosmiflora. Why are these flourishing on the island and absent or poor in the fields and riparian strip?

Five of them—the Aster hybrid, Tanacetum vulgare, Mentha sylvestris, Polygonum cuspidatum, and Tritonia crocosmiflora—are escapes from gardens bordering on the river;[1] and four—Silene acaulis, Saxifraga aizoides, Cnicus heterophyllus, and Oxyria digyna—are mountain plants, the last three of which habitually grow by streams. It is pretty clear that all these 9 species owe their presence on the island to the fact of having been brought down by the river and its tributaries. The island, owing to its position, would have a much better chance than the river-bank of intercepting water-borne plants.

Three of the 11 species — Silene acaulis, Saxifraga aizoides, and Oxyria digyna—would not find the fields or the riparian strip a suitable habitat; but there seems no reason why the remaining 8 species should not grow there if they got the chance. Cnicus arvensis would certainly do so, had it not been carefully eradicated. We are told that Tritonia crocosmiflora has in fact established itself on the river-bank some distance lower down. Why Alchemilla vulgaris is not growing better in the fields and the riparian strip, it is not easy to say; but this species habitually grows

[1] Four from gardens on the bank of the Orchy itself; and one, Tritonia crocosmiflora, from a garden on the bank of the Donachain burn.

by streams, and may therefore find the island more congenial than the fields.

In the case, then, of the 11 plants flourishing on the island and absent from the fields and riparian strip, we may conclude that difficulty of access has been the chief factor in determining that absence, inasmuch as it accounts for 9 species; while unsuitability of habitat accounts, at most, for only 4; and deliberate eradication for only 1.

The 53 plants growing well on the island.—It will be interesting now to turn our attention to all those plants which are growing *well* on the island, and to consider to what causes their prosperity is due. The question resolves itself into two parts: (1) the number of individual plants of any species, which is determined more or less by the plant's chances of reaching the island; and (2) the vigour of the plants, which is dependent on soil, light, moisture, &c., and on certain qualifications inherent in the plant itself. In the following list we have made general suggestions (1) as to what facilities the various plants have for reaching the island (columns 1, 2, 3, 4); and (2) suggestions as to the possible causes of their vigorous condition when there (columns 5, 6, 7, 8).

	Qualifications for reaching island.				Qualifications for thriving when there.			
	Readily carried by wind.	Readily carried by water.	Growing in profusion in fields.	Growing very close to island.	Liking sandy, stony, or waste places.	Liking damp or riparian places.	Being an adaptable species.	Having a creeping root.
Ranunculus acris . .		×		× ×	s		×	
R. repens . . .		×		× ×	w			×
Sagina procumbens . .	× ?	×		× ×	w			
Stellaria media . . .	× ?			×	w			
Geranium sylvaticum . .	× ?	×		×			×	×
Cytisus scoparius . .	× ?	×		×				
Trifolium pratense . .	× ?	×	× ×	× ×			×	
Lotus corniculatus . .	× ?	×	× ×	× ×	s w		×	×
Vicia Cracca . . .	× ?	×		× ×	w		×	×
Lathyrus pratensis . .								×
Prunus Padus . . .		× ×		×				
Spiræa Ulmaria . . .	× ?	×		×	s	d r	×	

	Qualifications for reaching island.				Qualifications for thriving when there.			
	Readily carried by wind.	Readily carried by water.	Growing in profusion in fields.	Growing very close to island.	Liking sandy, stony, or waste places.	Liking damp or riparian places.	Being an adaptable species.	Having a creeping root.
Potentilla silvestris . .	× ?	×	×	× ×	s		×	
P. Anserina . . .	× ?	×		× ×	s			×
Alchemilla vulgaris . .	× ?	×		×	st	r		
Rosa canina . . .		× ×		×	s		×	
Heracleum Sphondylium .	× ?	×		×			×	
Galium boreale . . .	× ?	× ×		×	st	r		×
G. palustre . . .	× ?	×		× ×		d		×
Valeriana officinalis . .	× ?	×		×		d r		×
Scabiosa Succisa . .	× ?	×	×	×	s		×	
Solidago Virgaurea . .	× ×	×		×	st	r	×	
Aster hybrid . . .	×	× ×						
Achillea Millefolium . .					s w		× ?	×
A. Ptarmica . . .	× ?	×		× ×	st w		×	×
Chrysanthemum Leucanthemum	× ?		× ×		s w			
Tanacetum vulgare . .	×	× ×			st w	r		
Tussilago Farfara . .	×	×		× ×	w	d		×
Senecio Jacobæa . .	× ×	×			s		× ?	
S. aquaticus . . .	×	×		× ×		r		
Cnicus heterophyllus . .	×	× ×				r		×
C. arvensis . . .	× ×				s w			×
Centaurea nigra . . .	×	×	×	×			×	
Hieracium vulgatum . .	× ×	×		×				
H. crocatum . . .	× ×	×		×				
Hypochœris radicata . .	× ×		×		w			
Campanula rotundifolia . .	× ?	×	× ×	× ×			×	
Volvulus sepium [1] . .	× ?	× ×						×
Rhinanthus Crista-galli . .	× ?		× ×					
Mentha sylvestris . .		× ×				r ?		×
Thymus serpyllum . .	× ?	×		× ×	s st		×	
Prunella vulgaris . .	× ?	×		×	w		×	×
Plantago lanceolata . .	× ?	×	× ×	× ×	s w		×	
P. maritima . . .	× ?	×		× ×	s	r		
Polygonum cuspidatum . .		× ×						
Oxyria digyna . . .		× ×			st	r		
Rumex crispus . . .	× ?	×		× ×	w		×	
R. Acetosa . . .	× ?	×		× ×	s		×	
R. Acetosella . . .	× ?	×	× ×		s		×	×
Alnus glutinosa . . .		× ×		×		r		
Salix aurita (?) . . .	×	×		× ×		r		
Equisetum arvense . .		×		× ×	s		× ?	×
Grimmia fascicularis . .		× ×			st			× ?

[1] In the summer of 1905 Volvulus sepium had made a considerable growth, but its flowers were only about half the usual size. By September 1906, however, it had apparently become better acclimatized, and the flowers were almost as fine as the original garden ones.

In column 1, "× ?" indicates that the wind may have played a subordinate, but probably not an important, part, in that particular case. In column 2 we have included those species that were obviously carried down by the stream, and also those that were growing on the river-bank or the wooded island above, and seemed to have some chance of dispersal by the river. Column 3 shows those plants which are growing *profusely* in the neighbourhood. Column 4 indicates our opinion that the plants therein may reach the island through the small dispersals of seed year by year, without special assistance from wind or water,—in fact, by a kind of "marching." By "× ×" in any of these columns we mean that we have reason to think the factor in question a specially important one; and this mark has only been put after careful consideration of the distances involved, and the lie of the land, in each case. Columns 5 and 6 deal with advantages of environment; and 7 and 8 with advantages inherent in the plant itself. Thus column 5 shows in what particular the island soil is suited to the plant, "s" meaning that the plant in question is known to thrive in *sandy* soil; "st," that it thrives in *stony* places; and "w," that it thrives in waste places.[1] Column 6 shows the plants that like moisture; "d" meaning that they usually grow in a *damp* situation, and "r" that they grow in a *riparian* situation. (The island would seem rather a dry place, but its closeness to water, and the frequent floods, presumably supply enough moisture to answer to the requirements of these plants.) Column 7 explains itself.[2] We shall discuss, later on, the advantage of the "creeping root" indicated in column 8.

Taking now the "qualifications for reaching the island," and analysing the figures, our results may be shown briefly in the table on next page.

[1] For lists of plants growing in sandy places we are indebted to the 'Botanical Survey of Scotland,' Part II., by Robert Smith, B.Sc., and Part III., by Wm. G. Smith, B.Sc.

[2] We have decided as to the "adaptability" of a plant by noting the variety of habitats in which it occurs; this information being drawn partly from our own notes and partly from lists in the 'Botanical Survey of Scotland.'

	1. Wind.	2. Water.	3. "Profusion."	4. Proximity.
No. of cases in which a factor [1] . .	13 or 41	46	11	37
No. of cases in which an important factor	6	12	7	20
No. of cases in which the chief factor	6	12	3	16
Total weight of factor [2] . .	25 or 53	70	21	73

The number 13 as regards wind would doubtless be an underestimate, since the 13 are all obvious cases; and there must be many cases in which the wind plays an appreciable though subordinate part. If we suppose the wind to have been a factor in 41 cases—that is, in all except those which were obviously due to water-carrying—we have as "total weight of factor" 53, which is probably nearer the truth.

Making allowance for the difficulty of arriving at anything approaching exactness, we think it is pretty clear that the river, and "close proximity," are the most important factors, and that there is little to choose between them; that the wind comes next in importance; and that the mere profusion of a species in the neighbourhood, *unless* in closest proximity, goes for comparatively little. As regards dispersal by wind, we may note that the plants growing in the fields would not have such a good chance as those growing in the riparian strip. In the fields, any seeds (except those of certain composites, &c., specially adapted for wind dispersal) would, on becoming detached, at once fall and be buried in the thick vegetation; whereas in the stony or sandy patches of the riparian strip, seeds would have a better chance of being blown to a distance.

[1] "A factor" is indicated in our list by ×; "an important factor" by × ×; and "the chief factor" by "× ×" when this mark is found in only 1 out of the 4 possible columns.

[2] It will be seen that we have assigned a value of 1 for every case of a probable factor, 2 for an important factor, and 3 for a chief factor; having counted important factors twice (as "factors" and as "important factors"); and counted "chief factors" thrice (as "factors," "important factors," and "chief factors"). This seemed to us a fair way of arriving at the "total weight" of a factor.

It will be seen that we have left the presence of two species unaccounted for — Lathyrus pratensis and Achillea Millefolium; they were growing in the fields, but not profusely, and were not present in the riparian strip.

Turning now to the second half of our list, we may tabulate the results in a somewhat similar way:—

	Soil.	Moisture.	Adaptability.	Creeping roots.
No. of cases in which an important factor	32	15	23	20
No. of cases in which sole factor	4	3	4	2
	36	18	27	22
	54		49	
No. of cases in which sole co-factors	4		1	
Total weight of co-factors .	58		50	

We find, then, that soil is clearly an important factor in 32 cases, moisture in 15, adaptability of the plant in 23, and the possession of a creeping root in 20. Owing to the obscureness of the factors and my own ignorance of plant physiology and œcology, these results are obviously less trustworthy than our first set; but we give them for what they are worth. The figures given in "total weight of factors"—that is, 58 for special suitability of environment, as against 50 for special qualities of fitness in the plants themselves—seem reasonable enough.

Whether the possession of a creeping root is really as great an advantage as we have here supposed, we do not know. It certainly enables a plant to spread quickly; and supposing a certain set of plants to arrive simultaneously on untenanted ground, those with a creeping root would probably extend more rapidly than the rest, and so get a first hold over a larger area. We are under the impression, from our own observations, that some creeping plants, such as Ranunculus repens, go on extending throughout the winter; and if this is the case, the value of the habit is enhanced. We have not, however, been able to get information on this point.

On such a place as our Shingle Island, the characteristic has additional value; for in times of flood, when slightly rooted plants may be swept away, a creeping root entwined round many pebbles gives its possessor a secure foothold and preserves it in safety.

We have not been able to confirm our results by tracing any correspondence between the number of "qualifications" any given plant possesses for reaching the island, and that plant's actual numbers there. In order to trace such correspondence, it would be necessary to calculate roughly the number of individual plants of each species on the island. We should have to take into account, also, other conditions, such as the length of time the species had been resident on the island, and its prolificness; and a further consideration is this, that *one* way of reaching the island is quite enough to ensure ultimate wide distribution there, provided that the plant finds the island a suitable habitat, and produces plenty of seed. We are similarly unable to trace a correspondence between any given plant's "qualifications" for thriving in the island, and its actual state there. Here, again, we should require further information. For instance, we have set down no "qualification" for thriving against the Aster hybrid; but since it certainly *is* thriving, the omission merely indicates our ignorance of what the qualification is, and not any lack of qualification in the Aster. We trust, therefore, that it is the insufficiency of our data, rather than any actual error in our figures, which is responsible for this lack of correspondence.

The *omissions* in our lists, then, are not intended to carry much weight, as they often (and especially in columns 5 and 6) indicate nothing beyond ignorance of the factor in question. All our *positive* statements in the lists, however, have been made with great care, and verified from books wherever we were able.

In conclusion, we have to express our hearty thanks to the friends who have helped us in various ways,—to Dr Cameron of Dalmally; to Mr H. F. Tagg of the Royal Botanic Garden, Edinburgh; and especially to Mr Peter MacVean, a crofter

of Stronmilchan, who told us a great deal regarding the history of the fields, the river, and the islands; and to my brother, Mr T. A. Sprague, who named our Gramineæ and Juncaceæ and made some valuable suggestions. Our fellow-members will, I feel sure, be pleased to know that this paper really owes its origin to my father, having been undertaken at his suggestion, during the summer of 1905, which we spent at Dalmally. Not only has he taken the greatest interest in it throughout, but he arranged for me to revisit Dalmally last September, for the express purpose of working out the problem more thoroughly.

IX.—*REPORT OF THE MICROSCOPICAL SECTION* (1905-6).

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

(*Read April 25, 1906.*)

It is the chief aim of the microscopical section of a Field Naturalists' Society to study by microscopical methods the common objects which are met with in the fields, in the ponds, in the woods, and on the shore, and thus to extend our knowledge of the things which surround us. It has been the custom of our Microscopical Section to take up some group of plants or animals, selecting a few typical examples to study as fully as our time would allow. In previous winters we have studied in this way the Algæ, the Fungi, the Crustaceans, the Ascidians, and some of the higher cryptogams. We have had a glimpse, also, into that great old curiosity-shop, the Worms. Last winter we have been occupied with the Cœlenterates, the simplest of the many-celled animals. We dissected a sea-anemone; examined microscopically examples of other cœlenterates, and some members mounted slides showing the alternation of generations so conspicuous in this class of animals. During the last two or three months we were occupied mostly with the lowest forms of the animal kingdom, the Protozoa, and have obtained some insight into a number of great problems which these minute organisms present to the thoughtful naturalist. There are no objects more beautiful than the Protozoa, when observed under the microscope in the living state,—and it is the ideal of the field naturalist to study the living organism first and chiefly, and afterwards to dissect it, or to employ methods of microscopical examination to get more knowledge as to how the living machine works. The living protozoan—say a vorticella, a paramœcium, or a stentor—is so transparently beautiful that no technical skill in the preparation of permanent objects does more than produce a well-preserved mummy of it. To-night we have got together a few living Protozoa—not so many as I should have liked. Preserved specimens, to show cell structure, muscular changes, and the like, are better reserved for special evenings.

As I have just indicated, there are many very interesting problems presented to us by the Protozoa. The Protozoa are mostly invisible to the naked eye: some are not. For example, the little organism which occurs in such enormous numbers as to make our seas luminous during the nights of autumn—the noctiluca—is quite visible, being about as big as a small pin-head. Notwithstanding their minuteness, and consisting as they do of a single cell, the Protozoa perform the vital functions of animals built up of many cells. They are *generalised* single cells. The cells of multicellular animals are *specialised* cells: muscle cells contract *par excellence*, kidney cells secrete, and so on; but in a protozoan the single cell does all these things, hence it is said to be *generalised*. Still, generalised though it is, it may have a great deal of intracellular structure,—structure within the cell itself. For example, in getting food an amœba is like a piece of fluid jelly: it seems to send out false feet anywhere, and so gets hold of another and smaller object than itself, such as a diatom, which is surrounded and then digested. But the false feet may be confined to one end of the animal, as in the shelled rhizopods (Difflugia or Arcella). For the higher Protozoa, flagella or cilia in fixed positions take the place of vague false feet in obtaining food.

Then in the higher Protozoa there may be some portion of the protoplasm more sensitive to external stimuli than the rest—*e.g.*, the so-called "eye spots" in Euglena. There are "trichocysts" in Paramœcium—very small, special, cilia-like organs for defence; and "nematocysts" much larger in Vorticella and others. These act like the thread-cells in cœlentera. Another specialisation is the muscular fibrils (myonemes) in, for example, the stalk of the Vorticella. Then the simple cell can secrete, say, chitin or cellulose, or carbonate of lime in most beautiful forms, as in foraminifera; or silica may be deposited in a network of hexagonal meshes, and from these prolongations in most artistic shapes may arise. It may be recollected that the architect of the late great exhibition at Paris frequently visited the Musée d'Histoire Naturelle to study the models of radiolarians, and from these he got ideas for the great entrance.

I have made these remarks to show how many things a single cell can do. One of the most interesting investigations that have been made lately is studies about what may almost be called the mental qualities of the Protozoa, by an American, Jennings, and others. It may be remembered that Haeckel said that every particle of matter-stuff had a particle of mind-stuff associated with it, or something to that effect. It may be crudely expressed, but it represents a great solid fact. Verworn and Laeb, ten years or less ago, propounded the theory of "tropisms," which has had a great many followers, and was an attempt to explain the movements of these organisms—say paramœcia, and many others. Explained briefly, stimulus excites or retards the movement of cilia on which it falls, and so the organism is steered about automatically. According to Jennings, that is not enough to account for the phenomena. Lloyd Morgan ('Introd. to Compar. Psychol.,' p. 257) tells of a dog which he wanted to bring a hooked walking-stick through a narrow gap in a fence. The dog seized the stick anywhere about the middle and tried to carry it through the gap. He could not get it through in that way, and dropped it. Again and again he seized it much in the same way, with the same result. At length he caught hold of it by the hooked end, and got it through easily. This is called by Lloyd Morgan the method of trial and error; and Jennings concludes from his experiments that paramœcia and other free-swimming, single-celled organisms act in the same way. He writes a report of over 200 pages, which is too long to summarise here, but is particularly interesting.

We know that a great German said, "There is no mind without phosphorus." It is becoming more and more the creed of scientific men that mind is an elementary factor in nature, or, to use a happy saying, which can hardly be translated without loss, "Wer keinen Geist hat, glaubt nicht an Geister."

A word as to what we propose for next winter. We think of taking up the Algæ, and several members have promised to co-operate. We cannot, of course, make any definite arrangements till the section meets at the beginning of next session; but those who are going to take a more active part in furnishing the intellectual fare will make preparations during the summer, and a very pleasant and most profitable course of study may be expected.

Owing to indisposition, Mr T. C. Day was unable to give at this meeting his "Lantern Demonstration on Colour Photography in its bearing on Natural History." Mr Symington Grieve kindly filled up a portion of the time thus left vacant with some very interesting remarks on a visit he had recently made to the West Indies. The remainder of the evening was devoted to an exhibition of microscopical and natural history specimens, of which a large number were shown,—most of the latter in the living state.

EXHIBITS IN NATURAL HISTORY.

During the past session the following objects were exhibited at the evening meetings:—

Numerous geological specimens; by Mr T. C. Day. Views of the Zoological Station at Naples, and specimen of the Sea-horse (*Hippocampus guttulatus*), from Naples; by Mr Williamson. Specimens of grain from tombs in ancient Egypt, of the times of the 5th and 19th Dynasties; by Mr W. C. Crawford. Shield-Drake (*Anas tadorna*), Summer Duck (*Æx sponsa*), Mandarin Drake (*Æx galerita*), and Common Fruit Bat or Fox Bat (*Pteropus medius*); by the Honorary Secretary. A Fungus (*Scleroderma vulgare*) from the New Forest, Hants; by Miss Sprague. A rare Fungus (*Phycomyces nitens*) from Jamaica; by Mr James Adams. Vegetable Caterpillar (*Torrubia Robertsii*), Calvary Clover (*Medicago echinus*), a Garryad (*Garrya elliptica*), a Globe Thistle (*Echinops amplexicaulis*), and Pekin Nut (*Cordyline australis*); by Mr A. B. Steele. The saffron finch, Bicheno's or double-banded birds, and a cherry finch from Australia; by Mr Brotherston.

ADDRESS BY THE PRESIDENT,

Mr JAMES RUSSELL,

October 24, 1906.

When I had the honour of addressing you last year on an occasion similar to this, I sketched out a plan which, in my opinion, would enable you to undertake the study, in a somewhat systematic manner, of the various subjects which form the object of our Society. In pursuing that study and in penetrating into the secrets of the animal or vegetable kingdom, the unaided human eye carries us but a little way. It requires the help of an optical instrument of some kind, be it a pocket-lens, a simple microscope, or a combination of lenses called a compound microscope. When we use the term "microscope" in common conversation, it is usually this last instrument, the compound microscope, which is meant. As, then, the microscope forms so important a part of the outfit of a naturalist,—so much so, that no really scientific study can be carried on without its aid,—it has occurred to me that it might not be uninteresting or uninstructive if I brought before you to-night in plain language a short account of the evolution of this instrument from the simple glass globules with worked surfaces mounted between two thin metal plates by which Leeuwenhoek made his magnificent discoveries, to the splendid first-class microscopes manufactured by the modern leading opticians.

As you are all aware, there are two causes which prevent the human eye seeing an object distinctly: these are, distance and smallness. To overcome distance we employ an optical instrument called a telescope, and to overcome the smallness of an object we employ a microscope. A microscope is thus an instrument to enable us to see objects which are almost or altogether invisible to the naked eye. In practice we find that there is a distance from the eye at which objects, according to their size, are most clearly seen. This distance is called the distance of distinct vision; it, of course, varies in the case of different persons, but for optical calculations it is usually assumed as 10 inches or 250 mm. If we look at a page of printed matter in which there are some lines of large type, some of medium size, and some of small type, we find that we can read the lines of large type at a greater distance than those of the smaller type, and that the smaller the type the nearer the eye the lines have to be brought. This shows that the smaller the object, the nearer the eye it has to be brought to enable it to be seen distinctly. There is, however, a limit to this, for when the object is brought too near the eye it again becomes indistinct. If, then, in this case a lens of a particular form, say bi-convex, be interposed between the object and the eye, it will bend some of the rays of light proceeding from the object from their original course, and bring some of them together at such an angle that they will enter the eye and thus enable the object to be seen distinctly.

This power which is possessed by all transparent bodies, whether solid or liquid, of bending from their original course the rays of light passing through them, is termed the power of *refraction*. There is another power, called the power of *dispersion*, which transparent bodies possess of breaking up and spreading out like a fan the primary colours of white light passing through them. It is these properties of refraction and dispersion which lie at the foundation of the principles on which microscopic lenses are formed, and on which they are dependent for their magnifying power. All known

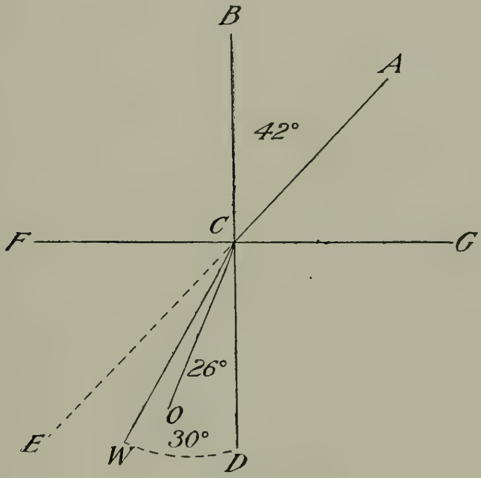


FIG. 1.

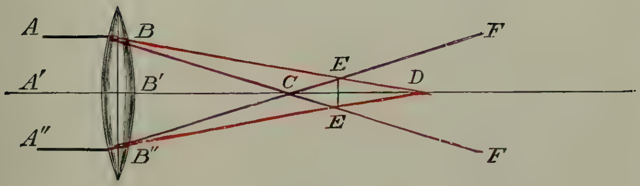


FIG. 2.

transparent substances possess a power of refraction greater than that of air, or, as it is theoretically called, a vacuum. Thus, if the power of refraction of air be taken as unity (1), the power of other media will be greater than unity. The measure of this power is called the *refractive index* of the medium. Thus if air be taken as 1, water will be 1·33, oil of cedar-wood 1·52, and crown-glass 1·52. Again, the refractive index of any particular medium will differ according to the ray of light employed. It will be least for the red and greatest for the violet, and the difference between these powers of refraction is termed the *power of dispersion* of the medium.

When a ray of light enters a denser medium from a rarer one, it is bent or refracted *towards* the normal; and conversely, when a ray of light enters a rarer medium from a denser, it is refracted *away from* the normal. The normal is a line drawn perpendicular to the *plane* surface of the medium, but if the surface be spherical then the normal is a radius of the curvature. The ray falling upon the medium is called the *incident* ray, and the angle it makes with the normal is called the angle of incidence; while the ray in the medium is called the *refracted* ray, and the angle which the refracted ray makes with the normal is called the angle of refraction. The angle of incidence and the angle of refraction are measured as between the ray and the normal, and not between the ray and the surface of the medium. The diagram on Plate XXV., Fig. 1, will make the matter clear.

Let F G be the plane surface of a transparent medium upon which a ray of light A C is incident; draw the normal B D perpendicular to F G at the point C. Let the incident ray make with the normal the angle B C A of 42°. Then if the medium be water, the ray A C, instead of proceeding in a straight line to E, will be refracted to W, making with the normal the angle W C D of 30°; while if the medium be oil of cedar-wood or crown-glass, the ray A C will be refracted to O, making with the normal the angle O C D of only 26°. It is thus evident that all the light which is contained in the angle of 42° in air is compressed when it enters water into an angle of 30°, and when it enters oil into an angle of 26°. The practical importance of this, in the case of the microscope, will be shown farther on. Meanwhile we may point out shortly how the refractive index of the medium is to be ascertained. The measure of the angle of incidence and of the angle of refraction can be found by experiment. You find then from a table of natural sines the sines of these respective angles, and dividing the sine of the angle of incidence by the sine of the angle of refraction, you obtain the refractive index of the medium. Thus in the foregoing example the angle of incidence is 42°, the sine of which by the table is 6691, and the angle of refraction in water is 30°, the sine of which is 5000: thus $\frac{6691}{5000} = 1{\cdot}33$, the refractive index of water. Again, in the case of oil the angle of refraction is 26°, the sine of which by the table is 4384: thus $\frac{6691}{4384} = 1{\cdot}52$, the refractive index of oil and of crown-glass. The smaller the angle of incidence in air, the smaller the angle of refraction in the medium, until the ray of light coincides with the normal, in which case it passes through the medium without any refraction.

If the bounding sides of the medium through which the ray passes are parallel, then the refracted ray after emergence proceeds in a direction parallel to the incident ray: it is otherwise if the sides of the medium are curved,—and in the case of lenses, one or both sides are always curved. In lenses, then, the direction of the emergent ray depends upon the nature of the curve. If one or both sides are convex, the parallel rays of light, after passing through the lens, are brought to a focus or point at a shorter or greater distance from the lens, according to the intensity of the curve; while if the lens is concave, the emergent rays of light tend to separate more and more. It is upon these principles that the construction of microscopic lenses proceeds.

Before proceeding farther I would like to draw your attention to an important point in optics. When rays of light pass from a denser medium into a rarer medium, as crown-glass into air, all the rays which entered the glass do not pass out into the air,—a number of them are reflected back into the medium. The angle at which this reflection takes place is called the *critical angle*. The sine of this critical angle is the reciprocal of the refractive index. Thus the refractive index of glass is 1·52 and of air is 1. Thus $1 \div 1{\cdot}52 = 658$, and from the table of natural sines this shows the critical angle for glass to be 41°, or, to be very exact, 41° 48′.

We have seen that, when parallel light passes through a convex lens, its emergent rays are brought to a point at a nearer or greater distance from the lens, according to the intensity of the curve of the side or sides of the lens. This point is called the focus of the lens, and it is the distance of this point from the lens which determines its magnifying power. For the calculations of the optician the distance of distinct vision has been taken in this country as 10 inches. If, then, the focus is one inch distant from the lens, its magnifying power is said to be 10 times; if half an inch distant, 20 times; and if a quarter inch distant, 40 times, and so on, the 10 inches of distinct vision being divided by the focal length of the lens.

When the practical optician came to construct convex lenses, he found himself confronted by two serious difficulties in obtaining a clear and distinct image of the object seen through the lens. The first of these was inherent in the form of the lens, and received the name of *spherical aberration;* and the other was in the composition of light, and received the name of *chromatic aberration.*

Spherical Aberration.—We have said that the emergent rays of light, after passing through a convex lens, were united in a point called the focus. This is not literally the case, for, owing to the form of the lens, the rays which pass through near the periphery of the lens are brought to a focus nearer the lens than those which pass through nearer the centre of the lens. The effect of this was to give a blurred view of the object. To remedy this defect in some measure, the peripheral rays were stopped out, and only those passing through near the centre of the lens were utilised. This is still what is done in the case of many pocket-lenses, such as that known as the "Coddington." This form was, however, of no use for the purposes of the higher optical instruments. Formerly for the construction of lenses the opticians had at their command only two materials — crown-glass and flint-glass. As both the refractive power and the dispersive power of these two kinds of glass are different, the opticians, by a judicious combination of different forms of lenses made from these glasses, succeeded in neutralising to some extent the spherical aberration.

Chromatic Aberration.—This arises from the composition of the light. White light, as we understand it, is made up of what are called the seven primary colours — red, orange, yellow, green, blue, indigo, and violet. Of these, red is the least refrangible and violet the most refrangible, the others being intermediate in the order stated. When this light is passed through a convex lens, the violet rays come to a point nearest, and the red to a point farthest from, the lens. The diagram on Plate XXV., Fig. 2, will make this clear.

The white light A A″ falling upon the peripheral portions of the lens B B″ is broken up, so that the violet rays come to a focus at C, and then pass on to F F, while the red rays only come to a focus at the point D, much farther from the lens; the other rays coming to foci at points intermediate between C and D. This difference of foci between the various coloured rays is termed chromatic aberration, which causes the object when viewed through the lens to be blurred by different colours of the spectrum. The great endeavour of the practical optician was to get rid of this colouring, and thus show the object in clear outline. This was accomplished to a very great extent by a combination of lenses, some convex and others concave, and some made of crown-glass and others of flint-glass. By this means the opticians were able to combine two rays of the spectrum coming to foci between the violet and the red. In the construction of a microscopic object-glass, as many as six lenses were used, usually combined in pairs. One maker employed seven; this was by making the front a triple combination, which consisted of two plano-convex lenses of crown-glass with a plano-concave of flint-glass between them. The microscopic object-glasses of this order are called *achromatic*—that is, without colour. Names which stand out in bold relief in those early days of achromatic object-glasses are Lister, Ross, Powell, and Smith & Beck. The dates were between 1830 and 1840, and it is not too much to say that the work of these opticians with the material at their command has never been surpassed.

To preserve microscopic preparations permanently, they are covered with a piece of very thin glass, which is called the

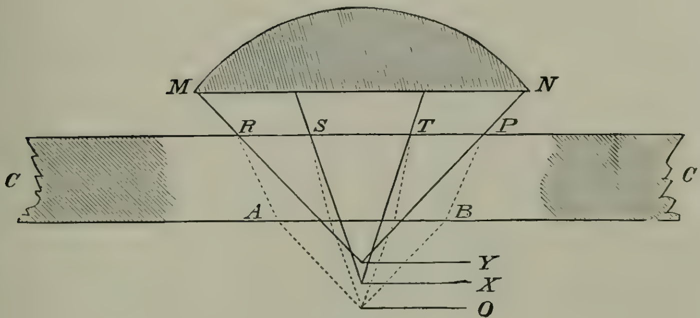


FIG. 1.

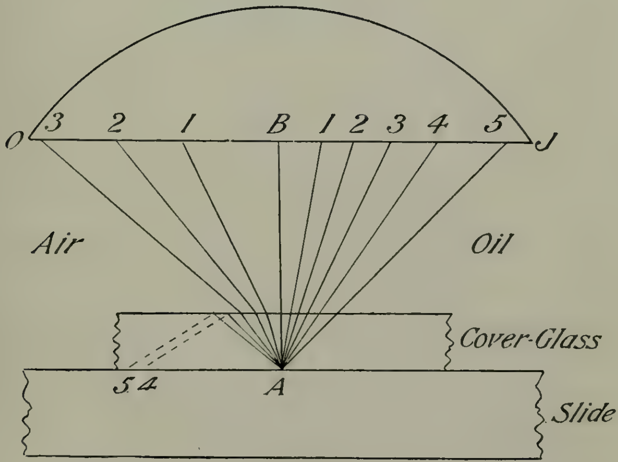


FIG. 2.

cover-glass. The correction of the spherical and chromatic aberration of microscopic object-glasses had now reached such a stage that it was found in the case of object-glasses of high power—say from 1-4th or 1-5th of an inch upwards—that the cover-glass created an indistinctness in the image of the object. The diagram on Plate XXVI., Fig. 1, will explain the cause of this.

Let M N be the front lens of an object-glass and O the object to be viewed. If there were no cover-glass, the rays of light would proceed in a direct course from the object to the object-glass. By the interposition of the cover-glass, C C, a refraction of the rays takes place. Thus the marginal rays enter the cover-glass at A and B, are refracted by it to R and P, and on emerging take a course parallel to their former course and enter the object-glass at M and N. But, according to optical principles, these rays appear to proceed from the point Y. On the same principle more central rays, as S T, appear to proceed from the point X, and so on till the central ray, which, as it does, appears to proceed from the point O. This, of course, produced indistinctness in the image of the object viewed.

Collar Adjustment.—Opticians now set about to devise a remedy for this indistinctness. One course suggested was to make all the cover-glasses of a uniform thickness and to correct the object-glasses for that thickness. This was, however, recognised to be unworkable. Mr Andrew Ross hit upon the correct means, and published them in the 'Transactions of the Society of Arts' for 1837. Put shortly, it was to vary the distance between the front and back lenses of the object-glass. This is effected by means of a collar. As has been said, object-glasses usually have three pairs of lenses: the front pair cannot be moved, the second pair is in a setting inside of the outer tube, and the third pair in an innermost setting. The settings of the second and third pairs are so joined that the turning of the collar moves them together, and makes them approach to or recede from the front pair. In the English form, especially of older date, the word "uncovered" is engraved on the tube; and in viewing an uncovered object the collar has to be set accordingly. When the object is covered the collar has to be turned so as to make the back lenses approach nearer the front lenses, according to the thickness of the cover-glass. The collar is marked with a numbered scale, but the correct position has to be found by experiment. In the Continental form the collar is marked with certain numbers corresponding to the usual thicknesses of cover-glasses, so that if the thickness of the cover-glass is known, you have only to set the collar to that number. Thus, if the cover-glass is 0·20 mm. thick, the collar should be set to the division marked 0·20. But as in the majority of cases the thickness of the cover-glass is not known, the correct position will also have to be found by experiment.

Immersion Lenses.—Hitherto we have been considering only what are called *dry* object-glasses—that is, object-glasses in which there is a film of air between the front lens of the same and the thin glass covering the object. It was, however, early perceived that a drop of water interposed between the front lens and the cover-glass improved the performance of the object-glass, but, at the same time, it altered the refraction of the rays of light, so that the lenses had to be corrected in accordance with the new conditions. When this was done a class of object-glasses was constructed termed water-immersion, which gave very good results. More light was admitted into the object-glass, and hence a brighter field of view was obtained in comparison with the dry objective of the same angle of aperture. The reason of this will appear from the remarks which were made under Fig. 1, Plate XXV., and from those about the *critical* angle of reflection. Under Fig. 1 it was seen that rays of light which passed into water were much more compressed than when they passed into air; again, that the critical angle of light passing from glass to air was 41°, but from glass to water it was 48°. Here there was a great increase of light which could pass into the object-glass. In using such glasses the front lens is brought into continuity with the cover-glass by means of a drop of distilled water.

A further and more important step was soon made in the construction of immersion object-glasses. The thought occurred to Mr John Ware Stephenson, London, of using instead of water some denser medium—a medium the refractive index of which would be as near as possible that of glass. He communicated his thoughts to the late Professor Abbe of Jena, who, in conjunction with the firm of Zeiss of that city, took up the matter. After many experiments the oil of cedar-wood was found to possess all the requisite properties, and then was constructed the excellent series of oil-immersion object-glasses —called also, from the refractive index being the same throughout, homogeneous immersions. With these object-glasses two important advantages were gained: there was no loss of light at the cover-glass by total reflection—all the rays which emerged from the object which the aperture of the object-glass was capable of taking up were taken up; and again, a collar adjustment for different thicknesses of the cover-glass was rendered unnecessary. The diagram on Plate XXVI., Fig. 2, will help to explain the gain obtained by the oil-immersion over the dry object-glass.

Let A be an object mounted in balsam with a cover-glass, and O J the front lens of an object-glass of which the right-hand side may be taken to represent an oil-immersion and the left a dry one. Let A B be the central rays,—thus it will be seen that the side rays 1, 2, 3, 4, and 5 are all admitted by the oil-immersions, while only rays 1, 2, and 3 are taken up by the dry objective, the rays 4 and 5 being lost by total reflection. In using these immersion-lenses one thing must be kept in mind,—the object must be either mounted in balsam or in some medium of equal refractive index; or if mounted dry, it must be *in close contact with the cover-glass*, otherwise there would be a film of air between the object and the cover-glass, in which case the latter would act simply as a front lens, and thus convert the whole into a dry system. Another point to be observed is immediately after use to wipe the oil clean off both the object-glass and the cover-glass. This should never be omitted.

Apochromatic Lenses. — The manufacture of achromatic object-glasses had now reached the highest stage of perfection possible with the materials—crown- and flint-glass—which were at the command of opticians. But there was still a desire for something better. With the crown- and flint-glass two rays of the spectrum, as we have seen, could be united, leaving a secondary spectrum of the other rays uncorrected; and for the correction of spherical aberration, one ray only between the violet and the red could be taken.

Before any further advance could be made a new kind of glass had to be found. This had long been the desideratum —a new vitreous compound which would allow of all the rays of the spectrum being brought to a point. In 1878 Professor Abbe of Jena made a report on the microscopes of the South Kensington Exhibition. This report came under the notice of a Dr Schott of Witten, in Westphalia, a chemist, but who had a practical knowledge of glass-making. He put himself into communication with Professor Abbe, and the two in conjunction entered into a series of experiments in the manufacture of different kinds of glass for optical purposes. At first they worked apart, Dr Schott taking charge of the chemical side and Professor Abbe that of the optical. Latterly Dr Schott removed to Jena, where the experiments were carried out on a larger scale. Then the Messrs Zeiss, the firm of opticians, joined them, and a subsidy of £3000 having been obtained from the Prussian Government, a large glass factory was erected. Enormous difficulties were encountered, as the optical properties of each new vitreous compound had to be tested. The experiments extended over about five years, and during that period something like 1000 prisms of different kinds of glass had been ground and tested for their refractive and dispersive properties. At last a glass was produced which allowed three rays of the spectrum to be united for chromatism and two for sphericity. This practically gave a colourless image of the object.

At the meeting of the Royal Microscopical Society in March 1886, two object-glasses in which the new glass—now called Jena glass—was used were exhibited. These were the first produced. Each of the object-glasses had ten lenses combined in five pairs, and their performance was pronounced by the most competent judges to be of the highest order. The name given to these object-glasses is *apochromatic*. At first the new glass was found to be liable to deteriorate on exposure to the atmosphere,—a piece so deteriorated was shown to me in the workshop of Messrs J. Swift & Son, when I was in London last June,—but, owing to a slight alteration in the composition or manufacture, it is now said to be quite stable in temperate climates. Owing to the extremely careful and delicate workmanship which these object-glasses require, they are necessarily very expensive, but a kind called *semi-apochromatic*, and which are also very good, can be bought at a very reasonable price.

We have now reached the end at present of the evolution of microscope object-glasses, but it may be well to explain a few technical terms applied to them.

Numerical Aperture.—This denotes the ability of an object-glass to collect and utilise a greater or less number of rays of light, and is expressed in figures followed by the letters N. A. Before the invention of immersion-lenses the expression used was *angular aperture*, and was expressed by an angle of so many degrees. But when immersion-lenses came into use, it was found that the expression angle of aperture did no longer denote the same quantity in the three different kinds of lenses —dry, water-immersion, and oil-immersion. Under Fig. 1, Plate XXV., we saw that an angle of 52° $(26^\circ + 26^\circ)$ in oil and of 60° $(30^\circ + 30^\circ)$ in water were both equal to an angle of 84° $(42^\circ + 42^\circ)$ in air. That is, the whole of the rays of light collected by an angle of 84° in air could be taken up by an angle of 60° in water and of 52° in oil. What was wanted was an expression which would denote the same equivalent in all the three media. Professor Abbe, to whom microscopy owes so much, solved the problem, and adopted the expression *numerical aperture.* Numerical aperture, then, is the sine of *half* the angle of aperture multiplied by the refractive index of the medium—that is, in air by 1, in water by 1·33, and in oil by 1·52; and by limiting the result to two figures, it will be found that ·67 is the numerical aperture for each of the three different angles. From what has been said, it is evident that immersion-lenses can be made of a much greater numerical aperture than dry lenses, and are thus capable of collecting and utilising a much greater number of rays of light. Thus, while the *theoretical* maximum angle of aperture for each of the three different kinds of lenses is 180°, the numerical apertures are very different, being for air 1, for water 1·33, and for oil 1·52. The greater the numerical aperture of an object-glass, so much the greater, other things being equal, is its *resolving power.*

There are three qualities desired in object-glasses—defining power, resolving power, and penetrating power. The first and second and first and third should always be united, but the second and third are opposed to each other, and cannot be united in the same object-glass, so that the kind of object-glass needed depends upon the object sought.

Defining Power.—This is the power of an object-glass to show clearly and distinctly the *contours* of an object. There should be no indistinctness about the edges—the image should stand out clear and crisp. This power of good definition depends upon the good correction of the lenses for spherical and chromatic aberration.

Resolving Power.—This is the power of the object-glass to separate, and thus make visible, the fine structure of the object. For instance, if there are fine lines or dots in the object, resolving power enables these to be seen. This is a power different altogether from that of magnification: an object-glass may magnify 500 times and yet not show fine details so well as one magnifying only 250 times. Magnification depends upon the length of focus of the object-glass; resolving power upon its numerical aperture and the number of rays of light from the object it is capable of admitting. This raises the question of the theory of *diffraction spectra*, which want of space forbids us entering upon. Those who wish to study the subject should consult Professor Abbe's papers in the 'Journal of the Royal Microscopical Society.'

Penetrating Power.—This is the power which an object-glass possesses of catching up and making visible more than one plane or stratum of an object, and is in inverse ratio to the resolving power, and is thus, other things being equal, best in object-glasses of moderate numerical aperture. As has been said, the object sought determines the kind of object-glass required.

As frequent reference has been made to the image formed by lenses, it may be well to look at the optical principles on which images are formed. Optical images are of two kinds—*real* and *virtual*. Real images are such as can be received upon a screen—such, for instance, as the image cast upon a screen by the projection lantern. Virtual images, on the con-

PLATE XXVII.—PRESIDENTIAL ADDRESS.

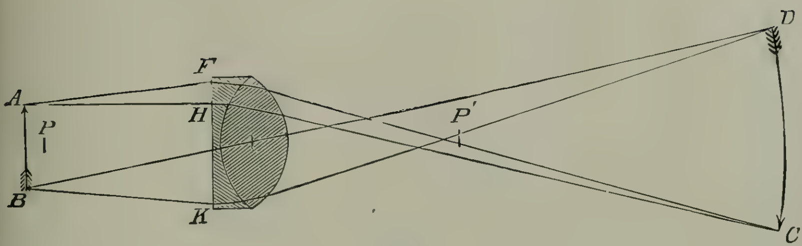


FIG. 1.

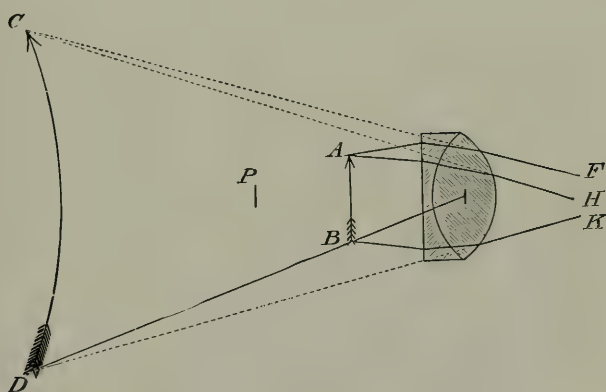


FIG. 2.

trary, cannot be received on a screen,—they can only be received on the retina of the eye. The diagram on Plate XXVII., Fig. 1, will enable this to be understood.

Let P be the focal point of a lens F K, and A B an object placed at a distance farther from the lens than the focal point: rays of light will emanate from every part of A B towards the lens, and, emerging from it after refraction, will pass on. Let us follow four of these rays. The rays A F and A H will, by the laws of refraction, meet at C, where it will form an image of the point A. In like manner the ray B K will proceed to D, and as we have seen that the rays which pass through the optical centre of a lens suffer no refraction—the other ray proceeding from the point B and passing through the centre of the lens will go straight to the point D, where it will unite with the ray B K and form at D an image of the point B. In like manner the rays proceeding from the other parts of A B will meet at various points between D and C, and thus a complete enlarged image of A B will be formed at C D. It is to be observed that the image is *inverted*, and is also concave towards the lens: if the object had been concave towards the lens, then the image would have been straight. It is, however, a real image, and could be received on a screen or *viewed by another lens.*

Let us see now, from Fig. 2 on Plate XXVII., how a virtual image is formed. In this diagram let A B be an object placed nearer to the lens than its focal point P. Rays of light will likewise emanate from it towards the lens, but after emerging, instead of being convergent they will be divergent, and consequently the rays proceeding from the same point of the object will never meet. If, however, an eye be applied to them at such a distance from the lens that it can receive the whole of the emergent rays, an image of the object will be formed upon the retina, and an enlarged virtual image will thus be seen at C D in the direction of the dotted lines. It will be observed that the virtual image, although curved, but in the opposite sense to the real image, is yet not inverted.

Having now got some notion of the various properties of lenses, and of the formation by them of images real and virtual, we are in a position to consider their combination in the form of a microscope. Microscopes are of two kinds, simple and compound. The fundamental difference between them is, that in the simple microscope the rays of light are received by the eye direct from the object itself, of which a virtual image is formed, as shown in Fig. 2, Plate XXVII.; while in the compound microscope the rays are received by the eye, not from the object, but from a real image of it.

The Simple Microscope.—The principal use of the simple microscope is for the purposes of dissection. The virtual image of the object which it forms is not inverted, so that dissecting can be easily carried on under it. At first the lens was but a single double-convex one; afterwards Dr Wollaston added another lens, when the combination was called a *doublet.* Mr Holland suggested a third lens, and thus the name *triplet* was applied. One of the best forms of these lenses is that known as the *Steinheil lens.* It is achromatic, and gives a large flat field of view. A holder of some kind is necessary for the lens, so that both hands may be free. There are various forms of dissecting microscope on the market of more or less completeness, but with a little ingenuity a very serviceable one could be made at very small expense, using an ordinary pocket-magnifier as a lens.

The Compound Microscope.—The compound microscope in its simplest form is a combination of Figs. 1 and 2, Plate XXVII.,—that is, one set of lenses, called the object-glass, of short focus, forms a *real* image of the object at some distance behind them, and this real image is caught up by another lens, called the eye-glass, which forms a *virtual* image of the same, and it is this virtual image which is seen by the eye on looking into the microscope. We have seen how the object-glass is constructed, and need not go back upon it. Its function is to form an enlarged real image of the object, and its position is thus near to the object. The eye-glass is that to which we apply the eye. There are several different kinds, but the form most commonly in use is called a Huyghenian, from Huyghens, a Dutch astronomer, who devised it. This form consists of two plano-convex lenses, fitted one at each end of a short brass tube, with a diaphragm between them to cut off extraneous rays. The lens to which the eye is applied is called the eye-glass, and the other lens is called the field-glass, and the combination is called an *eyepiece.* The function of the field-glass is to gather together the rays proceeding from the object-glass and bring them to a focus at the diaphragm, where the real image of the object is formed; and the function of the eye-glass is to form an enlarged virtual image of this real image. It will thus be seen that there are two enlargements of the object viewed—one by the object-glass and the other by the eyepiece; and it is these two multiplied together which gives the final enlargement. There has been a special form of eyepiece constructed, called a compensating eyepiece, for use with apochromatic object-glasses. Its purpose is to correct certain residual errors which could not be corrected in the object-glass.

The object-glass and eyepiece, together with a mirror used for reflecting the light upon the object, are called the *optical* part of a microscope. They are bound together by the *mechanical* part, which consists of several pieces, called collectively the *stand.* The essential part of the stand is the tube into the lower end of which the object-glass screws, while the eyepiece slides into the upper end. There are two conventional lengths of tube—the English form of 250 mm., and the Continental form of 160 mm. This is called the mechanical tube-length. There is another length of tube called the optical tube-length—that is, the distance at which the object-glass forms the real image of the object. Of course, whatever length of tube is used, the object-glass has to be corrected accordingly. Each length has its advantages. A convenient form is to have two or more tubes sliding inside one another, so that the mechanical tube-length can be lengthened or shortened to suit the object-glass in use.

The tube is supported upon a foot, and the little table attached to the foot for the support of the object under examination is called the stage, in which there is an opening for the admission of light reflected from the mirror placed beneath. The tube must be provided with some means of vertical motion, so that it can be approached nearer to or withdrawn from the object, according as the object-glass is of shorter or longer focus. In the better class of instruments there are two means of mechanical motion—one giving a quick movement and the other a slow movement. There is perhaps no part of a microscope-stand upon which so much ingenuity has been expended as upon the best means of effecting a satisfactory slow movement. It is a subject upon which, however, we cannot now enter.

At first I thought of adding some practical hints upon working with the microscope, and of the illumination of objects under examination, but I find that the foregoing has extended to such an inordinate length that any remarks I may have to make on these subjects must be reserved for some future occasion.

ANNUAL BUSINESS MEETING.

The annual business meeting of the Society was held in the Hall, 20 George Street, on the evening of Wednesday, October 24, 1906—Mr James Russell, President, in the chair.

The Honorary Secretary submitted his report, as follows:—

"During the Session 1905-6 six indoor meetings of the Society were held. The average attendance at these meetings was 49,—somewhat disappointing when it is considered that the Society numbers considerably over 200 members. There was some little difficulty in getting communications and exhibits, and it is hoped the members will bestir themselves in this respect on behalf of the Society.

"For the summer twenty-one meetings were arranged, as follows:—

April	28.	Aberdour—Burntisland.
May	2.	Arthur's Seat.
"	12.	Berwick.
"	16.	Port Edgar.
"	22.	Yarrow.
"	26.	Fettes Mount and Scott's Cottage.
"	30.	Ratho and Hallyards.
June	9.	Possil Marsh.
"	13.	Duddingston.

June 16. Comrie.
" 19. Heriot's Hospital and Old City Wall.
" 23. Dalhousie Castle.
" 27. Dalmeny Church.
July 3. Old Edinburgh.
" 7. Melrose (Newstead Roman Camp).
" 11. Inveresk and Musselburgh.
" 14. Wooden Hill.
" 21. Otterstone Loch.
" 25. Corstorphine (Experimental Garden for Ladies).
Oct. 6. Gilmerton (Mushroom Beds).
" 13. Dalkeith Park.

"The weather was all that could be desired for field work, with the exception of May 16, when the excursion to Port Edgar had to be abandoned owing to the inclemency of the weather. The average attendance at these meetings was 22—the same as last year.

"Compared with last year, the membership is reduced by 24—the total number of ordinary members being 231. Of new names 23 were added to the list, while 47 names were withdrawn. Of these latter 46 resigned, while 1—Mr Thos. Kilgour—died. I have also to report the death of one of our Honorary Members—Mr J. G. Goodchild, F.G.S. Both these gentlemen were valuable members, and had been connected with the Society for twenty and twelve years respectively.

"The meetings of the Microscopical Section were held at the house of the Convener, Mr W. C. Crawford. Altogether, there were ten meetings held, and the work was most interesting and instructive. It is hoped that members will this year attend in greater numbers."

The Honorary Treasurer then submitted his report and statement of income and expenditure for the past year, copies of which were already in the hands of the members, and which showed a satisfactory balance in favour of the Society.

The President then delivered an address on "The Development of the Microscope" (see *ante*, p. 319).

The election of office-bearers and councillors was afterwards proceeded with, the nominations of the Council being agreed to. The following is a complete list, the names printed in italics being those of members elected to fill vacancies:

President, James Russell; Vice-Presidents, William Williamson, W. C. Crawford, and *Miss Edith M. H. Gray;* Honorary Secretary, John Thomson; Honorary Treasurer, Geo. Cleland; Editor of 'Transactions,' Dr A. E. Davies; Auditors, R. C. Millar and Charles Campbell; Councillors, Miss Sprague, A. G. Stenhouse, G. M. Brotherston, E. Denson, John Laidlaw, D. S. Fish, Jas. B. Stewart, *Miss E. Elliot, Miss Crawford, Miss Macvicar, Jas. P. Duncan,* and *A. B. Steele.*

The meeting closed with the usual votes of thanks.

PRESENTED
19 FEB. 1907

THE EDINBURGH FIELD NATURALISTS' AND MICROSCOPICAL SOCIETY.

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Richardson, Mrs Ralph, 10 Magdala Place.
Ritchie, William, 75 Morningside Road.
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Robertson, Dr W. G. Aitchison, 26 Minto Street.
Rose, Miss, 3 Hillside Crescent.
Russell, James, 16 Blacket Place—*President.*
Sconce, Colonel, 18 Belgrave Crescent.
180 Scott, Alex., 24 Blackwood Crescent.
Sillars, Duncan, 205 Dalkeith Road.
Sime, David, 27 Dundas Street.
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Smith, Harry W., 23 Nelson Street.
Smith, Rupert, 38 Greenhill Gardens.
Smith, Wm. D., 43 Montgomery Street.
Smith, Wm. R., 4 N.-E. Circus Place.
Smith, W. W., M.A., 3 Warrender Park Terrace.
Speedie, M. H., 2 Alfred Pl., Mayfield Terrace.
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Speedy, William Hogg, Braeside, Liberton.
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Sprague, Dr T. B., 29 Buckingham Terrace.
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Steele, Mrs, 16 London Street.
Stenhouse, A. G., Whitelee, 191 Newhaven Road.
Stevens, Dr John, 2 Shandon Street.
200 Stewart, Miss Annie, 6 West Claremont Street.
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Tait, Miss Frances, 106 Thirlestane Road.
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Wood, T. A. D., Viewforth, Brunstane Road, Joppa.
Wright, Fred., 31A Minto Street.
Wright, Thomas, 12 Brunton Terrace.
230 Young, Miss A. N. 152 Morningside Road.
231 Young, David E., 60-62 High Street.

Edinburgh Field Naturalists' and Microscopical Society.

STATEMENT OF INCOME AND EXPENDITURE FOR YEAR TO 17th OCTOBER 1906.

INCOME.

To Balance from last Account			£23 6 10
" Annual Subscriptions—			
Session 1905-1906		£48 10	
" New Members, 1905-1907		3 15	
			52 5 0
" Arrears of Subscriptions—			
Amount outstanding, 17th Oct. 1905		£7 10	
" irrecoverable	£3 5		
" still outstanding	1 0		
		4 5	
			3 5 0
" recovered			0 5 0
" Donation for Publication Fund			0 10 0
" 'Transactions' sold			1 5 5
" Interest			0 13 1
			£81 10 4

Arrears of Subscriptions outstanding—	
Sessions 1902-1905	£1 0 0
Session 1905-1906	3 5 0
	£4 5 0

EXPENDITURE.

By Rent of Hall for Meetings, &c.		£6 2 6
" W. Blackwood & Sons—		
'Transactions' (Session 1904-1905)	£19 18 4	
Billets for Meetings, &c.	7 3 0	
		27 1 4
" Advertising Expenses		4 6 0
" Hire of Lantern		2 2 0
" Gratuities to Hall-keeper and at Excursions		0 17 0
" Stationery		3 15 6
" Secretary's Railway Fares to Excursions		1 10 8
" " Postages, 'Transactions'	£0 5 4	
" " " Billets	3 10 3	
" " " Ordinary	1 14 7	
		5 10 2
" Treasurer's Postages		0 18 6
" Millport Marine Biological Association		1 1 0
		£53 4 8
" Balance due by Bank of Scotland		28 5 8
		£81 10 4

PRIZE FUND.

To Balance from last Account	£5 0 0	*By* Balance due by Bank of Scotland	£5 0 0

GEO. CLELAND, *Hon. Treasurer.*

17*th October* 1906.—We hereby certify that we have audited the foregoing Statements of Income and Expenditure, and found them correctly stated and satisfactorily vouched, the balance in favour of the Society being Thirty-three pounds, five shillings, and eightpence sterling.

R. C. MILLAR,
CHARLES CAMPBELL, } *Auditors.*

BRITISH MUSEUM
NATURAL HISTORY

VOL. V. PART V.

TRANSACTIONS

OF

The Edinburgh Field Naturalists' and Microscopical Society

BRITISH MUSEUM NATURAL HISTORY

SESSION 1906-1907

CONTENTS.

Published for the Society

BY

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Price to Non-Members, Four Shillings

SESSION 1906-1907.

I.—*NOTES ON SOME OF THE WILD-FLOWERS IN THE VICINITY OF PENICUIK.*

By Mr JAMES M'CALL.

(*Read Nov. 28, 1906.*)

In writing this paper I am not forgetful that many of the members of the Society will probably have pleasant recollections of past excursions they have enjoyed in this district,—spending a long summer afternoon, it may be, on the open stretch of moorland that extends for some miles to the south and south-east of the village of Penicuik, or perhaps making a way for themselves through the dense shady woodlands that at many places completely screen the river Esk from sight. From here to Hawthornden the scenery is most picturesque, while the well-known Roslin valley is accounted by many to be one of the loveliest glens in Mid-Lothian. In these familiar haunts of the botanist and the lover of nature the flora is both varied and abundant, and while some of the members may know nearly all the wild-flowers that grow in the district, yet I have thought that a paper on the subject, from one who has long resided there, might contain something to interest those, at least, who have had little or no opportunity of visiting the place at the various seasons of the year.

I still remember the first glimpse I got of nature's loveliness while quite a boy. A large patch of bog-bean in full blossom on the wet moor near my home attracted my attention and roused all my boyish admiration. Every season since, about the beginning of May, I have watched and rejoiced to see the bog-bean expand its lovely fleecy-fringed blossoms. After becoming thus acquainted with such "a thing of beauty," which has proved indeed "a joy for ever," I soon began to take an interest in the rest of the wildlings that adorn our field-margins and waysides—an interest which has grown and continued to this day. I think it is to be regretted that so many of the dwellers in our country districts give little or no attention to the wild-flowers that constantly meet their gaze.

The different species of Orchis that grow on the moor are conspicuous objects, and their various contrivances for cross-fertilisation make them always an interesting study for the botanist. And here he will be sure to find the green-winged orchis (O. Morio), the early purple (O. mascula) and the spotted palmate orchis (O. maculata), which last seems to be the most abundant. The white sweet-scented butterfly orchis (Habenaria bifolia) is also to be got, and it appears to be much more plentiful in some seasons than in others. In experimenting in my garden with this plant, I find it thrives as well in a stiff clayey soil as when grown amongst peat.

The bog-asphodel (Narthecium ossifragum), with its narrow linear leaves and stellate yellow blossoms, is quite at home in the dank moss-hag, dotting it all over with scintillations of light; while Sedum villosum, with its soft rosy tint, makes the wettest and most unsightly spots of the moor pleasant to look upon. Another marsh-lover, and a general favourite with the botanist, is the Grass of Parnassus (Parnassia palustris), which, at the latter end of July or the beginning of August, is here so plentiful that one, however careful, can scarcely avoid trampling down its lovely blossoms. The common butterwort (Pinguicula vulgaris) is fairly common in the boggy ground; but the round-leaved sundew (Drosera rotundifolia) is less widely distributed, though, when its settlement can be located, it is generally found in great quantity. I have noticed that many other bog-loving plants are rarely to be got in the situation where the sundew chooses to thrive. The only plants in proximity to it that I have observed, exclusive of mosses, are the common ling (Calluna vulgaris), the hair-grass (Aira flexuosa), and the cotton-grass (Eriophorum vaginatum). Some chemical constituent in the soil may account for this, but I have never been able to determine the cause.

Other plants commonly met with in the moor are the milk-wort (Polygala vulgaris), the marsh marigold (Caltha palustris), the devil's-bit scabious (Scabiosa succisa), two species of St John's-wort (Hypericum pulchrum and H. humifusum), the field gentian (Gentiana campestris), the sneezewort (Achillea Ptarmica), and the cuckoo-flower (Lychnis Flos-cuculi). In a deep basin or hollow, retaining stagnant water, a plentiful crop of bur-weed (Sparganium ramosum) is to be seen, though rather difficult to reach.

It may not be out of place here to mention that about a quarter of a mile eastwards from Pomathorn Station are the ruins of what used to be known as the Roads farm-steading, once leased and tenanted by Thomas Denholm, a local herbalist, who in his day had a great reputation for curing certain maladies, both in children and in adults, even when medical men had agreed in pronouncing their cases hopeless. He would doubtless find his abode favourably situated for his many herb-gathering excursions; and one can picture this honest man wending his way through the moor on a summer morning or evening when he required to have his homely medicine-chest replenished. As far as I can learn from those still living who were acquainted with him, he took little or no remuneration for rendering such valuable service,—the sole object, apparently, of his praiseworthy labours being to alleviate human suffering when it lay within his power to do so. A few are still living in this district who well remember being under his treatment, and they one and all testify to his great kindness of heart, and have never forgot the gentle touch of his hand. The story of this humble herbalist has never yet been written, but some day it may receive worthy treatment.

Exploring Pomathorn and Auchendinny moors in a north-easterly direction, we enter on the Firth estate, whose woods and deep ravines, so prolific both in ferns and in flowering-plants, have long been favourite haunts of the botanist. Here the oak fern (Polypodium Dryopteris) and the beech fern (P. Phegopteris) find the shelter and shade which their delicate fronds require; while other species—such as Polystichum, Lastræa, Athyrium, and Blechnum—

adorn many a shady nook. The flowering-plants most common here are the wood hyacinth (Hyacinthus non-scriptus), the common primrose (Primula vulgaris), the wood anemone (Anemone nemorosa), and the wood crane's-bill (Geranium sylvaticum). The ground is much broken up by the action of running water, and wherever the minerals have been exposed the wood-sorrel is to be seen in all its delicate freshness, nestling beneath each ledge of sandstone, with its bright green trefoil leaves that close and go to sleep on the approach of darkness. Down in the sunless gully, and close to the edge of the stream, grows the humble moschatel (Adoxa moschatellina), a plant that is apt to be overlooked unless noted by some one specially on the alert for it. Near the Adoxa, and in a similar situation, grows the very handsome white meadow-saxifrage (Saxifraga granulata), which, when transferred to the garden as a rock-plant, soon develops into one of the best of its family, as its blossoms become much enlarged by cultivation. A strange Orchideous plant without chlorophyll is also pretty common here, namely, the bird's-nest orchis (Neottia Nidus-avis). This is a plant which I have never managed to transfer to my garden, though I have frequently attempted to do so, and with the greatest of care. It is probably parasitical. Another of those low forms of plants that derive nourishment from other plants is the cow-wheat (Melampyrum sylvaticum). It is a rather small, tender-stemmed plant, with pendent yellow blossoms that are almost sure to turn black in the process of drying for the herbarium. To these may be added yet another plant with the same parasitical characteristics—namely, the scaly toothwort (Lathræa squamaria). This plant thrives in a hollow of the wood near Dalmore Paper-mill, and I have found it also on the Penicuik estate: in both places it grows on the roots of hazel. It is said that the seeds of this plant, when sown in a new situation, lie in a resting condition for several years.

A great number and variety of plants are found on the banks of the North Esk as one follows its upward course from the village of Auchendinny to Penicuik. Large clumps of the two rest-harrows (Ononis arvensis and O. spinosa) are quite common; while sweet cicely (Myrrhis odorata), the common comfrey (Symphytum officinale), the knotted figwort (Scrophularia nodosa), and the common agrimony (Agrimonia Eupatoria) are in abundance in the vicinity of Penicuik.

In conclusion, I must confess that I have had few, if any, *rare* plants to enumerate; but if I have failed in this respect, I may at least have evoked memories of pleasant bygone rambles, with expectations of others yet to come, on the sunny moors and in the shady dells that surround "The Hill of the Cuckoo."

At this meeting Dr Watson made a very interesting communication on "A Mushroom Excursion: what common Fungi are found, and how they are identified."

II.—*A FEW REMARKS ON MUSHROOM PHENOMENA.*

By Mr JOHN PATON.

(*Read Dec. 19, 1906.*)

My object to-night is to present briefly some of the more notable phenomena of Fungi; but before taking up that branch, I would like to point out a few fallacies regarding mushrooms, some of which are even held by experts.

One of the most common blunders is to class all Fungi, with the exception of Agaricus campestris, A. arvensis, and A. gambosus, as "toadstools," and no doubt this unfortunate title has helped largely to hinder the appreciation of many species which would otherwise have been accepted as not only beautiful objects in themselves, but very dainty articles of food.

Another very common error is that mushrooms grow in a night. It is true that some species have very rapid growth, notably the puff-ball (Trichogastres). But this belief is no doubt induced by the experience of the outdoor gatherers of mushrooms. They go out to the fields in the morning and fill the proverbial clothes-basket with mushrooms which they positively assert were not there the night before. They overlook the fact that the early stages of the mushroom are hidden from view by the grass, and they rush to the conclusion that as they did not see them, they were not there!

Another very prevalent error is the opinion held by many that the French mushroom is superior to our own, and that it commands a higher price accordingly. The fact is, that we are now producing such a good article that we have beaten the French completely out of our markets. Twenty years ago we depended almost entirely on French mushrooms for our table-supply: at present there is no market for them, which accounts for their seeming scarcity.

Another fallacy is the belief that so much good food is allowed to go to waste in our fields. The error of this belief is evident to any one who sees the truck-loads of field mushrooms which are sent daily into the English markets during the season. Mushrooms were offered to the public this season as low as one penny per pound, and if commission, freight, baskets, &c., are taken off, there is not much left to the gatherer.

Some errors invariably crop up in all works relating to mushroom culture, and one of the most constant is that advising the use of leaf-mould as a material for mushroom beds. Cow manure is also suggested. Both these materials are absolutely of no value.

Again, many and various are the instructions how to grow mushrooms in frame-houses, heated artificially. I think I am right in saying that no mushroom ever grew in a frame-house that was entirely free from maggot.

In regard to the proper material for a mushroom bed, it is quite certain that up till now nothing but horse manure can be used successfully. It is possible that at some future time some new and improved method may be discovered which will take the place of this medium.

The mushroom has three separate parts: first, the mycelium; second, the stem and pileus; and thirdly, the gills or hymenium.

The mycelium is a delicate, filamentous substance, white in colour, and is the first stage with which we are acquainted in the life of a mushroom. By-and-by there appears a globose bud, which gradually becomes elongated, but showing no sign of cap or pileus, the outer covering being continuous over all. A longitudinal section, however, shows the incipient gills by a slight crescent-shaped opening on each side. As the mushroom grows larger, this opening distends until the outer skin bursts at the thinnest part, leaving an annulus or ring, and we have now the mushroom fully formed with its stem and cap. The collar is generally present on the Agarics, and, with some few exceptions, the cap and stem are one continuous whole; but the stem is more loose in substance than the cap, and in some cases hollow.

The spores of the Agaric are usually grouped in fours, each growing on a fine stem or sterigma rising from a thicker stalk or basidium. Along with these groups of basidia, other bodies termed cystidia are to be found. They are of unknown function. While only one spore appears at a time on the spicule, each one is followed by another, owing, no doubt, to the contents of the basidium being fully charged with the granular matter, and, as long as it retains its vitality, able to continue reproducing spores.

The germinating process under the surface of the ground occupies from three weeks to two months. It is said—but I do not vouch for its truth—that spawn can retain its power of germinating for twenty years. My own experience is that the best crop of mushrooms can be got only from fresh spawn.

Our common mushroom of commerce, Agaricus campestris, is the only mushroom which, up till now, has been successfully cultivated. It may be that, when the appreciation of mushrooms becomes more universal, efforts will be made to extend the field; but the grower is only human, and cannot be expected to create a supply till the demand justifies it. It might be worth the attention of cryptogamic societies to offer prizes in this connection, and perhaps growers would then strive to introduce other kinds which only require to be known to be appreciated.

Agaricus campestris, A. arvensis, and A. gambosus are frequently mistaken for each other. They are very similar in shape, and they grow together under very similar conditions. They are all good for eating, but no one, I think, would hesitate to give A. campestris the first place as an article of diet. It is much more fleshy than the others, and can remain in good condition much longer. The others are tougher, with a rank odour and a poor flavour.

A peculiar feature of the mushroom is seen in the entirely opposite qualities possessed by members of the same genus. The Marasmius oreades and the M. procerus are very much alike, but one is very good for eating and the other is not. The Agaricus orcella or vegetable sweetbread is palatable, while the A. prunulus or plum mushroom is the reverse, and so on.

There is no royal road to distinguish the edible from the poisonous mushroom. If it has a firm flesh and a pleasant odour, and does not melt or change colour when cut or bruised, and if taken at the proper time, then it may be eaten with safety. Ignorance has often much to answer for in cases of poisoning by mushrooms. Improper cooking or gathering at a wrong season may render otherwise harmless mushrooms injurious, and keeping for a few hours has frequently a similar effect.

The reproductive capacity of at least some mushrooms is probably unequalled by that of any other plant. All spores require to be microscopically examined, but some are so small as to be almost invisible even under a power of 350 diameters.

The question of sex is still undetermined. Evidences are plentiful of the presence of sporangia and zygospores in some of the lower families, but all attempts have failed to show sexual reproduction in the Hymenomycetes.

One of the most striking properties of certain Fungi is luminosity. Unfortunately, we in this country have to be content with the humble touchwood when impregnated with mycelium; but in South America, Central America, Borneo, Australia, and Southern Europe, some Agarics are remarkable for their phosphorescence. One of the best known is the Agaric of the olive, which throws out a very intense light. Phosphorescent Agarics are not many in number. A. lampas is found in Australia, A. igneus in Amboyna. In Brazil, Mr Gardner found a beautiful Agaric growing on the decayed leaves of a large palm. It is locally known as "Flor de coco," and now bears his name. One writer describes a jungle through which he passed as being one blaze of light, through incandescent mushrooms. The light was so strong that he could read at night quite easily by its help. The source of this light is not thoroughly understood. It was at one time thought that some special matter caused the phosphorescence, but it is now agreed that the luminosity must be owing to some climatic condition favourable to its development.

The colours of the Agarics range from white through every gradation to black. We find yellows, pinks, blues, reds,—in fact, all colours except greens. There is, indeed, a mineral green found in some, but chlorophyll green need not be looked for. It is interesting to note the extraordinary change of colour which occurs when certain Fungi are cut or bruised. Some of the Boleti when so treated become very bright blue; while some species of Lactarius from an orange colour turn to white, yellow, and even colourless. Fungi which undergo this change of colour are usually unwholesome, and should not be eaten. This change is thought by some to be due to aniline, others refer it to a molecular arrangement, while others again suggest oxidation. Whatever the cause, it indicates a poisonous state.

Phanerogams absorb carbonic acid and exhale oxygen: Fungi reverse this process, and to this is attributed the absence of green colouring-matter.

Another point worthy of our notice is the variety of form in Fungi. We find them like a parasol, a saucer, a goblet, an ear, a nest, a horn, a piece of coral, a ball, a button, a rosette, a mass of jelly, or a piece of velvet.

When we come to consider the different odours, we venture on more delicate ground. Many are aromatic, but in the beautiful Clathrus the smell is most obnoxious. There is also the fungoid odour, which is another name for mouldiness. Some of the genus Marasmius have a smell of aquafortis. Among the many pleasant smells we have that of violet, woodruff, tarragon, cinnamon, new-mown hay, anise, and walnut; while others, again, have the smell of onions, cheese, tainted meat, and garlic.

In the matter of taste we offer an equally varied choice. Some mushrooms, when eaten raw, have an acrid taste; but if cooked properly the acridity disappears, and they become quite palatable. In mushrooms the epicure can find almost every piquant flavour to meet his wishes.

The nutritious value of the mushroom is very great. It is to be feared that even lovers of the mushroom do not thoroughly understand how valuable it is as an article of food. While it holds a high place in the menu of the epicure as a delicate and dainty dish, the fact must not be overlooked that, as a wholesome and nourishing vegetable, it has no equal. The chemical constituents which go towards the making of a mushroom are as follows:—

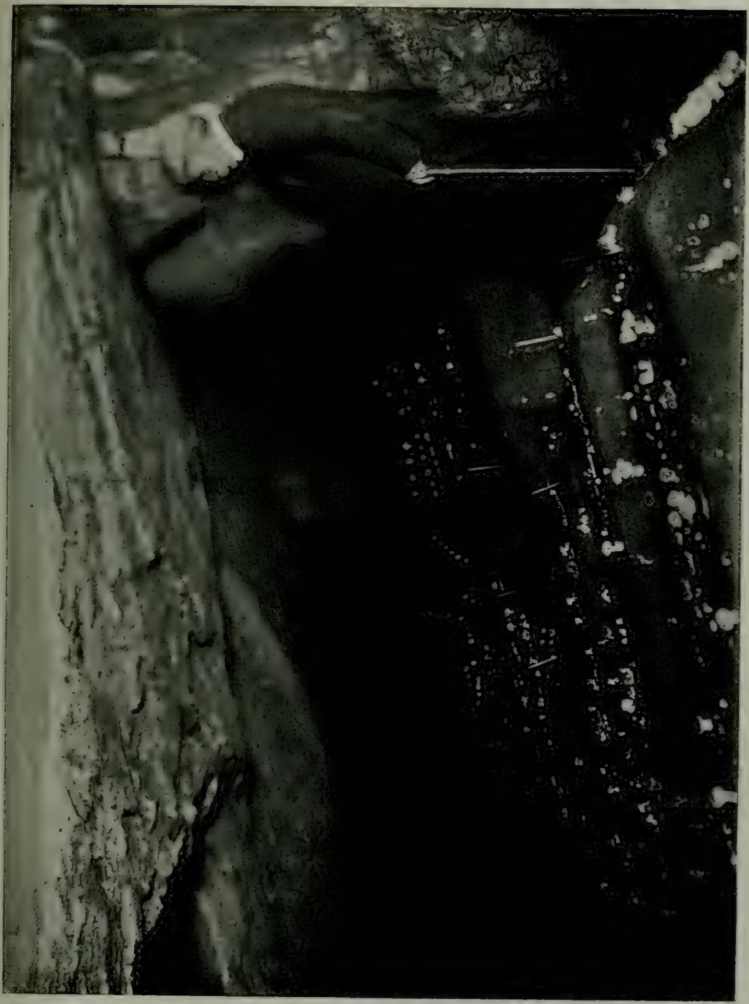
	In 100 parts.	In 1 lb. oz.	In 1 lb. grs.
Water	90·0	14	175
Albuminoids	5·0	0	350
Carbohydrates	3·8	0	266
Fat	0·7	0	49
Mineral matter	0·5	0	35

Few vegetables contain more flesh-forming material. Even meat has 75 per cent of water, while milk has 86 per cent and skimmed milk 89 per cent. Many vegetables contain more water than mushrooms; and celery, lettuce, cucumbers, turnips, cabbage, and onions have not the flesh-forming nor the heat-giving qualities of the despised Fungi.

We hear a great deal of the advantages of a vegetarian diet, and should the time ever arrive when meat will be tabooed, the loss will be fully met by a more steady use of the mushroom. In Fungi every taste is catered for, from the delicious oyster to the canned meat of the Chicago factories, from the walnut to the garlic. Even the wine-bibber can get sufficiently elevated by the use of some of the Amanitas. In short, I think I have abundantly shown that the mushroom is by no means to be regarded as a cumberer of the ground.

Dr Watson, in his very interesting summary of a large variety of Fungi at our last meeting, devoted most of his time to eulogising the more uncommon species, but on approaching the A. campestris he brushed it aside as not worthy of the attention of cryptogamists. I grant it is not one of the aristocrats of the mushroom world: it is so common with us that familiarity has bred contempt. We are apt to pay less attention to those things with which we daily come in contact. In my opinion, the field mushroom is an ideal mushroom: its symmetrical form is not equalled by any other, and I have no doubt that had it the bright colours of some of its confrères, it

PLATE XXVIII.—MUSHROOM PHENOMENA.



MUSHROOMS GROWING IN CAVE AT GILMERTON.

BRITISH MUSEUM
NATURAL HISTORY

would rank high in the estimation of fungologists. It belongs to the democracy of the fungus world: it is poor, yet honest, for it makes no pretence to be other than what it seems. It does not deceive the confiding, and Dr Watson acknowledged that some of the most beautiful mushrooms are not so good as they look. The Agaricus campestris is the backbone of the fungus world, but we shall only be doing justice all round, from the kingly Morel down to the plain Agaric, if we agree that each and all are entitled to our respect and esteem according to the virtues they possess.

I have in these few scattered words tried to convey some of the many points of interest that permeate the fungus world. Time will not permit further examination into the many phenomena still unmentioned. It is sufficient to say that I have only touched on the threshold of the subject. Volumes are required to embrace all the phases that could be mentioned, but I hope I have indicated, in a general way, enough to show that the oft-despised mushroom has beauties and interests worthy the attention of the earnest student. His reward will be great, and a chief incentive is the fact that so little is known or only conjectural, and that so much remains to be discovered. I have touched on some of the more notable phenomena, but the greatest of all is our ignorance regarding them.

[The accompanying Plate of the mushroom-beds at Gilmerton is from a photograph by Dr Davies, taken in the cave by means of the magnesium light.]

III.—*HINTS ON THE STUDY OF HEPATICS.*

By Mr SYMERS M. MACVICAR, Corresponding Member.

(*Read Dec. 19, 1906.*)

As students frequently find it difficult to learn how to begin the study of hepatics, a few remarks on the subject may be found useful. Hepaticæ are, broadly speaking, divided into two sections, frondose species and foliose or leafy species, the latter being popularly termed scale-mosses. The frondose species are prostrate, frequently forming large patches on soil and on wet rocks, one or two species also being found on trees. The only other plants with which they can be confused are some of the lichens, but those lichens having any resemblance to hepatics are thin and leathery, while the latter are more or less fleshy, or have a midrib running along the frond. The most common species of the frondose section, Pellia epiphylla, may easily be examined by the beginner. It is found on the sides of ditches and on moist soil generally, and fruiting abundantly in March and April. The capsules are borne on white pedicels, two to three inches in length. In a day or two the capsules split into four valves, exposing the spores and some spiral threads, which are termed elaters. The base of the pedicel will be seen to be enclosed in a white membrane, named the calyptra, and outside this membrane the frond appears raised except at the part nearest the apex of the frond. This raised part is the involucre. In our two other species of this genus the involucre forms a complete ring, the part nearest the apex of the frond not being absent. Instead of having a solitary capsule at the end of a pedicel as in Pellia, the species of another division of the frondose species have several capsules together, on the underside of a stalked receptacle, as in the familiar "umbrella" heads of Marchantia polymorpha. Most of the species in this latter division have a conspicuous network on the upper surface of the frond. Another family, the Ricciaceæ, of which Riccia sorocarpa is frequent in gardens and fallow fields in autumn, has the capsules embedded in the fronds.

The other great section of the Hepaticæ, containing the foliose species, comprises the great majority of our genera and species. In most of them the leaves appear as if arranged horizontally on two sides of the stem. A few mosses have also this appearance, and are frequently mistaken for hepatics by beginners. The genera of mosses thus confused are Plagiothecium, Pterygophyllum, and Fissidens. A glance through the microscope will show that the two former have long and narrow leaf-cells, which never are found in the leaves of hepatics. Species of Fissidens have a midrib running along the leaf, which structure does not occur in the foliose hepatics, though one of our commonest species, Diplophyllum albicans, has a line of cells on the centre of the leaf, but this is very different in appearance from the midrib of a moss, and it does not extend to the apex of the leaf as in Fissidens.

All the foliose hepatics have a single capsule at the end of a delicate white pedicel. The capsule divides on maturity into four valves, elaters are mixed with the spores, and the calyptra remains at the base of the pedicel. Mosses have a firm stalk for the capsule, the capsule usually opens with a lid, there are no elaters mixed with the spores, and the calyptra is carried up with the capsule, remaining on it as a hood. External to the calyptra in most hepatics is a more or less tubular organ named the perianth.

The leaves of hepatics are entire, toothed, two to five lobed or variously divided. Besides the row of leaves on the sides of the stem, many species have a third row on the posterior side. This row is usually composed of smaller leaves and of a different shape from the others. They are named under-leaves, or sometimes stipules.

In searching for hepatics the beginner must remember that their chief requisite is moisture, except in the case of a very few species. They are to be found in almost any moist ground, but are most plentiful in ravines where there are wet rocks combined with shade. Peat-mosses have also many species. In the drier parts of the country they are comparatively scarce, but where the rainfall is larger, as in hilly districts and towards the west side of the country, they are numerous.

The equipment necessary for collecting is very simple. A knife, paper bags, a fairly large waterproof bag, and a pocket lens of about an inch focal length, are all that is required. Some old envelopes for minute species which have to be scraped off rocks are also useful. It is important that the pocket lens should have a large field, so that the beginner may learn to recognise the various species to a large extent in his excursions. A more powerful lens may also be carried with advantage, but the weaker lens should always be used in the first place. On reaching home, the bags containing the specimens should be labelled with locality and date, by inserting slips of paper, and then laid out to dry for future examination. Hepatics quite recover their normal form on being moistened, though not always their natural colour.

For the examination of specimens the student will require a dissecting microscope, the stand of which can easily be made out of an old box, a compound microscope with 1 in. and ½ in. object-glasses, a pair of scalpels, forceps, and a pair of needles mounted on handles. A double nose-piece for the microscope will save an immense amount of trouble. A small tuft of the specimen to be examined is first to be placed in a saucer with water, and gently kneaded with the fingers to remove the soil and air-bubbles. If there be much soil attached to the tuft, a second saucer of water to clean the specimen will be necessary. Examine the plant with the pocket lens while in the water, then take it out and partially dry it with a towel and examine it again. The shape of the leaves will now have been noted, whether entire, toothed, or lobed, the angle which they form with the stem, and whether they are inserted on the stem obliquely or transversely. The next step is to place two or three stems under the dissecting microscope, add a drop of water, and note any points which could not be seen with the pocket lens, examining carefully the leaves from both the front and back aspects of the stem. Note whether the margins of the leaves are continued down the stem or not. Now put on a cover glass, add another drop of water, and examine the stems under the compound microscope, using the 1 in. object-glass. If doubtful of any point, the ½ in. object-glass may afterwards be used. The leaves of many of our hepatics do not lie flat, but are folded so that their shape cannot be seen when attached to the stem. In this case, four or five of them must be carefully dissected off the stem with the scalpels under the dissecting microscope and laid out flat. The shape of the whole leaf and of its lobes can then be made out. Also the under-leaves, if present, may be detached from the stem and examined. The beginner will find the cell-structure of the leaf too difficult to be of use, but it will be found very useful at a more advanced stage.

It is important to search for perianths in hepatics. In the majority of the foliose species they are at the apex of the stem, and are easily seen. The perianth in these cases terminates the growth of the stem; but frequently innovating shoots from near the base of the perianth are to be seen, making it to appear as if lateral instead of terminal. Perianths are not always present, but they are very frequently. The chief points to note are the shape, whether round or flattened, smooth or plicate, the mouth wide or contracted, entire, toothed, or ciliate. These characters are of great assistance in determining the species, or in some cases the genus. Some genera have the perianths placed on the posterior side of the stem, but in most of these cases the beginner will find the characters derived from the perianth too difficult to assist, and leaf-characters alone must be relied on.

In small and in tender species the scalpel is too coarse an instrument to employ, as it would break the stems. In such cases the needles must be used in separating single plants from a tuft, and this must always be done under water.

If the student will draw under the camera lucida the various parts of the specimens which he examines, it will be found that the characters of each species will be more rapidly retained in his memory. A cheap neutral-tint camera will be sufficient. Measurements of the various parts of the specimen may also be taken by this means.

In preparing specimens for the herbarium, the soil must be washed off as much as possible, the tufts divided into a convenient size and placed between sheets of drying-paper. The amount of pressure to be given will soon be learned by experience: much less is required than for flowering-plants. Care should be taken to make neat and characteristic specimens. When dry they are placed in packets, on which is to be written the name of the species, locality, date, and collector's name, with particulars regarding soil, &c. The packets can then be pinned on sheets, each sheet being devoted to one species, or the packets may be kept loose in drawers, the principal point being to have them so arranged that any species may be easily referred to when desired.

There is, unfortunately, no good handbook to Hepaticæ in English at a moderate price. Our standard work on the subject, Mr W. H. Pearson's 'The Hepaticæ of the British Isles,' has a full-page plate to each species, and is very expensive, the uncoloured edition being about £6, 6s. If the beginner is fortunate enough to have access to it, he will find the book of great assistance. A useful book which has illustrations is Cooke's 'Handbook of British Hepaticæ.' It contains the majority of our species, and can be bought second-hand for about 4s. The most recent book on the subject is Canon Lett's 'British Hepatics,' which can be bought from the author at Aghaderg Glebe, Loughbrickland, Co. Down, price 7s. 6d. It is without illustrations, but the beginner will find it useful. There are, unhappily, both in this and in Cooke's book, a considerable number of errors which detract from the value of the works, and are apt to mislead the student.

There are now several workers at hepatics in Britain, so that it is not difficult for beginners to get assistance. I shall be very pleased to give what help I can to any one who wishes to make a study of the subject.

IV.—*ON THE OCCURRENCE OF THE ROCK SAMPHIRE* (CRITHMUM MARITIMUM *L.*) *AND THE MARSH HELLEBORINE ORCHIS* (EPIPACTIS PALUSTRIS *CRANTZ*) *ON THE WEST OF SCOTLAND.*

By ALEX. SOMERVILLE, B.Sc., F.L.S., Corresponding Member.[1]

(*Read Jan. 23, 1907.*)

It is of interest that we are able to bring before the Society two plants, neither of them minute or inconspicuous, one of them tall and striking, which, during the past summer, were met with on the island of Colonsay, one of the South Inner Hebrides, where they proved to be practically additions to the known flora of the West of Scotland. Of these, one is an

[1] We regret to have to record the death of Mr Somerville, which took place on June 5, 1907, in his 66th year.—Ed.

umbelliferous dicotyledon, and the other an orchidaceous monocotyledon.

We shall refer in the first place to the former, the Rock Samphire (Crithmum maritimum of Linnæus), which has been known as British since 1548, or for 360 years,—a plant whose habitat is rocks and rocky cliffs by the sea, and which has been recorded hitherto from 26 out of the 112 vice-counties of Great Britain, only a single addition (East Suffolk) having been made to their number since the issue of 'Topographical Botany' in 1883. Crithmum is a plant well distinguished by its long, entire, fleshy leaflets, which are glaucous in appearance, cold to the touch, and have an aromatic scent. The young leaves, gathered in May, make, when sprinkled with salt and preserved in vinegar, the well-known pickled condiment: from this we can gather that, though Crithmum belongs to the Hemlock order, it is not in itself poisonous.

The inflorescence, or arrangement of the flowers on the flower-stalk, is, as will be seen from the specimens shown, a compound, many-rayed, flat-topped umbel, consisting of an assemblage of small-stalked, yellowish-white flowers, with numerous bracts and bracteoles,—the fruits, known as cremocarps, having thick primary ridges and many vittæ, and the whole plant differing much from all the other British Umbelliferæ, of which there are about seventy.

In Scotland Crithmum is both rare and local. It comes near the truth to say that it has of late been much restricted to a part of the Wigtownshire coast—the Rinns of Wigtown, that long narrow peninsula, which stretches south and ends in the headland, the Mull of Galloway. By Professor Trail, in his 'Topographical Botany of Scotland,' two East-coast counties are given for Crithmum—Mid-Lothian and Fife,—but they are double-queried in both cases, indicating decided doubts as to the correctness of any East-coast records. Coming west, the counties named both by Hewett Cottrell Watson and by Professor Trail are Kirkcudbright, Wigtown, and Ayr.

From Watson's 'Topographical Botany of Great Britain' (1883) we know that a Kirkcudbright specimen was shown to Watson by Boswell Syme, editor of Sowerby's Botany, 3rd edition; and as regards Ayrshire, that Crithmum is included by the late Rev. James Duncan (died 1861), whose catalogue of Ayrshire plants was treated by Watson as reliable, no Ayrshire station, however, being given.

That our plant should have made its way so far north as to Colonsay, where on the western side of the island it was last year met with growing in a compact mass, two square yards in extent, just at high-water mark, and among very savage large broken rocks, was interesting, as it extends the plant's geographical range a good way farther up the British coast, indicating that there is room for the discovery of other plants with which the higher latitude would not disagree.

There is but one species of the genus Crithmum known to science—this of ours,—and its distribution, according to Bentham, is the Atlantic coasts of Europe and Northern Africa, extending along the Mediterranean to the Black Sea. It is abundant in Southern and Western England, and, as F. H. Davey in his new tentative 'Flora of Cornwall' states, it occurs all round the Cornish coast. It is to be found, also, in Ireland, principally in the south; and the author of this paper, in the company of several members of this Society, met with it in 1901 on the shores of the Kenmore river, on the coast of County Kerry.

To other two British plants the name of Samphire has been given—viz., to the Glasswort (Salicornia herbacea), called the Marsh Samphire, a succulent shore-loving plant known to most of us; and secondly, to the Golden Samphire (Inula crithmoides), a rather striking Composite, occurring along the English Channel and in the Channel Islands, and somewhat remarkably recorded also as having been met with in years past in the South of Scotland, in Wigtown and Kirkcudbright.

The plant of to-night, the Rock Samphire, is distinguished, as I need not say to this audience, by having been named in Shakespeare's play, "King Lear" (Act IV. sc. vi.), and, up till not many years ago, used to be gathered on the Dover cliffs on what was known as Shakespeare's Day.

The poet supposes that Edgar is leading Gloucester along, and says—

> "Come on, sir; here's the place: stand still. How fearful
> And dizzy 'tis, to cast one's eyes so low!
> The crows and choughs that wing the midway air
> Show scarce so gross as beetles: half way down
> Hangs one that gathers samphire, dreadful trade!
> Methinks he seems no bigger than his head:
> The fishermen, that walk upon the beach,
> Appear like mice."

We are told that the name of our plant is more properly, as it was formerly, spelt Sampere, or Sampier, from the French Saint Pierre, being dedicated, owing to its love of sea-cliffs, to the fisherman apostle, whose name is Πέτρος, a rock, French Pierre.

In many Scottish libraries, private as well as public, there is to be found a former Flora of this northern division of the kingdom. I refer to the 'Flora Scotica' of Lightfoot, published in 1777, now 130 years ago. In this work we are informed of the finding in Kilmuir parish, in the island of Skye, in bogs near Duntulm Castle there, of that distinguished-looking plant among botanical aristocrats, the Marsh Helleborine Orchis (Epipactis palustris of Crantz), known previously as Serapias longifolia, to which we are now to refer. The only record of the plant from the West of Scotland seems to have been this of Lightfoot's, and we do not learn that any one has found it since his time, or at least has recorded it as occurring in that quarter.

To the satisfaction of the valued botanical referee, our Corresponding Member, Mr Arthur Bennett, F.L.S., this plant was, at the end of July last, met with, growing in an evidently suitable situation in the south-west corner of the island of Colonsay, on damp, almost marshy, sandy grass-land, well back from undulating dunes lying along the sea-coast. There were altogether some ten specimens, several not being likely to flower that year. In the immediate neighbourhood were large quantities of the greater Twayblade (Listera ovata R. Br.), and abundance also of Orchis pyramidalis, with which we in Scotland have but little acquaintance, together with the more widely-distributed Fragrant Orchis (Gymnadenia conopsea *Benth.*), with its rich pungent odour.

The circumstance of this striking plant (the *Epipactis*) appearing where it did is, as Mr Bennett remarks, odd, when one comes to look at its European, and especially its Scandinavian, distribution, and "I cannot help thinking," he adds, "that it will be found in one of the other isles between Colonsay and Skye, and, judging from analogy, I should have said it would be more likely to occur on the West of Scotland than in the East."

That Epipactis palustris is but a rare plant with us may be gathered from the fact that Professor Trail, in his 'Topographical Botany of Scotland,' is only able to give it for the three lowland counties on the East—Berwick, Haddington, and Mid-Lothian,—from Fife also, and from the three divisions of Perthshire, in all of which I believe it is a scarce plant.

In England it is widely distributed, and recorded as occurring in 59 of the 71 vice-counties. In Ireland Mr Praeger describes it as a characteristic plant of the Central Plain, thinning out in the north and east.

There are five British species of the genus Epipactis, several of them much alike. E. palustris, whose habit is marshy ground, is about a foot high, with leafy stem, flowers few, the outer leaves of the perianth green striped with red, the inner white striped with red. Orchis plants most commonly rise from ovate or palmate tubers. Of Epipactis, however, and some other genera,—*e.g.*, Cephalanthera,—the rootstock is a fibrous and creeping one, well seen in Cephalanthera ensifolia, of which an Arran specimen is shown.

At this meeting Mr B. J. Home delivered a lantern lecture on "Historic Edinburgh," which was greatly appreciated by the members, and their hearty thanks were given to the lecturer.

V.—*OBSERVATIONS ON SOME COPEPODA THAT LIVE AS MESSMATES OR COMMENSALS WITH ASCIDIANS.*

By THOMAS SCOTT, LL.D., F.L.S., Honorary Member.

(*Read Feb. 27, 1907.*)

In two previous papers read before this Society — one in January 1903 and the other in March 1905—I referred to a number of Copepoda which, in one way or another, are associated with fishes and with various marine invertebrates, as parasites, messmates, or commensals. In these papers I have shown that, in addition to fishes,—all of which now and then become, *nolens volens*, the hosts or entertainers of many kinds of Copepoda,—such organisms as Sponges, Echinoderms, Annelids, Crustacea, and Mollusca are also called upon to provide food and shelter for not a few of those guests which, in almost every case, may be correctly described as "uninvited."

As no special mention was made in my two last papers of the messmates of the Tunicata, my observations in this third paper will be confined chiefly to some of those Copepoda that are known to live in the company, and under the shelter and protection, of various kinds of Ascidians. To judge from the number of the organisms sometimes found located upon and within the test of one of the larger Ascidians or Tunicates, one might be led to imagine that the other invertebrata considered the test of an Ascidian to be common property, and had proceeded to carry out the socialistic idea, as far as they could, to its logical conclusion by taking forceful possession both of the outside and inside of the Ascidian's dwelling,—a dwelling which it had built up by its own exertions and for its own convenience.

Among the trespassers upon the preserves of the Tunicata is the *Modiolaria marmorata*. This dainty mollusc may frequently be found embedded in the tests of the larger Ascidians, such as, for example, *Ascidia* (*Phallusia*) *mentula*

O. F. Müller. It is sometimes buried so deeply in the substance of the test as to be almost entirely concealed, and where it can only communicate with the outside world by means of a small passage having an opening on the outer surface. Dr J. Gwyn Jeffreys, referring to this mollusc, remarks that sometimes a score of specimens may be extracted from a single large Ascidian. I have also found in cells formed in the tests of Ascidians several specimens of the curious little Amphipod, *Tritæta gibbosa;* while zoophytes of several kinds have been seen adhering to various other parts of its surface.

But if, having finished the examination of the outside of the test, we proceed to investigate the inside of it, perhaps the first of the objects to be observed will be one or two specimens of *Leucothoë spinicarpa* Abildgaard—a moderately large, soft-bodied, and sluggish Amphipod of a pale flesh colour, and bearing green-coloured ova. Then there are nearly always present in the branchial chamber a number of Copepoda which may belong to several distinct species, and thus it sometimes happens that the capture of a large Ascidian may turn out to be a miniature treasure-house to the marine zoologist.

The Copepod-messmates of Ascidians have had a good deal of attention devoted to them, especially by Continental zoologists, and the results of recent study seem to favour the opinion that in development and structure they exhibit a more or less near relationship with *Cyclops.* But this relationship, though obvious in some cases, is obscure in others. There are, for example, a few species that resemble *Cyclops* somewhat closely, both in their general appearance and habits. Like *Cyclops,* they carry two external ovisacs; they are active in their movements, gliding freely and quickly over the walls of the branchial chamber. These forms belong to the Lichomolgidæ, and their affinity with *Cyclops* is so evident that they have been classified along with that group and some other Copepoda in the division Cyclopoida. It may be observed in passing that while there are Lichomolgi which pass their lives as the messmates of these Ascidians, there are other species belonging to the same genus that live a free life amid the forests of Laminaria and zoophytes which in some places fringe our shores, and it has been suggested that the forms which now seek the shelter and protection of the Ascidians were formerly as free-living as the others.

But though these Lichomolgi and a few other species have retained their active habits along with a certain amount of freedom within the branchial chamber of the larger Ascidians, the majority of the Copepoda found in such situations are usually inactive and sluggish in their movements, and have their limbs more or less imperfectly developed. Dr Brady, the eminent British authority on the Entomostraca, referring to these Copepoda, observes that they are indeed, in all probability, Cyclopidæ which have become modified in build by their inactive habits and the restricted boundaries of their dwellings; and it is evident that under these conditions the long antennæ and limbs of the free-swimming species would be an encumbrance, or at any rate be of very small service, and one would almost be inclined to believe that these appendages must still be in course of degradation, owing to constant disuse.

The Copepoda chiefly referred to in the foregoing remarks are those usually found within the comparatively roomy branchial chamber, but there are other species which hitherto have only been obtained in the alimentary tract, and are in consequence more restricted in their movements, and they also exhibit a rather more retrograde development. There also appears to be another and a rather interesting difference between a few of these forms whose environment is so limited and others that are favoured with a more liberal allowance of space. The females of the former species carry two external ovisacs, which are slender and sometimes considerably longer than the animal itself, as exemplified in *Aplostoma affinis* mentioned in my recently published 'Catalogue of Forth Crustacea.' On the other hand, the females of several of the species living in the more roomy branchial chamber are not furnished with external ovisacs, but have the fourth thoracic segment, with which the fifth is usually coalesced, enlarged on the dorsal aspect to form a pouch in which the ova are enclosed. This pouch when packed with ova becomes greatly distended, and forms a conspicuous part of the animal, owing to the colour of the developing eggs showing through the thin integument. It is because of this modification of the fourth thoracic segment that the name *Notodelphys* was given by Professor Allman to what is made the representative genus of Sars's division Notodelphyoida.

Having seen how closely these Copepoda are associated with the life and fortunes of the Tunicata, the question may be asked, What is likely to happen to the Copepoda should the Ascidian die? Dr Canu, speaking of some of the more active species, says that, on the death of their host, they are able to quit their shelter and proceed in quest of another Ascidian, and while doing so, move freely about on the bottom of the sea. But as they are seldom captured in this free-living condition, it can only be on rare occasions that they require to adopt this form of life.[1] Yet though the more active and lively species may be able to look after themselves in the manner described by Dr Canu, it is probable that not a few will share the fate of their host.

The alteration from a free-living to a semi-parasitic life has doubtless taken place long ago, seeing that the change of habitat has resulted in such a retrograde development as to cause the structure both of the body and its appendages to become so modified as to differ profoundly from that of the free-living species to which their ancestors appear to have been related. It is also interesting to find that in the early larval stages of even the most degraded forms they still retain some traces of their former free-living habits; and, moreover, it is during this early stage that such degraded forms usually seek for, and select, a suitable host, which, when selected, has henceforward to shelter and provide food for these unbidden guests.

The number of Copepod species that have been recorded as messmates of the Tunicata is considerable,—so much so, that I can claim only a limited acquaintance with them. The species of Tunicata which have been described as the hosts of these Copepoda are also fairly numerous, and include such large forms as *Ascidia mentula*—already referred to,—*Ciona intestinalis*, specimens of which have been obtained "measuring as much as a foot in length,"[2] and also the small *Cynthias*, *Styelas*, *Botryllus*, &c.

[1] 'Les Copépodes du Boulonnais,' by Dr Eugene Canu, p. 187 (1892).

[2] 'Jour. Plymouth Marine Biol. Assoc.,' vol. vii. (N.S.), No. 2, p. 296 (Dec. 1904).

The Copepoda I now proceed briefly to describe may be arranged as follows :—

A. NOTODELPHYOIDA Sars.

1. Females provided with a single dorsal incubatory pouch in place of external ovisacs :—

Notodelphys Allman.
Agnathaner Canu.
Doropygus Thorell.
Notopterophorus O. G. Costa.
Doroixys Kerschner.
Bonnierilla Canu.
Gunenotophorus O. G. Costa.
Botachus Thorell.

2. Ovisacs, two, external, situated on the dorsal aspect, contiguous, and comparatively small, or situated laterally and more or less elongated :—

Ascidicola Thorell.
Botryllophilus Hesse.
Enterocola P. J. van Beneden.
Enteropsis Aurivillius.
Aplostoma Canu.

B. CYCLOPOIDA.

Lichomolgus Thorell.

In Lichomolgus the fourth pair of swimming-feet has the outer branches three-jointed, but the inner only two-jointed, and this forms one of the principal points of difference between it and other genera of the Lichomolgidæ. In *Pseudanthessius*, for example, the inner branches of the fourth pair consist of only one joint, while in *Herrmannella* they are three-jointed like the outer branches.

I shall now proceed to make a few observations on the better known species belonging to the various genera mentioned, and in the order in which they are given.

Genus Notodelphys.

Four species of Notodelphys have been recorded for the British Islands — viz., *Notodelphys Allmani*, *N. cœrulea*, *N. agilis*, and *N. prasina*. These have all been described by M. Thorell. The first-named appears to be the most common. I have obtained it in the Firth of Forth, in Loch Tarbert, and at Tarbert Bank at the mouth of Loch Fyne: indeed, whenever large and aged Ascidians are brought up in the dredge or trawl-net we nearly always find these Copepoda in the branchial chamber, and frequently other species as well. *Notodelphys Allmani*, besides being the most common, appears to be also the largest, of the various species. According to M. Thorell, they sometimes measure five millimetres in length, but the largest Scottish specimens I have noticed scarcely reach four millimetres. This form has long tail-segments, and the dorsal egg-pouch in the case of adult females is usually coloured and distended with ova, so that the specimens are conspicuous enough.

Notodelphys prasina is also of frequent occurrence, but it is not so common as the one just referred to. Though resembling that species in some respects, it is smaller, and is, besides, readily distinguished from it by the very short tail-segments. Rev. A. M. Norman, who collected this species at Oban, found it to be more abundant there than any other of the Entomostraca taken from the branchial sacs of *Ascidia mentula*. He has also recorded it as occurring in the same Ascidian in Shetland.[1] I have taken a number of specimens in large Ascidians dredged in East Loch Tarbert, Tarbert Bank, and Kilbrennan Sound, Firth of Clyde.

Notodelphys agilis is apparently less common than the others. Like *N. Allmani*, the tail-segments are elongated, and its appearance being otherwise somewhat similar to that species, the one might be easily mistaken for the other were it not that *N. agilis* is a distinctly smaller form. Dr Brady reports its occurrence off the coasts of Durham and Yorkshire, and at Shetland on the authority of Rev. A. M. Norman. I have obtained it very sparingly in the Firths of Forth and Clyde.

Notodelphys cœrulea.—Dr G. S. Brady states that this species differs scarcely at all from *Notodelphys Allmani*, and that he cannot find any good reason for separating it from that species.[2] He records it as having been obtained in *Corella* (*Ascidia*) *parallelogramma* and *Ascidia venosa*. I have not been able to identify this form among any of the Notodelphyidæ examined by me.

Other species of *Notodelphys* have been described as *Notodelphys elegans* Thorell, *rufescens* Thorell, and *tenera* Thorell,

[1] 'British Copepoda,' by Dr G. S. Brady, vol. i. p. 132 (1879).

[2] Ibid., p. 130.

but none of these have so far been recognised as members of the British fauna.

Genus AGNATHANER Canu.

Two species of *Agnathaner* have been recorded by Dr Canu in his work already referred to,[1] but as only the males have been described, the relative position of the genus is somewhat uncertain. One of the species, *Agnathaner typicus* Canu, was obtained in the branchial chamber of *Styelopsis grossularia* Van Beneden, and the other, *A. minutus* Canu, in *Circinalium concrescens* A. Giard. Neither of the two species has been observed in British waters.

Genus DOROPYGUS Thorell.

The Copepoda of this and other allied genera differ distinctly in appearance and habits from *Notodelphys*, and constitute the family Doropygidæ. In this group the cephalothorax is usually robust, and the posterio-dorsal sac with which the females are furnished is in adult specimens large and crowded with coloured ova: the colour varies to some extent, probably owing to the advancing development of the embryos. Several species of *Doropygus* have been described, and five at least belong to the British fauna. They require careful examination, however, as the specific characters are somewhat obscure, and are only reliable when dealing with mature specimens. All the species are moderately large, but I have not met with any British examples that reach the dimensions given by Continental authors. Though these creatures have robust bodies their legs are small, and, as might be expected, they are rather sluggish in their movements.

Doropygus pulex Thorell has been observed in large Ascidians dredged at various places, as off the coasts of Durham and Yorkshire, Shetland, Oban, and Loch Fyne. It has been obtained off Millport in *Ciona parallelogramma* by Alexander Gray, formerly of Millport Marine Station; and Dr Canu also gives the names of several species of Ascidians in which it has

[1] 'Les Copépodes du Boulonnais,' p. 210.

been observed. Adult specimens measure fully two millimetres in length. The furcal segments are long and slender, and are about one-fourth of the entire length of the animal.

Doropygus auritus Thorell appears to be a moderately large species, reaching, in the case of adult females, to one-fifth of an inch in length. It has been recorded from Shetland by Rev. A. M. Norman, who obtained it in *Ascidia* (*Phallusia*) *mentula* O. F. Müller. This species differs from *D. pulex* in having very short tail-segments.

Doropygus Normani G. S. Brady is described as moderately common in large Ascidians. The length of adult females is stated by Dr Brady to be 3·3 millimetres. The tail-segments, though short, are distinctly longer than in the last species. This form has been obtained in the Firth of Forth off Musselburgh in the branchial chamber of large Ascidians (? *A. virginea* O. F. Müller).

Doropygus porcicauda G. S. Brady.—This species is not much inferior in size to *D. auritus*, the length of adult females described by Dr Brady being about four millimetres. It has been obtained in *Corella parallelogramma* dredged off the coast of Durham, and in large Ascidians dredged in Loch Fyne and at Birterbuy Bay, Ireland. I have taken what appears to be the same species in the Firth of Forth. This species, as implied by the name, is a robust form; the tail-segments are also moderately elongated.

Doropygus gibber Thorell has been recorded from Exmouth, from the pharyngeal cavity of *Ciona intestinalis*,[1] and Dr Canu describes it as very common in many of the Ascidians of the Boulogne littoral. The females of *D. gibber* are described as reaching to five and six millimetres in length. This species has been ascribed to the genus *Notopterophorus* by Giesbrecht and Canu, but as the wing-like dorsal expansions, which are apparently the chief distinguishing character of that genus, are entirely wanting, I have retained it in the genus to which it was originally assigned by M. Thorell.

Doropygus psyllus Thorell is a rare form, and has not yet been observed in British waters. I refer to it here because, according to Dr Brady, it seems to be very nearly allied to

[1] "The Fauna of the Exe Estuary," by E. J. Allan and R. A. Tod, 'Jour. Plymouth Marine Biol. Assoc.,' vol. iv. (N.S.), No. 3, p. 325 (1902).

D. Normani. The maxillæ and foot-jaws, however, are apparently decidedly different in the two species. Canu records *D. psyllus* from *Ascidia virginea* and some other Ascidians.

Van Beneden, in his work on 'Animal Parasites,' divided these creatures into three groups—Messmates, Mutualists, and Parasites; and the Copepoda mentioned here under the Notodelphyoida he classified with the third,[1] but where he would place the others he does not say. I think, however, that they should all be arranged with the first group, the Messmates, for they do not appear to live on the tissues of their host, but are content to take a share of its food, or to live on the refuse matter in the branchial sac or digestive canal.

Genus NOTOPTEROPHORUS O. G. Costa.

The only species of Notopterophorus I have met with is that which I ascribed to *N. papilio* Hesse. It is a robust form, and is furnished with dorsal wing-like appendages entirely different from anything met with in other species, while if wanting in these appendages it would scarcely be recognised from a *Doropygus.* These wings, when perfect, taper off at the corners into long slender filaments, as may be seen in some of the specimens exhibited. *N. papilio,* though not the only species described, appears to be the one most common and widely distributed. I found it fairly plentiful in large Ascidians dredged in Scapa Flow in Orkney. It has also been obtained in East Loch Tarbert, Loch Fyne, at Oban, and the Shetland and Channel Islands. The appendages, which in some respects resemble the wings of a butterfly, but of course are not used in the same way, can, it is said, be moved with considerable energy, and Dr Brady's remark that the use of these appendages is at present quite unknown,[2] is apparently as applicable now as when it was published.

I may mention that the species I have here recorded as *N. papilio* Hesse appears to be much more robust than the drawings in the 'Monograph of British Copepoda' (Plate 31) represents that species to be, and therefore it is just possible

[1] 'The International Scientific Series,' vol. xx. p. 251 (1876).
[2] 'British Copepoda,' vol. i. p. 144 (1879).

that my specimens may belong to another species, but I scarcely think so.

A second species described by Buchholz under the name of *Notopterophorus elongatus* has been doubtfully recorded as British by Dr Brady, but none of my specimens agree with it. The largest of the specimens from Scapa Flow do not much exceed four millimetres in length.

Genus Doroixys Kerschner, and *Genus* Bonnierilla Canu.

These two genera, which are each represented by a single species,—*D. uncinatus* Kerschner and *B. longipes* (Kerschner),—do not appear to have yet been observed in British waters. They both have a general resemblance to species of *Doropygus*, and are found in similar situations. Dr Canu describes the first as very frequent in *Morchellium argus* M.-Edw., *Circinalium concrescens* Giard, and *Polyclinum luteum* Giard; and the other as very common in the branchial cavity of *Cynthia lurida* Thorell.

Genus Gunenotophorus O. G. Costa.

This genus, like the two last mentioned, is represented by only one species, *G. globularis* Costa, of which I have only seen a single specimen. This specimen was dredged near Sanda Island, at the mouth of the Firth of Clyde, in 1898, and is described and figured in Part III. of the 'Eighteenth Annual Report of the Fishery Board for Scotland' (p. 387, Plates 13 and 14). Dr Canu, who describes *G. globularis* as rare, says that it has been found in the branchial cavity of *Cynthia lurida* and a few other Ascidians.

Genus Botachus Thorell.

The only species of *Botachus* which, up till the present time, appears to have been described is *B. cylindratus* Thorell. This species, unlike any of those previously referred to, is rather small, slender, and elongated. The average length of the specimens exhibited is about two millimetres. In nearly all those examined the abdomen is bent downwards, and forms a considerable angle with the thorax. The furcal joints are very short, and armed with hooked spines; the limbs are also short; while the ovigerous pouch, though of moderate length, is but slightly dilated. I found this species fairly common in large Ascidians dredged in Scapa Flow, Orkney, and I have also collected it in Loch Fyne. The Rev. A. M. Norman records it from the branchial sac and water-passages of *Ascidia mentula* collected at Shetland and Oban.

Genus ASCIDICOLA Thorell.

Ascidicola rosea Thorell is the only described species, and, like *Botachus cylindratus*, is elongated and slender, and might at a casual glance be mistaken for that species. But besides being at least twice as long as *Botachus*, *A. rosea* is furnished with two external ovisacs on the posterio-dorsal aspect of the thorax.[1] These ovisacs are at first contiguous, but later when the eggs have developed the ovisacs may become divaricate, as exemplified by some of the specimens now exhibited. I have obtained this species in Ascidians from Scapa Flow, Loch Fyne, and the Firth of Forth, but always sparingly. The Rev. A. M. Norman has found it in *Ascidia sordida* from Shetland, and in *Ascidia mentula* dredged at Oban and at Birterbuy Bay, Ireland, while Dr Brady has dredged it off the coast of Durham. Dr Brady gives the length of *Ascidicola rosea* as 5 mm., but those I have from Scapa Flow scarcely reach 4 mm. in length.

Genus BOTRYLLOPHILUS Hesse.

Several species of *Botryllophilus* have been described, but they may not be all distinct. They all appear to be somewhat rare, but that may be more apparent than real, for they are small species, and usually occur in the smaller Tunicates, such as *Botryllus* sp., *Distoma*, &c., which are more troublesome to examine than the larger Ascidians. The *Botryllophili* are readily distinguished from other Notodelphyoida by

[1] "Les œufs pondus en sacs ovigères externes, sans abri dans cavité incubatrice close."—'Les Copépodes du Boulonnais,' p. 208.

the peculiar position of the fifth pair of thoracic feet in the female. This pair, each of which consists of a single, elongated, one-jointed branch, instead of being, like the preceding pairs, situated on the ventral aspect of the thorax, are each inserted on the fifth thoracic segment — one on each side, well round towards the dorsal surface—and project outwards in the form of prominent spine-like appendages. The ovisacs are external and contiguous, and together form a globular mass, which is situated on the dorsal aspect of the last thoracic segment, and between the two fifth feet.[1] It is fairly evident, from the peculiar and abnormal position occupied by the fifth pair of feet, that this remarkable arrangement has been brought about so that these appendages could protect the globular ovisac and hold it between them in its proper position, when otherwise it would have been easily displaced.

The few specimens I have obtained, and which I have doubtfully ascribed to Hesse's species *B. ruber*, were found in specimens of a *Botryllus* dredged in the Moray Firth, and also in Loch Fyne.

Genus ENTEROCOLA P. J. van Beneden.

Specimens of an *Enterocola* which I have doubtfully referred to *E. fulgens* van Beneden have on two occasions been dredged in the Firth of Clyde. They were found in the digestive canal (not the branchial cavity) of small Ascidians, the name of which I failed to obtain. All the specimens observed were females, and only one Copepod was noticed in each single Ascidian. The specimen seemed to occupy, to its full extent, that part of the canal where it occurred, and it was therefore somewhat difficult to remove the Copepod without displacing one or both ovisacs. The ovisacs,

[1] In the 'Nineteenth Annual Report of the Fishery Board for Scotland,' Pt. III., p. 242, pl. xvii., figs. 15-27, I give a description and drawings of a female and a male. The female figure shows the relative positions of the fifth pair of feet and the globular ovisac. Hesse's figures of *Botryllophilus ruber*, while agreeing generally with the Moray Firth and Loch Fyne specimens, show the two ovisacs widely apart, one under each fifth foot,—thus presenting an arrangement that apparently has not been hitherto observed by any other author.

which are widely apart and vary in size in different specimens, are attached to the last thoracic segment: they extend along each side of the abdomen, and reach to some distance beyond its extremity. Each ovisac, which has its point of attachment to the thoracic segment protected by the short but broad fifth foot, contains a moderate number of fairly large ova. The body is cylindrical in form, and distinctly segmented. The thoracic limbs, as might be suspected from the confined habitat, are very short, and the animal itself appears to be sluggish. The ovisacs, which were of a red colour, were easily noticed through the semi-transparent integument of the digestive tube. Dr Canu says that he found the male of *E. fulgens* is frequent in spring-time and in September, while the female is common at all seasons in the digestive canal of *Polyclinum luteum* Giard.[1]

Genus ENTEROPSIS Aurivillius.

Very few species of *Enteropsis* have been described, and none of them, as far as I know, has been recorded from British waters, except that which I have described as *E. vararensis.*[2] They all seem to have a general resemblance to *Enterocola*, the female also being provided with two external ovisacs as in that genus. All the species appear to be moderately rare, and Dr Canu says that his *Enteropsis pilosus* was described from a single female obtained in the branchial sac of *Diazona hebridica* Forbes, one of the Social Ascidians.[3] Other two described species are *E. dubius* Schimkevitsch and *E. sphinx* Aurivillius.

Genus APLOSTOMA Canu.

Four female examples of a species belonging to Canu's genus *Aplostoma* were obtained in the alimentary canal of a species of Ascidia, identified doubtfully as *Ascidia* (*Ciona*) *intestinalis.* Only one specimen of the Copepoda was observed

[1] 'Les Copépods du Boulonnais,' p. 217.

[2] 'Nineteenth Annual Report Fishery Board for Scotland,' Pt. III., p. 241, pl. xvii., figs. 28-34.

[3] 'Les Copépodes du Boulonnais,' p. 220.

in each single Ascidian. The specimens were of a narrow cylindrical form, and the ovisacs they carried were slender and elongated, being about twice the length of the entire animal. They had a general resemblance to *Enterocola*, and were at first ascribed to that genus.[1] A more familiar acquaintance with these interesting Ascidian Copepoda, however, showed that they could not retain their position in van Beneden's genus, and that their true place was with the *Aplostoma* of Canu. They are closely allied to *Aplostoma brevicauda* Canu, but appear to differ in some minor details of structure: they have therefore been recorded under the name of *Aplostoma affinis*.[2] Dr Canu has obtained *A. brevicauda* in *Morchellium argus* M.-Edw., *Amaræcium Nordmanni* M.-Edw., and *Polyclinum luteum* Giard.

Genus LICHOMOLGUS Thorell.

Notwithstanding that there are numerous Copepoda included in the Cyclopoida, and also though not a few of them have been recorded as the semi-parasites or messmates of various other groups of invertebrates, scarcely half a dozen species—and all of them limited to the genus *Lichomolgus*, as that genus is at present defined—have been found among the different forms associated with the Tunicata.

Lichomolgus forficula Thorell appears to be the most common and generally distributed species, and it is scarcely ever found anywhere else than in the branchial sac of the larger Ascidians. This *Lichomolgus* is readily distinguished from its nearest allies by the two long tail-appendages: both of them are jointed near the middle, and this in itself is an innovation on what is usual among Copepoda. The species is small and of a whitish colour, and it is active in its movements, running with considerable agility over the surface of the branchial sac. I have found it moderately common in large Ascidians dredged in Scapa Flow, Orkney, and in the Clyde, but there

[1] "On some New or Rare Crustacea from the Firth of Forth," 'Ann. and Mag. Nat. Hist.' (6), vol. x. p. 203, pl. xvi., figs. 1-11 (1872).

[2] "Catalogue of Forth Crustacea," by T. Scott, 'Proc. Roy. Phys. Soc.,' vol. xvi. p. 363 (1906).

does not seem to be any published record of its occurrence in the Firth of Forth. The Rev. A. M. Norman obtained it in *Ascidia mentula* dredged in Shetland: he has also found it at Oban, and at Plymouth in *Phallusia mamillata;* and Dr Brady records it from Mulroy Lough, Donegal.

Lichomolgus furcillata Thorell has been obtained very sparingly in large Ascidians dredged in the Firth of Forth; and Dr Brady found the same species in the branchial sac of *Corella parallelogramma* sent to him from Shetland by the Rev. A. M. Norman, who has also dredged it near Eddystone Lighthouse. It is also recorded from Port Erin, Isle of Man, by the late I. C. Thompson, Liverpool.[1]

Lichomolgus albens Thorell.—I know of only two records of this species from British waters. The first in point of time is that published by the late I. C. Thompson, who found the species among algæ on rocks at Puffin Island off the coast of Anglesea;[2] the second mentions its occurrence in dredged material from Otter Spit, Loch Fyne;[3] but in neither case were the specimens found as messmates of Ascidians. Dr Canu, however, referring to this species, says: "Dans le Boulonnais je l'ai trouvée habitant la cavité péribranchiale et le cloaque de diverses Ascidies: *Ciona intestinalis* Mueller, *Molgula socialis* Alder, *Cynthia lurida* Thorell."

Lichomolgus Poucheti Canu, another species sometimes found associated with Ascidians, has not yet, so far as I know, been obtained in British waters. Dr Canu, the describer of the species, says that it is moderately rare, and that he found it in the Bay of Concarneau living as a semi-parasite with *Morchellium argus* and *Fragrarium areolatum*—two species belonging to that group of the Tunicata known as Social Ascidians.

And now, in bringing these observations to a close, I have only to add that though much still remains to be done

[1] "Revised Report on the Copepoda of Liverpool Bay," 'Trans. Liverpool Biol. Soc.,' vol. vii. p. 33 (1893).

[2] Ibid.

[3] "Some Additions to the Invertebrate Fauna of Loch Fyne," by T. Scott, 'Sixteenth Annual Report Fishery Board for Scotland,' Pt. III., p. 269 (1898).

among the semi-parasitic Copepoda of Scotland, not to speak of the British Islands, our knowledge of them is being gradually added to, and ere long, instead of forming a small portion of a general monograph, they may require a monograph all to themselves.

At this meeting Mr T. Cuthbert Day gave a very interesting and instructive Lantern Demonstration on "Colour and Colour Photography," which was greatly appreciated by the members.

At the meeting of the Society, held on March 27, 1907, Dr Watson communicated a paper, entitled "Notes on Acclimatised Plants," by Mr William Wilson of Alford, Aberdeenshire. At the same meeting Mr Symington Grieve, under the title of "A Field Naturalist's Ramble in Martinique and Dominica," gave an extremely interesting account of his recent visit to the West Indies. This paper was illustrated by a large number of lantern slides from photographs taken during Mr Grieve's visit.

VI.—*BRITISH HYDRACHNIDÆ: THE GENUS PIONA.*

By Mr CHAS. D. SOAR, F.R.M.S., Corresponding Member.

(*Read April 24, 1907.*)

There is a difference of opinion amongst writers on the Hydrachnidæ in regard to the correct name of this genus. It was called Nesæa by Koch in 1842, and for a long time all the species were arranged under that generic name. It was, however, afterwards found that the name Nesæa had already been used by Lamarck in 1812 for a genus of Polypes. Nevertheless, the name Nesæa continued to be used by all the writers on water-mites until 1891, when Dr Koenike of

Bremen proposed the name of Curvipes, on account of the peculiar formation of the patella segment of the fourth leg of the male. This does not appear to be a very good name, as it is based on a characteristic pertaining to one sex only. The name was adopted by all subsequent writers on this genus, including Dr Piersig and Dr Wolcott. Dr Piersig, however, in 'Das Tierreich,' made another alteration, by rejecting Curvipes and substituting in its place Piona,—a generic name proposed by Koch in 1842. There is a doubt in some minds as to what species Koch intended to include in this genus. For some time quite another group of species was ranked under that generic name,—species with only three acetabula on each genital plate. However, if Piersig is right, and what we are considering as Piona are really what Koch intended to include in this genus, his name should, of course, have priority over any proposed since.

It is not here proposed to go into this question any further, but to use the generic name of Piona. So long as the generic characteristics are distinct and easily understood, it does not appear of much consequence what name is used.

The genus Piona contains a number of well-defined species whose points of identity are fairly well understood. These species exhibit a great diversity in size and colour, but are not so interesting in structure as some belonging to other genera. The body length varies from a little over half a mm. to nearly three mm., and in colour we get all shades of red, blue, yellow, and green. They appear to be very common in most ponds and small rivers, and when captured there is generally a large number of one species taken. They are strong and active, and appear to feed on any small animal or vegetable matter which comes in their way.

It was during the year 1899 that members of this genus were first recorded for Britain, eleven species being figured and described.—(See 'Science Gossip' for 1899.) Since then a number of other species have been recorded, so that we have now nearly double that number. In 1899 they were all described under the name Curvipes, for reasons already mentioned.

The species of this genus vary greatly,—so much so that without examination of all the points of identity it is fairly easy to mistake one for another, so that however careful one may be in making a drawing of a specimen, the result only depicts that particular individual. When a number are taken from one pond they are generally found to be all very much alike, but may be quite different to those obtained from another pond. It is as well to draw attention to this, so that any one using this paper and its keys of identification may not be disappointed because their particular specimens may have a different number of acetabula, or the colour and contour of the body may be quite different to those here described.

External structure.

The body is elliptical or oval in outline, sometimes slightly compressed on either side of the posterior region and sometimes, particularly in the male, slightly flattened or bowed in on the anterior. The body is more or less arched and thick. The skin is thin and transparent, with a fine surface very often finely striated, but never papillose. The eyes, composed of one or more lenses, are sessile, wide apart and usually very dark in colour. In front of the eyes are two hairs, known as antenniform bristles. These vary much in length and thickness in different species. On and across the median line of the dorsal surface is situated the Malpighian vessel. This belongs to the internal structure, but it is so conspicuous, exhibiting, as it does, through the thin skin of the dorsal surface such a variety of, sometimes brilliant, colouring that it adds much to the beauty of these interesting creatures, and we must take it into our consideration. The Malpighian vessel varies in form very much, particularly in the females, but it is generally T-shaped. The dermal glands are found on various parts of the body on both dorsal and ventral surfaces. There is usually a hair near the edge of each gland.

The maxillary shield, mouth-organs and the palpi are attached to the anterior portion of the ventral surface. Frequently, the mandibles can be seen projecting forward from the anterior part of the shield. The epimeral plates of the female are arranged in four groups on the ventral surface, the first two pairs being close to the maxillary shield, one pair on each side. The posterior pairs are much larger and are placed directly behind the others with a wide space between the inner margins. The legs, four on each side, are attached to the epimera. The first, or anterior, pair are the shortest and have the least number of long swimming-hairs. Each pair, going backward, gets longer and more hairy. The fourth, or posterior, pair are very long and strong and well supplied with long swimming-hairs,—the swimming-hairs, so-called, being the long ones found near the joints of the legs. Each leg is composed of six segments —viz., the coxa, articulated to the epimeron, trochanter, femur, patella, tibia and tarsus,—the distal segments being usually thinner than the proximal. The patella and tibia are best equipped with swimming-hairs. All the tarsi are furnished with retractile claws.

The genital area of the females is composed of a long cleft with lips on each side, outside of which there is usually a special plate or plates with numerous acetabula. These plates may be tongue-, disc-, or sickle-shaped, or modifications of these forms, according to the species, as will be seen in the descriptions given later on. Sometimes there is more than one plate on each side, and in two or three cases a number of acetabula are found free on the skin. These acetabula also vary much in size, some species having two or more much larger and more conspicuous than the others.

Each palpus is composed of five segments, the second being the thickest and the fourth the thinnest. The palpi are placed directly in front of the maxillary shield. On the flexor edge of the fourth segment are two or more hair pegs. The distal end of the fourth segment has also a strong tooth on the inner edge. At the extremity of the fifth segment are three or four small teeth and two or three small hairs. The mandibles are placed under the maxillary shield. The claw of each mandible is marked with what looks like fine striæ, but what Dr Wolcott has stated to be a comb of fine hairs.

The males differ from the females in several respects. The epimeral plates are closer together, the two posterior pairs nearly meeting on the median line, with the genital area close to the posterior margin of the epimera. Instead of a cleft they are more or less provided with a seminal pocket, the common forms of the aperture being cherry or trefoil shaped. The genital plates lie close on each side, and in some cases extend backwards sufficiently far to enclose the anal opening. The last segment of the third pair of legs is very much modified as compared with the corresponding segment of the first and second pair of legs. The claws assume different forms in different species. In spring-time, large numbers of the males taken will be found to have their third pair of claws firmly fixed in the genital pouch: indeed, so tightly are they fixed, that it is often difficult to remove them without destroying part of the structure. The fourth pair of legs also have a peculiar formation, the patella being adapted for seizing and retaining hold of the female. The distal end of this segment has two or more long swimming-hairs,—a feature which is rather important for identification.

The colouring varies very much even in the same species, as will be seen on reference to Piona rufa. Some species are almost colourless, while others are dark or brilliant,—Piona longipalpis, Kren., being a good example of this.

Briefly, the generic characters of Piona are: Body, soft-skinned; all legs supplied with swimming-hairs; claws to all feet; third pair of feet of the male and the patella segments of the fourth pair of legs much modified; on each side of genital aperture six or more acetabula, either on special plates or free on body skin; epimera in four distinct groups; eyes wide apart.

In the Plates the bodies are all drawn to the same scale, to allow of easy reference to their relative proportions. The other figures are drawn to show structure and arrangements of parts only, not for comparison in size.

There are twenty-one species to consider,—twenty already recorded, and one new one. Of the eleven species described in 'Science Gossip,' it is intended to leave P. ambigua out, as it was only described from a nymph.

There are only a few men who have worked at the Hydrachnids at all in Britain, and the ground they have covered is as yet very small, so there is no reason why the present records of Piona should not be very considerably augmented. In Ireland we have records by Mr Halbert and Dr Freeman; in Scotland by Mr Williamson, and a large collection made by that indefatigable collector, Mr Taverner. In England Dr C. F. George has done a great deal of work, mostly on collections made in Lincolnshire. Mr A. D. Michael has also done some splendid work, but I do not think he has written on the genus Piona. I take this opportunity to thank the above gentlemen for specimens sent, and for loans of type specimens for the preparation of this paper. My own collecting has been made mostly in the counties round London, in the lakes of Wales, and the Broads of Norfolk.

Life-history.

Of this we know very little. The eggs are usually deposited on the leaves or stem of some water-plant, anacharis being a favourite for the purpose. Piona longipalpis, Krend., generally deposit their eggs in a line on the upper side of a leaf. Each egg seems to be deposited separately, as the line of demarcation can be plainly seen for some time. [A drawing illustrating this was shown. This drawing was made direct from the eggs, these being selected and drawn every second day from deposition until the escape of the larvæ. The eggs were deposited on a leaf of anacharis on April 28, 1904, and hatched on May 15,—eighteen days in incubation. It was shown that the eggs enclosed in the gelatinous mass gradually grew until they were nearly twice the size they were originally, and the line of demarcation in the horny envelope had been quite obliterated.] The larvæ are free-swimming, but have only six legs, not eight as in the adult. These larval forms no doubt now begin to look about for a host to which to attach themselves, but what this host is remains to be discovered. At the end of the larval stage they go into an inert condition, from which they emerge free-swimmers, this time with eight legs. In this stage they are called nymphs. They now possess all the characteristics of the adults except the distinctive sexual ones, and are, of course, very small when compared with the full-grown adult. How long they remain as nymphs is not known, but after passing through another short inert period they become adults, and rapidly develop to their full size.

1. *Piona fuscata*, Herm.

Female.—Body about 1·20 mm. in length, of a dark red colour, with black markings. Malpighian vessel very little lighter in colour than other parts of the body. Legs long and well supplied with swimming-hairs. Retractile claws very prominent. Colour of legs red like the body, but a little brighter in tone. Palpi rather small and insignificant, the flexor edge of the fourth segment having 2 papillæ with setæ placed a little way apart, one behind the other. Genital plates sickle-shaped, each with from 8 to 12 acetabula, none being free on the ventral surface.

Male.—About 0·84 mm. in length, generally of a lighter colour than female, with a much lighter-coloured Malpighian vessel, and the body rather broader in shape at the posterior margin. The third pair of tarsi have the distal end rather thickened or broadened and a strong claw (Plate XXX., fig. 5). The fourth leg has the usual shaped patella segment, with three swimming-hairs at the distal end. The genital area is composed of a trefoil-shaped seminal pocket with plates on each side, each plate with from 8 to 12 acetabula.

Plate XXX., figs. 1-7. Figs. 1 and 2 are drawn to same scale as all the other body figures.

Localities.—It is a very common mite, and when found it is frequently in large numbers.

2. *Piona laminata*, Sig Thor.

This is very closely related to P. fuscata, Herm., and may be only a variety of that mite. It is a little lighter in colour than P. fuscata, and measures 1·50 mm. in length. Its great difference is in the genital plates, which are much more spread out than in P. fuscata, and have from 12 to 20 acetabula each. The specimen from which my drawing was made had 16 on each plate. (Plate XXXI., figs. 13, 14.)

Male.—Not taken. A male was taken with the female, and it may prove to be a male P. laminata, but I should not like to record it as such at present. It is very like P. fuscata, but the tarsi of the first and second pair of legs are longer and straighter, and not spread out wide in the centre as we find in the same segment of P. fuscata.

Locality.—Catfield Fen, Norfolk Broads, 1904.

3. *Piona Neumani*, Koen.

Male.—About 0·80 mm. in length. Colour yellow, with brownish markings on dorsal surface. Palpus thicker than trochanter of first leg. Three swimming-hairs at distal end of patella. Seminal pocket much broader than long. 12 to 15 acetabula on each plate. Three hair-pegs on fourth segment of palpus. Male only as yet found in Britain. (Plate XXXI., figs. 8-12.)

Locality.—Norfolk Broads.

4. *Piona obturbans*, Pier.

Female.—About 1·10 mm. in length, of a brownish-yellow colour with dark-coloured markings, in some specimens nearly black. Malpighian vessel often very indistinct. Legs, palpi, and all chitinous parts generally of a pale-blue colour. Palpi strong, and having on the flexor edge of the fourth segment two prominent hair pegs nearly side by side, about one-third from distal end of fourth segment. The genital plates are sickle-shaped, with from 18 to 25 acetabula each. There are also from 1 to 5 acetabula free on the ventral surface within the curve of the sickle-shaped plates.

Male.—About 0·64 mm. in length. The third pair of legs are each terminated by a strong claw (Plate XXXIII., fig. 25). There are three swimming-hairs at distal end of the patella of fourth leg. The anus is placed so close into the bay of the genital plates that, on first observation, it appears to be on the plate itself. (Plate XXXII., figs. 15, 16; Plate XXXIII., figs. 23-25.)

Localities.—Common.

5. *Piona disparilis*, Koen.

This is a species or variety very near to P. obturbans, Pier. The female is larger, measuring as much as 1·30 mm. in length. The genital plates are sickle-shaped, with from 50 to

60 acetabula each, and one or two free on the ventral surface within the curve of each plate. It is rather a rare species, having only been found at Chesham and Sevenoaks up till the present. The male is, as yet, unknown in Britain. (Plate XXXII., figs. 17, 18.)

6. *Piona rotundoides*, Sig Thor.

This is another variety of the group with sickle-shaped genital plates. It is a much larger species, measuring as much as 1·80 mm. in length. Genital plates with from 30 to 40 acetabula on each plate. Colour, a pale yellow, with very dark markings, which are very regular in their arrangement. It is a rate mite, having only been found at Earlswood and on the Broads.

Male.—About 0·96 mm. The genital plates are larger than those on P. rotunda, Kram., and have from 30 to 35 acetabula on each plate. The plates also project further beyond the posterior points of the fourth pair of epimera. (Plate XXXII., figs. 19, 20; Plate XXXIII., figs. 30-32.)

7. *Piona rotunda*, Kram.

Female.—About same size as P. obturbans, Pier., 1·10 mm. in length. Colour yellow, with brown markings on the dorsal surface. Malpighian vessel very distinct. Legs long and rather thin, well supplied with swimming-hairs; claws rather prominent; colour of legs pale yellow. Palpi strong, and nearly twice as thick as trochanters of first pair of legs. There are two hair pegs placed very near one another on the flexor edge of palpi. The genital plates are sickle-shaped, with from 15 to 20 acetabula on each plate, and some free on the ventral surface within the curve of each plate.

Male.—About 0·80 mm. long, of same colour as female, but very often darker in tone. The seminal pocket is very small and pointed at each end. It can easily be recognised from the male P. obturbans by the anus being some little distance behind the plates instead of being placed within the bay. This can be more easily understood by comparing figs. 24 and 27, Plate XXXIII. Each plate has from 24 to 30 acetabula.

The tarsus of third leg is very like that of both P. obturbans and P. rotundoides. The distal end of patella has three long swimming-hairs. (Plate XXXII., figs. 21, 22; Plate XXXIII., figs. 26, 27.)

Localities.—Common in several parts of Britain.

8. *Piona alata*, Sig Thor.

Male.—About 0·85 mm. in length. Colour yellow, with black markings. It can easily be recognised by the lanceolate form of the seminal pocket and the tongue-shaped plates. The seminal pocket occupies the whole space between the plates without any extra chitinous plate, such as we find between the plates on P. obturbans, Pier., P. rotunda, Kram., or P. rotundoides, Sig Thor. The dorsal surface is very distinctly marked, the Malpighian vessel being well defined. The female has not yet been found in Britain, but the male was found by Dr C. F. George in Lincolnshire, and my drawing was made from his mounted specimen. Unfortunately the mount was not good enough to enable drawings of details of the legs being obtained, but I think the peculiar shape and position of the seminal pocket are enough to make us sure that it is the mite Sig Thor described and figured. (Plate XXXIII., figs. 28, 29.)

9. *Piona fallax*, Karl Thon.

Female.—About 1·36 mm. in length. Palpus large and strong, nearly twice as thick as first segment of first leg. Genital plates tongue-shaped, with about 30 acetabula, all very much of one size, to each plate. Tongue-shaped plates nearly 1½ times as long as broad. Width across each plate about 0·56 mm. Only the female has been found up till now by Dr C. F. George in Lincolnshire. My drawing was made from an unmounted specimen taken by him in 1900. (Plate XXXIII., figs. 33, 34.)

10. *Piona discrepans*, Koen.

Female.—About 1·12 mm. in length, and of a yellowish brown colour. Genital plates in two pairs, the anterior pair having each one acetabulum, with about three hairs, and the posterior plates having about 20 acetabula each, nearly of one size.

Male.—About 0·90 mm. in length, darker in colour than female, and not so oval in shape. It is best recognised by the genital plates surrounding the anus, and also by the plates extending along the outside edge of the fourth pair of epimera, as far as the articulation of the fourth leg with the epimeron. Each plate with about 27 acetabula. The patella has two hairs at the distal end. (Plate XXXIV., figs. 35-41.)

Localities.—Epping Forest and Lincolnshire. Not common.

11. *Piona longipalpis*, Krend.

Female.—Body about 2·70 mm. long, of a beautiful bright red colour, with very faint dark markings on dorsal surface. Malpighian vessel hardly visible. Chitinous parts of body a dark slatey-blue colour. This applies to all the limbs, as well as the genital plates and epimera. Genital plates large, each having a large number of acetabula, with two—one on the anterior edge and one near the centre—much larger than the others. Acetabula all on the plates, none free on the ventral surface. The most prominent feature of this mite is the one it derives its name from—viz., the large and well-developed palpi which have two large hair pegs on the flexor edge of the fourth segment of each palpus, almost as noticeable as the pegs on the palpi of Atax crassipes, Müll.

Male.—Measures about 2·10 mm. in length, of the same bright colour as the female. Plates with a large number of acetabula, two being larger than the others as in the female. Tarsus of the third leg terminated with two small modified claws. Distal end of patella with six or seven swimming-hairs. Seminal pocket heart-shaped. (Plate XXXV., figs. 42-47.)

Localities.—Very common on the Norfolk Broads.

12. *Piona nodata*, Müll.

Female.—Body about 2·70 mm. in length. Colour red inclined to crimson, with yellow at both anterior and posterior margins. All chitinous parts of the same crimson red. Colour of each segment of the legs inclined to yellow at the distal ends, more particularly in the tarsi. Legs strong, and well supplied with swimming-hairs. Palpus rather large, with two hair-pegs on flexor edge of fourth segment. Palpus about $1\frac{1}{2}$ times as thick as trochanter of first leg. Genital plates more or less disc-shaped, each with from 25 to 35 acetabula.

Male.—About 1·90 mm. in length; similar in colour to female. Seminal pocket trefoil-shaped. Claws on third pair of feet very peculiar, being hooked and partly screwed round. (See fig. 53.) Distal end of patella with six or seven hairs. (Plates XXXVI. and XXXVII., figs. 48-58.)

Localities.—Common.

13. *Piona nodata*, var. *imminuta*, Pier.

Same characteristics as above, only much smaller, and yellow in colour, with brown markings. The female measures about 1·60 mm. in length, and the male about 1·20 mm. Figs. 51 and 56 are drawn to show the actual difference in size when compared with figs. 49 and 55. (Plate XXXVI., fig. 51, and Plate XXXVII., fig. 56.)

Localities.—Lincolnshire and Suffolk.

14. *Piona carnea*, Koch.

Female.—About 2.10 mm. in length, of a dull dirty brown colour, with dark-brown markings on dorsal surface. Malpighian vessel scarcely visible. Genital plates disc-shaped, with from 18 to 24 acetabula on each plate. Palpi very small and weak, with two hairs wide apart on flexor edge of fourth segment.

Male.—About 1·55 mm. in length. Similar in colour to female. Palpi small and weak. Seminal pocket cherry-shaped, genital plates with about 15 acetabula each. Nine swimming-hairs at distal end of patella of fourth leg. (Plate XXXVIII., figs. 59-65.)

Localities.—Lincolnshire, Norfolk and Suffolk.

15. *Pióna rufa*, Koch.

Female.—About 1·30 mm. in length. Colouring of this species varies very considerably. There is one variety a bright scarlet with black dorsal markings and yellow legs; another is of a beautiful cerulean blue; while there have also been found brown and green specimens. The locality, no doubt, has a great deal to do with this. Body rather narrow, and markings on dorsal surface very distinct. Eyes large, and each surrounded by a light patch of colour, much lighter than the other parts of dorsal surface. Chitinous parts always of a different colour from the body, making this mite a very beautiful object from a colour point of view. Legs long and thin, and well supplied with swimming-hairs. Palpi not quite so wide as trochanters of first legs. Two hairs on flexor edge of fourth segment of palpi rather close together. Genital plates sickle-shaped, with a large piece of the anterior portion cut away, leaving four plates, two on each side of genital aperture; anterior plates each with one acetabulum and some hairs, and the posterior plates with about 8 or 10 acetabula each.

Male.—About 0·60 mm. in length, with from 8 to 12 acetabula on each genital plate. Seminal pocket more distinctly marked than P. conglobata, Koch, with the anus well behind the plates. There are three long swimming-hairs at distal end of patella, and a straight-pointed claw to tarsus of third leg. (Plate XXXIX., figs. 66-72.)

Localities.—Common.

16. *Piona circularis*, Pier.

Female.—About 1·30 mm. in length, of a pale straw colour. Genital plates sickle-shaped, each divided by a space into an anterior and posterior plate; each posterior plate with from 12 to 14 acetabula.

Male.—About 0·82 mm. in length. Colour, a pale straw yellow, as in female. Seminal pocket cherry-shaped, broader than long, with about 12 acetabula on each plate.

Three swimming-hairs to distal end of patella. (Plate XL., figs. 73-78.)

Localities.—Not common.

17. *Piona conglobata*, Koch.

Female.—About 1·10 mm. in length, brownish-yellow in colour, with dark-brown markings on dorsal surface. Skin marked with rather coarse lines. Epimera, palpi and legs generally of a pale-blue colour, with the tarsi sometimes inclined to red. Locality no doubt has a great deal to do with the intensity of the colouring; some specimens taken on Wimbledon Common were very decided in colour, while others taken at the same time from the Warren, Folkestone, were very faint. Palpi thicker than trochanters of first pair of legs, and strong in structure; two hair pegs on inner flexor edge of fourth segment of each palpus rather close together. Acetabula nearly all free on the ventral surface, only one or two being on hair plates; arrangement of acetabula very irregular. Legs well supplied with bristles and swimming-hairs; claws rather prominent. First pair of legs measure about 0·80 mm.; fourth pair about 1·02 mm.

Male.—Measures about 0·60 mm. Acetabula on plates which surround the anus, and not free on the body surface as in the case of the female. Width across the plates 0·32 mm. Claws on third pair of legs very short and close to tarsi. Patella on each of fourth pair of legs, with three swimming-hairs at distal end. (Plate XLI., figs. 79-84.)

Localities.—Very common.

18. *Piona stjördalensis*, Sig Thor.

Female.—About 1·40 mm. in length. Colour yellow with dark-brown markings. Genital plates tongue-shaped, with from 20 to 25 acetabula each, all nearly of one size.

Male.—About 1·20 mm. in length, with same colouring as female. Seminal pocket trefoil-shaped; genital plates, with about 25 acetabula on each plate. There is a hook-like claw to tarsus of third pair of legs, but not so prominent or so nicely curved as in the case of P. nodata, Müll. Distal end of patella with only five long swimming-hairs. (Plate XLII., figs. 85-90.)

Localities.—Norfolk Broads. Rare.

19. *Piona paucipora*, Sig Thor.

Female.—About 1·20 mm. in length. Colour very pale and transparent, with very faint markings on dorsal surface. Chitinous parts colourless. Genital plates sickle-shaped, with about 10 acetabula on each plate, and some free on the ventral surface.

Male.—About 0·96 mm. in length. It can easily be identified from Piona males at present known in Britain by the wide space between the epimera, the third and fourth pair being as wide apart as in the females. (Plate XLIII., figs. 91-97.)

20. *Piona uncata*, Koen.

Female.—About 1·80 mm. in length. Colour yellow with brown markings, Malpighian vessel in some cases red or light yellow. All chitinous parts blue-grey. Legs well supplied with swimming-hairs. Most prominent feature is the number of hair pegs on the flexor edge of fourth segment of palpus (see fig. 100). Palpi thicker than trochanters of first pair of legs. Genital plates disc-shaped, with from 15 to 25 acetabula each, two on each plate being larger than the others. In Koenike's figure of the female there are several small hair pores between the genital plate and the front part of the genital aperture, but in the specimen from which my drawing was made there are only two on each side.

Male.—About 1·20 mm. in length; similar in colour to female. Short, thick, blunt-looking claws to tarsi of third pair of legs. Five hairs to distal end of patella. Genital area with the usual plates, and trefoil-shaped seminal pocket; each plate with from 20 to 24 acetabula. (Plate XLIV., figs. 98-104.)

Localities.—Not common.

21. *Piona aduncopalpis*, Pier.

Female.—Body about 1·30 mm. in length, of a light red colour with dark-brown markings. Malpighian vessel a light yellow colour, but sometimes very irregular in its position on the dorsal surface. Legs a straw-yellow colour, long and well supplied with swimming-hairs; retractile claws small. Palpus quite different from any previously referred to in this communication (fig. 107). Second segment very thick and strong, the extensor margin being carried forward beyond the front of the flexor edge. Third segment very short and small, making it almost impossible to open the palpi more than is shown in figure. It is from this hooked shape that Piersig named it. Two long hairs on the flexor edge of fourth segment, one behind the other. No genital plates, the acetabula being free on the ventral surface in both sexes. This is a peculiarity met with in no other British species of Piona; P. conglobata, Koch., ♀, comes very near to it in this respect, but it always has one or more acetabula on hair plates. About 12 acetabula on each side of genital aperture.

Male.—About 0·75 mm. in length; a little darker in colour than the female. Malpighian vessel more regular in shape and position than in the female. Each of the third pair of legs is terminated by a strong claw. Three swimming-hairs on the distal end of patella of each of the fourth pair of legs. (Plate XLV., figs. 105-111.)

Localities.—Not common, but has been found in Lincolnshire and on the Norfolk Broads.

22. *Piona elegans*, n. sp.

This, to the best of my knowledge, is an undescribed species. I cannot find any description which agrees with it, neither will it fit in with Dr Piersig's key to this genus.

Female.—About 1·60 mm. in length. Colour a yellowish brown; all chitinous parts a pale slatey-blue; very dark-brown, well-defined and regular markings on dorsal surface.

The legs have nothing remarkable about them. Palpi strong and about $1\frac{1}{2}$ times as thick as trochanters of first pair of legs, with two hairs on fourth segment, one being on a very strong hair peg on flexor edge. Genital plates irregular disc-shaped, with from 10 to 16 acetabula each, one or more being much larger than the others on each plate.

Male.—About 1·10 mm. in length; about same colour as female. Seminal pocket heart-shaped, with the margins almost extending out into the trefoil form we have noticed in some others; about 12 acetabula on each plate. Four swimming-hairs on patella of fourth leg. (Plate XLVI., figs. 112-118.)

On account of its beautiful form and colouring, I propose to call it Piona elegans.

Localities.—Norfolk Broads, common.

[Chart

CHART SHOWING DISTRIBUTION OF PIONA.

	Scotland.	Ireland.	Wales.	Norfolk Broads.	Suffolk.	Essex.	Surrey.	Middlesex.	Lincolnshire.	Derbyshire.	Berks.	Bucks.	Kent.	Leicestershire.
1. P. fuscata	×	×	...	×	...	...	×	...	×	...	×	...	...	...
2. P. laminata	...	...	...	×	...	...	...	...	...	...	...	...	...	...
3. P. Neumani	...	...	...	×	...	...	...	...	...	...	...	...	...	...
4. P. obturbans	×	...	...	×	...	...	...	×	×	...	×	×	...	...
5. P. disparilis	...	...	...	...	...	...	...	...	...	...	...	×	×	...
6. P. rotundoides	...	...	...	×	...	...	×	...	...	...	...	...	...	...
7. P. rotunda	...	...	...	×	...	×	×	...	...	...	×	×	...	...
8. P. alata	...	...	...	...	...	...	...	...	×	...	...	...	...	...
9. P. fallax	...	...	...	...	...	...	...	...	×	...	...	...	...	...
10. P. discrepans	×	...	...	...	...	×	...	...	×	...	×	...	...	...
11. P. longipalpis	×	×	...	×	...	...	...	...	×	...	×	...	...	...
12. P. nodata	×	×	×	×	...	×	...	×	×	...	...	...	...	×
13. P. nodata var. imminuta	...	...	...	×	×	...	...	...	×	...	...	...	...	...
14. P. carnea	×	...	...	×	×	...	...	...	×	...	×	...	...	...
15. P. rufa	×	...	...	×	...	...	×	...	×	...	...	...	...	...
16. P. circularis	×	...	...	...	...	...	...	...	...	...	...	...	...	...
17. P. conglobata	×	×	...	×	×	...	×	×	×	×	×	...	...	×
18. P. stjördalensis	...	×	...	×	...	...	...	...	...	...	...	...	...	...
19. P. paucipora	×	...	...	...	...	...	...	...	...	...	...	...	×	...
20. P. uncata	×	...	...	×	...	...	...	...	...	...	...	...	...	...
21. P. aduncopalpis	×	...	...	×	...	...	...	...	×	...	...	...	...	...
22. P. elegans	...	...	...	×	...	...	...	...	...	...	...	...	...	...

KEY TO HELP IDENTIFICATION OF SPECIES OF PIONA.

FEMALE.

1. With acetabula entirely free, none on special plates. 21. **Piona aduncopalpis** ♀
   With acetabula partly free and partly on special plates . . 2
   With acetabula entirely on special plates 4

2. With one sickle-shaped genital plate on each side of genital fissure, and one or more acetabula free within the curve of the plate 3
   With two plates on each side of genital fissure, sickle-shaped, with division, and one or more free acetabula. 19. **Piona paucipora** ♀
   Nearly all acetabula free, 3 or 4 only on small hair plates. 17. **Piona conglobata** ♀

3. All chitinous parts a brownish yellow and 15 to 20 acetabula on each plate . . . . 7. **Piona rotunda** ♀
   Chitinous parts generally blue, with 18 to 25 acetabula on each plate . . . . 4. **Piona obturbans** ♀
   With from 30 to 40 acetabula on each plate 6. **Piona rotundoides** ♀
   With from 50 to 60 acetabula on each plate . 5. **Piona disparilis** ♀

4. With two plates on each side of genital fissure 5
   With one sickle-shaped plate on each side of genital fissure . 6
   With one disc-shaped plate on each side of genital fissure . . 7
   With one tongue-shaped plate on each side of genital fissure . 8
   With one large irregular-shaped slate-blue plate on each side of genital fissure, having a large number of small acetabula, two being distinctly larger than the others 11. **Piona longipalpis** ♀

5. The two posterior plates irregularly tongue-shaped, having about 20 acetabula each . . . 10. **Piona discrepans** ♀
   The two posterior plates irregularly tongue-shaped, having about 10 acetabula each . . . . . . 15. **Piona rufa** ♀
   The two posterior plates sickle-shaped, having about 13 acetabula each . . . . 16. **Piona circularis** ♀

6. Irregular sickle-shaped plates, having about 9 acetabula each. 1. **Piona fuscata** ♀
   With much wider irregular sickle-shaped plates, having about 17 acetabula each . . . . . . 2. **Piona laminata** ♀

7. Genital plates disc-shaped, with two acetabula larger than the others on each plate. Palpus with four or more hair pegs on flexor edge of fourth segment . . 20. **Piona uncata** ♀

Genital plates disc-shaped, acetabula nearly one size, and from 18 to 24 on each plate, numerous small hairs round outer curve of genital lips . . . . . 14. **Piona carnea** ♀
Genital plates elongated, having from 10 to 15 acetabula, one or more being larger than others on each plate 22. **Piona elegans** ♀

8. Genital plates tongue-shaped, with about 30 acetabula all one size on each plate . . . . 9. **Piona fallax** ♀
Genital plates tongue-shaped, with from 20 to 25 acetabula. 18. **Piona stjördalensis** ♀
Genital plates tongue-shaped, with from 25 to 35 acetabula each, 2 acetabula on each plate being larger than others. 12. **Piona nodata** ♀

MALE.

1. With acetabula entirely free, none on special plates. 21. **Piona aduncopalpis** ♂
With one or more acetabula free, remainder on special plates. 19. **Piona paucipora** ♂
With all acetabula on special plates 2

2. With cherry-shaped seminal pocket 3
With trefoil-shaped seminal pocket 4
With small seminal pocket, more or less pointed at each end . 5
With heart-shaped seminal pocket 6
With reniform seminal pocket, much broader than long. 3. **Piona Neumani** ♂

3. With 9 swimming-hairs at distal end of each patella. 14. **Piona carnea** ♂
With 3 swimming-hairs at distal end of each patella. 16. **Piona circularis** ♂
4. With 6 or 7 swimming-hairs at distal end of each patella, and corkscrewlike claw on third tarsus; two acetabula larger than others on each genital plate . . . 12. **Piona nodata** ♂
With 5 swimming-hairs at distal end of each patella, and smaller claw than P. nodata on third tarsus; anus almost within the bay of genital plates . . . . 18. **Piona stjördalensis** ♂
With 5 swimming-hairs at distal end of each patella, and anus well outside the bay of genital plates; claws short and close to tarsi . . . . 20. **Piona uncata** ♂
With only 3 hairs at distal end of each patella 1. **Piona fuscata** ♂

5. With 2 hairs at distal end of each patella, and anus on genital plate; outer edge of genital plates extending along margin of posterior epimera as far as fourth leg 10. **Piona discrepans** ♂
With 3 swimming-hairs at distal end of each patella, and anus on genital plate . . . . . . 17. **Piona conglobata** ♂

With 3 swimming-hairs at distal end of each patella, and anus within the small bay on posterior margin of plates.
4. **Piona obturbans** ♂

With the points of seminal pocket reaching both anterior and posterior edges of genital plates . . . 8. **Piona alata** ♂

With 3 swimming-hairs at distal end of each patella. Genital plates not extended so far as posterior point of fourth epimera, with less than 12 acetabula on each plate . . 15. **Piona rufa** ♂

With 3 swimming-hairs at distal end of each patella. Genital plates extended just beyond the posterior point of fourth epimera, with from 24 to 30 acetabula on each plate.
7. **Piona rotunda** ♂

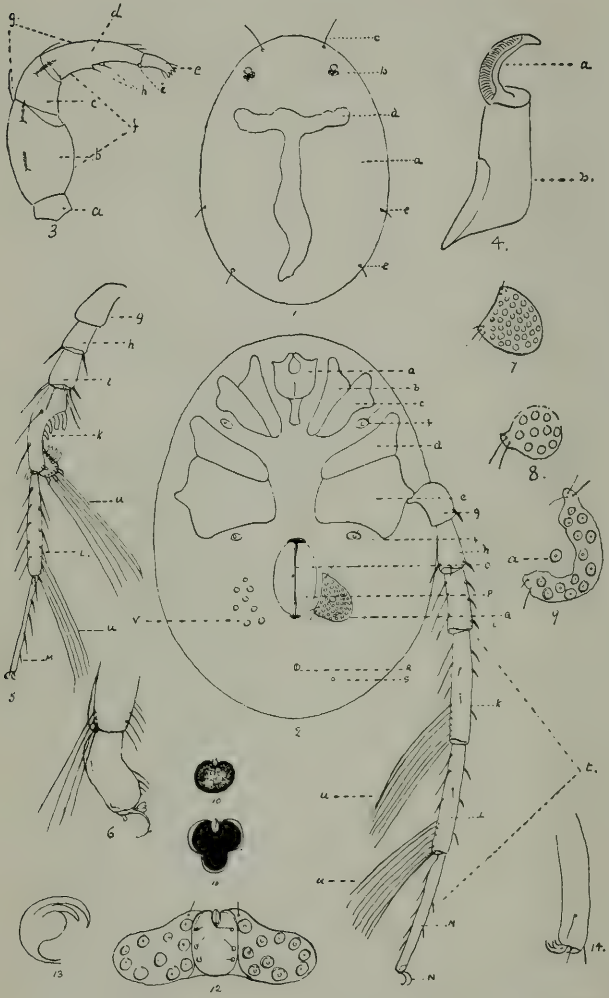
Genital plates much more extended, with 30 to 35 acetabula on each plate . . . . . . 6. **Piona rotundoides** ♂

6. With 8 swimming-hairs at distal end of each patella. Large wing-shaped genital plates, with a large number of acetabula.
11. **Piona longipalpis** ♂

With only 4 hairs at distal end of each patella 22. **Piona elegans** ♂

BRITISH MUSEUM NATURAL HISTORY

PLATE XXIX.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.



Piona External structure. *Chas D. Soar 1906.*

PLATE XXIX.

External Structure.

Fig. 1. Dorsal surface of female.
- *a* Dorsal surface.
- *b* Eyes.
- *c* Antenniform bristles.
- *d* Malpighian vessel.
- *e* Dermal glands.

Fig. 2. Ventral surface of female.
- *a* Maxillary shield.
- *b–e*; 1st (*b*), 2nd (*c*), 3rd (*d*), and 4th (*e*) epimera.
- *f* Epimeral glands.
- *g* Coxa.
- *h* Trochanter.
- *i* Femur.
- *k* Patella.
- *l* Tibia.
- *m* Tarsus.
- *n* Retractile claws.
- *o* Genital cleft (vulva).
- *p* Genital lips.
- *q* Genital plates with acetabula.
- *r* Anus.
- *s* Anal glands.
- *t* Fourth leg of female.
- *u* Swimming hairs.
- *v* Acetabula without special plates.

Fig. 3. Palpus.
- *a–e*; 1st (*a*), 2nd (*b*), 3rd (*c*), 4th (*d*), and 5th (*e*) segments.
- *f* Flexor margin.
- *g* Extensor margin.
- *h* Papillæ with setæ.
- *i* Peg or tooth without setæ.

Fig. 4. Mandible.
- *a* Claw.
- *b* Manubrium.

Fig. 5. Fourth leg of male. (Letters correspond with those of Fig 2.)

Fig. 6. Terminal segment of third leg of male. (Fig. 14 is another form.)

Fig. 7. Tongue-shaped genital plate of female.

Fig. 8. Disc-shaped genital plate of female.

Fig. 9. Sickle-shaped plate of female, with acetabula on plate.
- *a* Acetabula free within the curve of the sickle-shaped plate. There may be one or more such acetabula according to the species.

Fig. 10. Cherry-shaped seminal pocket of male.

Fig. 11. Trefoil-shaped seminal pocket of male.

Fig. 12. Genital area of male without any distinct seminal pocket.

Fig. 13. Common form of retractile claw.

Fig. 14. Terminal segment of third leg of male. (Fig. 6 is another form.)

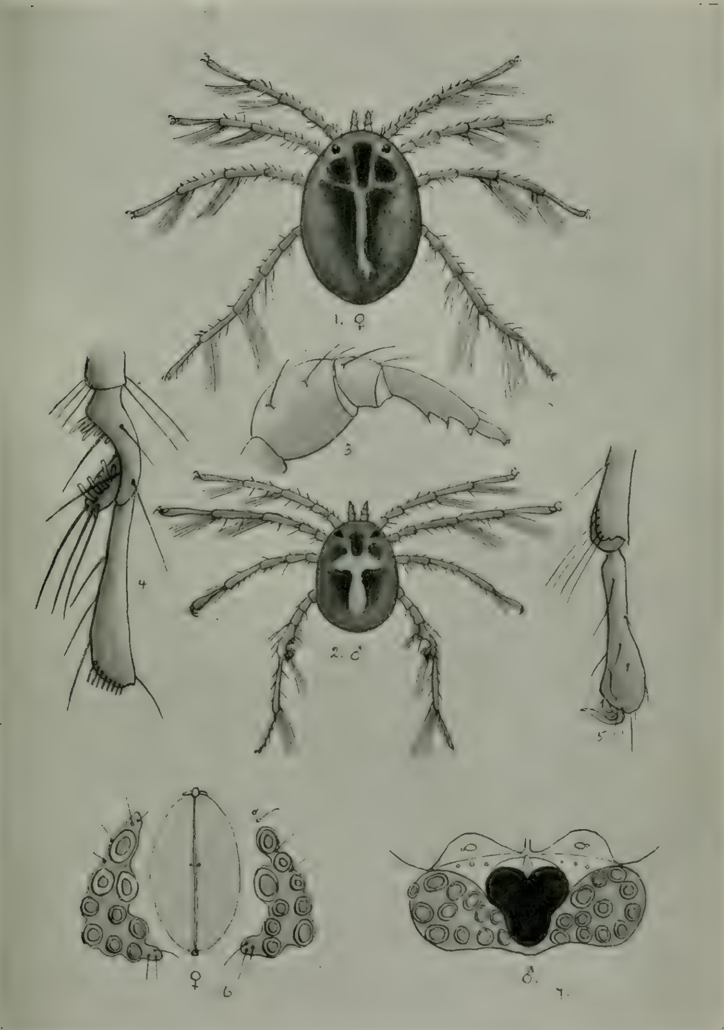
PLATE XXX.

PIONA FUSCATA, Herm.

Fig.

1. Dorsal surface, ♀.
2. Dorsal surface, ♂.
3. Palpus, ♀.
4. Patella and tibia of fourth leg, ♂.
5. Tarsus and claw of third leg, ♂.
6. Genital area, ♀.
7. Genital area, ♂.

PLATE XXX.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.



From Drawings by *Chas. D. Soar.*

BRITISH MUSEUM NATURAL HISTORY

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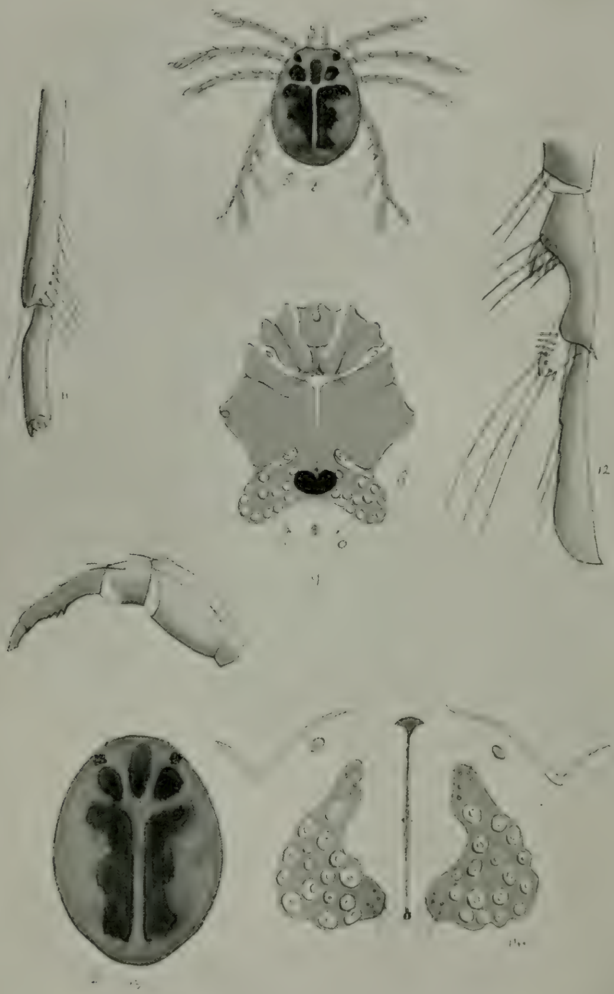
NATURAL HISTORY

PLATE XXXI.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.



From Drawings by *Chas. D. Soar.*

PLATE XXXI.

PIONA NEUMANI, Koen.

Fig.

8. Dorsal surface, ♂.
9. Epimera and genital area, ♂.
10. Palpus, ♂.
11. Tarsus of third leg, ♂.
12. Patella of fourth leg, ♂.

PIONA LAMINATA, Sig Thor.

13. Dorsal surface, ♀.
14. Genital area, ♀.

PLATE XXXII.

PIONA OBTURBANS, Pier.

(18 *to* 25 *acetabula.*)

Fig.
15. Dorsal surface, ♀.
16. Genital area, ♀.

PIONA DISPARILIS, Koen.

(50 *to* 60 *acetabula.*)

17. Dorsal surface, ♀.
18. Genital area, ♀.

PIONA ROTUNDOIDES, Sig Thor.

(30 *to* 40 *acetabula.*)

19. Dorsal surface, ♀.
20. Genital area, ♀.

PIONA ROTUNDA, Kram.

(15 *to* 20 *acetabula.*)

21. Dorsal surface, ♀.
22. Genital area, ♀.

PLATE XXXII.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.

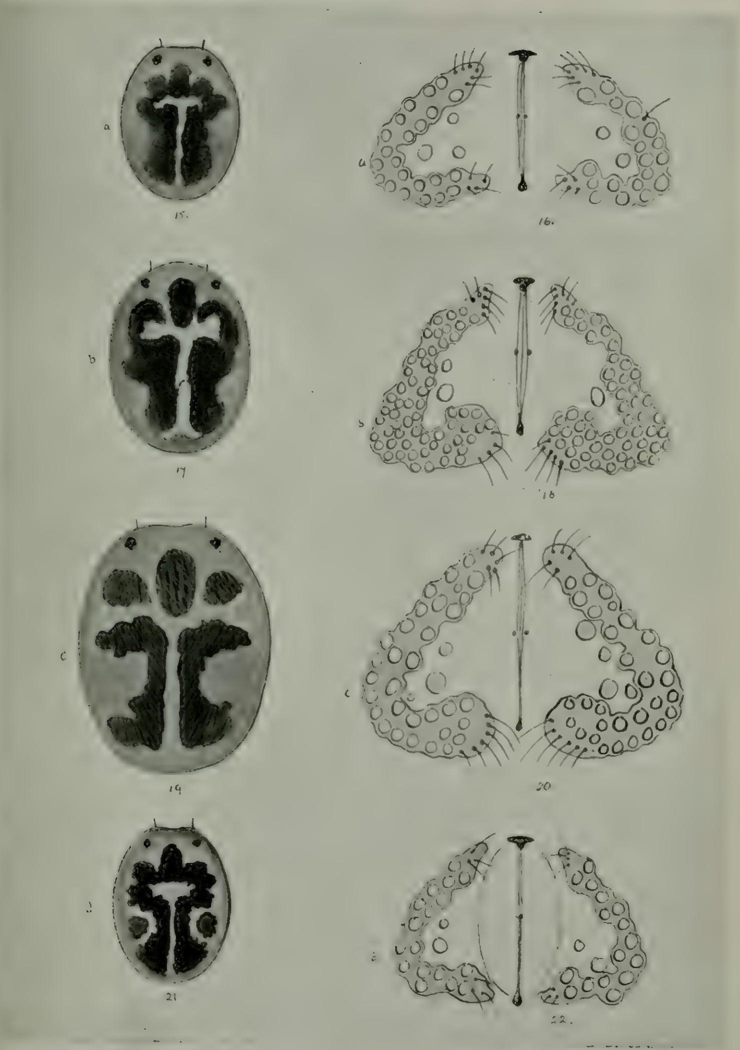


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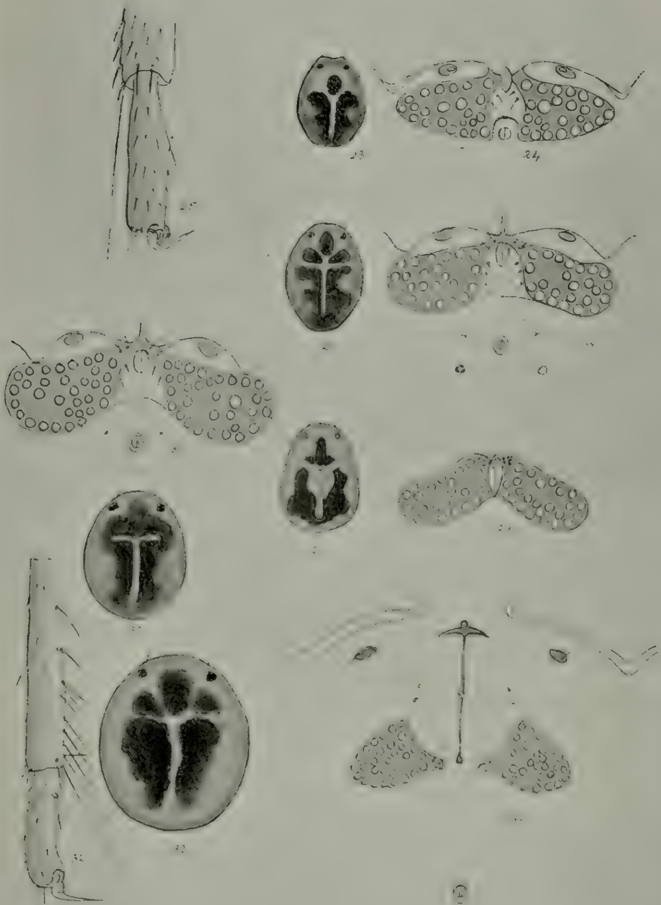
PLATE XXXIII.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.



From Drawings by **Chas. D. Soar.**

PLATE XXXIII.

PIONA OBTURBANS, Pier.

Fig.

23. Dorsal surface, ♂.
24. Genital area, ♂.
25. Tarsus and claw of third leg, ♂.

PIONA ROTUNDA, Kram.

26. Dorsal surface, ♂.
27. Genital area, ♂.

PIONA ALATA, Sig Thor.

28. Dorsal surface, ♂.
29. Genital area, ♂.

PIONA ROTUNDOIDES, Sig Thor.

30. Dorsal surface, ♂.
31. Genital area, ♂.
32. Tarsus and claw of third leg, ♂.

PIONA FALLAX, Karl Thon.

33. Dorsal surface, ♀.
34. Genital area, ♀.

PLATE XXXIV.

Piona discrepans, Koen.

Fig.

35. Dorsal surface, ♀.

36. Dorsal surface, ♂.

37. Patella, ♂.

38. Tarsus and claw of third leg, ♂.

39. Palpus, ♀.

40. Genital area, ♀.

41. Genital area, ♂.

PLATE XXXIV.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.

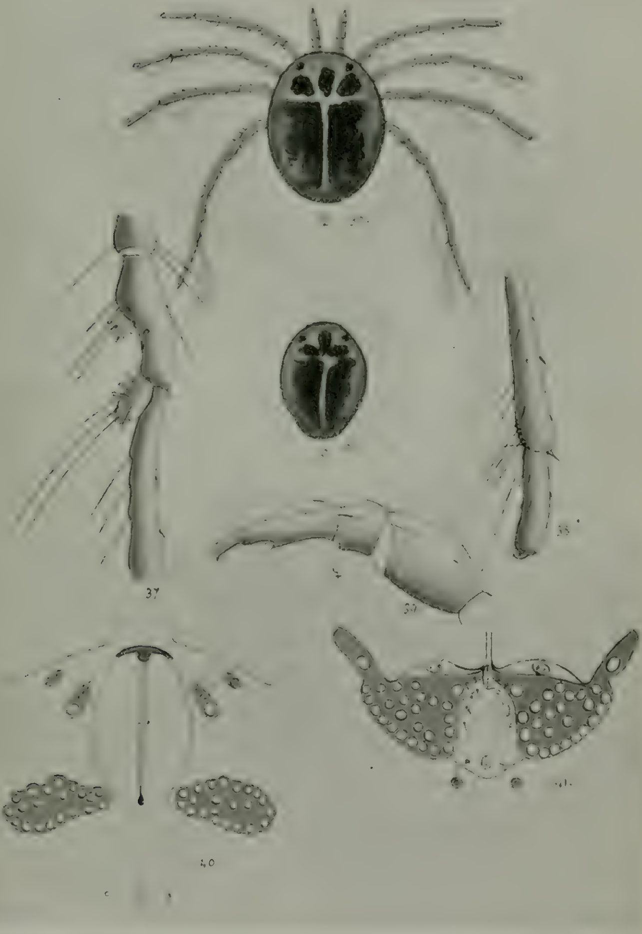


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PLATE XXXV.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.

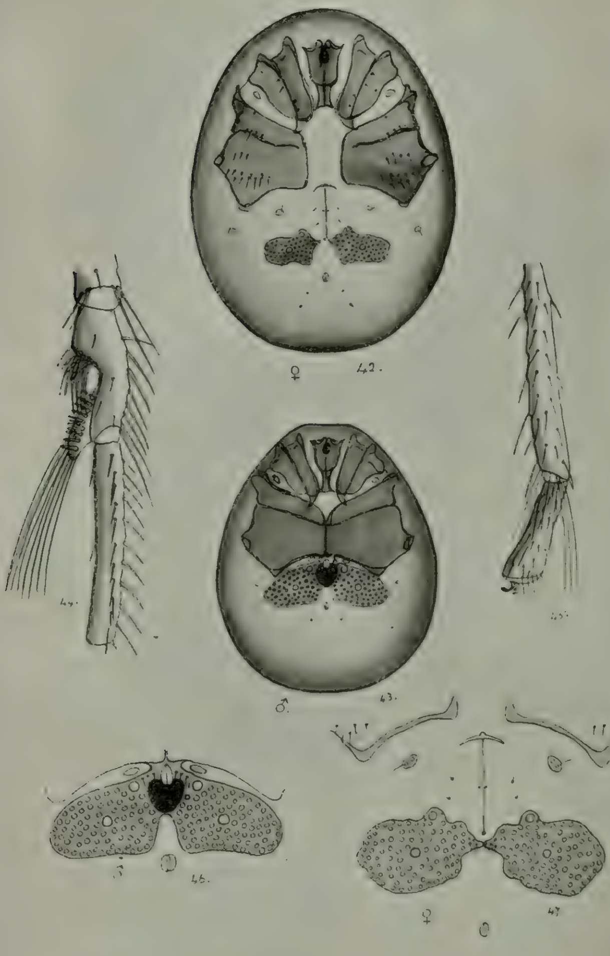

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PLATE XXXV.

PIONA LONGIPALPIS, Krend.

Fig.

42 Ventral surface, ♀.

43. Ventral surface, ♂.

44. Patella, ♂.

45. Tarsus and claw of third leg, ♂.

46. Genital area, ♂.

47. Genital area, ♀.

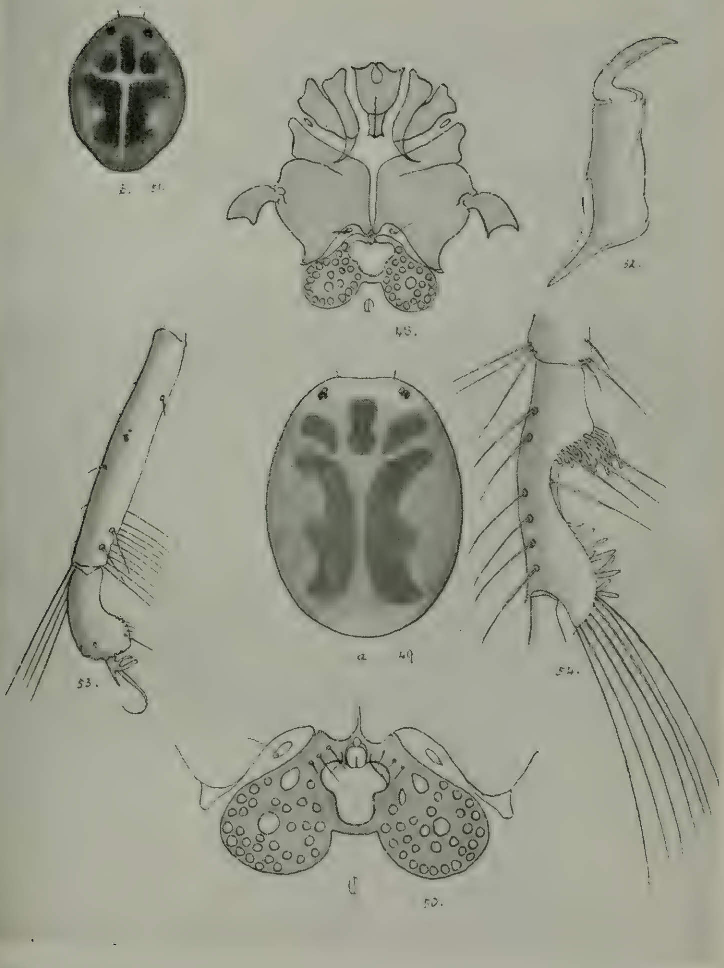
PLATE XXXVI.

PIONA NODATA, Müll.

Fig.

48. Ventral surface, ♂.
49. Dorsal surface, ♂.
50. Genital area, ♂.
51. Dorsal surface, var. imminuta, ♂.
52. Mandible, ♂.
53. Tarsus and claw of third leg, ♂.
54. Patella of fourth leg, ♂.

PLATE XXXVI.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.



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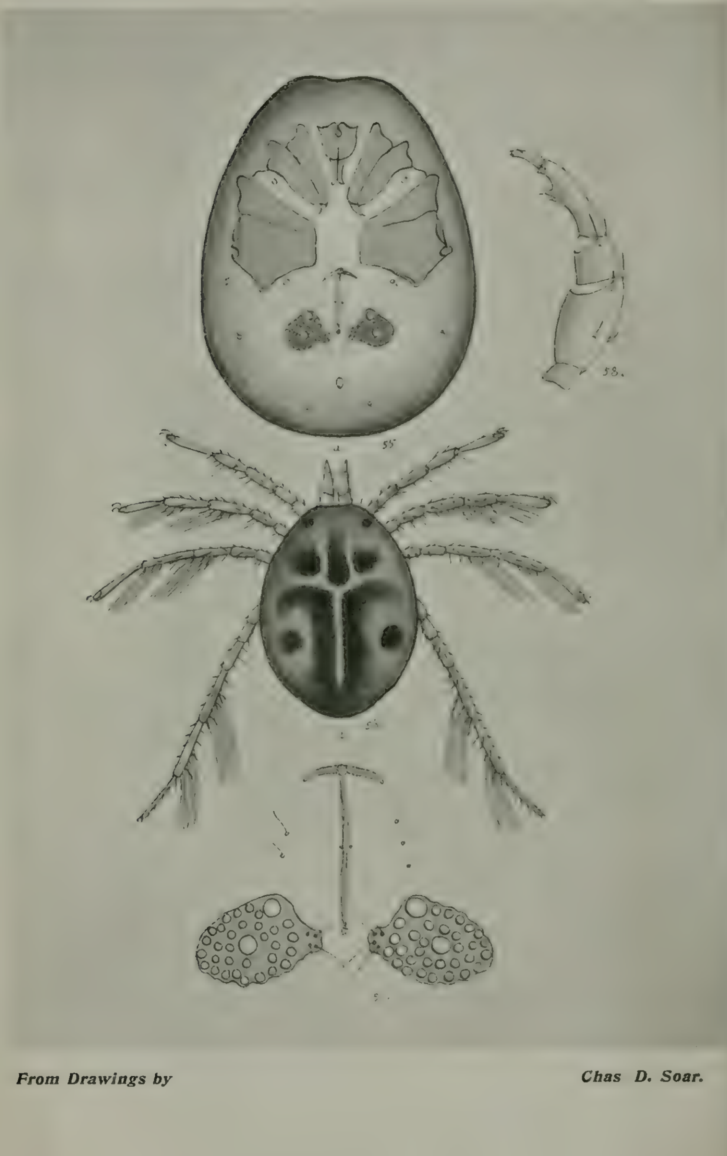
NATURAL HISTORY

PLATE XXXVII.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.



From Drawings by *Chas D. Soar.*

PLATE XXXVII.

PIONA NODATA, Müll.

Fig.

55. Ventral surface, ♀.

56. Dorsal surface, var. imminuta, ♀.

57. Genital area, ♀.

58. Palpus, ♀.

PLATE XXXVIII.

PIONA CARNEA, Koch.

Fig.

59. Dorsal surface, ♀.

60. Ventral surface, ♂.

61. Tarsus and claw of third leg, ♂.

62. Patella of fourth leg, ♂.

63. Palpus, ♀.

64. Genital area, ♂.

65. Genital area, ♀.

PLATE XXXVIII.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.

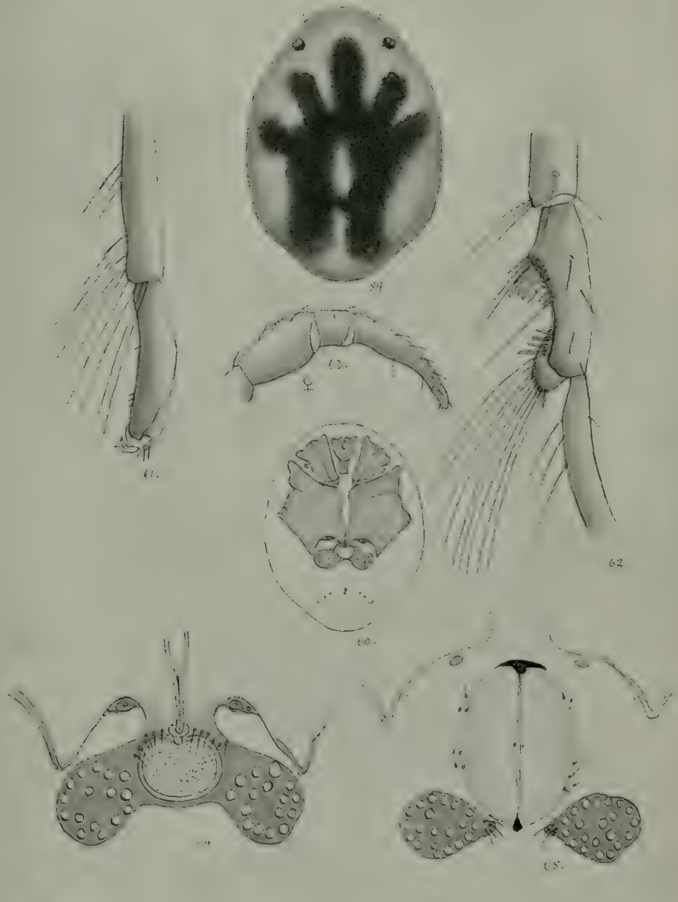


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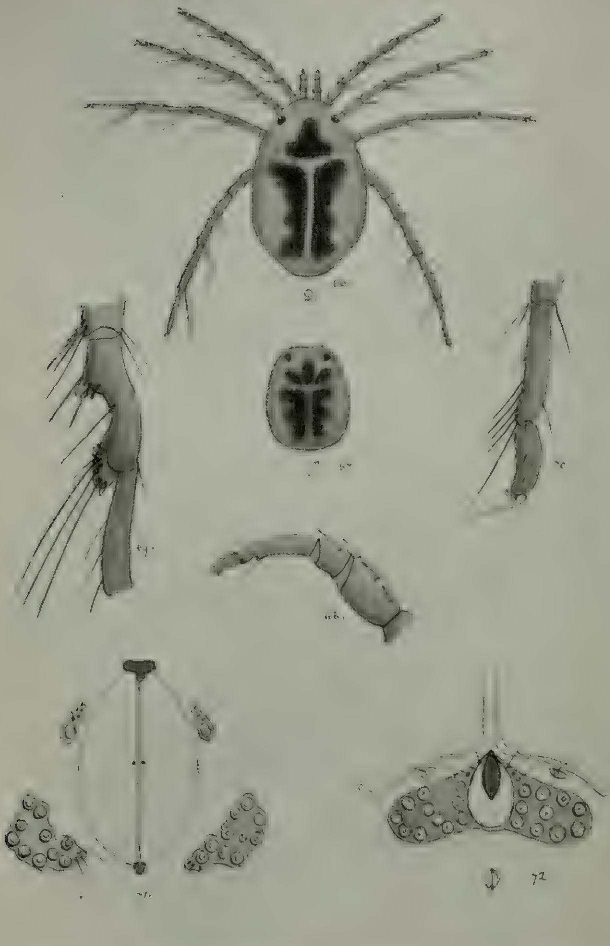
PLATE XXXIX.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.



From Drawings by *Chas. D. Soar.*

PLATE XXXIX.

PIONA RUFA, Koch.

Fig.
66. Dorsal surface, ♀.
67. Dorsal surface, ♂.
68. Palpus, ♀.
69. Patella, ♂.
70. Tarsus of third leg, ♂.
71. Genital area, ♀.
72. Genital area, ♂.

PLATE XL.

PIONA CIRCULARIS, Pier.

Fig.
73. Ventral surface, ♀.
74. Ventral surface, ♂.
75. Patella of fourth leg, ♂.
76. Tarsus of third leg, ♂.
77. Genital area, ♀.
78. Genital area, ♂.

PLATE XL.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.

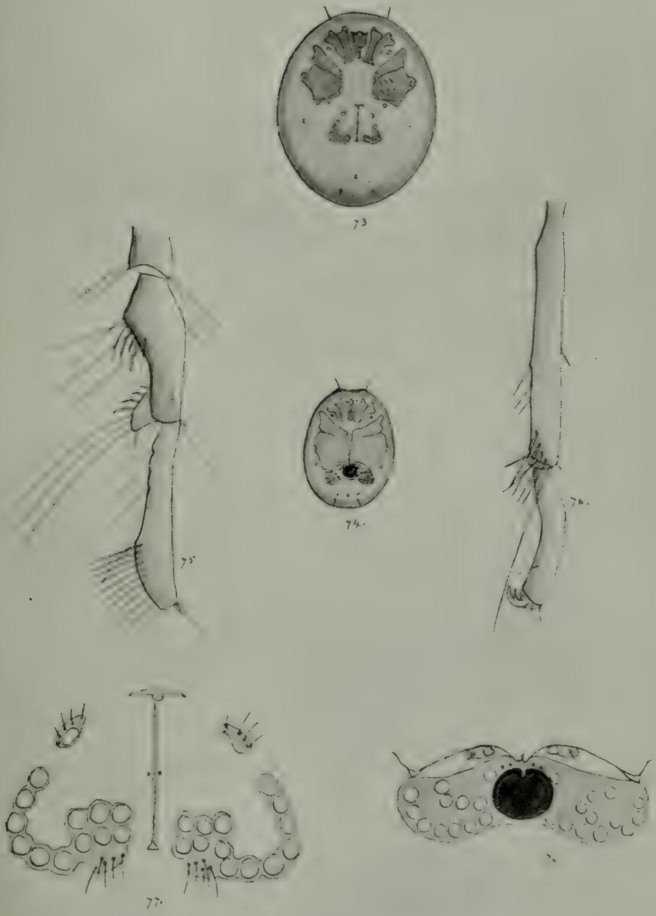


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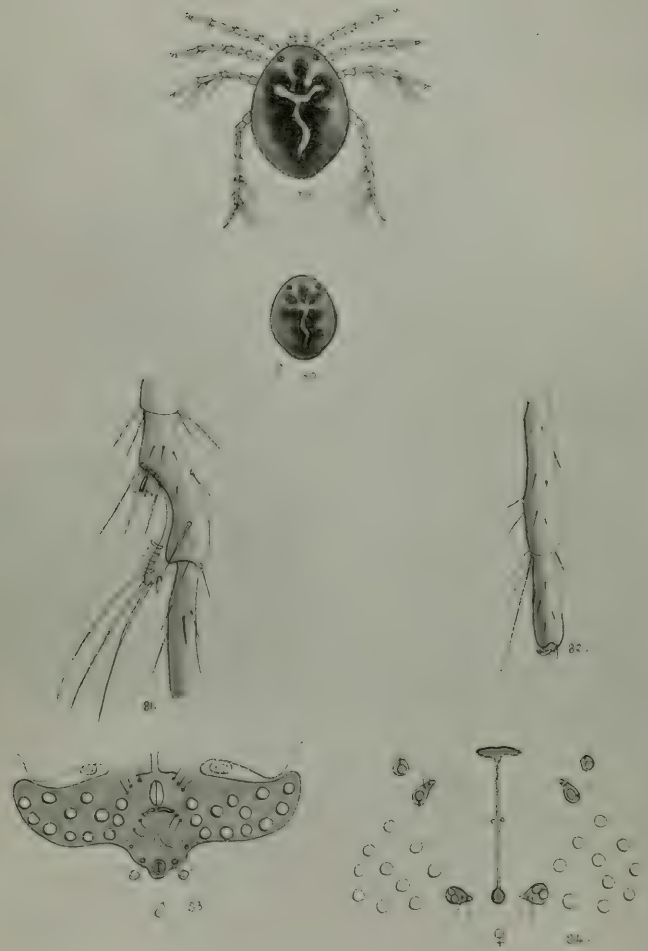
PLATE XLI.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.



From Drawings by *Chas. D. Soar.*

PLATE XLI.

PIONA CONGLOBATA, Koch.

Fig.

79. Dorsal surface, ♀.

80. Dorsal surface, ♂.

81. Patella of fourth leg, ♂.

82. Tarsus of third leg, ♂.

83. Genital area, ♂.

84. Genital area, ♀.

PLATE XLII.

Piona stjördalensis, Sig Thor.

Fig.

85. Dorsal surface, ♀.
86. Dorsal surface, ♂.
87. Tarsus of third leg, ♂.
88. Patella of fourth leg, ♂.
89. Genital area, ♀.
90. Genital area, ♂.

PLATE XLII.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.

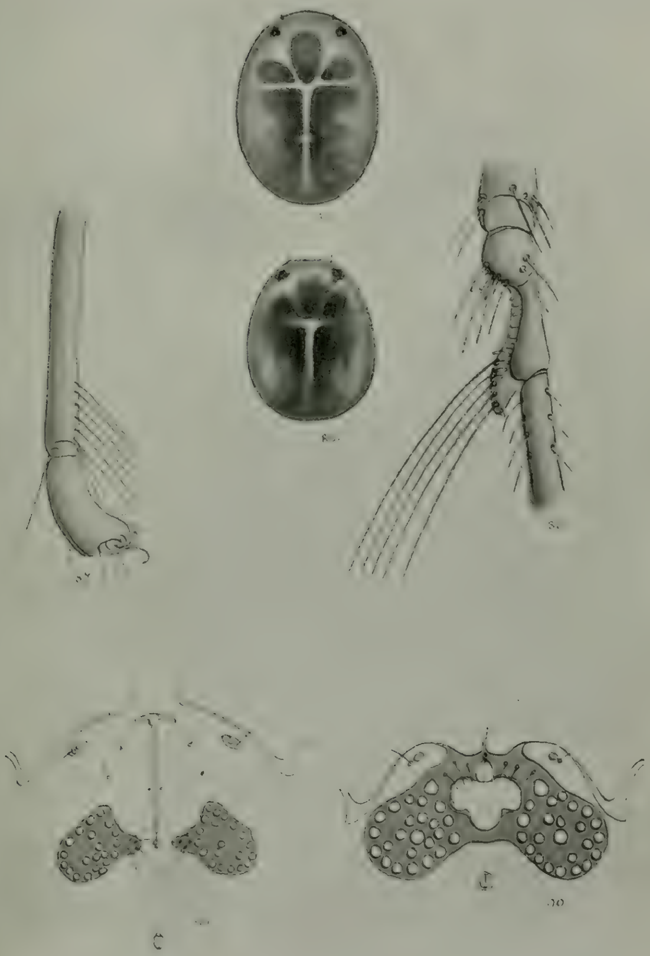


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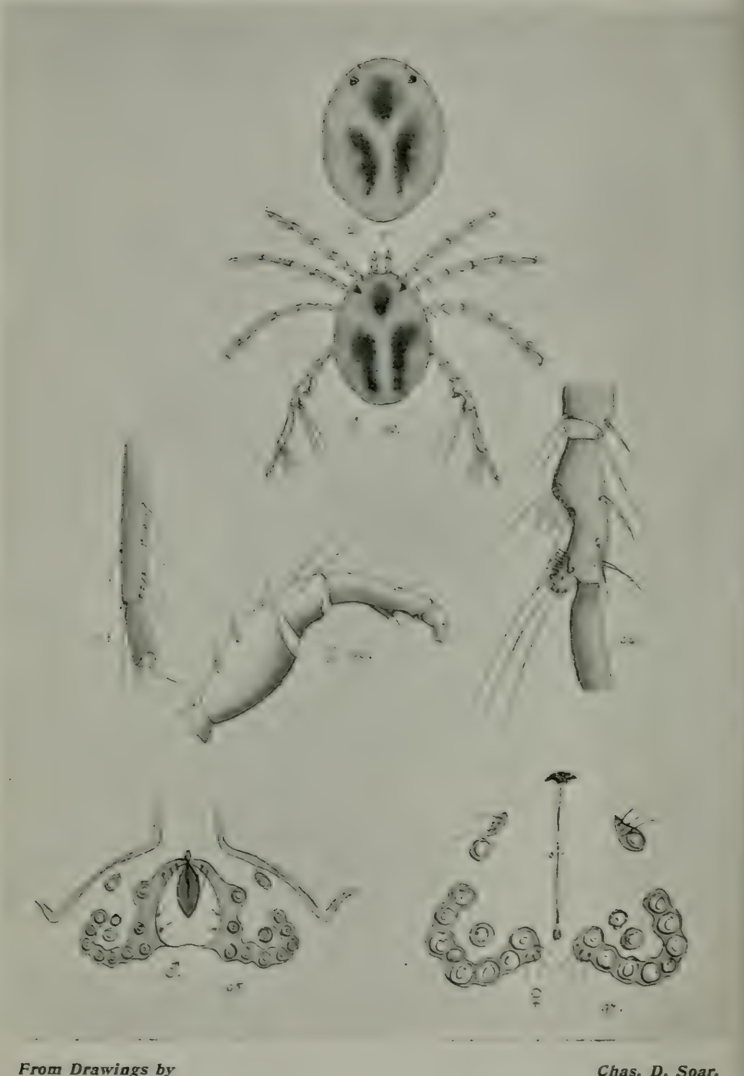
PLATE XLIII.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.



From Drawings by *Chas. D. Soar.*

PLATE XLIII.

Piona paucipora, Sig Thor.

Fig.

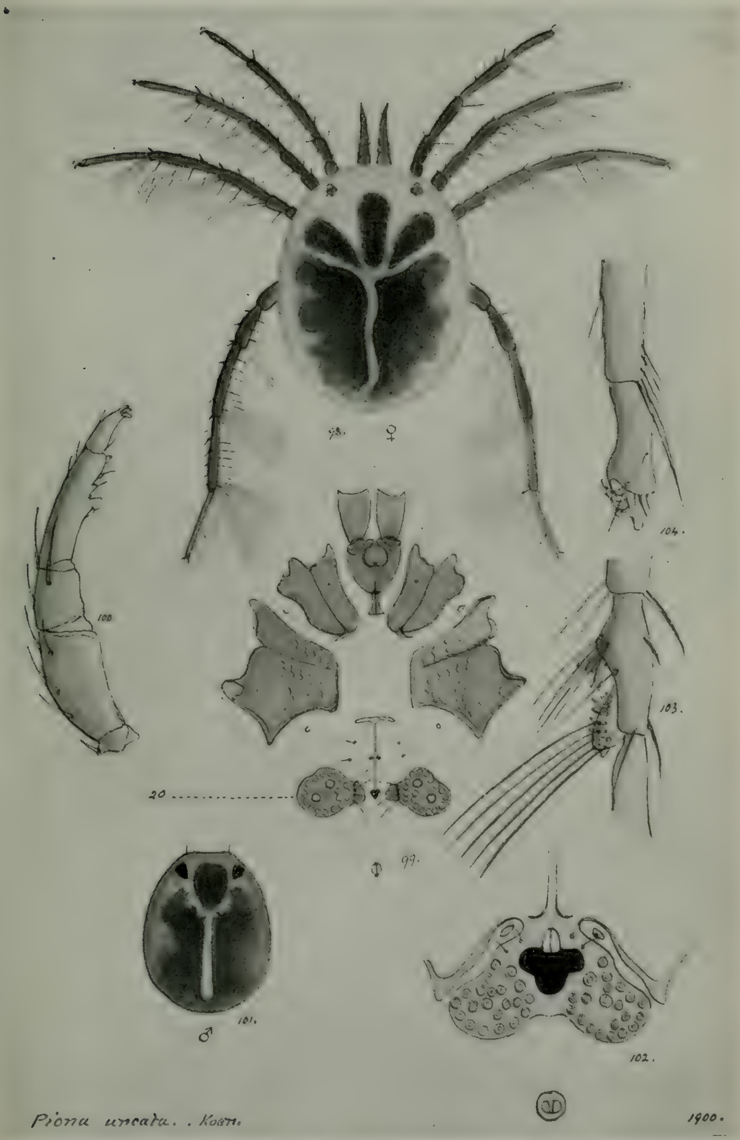
91. Dorsal surface, ♀.
92. Dorsal surface, ♂.
93. Tarsus of third leg, ♂.
94. Patella of fourth leg, ♂.
95. Genital area, ♂.
96. Palpus, ♂.
97. Genital area, ♀.

PLATE XLIV.

PIONA UNCATA, Koen.

Fig.
98. Dorsal surface, ♀.
99. Ventral surface, ♀.
100. Palpus, ♀.
101. Dorsal surface, ♂.
102. Genital area, ♂.
103. Patella of fourth leg, ♂.
104. Tarsus of third leg, ♀.

PLATE XLIV.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.



From Drawings by Chas. D. Soar.

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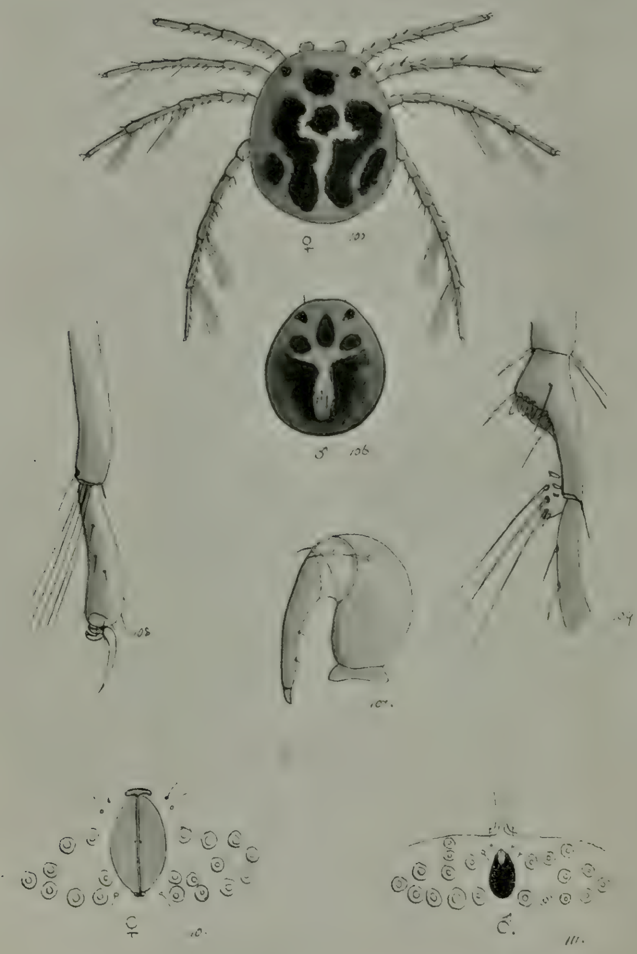
PLATE XLV.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.



From Drawings by *Chas. D. Soar.*

PLATE XLV.

PIONA ADUNCOPALPIS, Pier.

Fig.

105. Dorsal surface, ♀.

106. Dorsal surface, ♂.

107. Palpus, ♀.

108. Tarsus of third leg, ♂.

109. Patella of fourth leg, ♂.

110. Genital area, ♀.

111. Genital area, ♂.

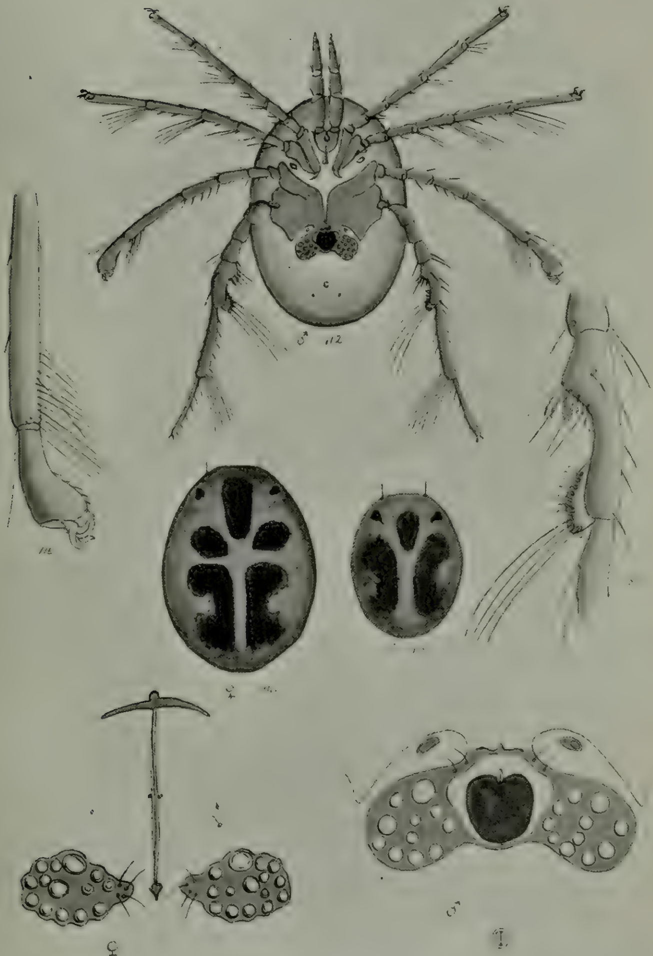
PLATE XLVI.

PIONA ELEGANS, *n. sp.*

Fig.
112. Ventral surface, ♂.
113. Dorsal surface, ♂.
114. Dorsal surface, ♀.
115. Patella of fourth leg, ♂.
116. Tarsus of third leg, ♂.
117. Genital area, ♀.
118. Genital area, ♂.

NATURAL HISTORY

PLATE XLVI.—BRITISH HYDRACHNIDÆ: THE GENUS PIONA.



From Drawings by *Chas. D. Soar.*

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NATURAL HISTORY

VII.—*SCOTTISH HYDRACHNIDS—SPECIES COLLECTED DURING* 1906.

By Mr WM. WILLIAMSON.

(*Read April 24, 1907.*)

The Hydrachnids recorded in the following list were collected since my last communication to this Society. With the exception of Possil, none of the localities noted had been visited by me previously for the purpose of collecting Hydrachnids.

For convenience, the nomenclature followed is that of 'Hydrachnidæ u. Halacaridæ,' Piersig u. Lohman (*Das Tierreich*, Lief 13), with the exception of *Piona discrepans*, Koen., as Koenike's specific name must take precedence to that of Piersig.

1. Genus EULAIS, Latr.

**Eulais mülleri*, Koen. Wooden.

2. Genus HYDRACHNA, Müll.

Hydrachna scutata, Pier. Faldonside.

3. Genus DIPLODONTUS, Ant. Dug.

Diplodontus despiciens, Müll. Faldonside.

4. Genus ARRHENURUS, Ant. Dug.

**Arrhenurus globator*, Müll. Wooden; Faldonside.
**Arrhenurus sinuator*, Müll. Faldonside.
Arrhenurus caudatus, De Geer. Auchendinny.
Arrhenurus, sp. (females). Hallyards; Auchendinny; Faldonside.

5. Genus MIDEOPSIS, Neuman.

Mideopsis, a nymphal form found at Wooden.

6. Genus LIMNESIA, C. L. Koch.

Limnesia histrionica, Herm. Faldonside; Otterstone.
**Limnesia undulata*, Müll. Faldonside; Possil.
Limnesia connata, Koen. Possil.
Limnesia maculata, Müll. Wooden; Faldonside.
Limnesia koenikei, Pier. Wooden; Faldonside; Possil; Auchendinny; Lochwinnoch.

7. Genus HYGROBATES, C. L. Koch.

Hygrobates longipalpis, Herm. Wooden; Faldonside; Auchendinny; Lochwinnoch (nymph).

Species marked with an asterisk are new Scottish records.

8. Genus HYDROCHOREUTES, C. L. Koch.

**Hydrochoreutes krameri*, Pier. Wooden; Faldonside; Lochwinnoch (nymph).
**Hydrochoreutes ungulatus*, C. L. Koch. Faldonside; Possil.

9. Genus PIONOPSIS, Pier.

Pionopsis lutescens, Herm. Auchendinny.

10. Genus ATAX (Fabr.), Bruz.

Atax crassipes, Müll. Wooden; Faldonside; Lochwinnoch (nymph).

11. Genus NEUMANIA, Lebert.

Neumania vernalis, Müll. Auchendinny.

12. Genus PIONA, C. L. Koch.

Piona conglobata, C. L. Koch. Wooden; Faldonside; Auchendinny.
Piona carnea, C. L. Koch. Faldonside; Auchendinny.
Piona nodata, Müll. Wooden; Faldonside.
Piona fuscata, Herm. Wooden; Possil.
Piona rufa, C. L. Koch. Wooden; Faldonside.
Piona paucipora, Sig Thor. Faldonside.
**Piona discrepans*, Koen. (*P. thoracifera*, Pier.) Faldonside.

During the past year (1906) I made an attempt to find out if any records relating to Hydrachnidæ existed in the Transactions of the various Natural History Societies in Scotland. Communications were sent to the secretaries of these societies, but the result was disappointing, as only four replies were received—viz., from Mr A. M. Rodger, Perthshire Natural History Museum; Mr A. B. Johnston, Andersonian Naturalists; Mr S. Arnott, Dumfriesshire and Galloway Natural History Society; and Mr Alex. Ross, Natural History Society of Glasgow. These gentlemen reported that their Transactions contained no Hydrachnid records. I take this opportunity of thanking the gentlemen named for their cordial assistance in this matter. It may be fairly safe to assume that practically no records exist other than those appearing in Part IV., Vol. V. of this Society's 'Transactions' and Mr Soar's list in the 'Journal of the Quekett Microscopical Club' in November 1900. Possibly an isolated record may exist here and there, and if so, I shall be glad to be informed of it.

VIII.—*THE GRAMINEÆ UNDER ECONOMIC ASPECTS.*

By Mr RUPERT SMITH.

(*Read April 24, 1907.*)

Our worthy President, in his address at the beginning of last Session, made some commendable observations anent the desirableness of members of this Society taking up the study of some section of Natural History. Many of us, I believe the majority, have not the leisure to make an exhaustive study of any scientific subject, but we can very easily add much to our own knowledge, as well as assist others, by devoting some part of what leisure we may have to the fascinating study of nature. My object, therefore, in this paper is mainly to suggest that some of our members might take up the study of the Gramineæ, by far the most important order of the vegetable kingdom, and on which both man and beast depend for their sustenance.

I shall first take up the grasses used principally by man for food, and afterwards deal with what are called the natural grasses, those on which the lower animals depend for sustenance. A long list of genera and species would be uninteresting, and is unnecessary, especially as I am treating the subject of the Gramineæ more from its economic aspect than from a purely botanical point of view.

The grasses belong to the Monocotyledons, and with the sedges form the sub-class Glumaceæ. In the grasses the spikelet is composed of florets, usually perfect, but sometimes imperfect, or even neuter (without stamens or pistils), solitary or two or more, imbricated on a common axis, and contained within an involucre consisting of 2 (sometimes 1, rarely 0) glumes. The stamens are usually three, with two-celled anthers. The ovary is one-celled, and the stigmas usually two and feathery. The nutritive value of its fruit makes this the most important of all the orders of the vegetable kingdom. To the inhabitants of the temperate zones, wheat is the most important product of this order.

It is the principal cereal crop of Europe and North America, besides many other countries. As in most of the cereals, the wild prototype is unknown, or at least very doubtfully known.

It is now recognised that man's existence on this earth extends back to a period vastly more remote than was formerly supposed,—to an age when his reasoning power would be little more than what we call instinct. One can observe how instinct guides the animal world in the selection of its food, and it is not too much to deduce that man, in the early times of his race, would not only observe what plants other creatures fed on, but what could be made useful to himself. To avoid long journeys he in time would plant them near his abode, and by selection take the first step in cultivation. In tropical countries, with their luxuriance of vegetation, such efforts would be unnecessary, hence we find that intellectual development has been slower in these parts than in colder climes. It is now generally agreed that none of our cereals exist or have existed wild in their present state. We know that at the remote period of the Lake-dwellings of Switzerland man was sufficiently civilised to cultivate a Triticum, a Hordeum, a Panicum, or a Setaria. Wheat was the chief crop of ancient Egypt and Palestine. The area under wheat in this country is decreasing rapidly, for we cannot compete with countries having a more favourable summer, with less burdens on land and cheaper transit.

The countries from which we obtain the largest supplies of wheat are the United States, Canada, Argentina, Russia, and India. The importation varies considerably each year, on account of the respective harvests and relative fiscal considerations. The importation from the United States of America is declining because of their increasing home consumption. In comparing the relative consumption of wheat per head of population, we find France takes the premier position, followed by Belgium, the United States, Britain, Italy, Austria, &c. Semolina and macaroni are articles of food produced from wheat.

Next to wheat, Barley is our most important cereal. All varieties are probably derived from Hordeum distichum, which is what is known as two-rowed barley. Its cultivation is also of great antiquity. It has a much wider range than wheat, ripening its seeds in the cold summers of the north as well as in the hot summers of the south. It succeeds best on light sandy or loamy loose land. What we produce here and what we import are entirely used for distilling or brewing. On the continent of Europe, however, barley bread is extensively used by the poorer classes.

Avena sativa, or the Oat, is another cereal flourishing in the temperate zones, and particularly in those countries having a cool moist climate such as our own. There are three principal groups, distinguished by their colour,—white, black, and dun. The first is used for man's consumption in various forms, and the others for feeding horses, &c. Oats are now regarded by many farmers as their best-paying cereal crop. Oat-straw is almost as valuable as that of wheat. Although there is a large importation of oats and oatmeal, the quality and flavour of the home-grown are superior, and it fetches a better price.

Nearly allied to Avena sativa is Secale cereale or Rye, which used to be more extensively cultivated in our country than is the case now. Rye, however, is a very important product in such countries as Germany, Russia, and Austria, where it forms the daily bread of vast numbers. The "Schwartzbrod" of Germany is made from it. It is also largely used for distilling, the spirit called hollands being obtained from it.

The foregoing comprise the cereals cultivated in our own country, and we now come to a group generally designated Millets, which for tropical and sub-tropical countries are quite as important as those we have already considered. In the South of Europe we find two varieties cultivated—viz., Panicum miliaceum and Setaria italica. The Italians make from the flour a coarse bread, but its main use is a food for poultry and horses. It is only imported into this country as a food for cage-birds.

Millet (Sorghum vulgare) constitutes the diet of vast populations in Egypt, Equatorial Africa, China, and India. In the latter country the millets comprise a more important crop than either rice or wheat. They are autumnal harvest crops, being generally sown in the early weeks of the monsoon—*i.e.*, June or July—and reaped in October and November. Wheat and barley are in India winter-harvest crops.

Coix lachryma, or Job's tears, is an annual grass occurring as a weed of cultivation in the rice-fields of Bengal. Throughout Assam and Eastern India this coarse millet is an important food of the hill tribes.

We now come to Maize—Zea mays—often called Indian corn, or in France Blé de Turkie. About 2½ million acres are under this crop in India, and it shares the empire with rice in Africa. As a food it is more used in North and South America than in other continents. Immense quantities of starch are manufactured from maize, both for laundry and dietetic purposes. The dried leaves are used as winter fodder, and the stalks for thatch and making baskets.

Our next grass is in one respect the most important of all, for on Oryza sativa, or Rice, more human beings depend than on any other cereal. It is the sustenance of the teeming multitudes of Asia and Africa. It is an annual grass, with six stamens, and the most important varieties are semi-aquatic. There is little doubt but that it is of Asiatic origin. As a food it is not equal to wheat, as the flour of rice is almost entirely composed of starch, having little gluten, but it forms a valuable diet for rich and poor. In Europe its cultivation is confined to two districts—viz., the plains of Lombardy and the province of Valencia in Spain. In America the rice-growing states are South Carolina, Louisiana, and Georgia, the first-named state producing the finest rice in the world.

We shall now consider that very important member of the Gramineæ, Saccharum officinarum—the Sugar-cane. Sugar is a carbonaceous substance, which contributes to the development of animal heat, in distinction to those vegetable products which contain nitrogen, and are of special use in the nutrition of the body. The cane has been known in India from time immemorial, and in that country sugar was first prepared in a dry granular state. The sugar-cane is now cultivated mainly in the East and West Indies, the southern states of the United States of America, Central America, and Brazil. Molasses is that part of the cane-juice that will not crystallise. It is fermented and distilled for the production of rum or other spirit.

We shall now consider those genera and species which are cultivated as food for our herbivorous animals — viz., the natural grasses, all of which are indigenous to our country, and consequently to the Field Naturalist more interesting than purely cultivated grasses.

For the hay crop in Europe the Lolium perenne, Perennial rye-grass, and its variety, L. italicum or Italian rye-grass, named after the country of its original cultivation, are the grasses mainly used. Lolium perenne grows wild all over Europe. In one respect it is the most interesting natural grass we have, being of great economical value to Scotland and Ireland. For seed purposes it is largely cultivated in the north of Ireland, in Ayrshire, and, in a lesser degree, in Aberdeenshire and the Black Isle of Ross-shire. The hay crop is a very important one to our farmers, but increasing importation, amounting to several thousands of tons every week, and fostered by preferences in freight charges, is telling a tale. Hay can be brought from France, Germany, or Holland to London at less cost than from Peterborough or Norwich.

The great hay grass of North America is Phleum pratense, —Timothy grass, or Cat's-tail. It is a very important grass for permanent pastures. The seed is imported from America.

Somewhat similar in appearance to Phleum is the genus Alopecurus. Two species, P. geniculatus and P. pratensis, are very common in this district. The former has no commercial value, but P. pratensis, or Meadow Fox-tail, recommends itself to agriculturists on account of its early growth and succession of broad succulent leaves. The seed is saved in Finland.

Dactylis glomerata, or Cock's - foot grass, is well defined and easily recognised. In the United States it is called the orchard grass, being sown among the orchards of Kentucky for seed purposes. The seed is also saved in New Zealand. It has a large production of leaves, which are much esteemed by cattle, sheep, and horses.

The Poas form a very useful group. There are eight species of British Poas, of which four are very common in this district—viz., P. annua, P. pratensis, P. trivialis, and P. nemoralis. The Poa annua, the grass that one sees on every wayside and in every neglected street, is not one of cultivation, but as it blooms and ripens its seeds very nearly throughout the year, it establishes itself more or less in every pasture and in innumerable places where it is not wanted. The three other species are valuable agricultural grasses, P. pratensis being the most important. P. trivialis, or rough-stemmed Poa, is indigenous to Europe, North Africa, and North Asia. It is used for permanent pastures and for irrigated meadows. It is curious to note that the seed for the whole world is saved in one district in Denmark. Poa nemoralis, as its name implies, is one that flourishes in woods, and on this account recommends itself for shaded pastures. The German Forestry Department grants licences to the peasants to gather the seeds which constitute the supply for commerce.

Nearly allied to the genus Poa, and equally important economically, is that of Festuca. Festuca ovina, or the Sheep's fescue,—that beautiful, deep-green, fine-leaved grass so much admired on lawns,—has a very wide geographical distribution. It is an arctic grass, but flourishes in the higher temperate regions of Europe, North Africa, Siberia, North and South America, and on the mountains of Australasia. With us it grows well, and forms a large proportion of our Highland pastures. Being a very early-flowering grass, our spring is too variable for the saving of the seed, hence we import it from North Germany. Festuca elatior and F. pratensis are very productive of early herbage. Festuca pratensis is not credited with being indigenous to the United States, but we now import the seeds from the state of Kansas. It is rather curious to note how many kinds of permanent pasture-grasses have been introduced by human agency into North America, and from which continent we now import their seeds.

Crested Dog's-tail (Cynosurus cristatus) is another valuable pasture grass. It seems to delight in moist ground, such as the Hunter's Bog in the King's Park, but will thrive equally well in a dry place. It has long roots, and can withstand drought. Until recently we imported the seed from Holland, but now it is being cultivated very successfully in the north of Ireland, where it is called by the field-workers the "New Grass," in distinction to the rye-grass.

Among our most beautiful grasses is the genus Agrostis. The three species—A. canina, A. alba, and A. vulgaris—are common. The last is a particularly pretty grass when in full bloom. Agrostis alba, variety stolonifera, or Fiorin grass, is largely used in this country for permanent pasture, and more so in Canada, whence we import the seed.

The sweet vernal grass (Anthoxanthum odoratum) is used in mixtures for a hilly district. Some books say that this is the grass which gives the sweet smell to hay, but the statement is erroneous, as it is not a hay grass, and not sown for that purpose.

The yellow oat-grass (Trisetum flavescens), which grows plentifully on the sloping base of Salisbury Crags, is valuable for some situations and succeeds well on poor ground.

Holcus lanatus, or Yorkshire fog, is a very common species everywhere. It is only sown in poor districts of the Continent. Other species of the Aveneæ tribe—Aira (Deschampsia) flexuosa, A. cæspitosa, and Avena pubescens—are also used agriculturally.

In watery places many of you will have observed a creeping grass with rather stout stems and linear spikelets. This is Glyceria fluitans, or Manna grass, which is sown on the continent of Europe for pastures which are subject to river overflows.

I have thus drawn your attention to the principal pasture-grasses that are used to any extent in Europe, and I shall now only allude to a few other well-known species. In the neighbourhood of cottages, and especially in places where rubbish has been deposited, we are sure to find stray plants of the Phalaris canariensis, the common Canary grass, which we import for the feeding of cage-birds. Another species of the same genus — Phalaris — is the P. arundinacea, which is common in Duddingston Loch, growing with the well-known reed, Phragmites communis, our largest British grass. This reed, although formerly used for thatching, is now of no value; but the woody stems of another reed found in South Europe—the Arundo donax, the largest of European grasses—are used by musical instrument makers for reeds, clarionets, and mouthpieces for oboes.

The Bamboo, one of the most useful of all grasses, serves many purposes. In China and the East it is the principal building material. Bamboos are arborescent grasses, some species growing as much as a hundred feet high. The stems are very siliceous, and consequently strong.

In the manufacture of paper the Gramineæ are called into requisition. In the very common kinds of brown wrappers the stem of wheat, oat, and rye is taken, but the principal grass used is Esparto (Stipa tenacissima), which is imported from Spain and Africa. Two grasses, Elymus arenarius and Ammophila arundinacea, are valuable for binding the loose sand on our sea-shores.

There are many grasses cultivated for decorative purposes. Deschampsia cæspitosa and Briza media, or quaking grass, for example, are very beautiful. Our rarest native grass is Hierochloë borealis, or Northern Holy grass, found in this country on the banks of the Thurso river in Caithness. This grass was originally found by Don in the Clova mountains, Forfarshire. It derives its name of Holy grass from being strewn on church floors in some countries.

The order Gramineæ does not furnish any marked medicinal plants. We have only one grass reputed poisonous, and that is a species of rye-grass—Lolium temulentum or darnel. It is sporadic in growth, but is to be found in this district at Leith Docks and near Slateford.

IX.—*OBSERVATIONS ON A MYGALE SPIDER* (PSALMOPŒUS CAMBRIDGII *POC.*).

By Mr JAMES ADAMS.

(*Read April 24, 1907.*)

The large Mygale spider (*Psalmopœus Cambridgii* Poc.) now exhibited was found on the 15th of September 1905 on a bunch of West Indian bananas, in a fruit shop in Dunfermline. It is a female, and has reached maturity. I have now kept it in confinement for nineteen months, during which period it has changed its skin three times, but has grown very little. The Mygalidæ are a family of spiders which include the trap-door and large lurking spiders, which latter are said to kill birds. A little over two hundred years ago Madame Merian published her account of the insects of Surinam, where she mentions she found many large dark-coloured spiders on the guava tree. She says: "Their common food is ants, but when they cannot obtain ants they carry off even small birds from their nests, and suck the blood from their bodies." For one hundred and fifty years this statement was disbelieved, until Mr Bates, who spent eleven years on the banks of the Amazon, verified her statement.

The only example of the Mygalidæ we have in this country is Atypus sulzeri, a trap-door spider, which is chiefly confined to the southern counties of England, but a few have been found nearly as far north as the Scottish border.

When this spider, Psalmopœus Cambridgii, came into my possession its abdomen was shrunk and wrinkled, and it looked as if it had been starved for some time. For the first few weeks it was fed on flies, but as winter was approaching the supply soon failed. It was next tried with field beetles, and on an average it would consume three a-day. By the beginning of November beetles were difficult to get. Since then it has been fed with cockroaches, which were much larger than the beetles it had been getting. For the first few weeks it took about three cockroaches a-week, but this number gradually decreased until the middle of March, when it stopped eating altogether, and on the 13th of April 1906 it cast its skin. For fully a month after this it remained in a semi-comatose state, and although it had always plenty of food for the taking, this it strenuously refused. During the next five months it took very little food, and again cast its skin on the 10th of October. Five months after, on the 7th of March 1907, for the third time since it came into my possession, it again shed its skin.

I may here mention that the house I occupy is the half of a double villa. On the mutual wall that separates the two kitchens, opposite my neighbour's fireplace, where the wall is always warm, the spider's box is hung. The temperature in the box varies between 64° and 76°. There are always a few cockroaches in the box along with the spider:

they do not seem to be the least afraid of it; they run over it and under it, and are often seen in the spider's little nest along with it. I have never found a dead or maimed cockroach in its box, and believe spiders never take life wantonly, but only kill what they require for food. Our domestics take a great interest in the spider. They had often noticed that the cockroaches shed their skin, and were looking for the spider doing the same. A year past, on the 10th October, when the cook was dusting the top of the spider's box, she noticed it was standing with its feet in the water-dish, and drew the housemaid's attention to the fact. About ten or twelve minutes after, they returned to have another look at it, and found it had cast its skin, so the process did not occupy many minutes. The cast skin was lying back downwards on the top of the water-dish—quite clean and perfect. The next time it cast its skin, it seems to have had a greater struggle to get out of it, for all the feet were firmly fixed with web to the floor of the box, and the whole skin was twisted into a shapeless mass. From this skin some interesting microscopic objects were made. The night before this spider cast its skin for the third time, I noticed it was standing with its four front feet in the water-dish. Next morning I looked at it a little earlier than usual, and found it had cast its skin during the night. This and the first cast skin when set were nearly as perfect as the living animal.

The moulting or "skin-casting" of spiders is a much more complicated process than simply throwing off the outer integument. The whole of the internal covering of the alimentary canal, lungs, and other internal cavities, seem to be also shed. Lost and mutilated members, such as legs, palpi, and spinners, are reproduced at the same time. Mygale spiders differ somewhat from other spiders, both in structure and intelligence. In some respects they stand higher in the scale of animal life. Although they do not construct a web or snare for catching prey, many of them show much skill in constructing their underground retreats, which are lined with silk, and furnished with a cleverly contrived hinged door, so neatly finished in imitation of the surrounding ground that it is nearly impossible to detect the entrance.

During the time I have had this spider, it has made a good deal of web—but, from our point of view, the most of it to little purpose. The box it is kept in has two sides of glass, the others being of wood. At one end it has a small nest or den, where it spends a good deal of its time. Often, but not always, after it has entered this den it runs a number of silken threads across the entrance to keep out intruders. A few months ago it spent many days in making a thick and strong wall from the entrance of its den to the side of the box. It has also covered the floor with a thick carpet of silk.

The body of the spider is divided into two parts. The head and chest are united, forming one mass, called the cephalo-thorax. The hind part, called the abdomen, is united to the cephalo-thorax by a short pedicel. The cephalo-thorax is covered on the upper side with a hard horny plate, which is called a shield. The under plate, to which the legs are jointed, is called the sternum, or breast-plate. Beginning with the head, the Mygalidæ differ from other spiders by having their falces or poison-fangs with their points directed downwards, and moving vertically parallel with each other. The poison-fangs of other spiders move in a horizontal direction, with their points facing each other. The fangs are hard and sharp, and have an opening near the point, from which the poisonous fluid is ejected.

On each side of the poison-fangs are the five-jointed palpi. In the female they are long, leg-like, and terminate in a single claw. The ocelli or simple eyes, eight in number, are placed together on an eminence of the shield. Immediately behind the poison-fangs the four largest eyes form a row. At the back of each end eye of the row two smaller eyes form with it a triangle. Spiders have eight legs. Each leg, except in one small genus, is composed of seven joints. The first is called the haunch, the second and third the thigh, the shank and the foot each formed of two joints. In this spider the leg terminates in a pair of claws, which are retractile, like those of a cat. The last joint of the palpi and the two last joints of the foot are densely clothed on the under side with compound hairs, which enable the spider to climb up glass and other smooth and polished surfaces.

In the Mygalidæ respiration is effected by four pulmonary sacs, composed of a number of thin flat bags, called lung-books, which open to the air by stigmata, situated on the under part of the abdomen near the front. In the female the oviducts terminate between the four stigmata.

The spinning-organs of spiders are situated near the extreme end of the abdomen. This spider has only two pairs of spinnerets,—one pair long and prominent, and composed of several joints; the under pair short and single-jointed.

Supplementary Note—*Oct.* 1907.

It is well known that spiders can exist for a long time without food; and if they have access to water, little change will be noticed in their appearance. The one now under review took no food for over six months, and for fully four months before that time it took very little, although it had always a good supply. Notwithstanding this long fast, it kept plump and healthy looking up to Friday evening, Oct. 11, when it was observed standing with its feet in the water. The abdomen was much shrunk and wrinkled, and when touched with the finger the spider made but a feeble response. Next morning we were surprised to find it had changed its skin, for it seemed to be dying the night before. On examining the cast skin, it was noticed that it had cast the left fore-leg with it, and for the present it is minus a leg; but should it live to change its skin again, it will in all likelihood reproduce the lost member.

X.—*OBSERVATIONS ON THE FLIGHT OF FLYING FISHES.*

By Mr MERVYN VAUGHAN,
Second Officer of the Cable Steamer *Cambria.*

(*Communicated May 8, 1907.*)

Before starting I would like to say that the following are simply my own ideas, based on my own observations, and that you must take them for what you think they are worth.

To begin with, the reason, or one of the reasons, of my having taken such close observations of flying fish is that some years ago I stated that I thought they really did use their wings in flight, and my statement was ridiculed by a man who takes a good deal of interest in such things. At that time I was not so sure of my facts as I am now, and the number of

PLATE XLVII.—MYGALE SPIDER.

FIG. 1.—MYGALE SPIDER (*Psalmopœus Cambridgii Poc.*).
(*Photo from life by Mr Jas. Adams, ½ nat. size.*)

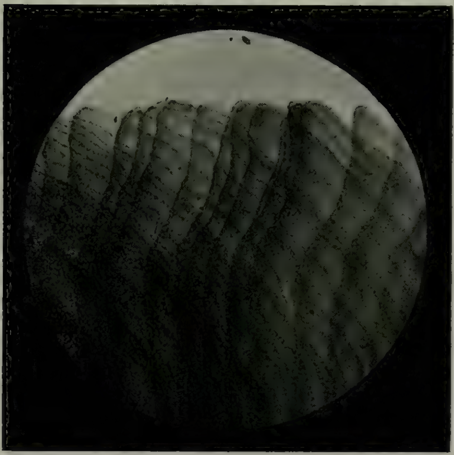

FIG. 2.—LUNG-BOOK FROM CAST SKIN OF ABOVE SPIDER, MAGNIFIED 60 DIA.

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NATURAL HISTORY

authorities that the other man was able to quote made me think I must have been mistaken. It also made me determined to watch the fish much more closely in the future, so that I should be in a position at another time to speak with more certainty. That was my first reason, and it led to my becoming really interested in the subject; the result being that for some years now I have never missed an opportunity of watching the flying fish when the weather was favourable. They can be watched to advantage only when the sea is absolutely calm, and unruffled by the slightest breeze. At other times the movement of the surface—the background against which the fish is seen—makes it difficult to distinguish the movements of the fish. It also makes it more difficult to keep the fish in view, especially in the very much restricted field allowed by a telescope. On a really calm day, however, the telescope becomes quite easy to manage after a little practice, the only difficulty being the focussing. At first, while waiting for a fish to rise, it has to be focussed on the water just over the bow. As soon as the fish rises and increases its distance from the ship, the focus has to be correspondingly adjusted. With the ordinary telescope, altered by sliding the eye-piece in and out by hand, I found it impossible to keep the adjustment right. In the end I got a telescope that was adjusted by means of a milled screw, and with it was able to manage perfectly, keeping the fish in focus from beginning to end of its flight.

First of all, I think, comes the question why the fish leave the water at all. I have come to the conclusion that it is solely to escape from their natural enemies; and hardly ever, if ever, as a means of getting about. In support of this theory is the fact that I have never seen them flying unless chased by the large fish which prey upon them, or to get out of the way of the ship. Even on days when they were getting up in thousands from under the bow, I have never seen them rise from the water round about unless pursued.

The direction in which they go away from the ship seems to depend entirely on the direction in which they rise from the water. Sometimes they will fly straight ahead only a short distance, and when the ship reaches the spot a few seconds later, they get up and go off again, perhaps straight ahead, perhaps at a tangent. Those that rise right ahead *under* the bows appear to fly right ahead; and those which rise a little *on* the bow go away in that direction which will take them most directly away from the ship and from danger.

The recognised idea of the flight is that the fish swim tremendously fast, and gather enough way under water to carry them, aided by outspread wings, when they rise into the air. I do not think this is so, as I have often watched them swimming just ahead of the ship, apparently as fast as they could, and yet have to take to the air because the ship was travelling faster than they were. Apparently they are unable to keep ahead of a ten-knot steamer unless they rise into the air. In that case they immediately leave the steamer behind, and must travel at a speed three or four times as fast as their swimming speed.

When surprised by dolphin, bonito, or albacore, they rise from the water, as far as I have been able to see, exactly from the spot where I had just seen them moving idly about, and not from some distance away, as must have been the case if they had had to gather way under water to give them impetus through the air. The moment before, they had been moving aimlessly about close to the surface, backwards and forwards, round and round, in the vicinity of a mass of floating weed, or something of that kind, and not swimming steadily in one direction.

Now for the flight itself. At the moment of rising from the water the movement of the wings is plainly discernible, even to the naked eye. After a small space of time, perhaps two seconds, the movement becomes invisible even through glasses, and the fish appears to float through the air with still wings, outspread. The movement of the wings, while visible, is tremendously fast, and the fish looks much like a dragonfly. The stillness of the wings which follows is, I think, only apparent, while in reality the wings are moving as fast as ever. The conclusion I have come to is that when the fish emerges from the water the wings are gleaming and iridescent, and, flashing in the sun, show the movement quite distinctly. The warmth of the air—they are seldom seen out of warm latitudes—and the speed at which the wings are beating, dries up the dampness and renders the wings dull, under which condition their rapid motion becomes invisible. As soon as the wings get very dry the fish has to make them damp again, and to that end sinks down to the surface, in such a position that its head and wings are much higher than its tail. As soon as the tail touches the surface the fish ceases to sink, and with its tail held in the water continues its flight, not diminishing, but on the other hand apparently at once increasing, its speed. As soon as ever the tail touches the water the movement of the wings again becomes visible, and though I have watched most carefully, I have never been able to see that the wings, even the tips of them, touch the water. Working on my theory that the dampness of the wings causes the gleams which show them to be moving, I am of opinion that the tail, when touching the surface, besides acting as a rudder, also acts like a wick, along which dampness is conveyed to the wings. The fish travels a few yards only with its tail in the water, and then rises again and continues its flight, the movement of the wings again becoming invisible.

How far the fish can travel without falling entirely into the water I cannot say, but I have watched them through a powerful telescope till I could see them no longer. The flight is always made up of short flights,—perhaps a hundred or a hundred and fifty yards each,—between which the fish flies low enough to enable it to get its tail into the water, but never more than its tail. From the time the tail leaves the water till it returns, the flight is perfectly straight; though with the tail in the water the fish sometimes alters its course to one at right angles, or even more, from the original one. For this reason I think that, once in the air, they must keep straight on; but that by coming close to the water and putting the tail in, they can go in any direction they may please. As a rule they never fly higher than from one to two feet above the surface, but that they can do so is proved by their sometimes reaching a ship's bridge between twenty and thirty feet above the water. As this happens usually during a gale of wind, I think the explanation is that the wind is too strong for them. They appear on windy days to get suddenly lifted into the air to fair heights above the water, and then, as if afraid of going higher, they plunge back into the water. On calm days they always settle down slowly, almost like a seagull, and with hardly a splash.

It is rather interesting, I think, that while the fish are in the water nothing can be seen of their wings. I have often watched them swimming along the surface, perhaps thirty or forty feet from me, and appearing, through glasses, almost to be within reach of my hand, and yet been able to see nothing of the wings till the fish took to the air.

The biggest flying-fish I have ever seen I found inside an albacore that I caught in the Gulf of California. The albacore weighed 150 odd pounds, and the flying-fish must have been at least 2 pounds and about 14 inches long. The smallest was about 1 inch long, and it was sucked through the pump when a bucket of salt water was being drawn. On fine days I have often seen little tiny things like flies flitting about the surface, and I suppose they must be flying-fish also, though I have never been able to catch them.

Note by Miss Beatrice Sprague.

The accepted theory regarding the flight of flying fishes is that their wings are used merely as parachutes, and are never flapped. Mr Vaughan's observations, however, clearly tend to establish the contrary; and it seems worth while, in view of this difference of opinion on the subject, to sum up the main points of his argument, as follows:—

1st. The flight in the air is much swifter than the swimming speed; Mr Vaughan estimates it at from three to four times as great.

How is the increase in speed to be accounted for, unless the wings flap?

2nd. The flight is estimated at from 100 to 150 yards, at a height of only 1 to 2 feet above the surface.

Could such a long low flight be sustained otherwise than by flapping the wings?

3rd. After descending to the surface of the water and dipping its tail in, the fish rises again and continues its flight, and can do this several times in succession. On the parachute theory this would hardly seem possible.

4th. On being alarmed, the fish rises directly from the spot at which it was before idly moving. If the observation is correct, this alone would dispose of the parachute theory, since the necessary initial impetus would be wanting.

5th. Mr Vaughan has actually seen the wings flap, and says that at the moment when the fish rises the flapping is clearly discernible by the naked eye.

Taken together, these five arguments seem to me most convincing.

There is one point which strikes me as very curious—namely, the sudden increase of speed noticed directly the fish descends to the surface and dips its tail in the water. This increased speed coincides with the moment at which the movement of the wings again becomes visible. It occurs to me, therefore, that the fish perhaps flaps its wings *only at the commencement* of each short flight—that is, for the two seconds or so during which the movement is visible; and that after enough initial velocity is gained the wings are held motionless, and serve as a parachute till the fish again descends to the water, when flapping again begins. This supposition would account for the otherwise unexplained increase in speed each time the fish touches the water.

At this meeting Mr Tom Speedy read a very interesting paper entitled "Jottings on Jura," which was much enjoyed by the members present.

XI.—*SUGGESTIONS FOR CO-OPERATION AMONGST LOCAL SCIENTIFIC SOCIETIES.*

Report of the Delegate to the British Association.

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

(*Read Nov. 28, 1906.*)

This Society was invited by the British Association to send a delegate to attend the Conference of Delegates of Corresponding Societies at York, and your Council appointed me their representative. I attended both the meetings of delegates.

Three years ago, at Southport, Sir Norman Lockyer, in his presidential address, spoke very strongly of the disorganised state of science as a social and political power. "Our crying need," he said, "is to bring about an organisation of men of science, and all interested in science, similar to those which prove so effective in other branches of human activity. For the last few years I have dreamt of a Chamber, Guild, League, call it what you will, with a wide and large membership, which should give us what, in my opinion, is so urgently needed." And he thought that a splendid basis for such a Guild could be found ready-made in the Corresponding Societies,—70 in number, with a membership, he said, of 25,000. "The number could be greatly increased," he added, "by creating more Corresponding Societies: it might reach nearly half a million,"—to my mind an extravagant estimate. "A British Science League," Sir Norman went on to say, "of 500,000 with a sixpenny subscription would give us £12,000 a-year,—quite enough to begin with," and he gives as an example the German Navy League, which has branches even in our Colonies, and has a membership of 630,000, and an income of nearly £20,000 a-year!

Inspired by these ideas, the Council of the British Association altered and widened its rules for the admission of Corresponding Societies. Previously the indispensable condition was the doing of original work and publishing the results. Now, the chairman at one of the recent conferences said, "It is doubtful whether publication is the best test of merit." His own impression was that we have had "too much cry for the amount of wool," and "if we exclude from our deliberations all those societies whose circumstances and inclinations have caused them to refrain from adding to the mass of literature under which there is danger of our being smothered, it is possible that we are excluding the very bodies whose sympathy and interest we should most wish to encourage." So it was resolved to form a new class of Corresponding Societies,—societies "which exist for the encouragement of the study of science," which need not publish anything, but must have at least 50 members, and have been in existence for not less than three years. The chairman I have already quoted, in explaining this new arrangement, made the almost comical statement, that societies should be affiliated from the number of their members rather than from the quantity of printed matter they issue. It seems a curiously democratic principle. Of course, the ground idea is that the greater the number of members a society has, the greater is its influence. These remarks apply to the newly admitted class of *associated* societies only, and not to the *affiliated* societies, to which this Society belongs, and which were called Corresponding Societies before the new standard of admission was adopted.

Some years ago (Belfast, 1902) the chairman of one of these conferences said that it was the only body which gives a kind of corporate existence to local societies; and he went on to say that it gives standing to these societies as a whole, bringing them into touch with one another. When he said that "it was the only hope that at present exists for united action and systematic work," he went, I think, too far. "The scientific societies scattered all over the country are like iron filings sprinkled over a sheet of paper,—they need the magnetic action of the British Association to transform the confused particles into a field of symmetry and beauty." A very pretty illustration, which assumes too much,—that the local scientific societies are magnetisable particles. I have represented occasionally other societies at these meetings of delegates for more than twenty years, and the Corresponding Societies have hitherto not received much encouragement or inspiration. In the future we may expect more, if societies like ourselves can be transformed into a political power. "If we could," to make another quotation, "bind together all the scientific societies of this kingdom, so that in matters of national importance they would move as a united body, it would be difficult to over-estimate the influence which could be thus exerted, for it is certain that amongst the members of these local societies are included many of the most intelligent and influential men of their districts." It will be most interesting to observe how the local scientific societies catch on to the idea of advancing science by political influence. It never occurred to any of us until now that the Edinburgh Field Naturalists and similar societies could have by co-operation political weight.

A proposal was made to issue a Journal of Corresponding Societies—notwithstanding the remarks already made to "a halfpenny-worth of bread to an intolerable quantity" of printed matter. Fortunately the proposal was considered impracticable.

Some one remarked that local societies, especially Field Clubs, admitted too many antiquarians, and some scathing things were said about excursions being social meetings and little else.

During the Conferences held since the Southport meeting, some good ideas were thrown out regarding the work of local scientific societies. I shall mention a few. One chairman of the Conferences said that the work of scientific societies may be classified (as we all know) either as educational or as technical; and he added, "I confess that, at the present time, I regard the educational as the more important branch." This is most striking, following upon the long and persistent efforts after original research.

Local societies were recommended to "make exploration and registration part of their systematic work, and to enter upon the 6-inch Ordnance maps of their districts any natural features and archæological remains which are not indicated thereon." This hardly applies to us in Edinburgh, which is the home of the Geological Survey, of a vigorous Antiquarian Society, and other professional scientific institutions. It was suggested that county councils should be asked to allocate annually small sums for carrying out the work of local exploration and registration,—but no action was taken.

Suggestions as to subjects suitable for discussion at future conferences were asked. The best methods of utilising local museums in connection with education are to be considered. Some subjects suggested for local societies were,—

Cave faunas, or well faunas.

Zoological changes in a given plot of land.

Compilation of local faunas.

Systematic observation of the micro-organisms in a given pond or ditch.

Collection of slugs from all parts of the British Isles. (For information apply to W. Denison Roebuck, Hyde Park Road, Leeds.)

Some matters connected with orchids and potamogetons were asked to be investigated.

Photographic records of plants.

Photographs of anthropological interest.

These are some of the subjects recommended to the attention of the Corresponding Societies: at the York Conferences the making of meteorological records, chiefly as to rainfall, was shown to be desirable in many districts,—not in Edinburgh, where public records are kept. Another subject discussed was the desirability of promoting county photographic surveys. In this we could do a good deal.

Lastly, the matter which interests us most was discussed at the Cambridge meeting, and the Committee recommended it strongly to Corresponding Societies—viz., *to promote, as far as they could, Nature Study.* Nature Study is the *raison d'être* of the Edinburgh Field Naturalists.

One remark made by Principal Griffiths at Cambridge cannot be too often repeated to societies like ours. "There can be no doubt," he said, "that the best work done by the smaller societies is that of instruction in the current progress of science, and the presentation of the matter in such a form as to rouse interest in scientific pursuits." In fact, our chief function, and that of societies like ours, is to act as a current events club for the science or sciences we represent; and by conversational demonstrations, rather than by formal lectures, to aid each other to follow the great advances that are being made, particularly now, in our knowledge of nature.

XII.—*CUP-MARKED STONES.*

By Colonel JAMES SCONCE.

(*Read Jan. 23, 1907.*)

Before asking your attention for a short time to those obscure relics of antiquity, cup-marked stones, I beg to be allowed to make my acknowledgments to our President for the favour he has shown to me in permitting me to read a paper on this subject, which has become of personal interest to me, while it can hardly be said to be one such as is ordinarily included among the researches of Field Naturalists.

I should state at the beginning that my interest in the subject has become aroused by the tradition which is attached to one particular example of these stones which has unexpectedly come under my notice, although, after seeing this one, I have taken the opportunities I have had of visiting other specimens.

With regard to the particular stone I have referred to, I will ask you to accompany me in spirit on a short tour I made along with my wife in June of last year (1906) to Gartan, in County Donegal, in Ireland. Gartan, I may at once mention, is the birthplace, well established by history and tradition, of St Columba, who in middle life left Ireland for Iona, there to become the great missionary saint of Western and Northern Scotland. The object of our tour was that my wife should revisit a locality which had been the home of an elderly relative who had laboured very devotedly for many years to elevate the condition of her poorer neighbours; and although over thirty years had elapsed since this good lady died, we found her memory was still held by many in deep respect, and on her account we received several hearty welcomes.

My wife had inquiries to make concerning occupants of her relative's household, and in one case an incident was related to us which seems worth recounting here, as showing how ancient superstition in connection with remarkable stones still lingers in a secluded district. With regard to this incident, it is first necessary that I should refer to the Glenveigh evictions, which were carried out with great harshness fifty years ago, and which at that time made the neighbourhood of Gartan notorious. The evictions were the work of a new proprietor, Mr Adair, who had come from the South of Ireland with every desire to be fair to the peasantry, but with whom he quarrelled as to the exclusive right of sporting over his new possession. Mr Adair by these evictions had become the aversion of all the neighbourhood. Reverting now to the retainer of the Gartan household, at first no reply was given to my wife's inquiry, and then with bated breath the reply came, "Oh, she had a dreadful death! She was engaged in washing, and fell into a boiling caldron, from which she could not be got out alive." But the awful thing about her death was, that the very morning it occurred she had been heard to be bargaining with a man to go on her account for a payment of £5 to Tory Island, off the Donegal coast, where there is a stone which, if it could be turned, and the name of Mr Adair repeated over it, would have been sure to bring about his death within a year. In view of what will be said hereafter about cup-marked stones, it would have been interesting if we could have visited Tory Island to have seen this baleful stone; but there was no direct communication from Gartan, and the island is a considerable distance from the mainland.

Another experience we had during our short stay at Gartan was our visit to a holy well, about eight miles distant, which at certain times of the year is said to be resorted to by numbers of crippled people, although only two were on their way there on the day we went. But we had the positive evidence of the reputation of the well, and of the benefit derived from a pilgrimage to it, in finding about a dozen or so crutches, not at all old, planted in a semicircle facing the well, and in seeing the bushes growing around covered with strips of rags which had been used by pilgrims for applications of the water.

I have spoken of Gartan as being held on very reliable records to have been the birthplace of St Columba, and I may further mention that a great celebration was held there in 1897, on the 1400th anniversary of his death, similar to that which, it may be remembered, was held at the same time at Iona.

The family of the saint occupied a princely position, and for four generations, since St Patrick himself had converted and baptised the great-great-grandfather of the saint, the family had been Christian. Their permanent abode or fort was about ten miles from Gartan. But at Gartan there is the "natal stone," as it is called, which is said to be the actual spot where St Columba was born. His mother, the Princess Ethne, so tradition says, had been brought here for the birth. This stone, to my surprise when I visited it, I found to be at one end covered with cup marks. Whatever these marks mean or were made for, there seems to be little doubt that they were connected with some pagan rite or practice; and the interest attached to this particular stone to my mind is that a Christian family still held it in so much veneration, probably for good luck, as to have brought the lady to it from her own home at such a critical time. The size of the stone is about eight feet long by six feet broad and one and a half feet thick, fairly flat, and slightly raised from the ground around it. It bears no trace of any building, either permanent or temporary, having ever been raised over it. Its situation is on a slightly elevated ridge of cultivated land, from which there is a good outlook all round. I saw no other stones like it in the immediate vicinity. Besides the stone being held in reverence as the actual spot of St Columba's birth, a curious belief is attached to it, that whoever sleeps on it will never know home-sickness; and many a man starting for America is said to have tried the remedy. May this be a reverential reflection on the grace obtained by St Columba, who was able to transfer his affection from the land of his birth in pious devotion to the land of his adoption?

About a mile from this stone there is a small roofless chapel, said to have been the first ecclesiastical building erected by St Columba; and among his other foundations in County Donegal and neighbouring counties were the monastic establishments of Kilmacrenan, Raphoe, and Londonderry.

St Columba remained in Ireland until he was forty-two years of age, when, on account of a dispute with a chieftain concerning the possession of a manuscript copy of the Psalms written by him, and which had come to be used as a charm to be carried into battle, he was forced to accept the protection offered to him by a chief in Scotland. It is worthy of mention that this charm, called the Cathach or Battler, which is enclosed in an ancient silver and gold case, and which had been retained and handed down through the generations of O'Donnells, is now lodged in the Royal Museum in Dublin.

On my return from this short tour in Ireland I went to spend the rest of the summer in Strathtay, and when there I learnt from a Perthshire newspaper that near to Birnam there is the "cup-marked rock of Rohallion." On the Ordnance Survey map there is shown the modern mansion-house of Rohallion, as well as the old castle of the same name on Birnam Hill, about two miles from Birnam railway station. But all my inquiries were fruitless to learn anything of the cup-marked rock, until I very fortunately met the forester of the Rohallion woods, who, with great kindness, led me up the hill and showed me the rock. I found it to be a natural feature on the hill-side, standing *in situ*, and resembling, if I may so describe it, a low pulpit, and well adapted, supposing such were the purpose to which it was put, of forming a natural sacrificial altar. The upper surface, about 4 feet by 5 feet, is quite in its natural rough state except that it has five or six of the ordinary cup-marks worked upon it. The vertically upright front of the rock is without marks of any kind. The rock overlooks the old Rohallion Castle, now a mere shapeless mass of broken-down walls; and these two remains of antiquity, being near together on a hill consisting of many confused features, may be presumed to have some connection one with the other.

In Strathtay I was fortunate to find for myself two good examples of cup-marked stones. These are lying among a gathering of other stones round a small stone circle between Grandtully Castle and Aberfeldy, and immediately below the ancient pre-Reformation church of Pitcairn. The stones composing the circle are massive and upright, but those which are cup-marked are of no great size, flat, and almost flush with the ground. The marks, however, are very numerous, covering the entire surfaces of the stones.

I am able to indicate another stone circle in the neighbourhood of Aberfeldy, where there is a good example of a cup-marked stone. The existence of cup-marked stones in connection with stone circles is noticeable, as it may afford some guide to the purpose of the markings. This second stone circle is four miles from Aberfeldy, on the road to Kenmore, and close to the road. It is of a somewhat exceptional design, consisting of two concentric circles of stones both fairly complete, and the stones are very massive. I have since heard of two other examples of cup-marked stones in the neighbourhood of Aberfeldy, lying by themselves, and not in connection with stone circles. One is on the hill-side to the east of Aberfeldy, above the new distillery. The other is about three miles off, on the opposite side of the Tay, between the village of Weem and the very interesting village of Dull, where there had been an ecclesiastical college previous to the foundation of that of St Andrews.

Having given descriptions of the stones and one solid rock with cup-marks which have come under my personal observation, I shall now refer to a very valuable and comprehensive paper on these mysterious markings furnished to the Society of Antiquaries of Scotland for their Session of 1864-65, by Professor, afterwards Sir James Y. Simpson. At the beginning of his paper Sir James points to the different varieties of the sculpturings, and the first type which he mentions, as being the simplest and the most common, are described as shallow hollowed-out depressions or cups varying in diameter from 1 inch to 3 inches, and generally scattered irregularly over the surface of the stone, but occasionally placed in small groups. The cup-marks on the stones I have visited are exclusively of this type. The second type has the cup surrounded by a ring cutting, the ring being usually shallower than the cup. Sir James then describes five other types, which have several rings round the cup, but which possess varieties of the rings being broken, either by a line drawn radially from the cup to the outer ring, or by a wider space being left between the breaks in the rings. Sir James shows examples of them all in a set of plates accompanying his paper, from which it appears that ring cuttings and cups are often found together on the same stone, and rings are found where there are no cups.

There is an interesting classification given by Sir James of the localities in which the cup- and ring-marked stones have been found—namely: (1) On stones in megalithic, or so-called Druid, circles, and in similar avenues of stones; (2) on the capstones of cromlechs; (3) on stones in sepulchral tumuli; (4) on the covers of stone coffins or of urns; (5) in underground houses; (6) in fortified buildings and in ancient towns or camps; (7) on isolated stones.

Classified thus, particulars are given in this comprehensive paper, largely from personal inspection by Sir James himself, or from special reports obtained by him, of fifty-eight marked stones in Scotland and eleven in England, and he has embodied extracts from other papers regarding two examples in the Isle of Man, five in Ireland, two in Brittany, and three in Scandinavia.

Sir James Y. Simpson's inquiries regarding these cup-marked stones having been so extensive, it might have been expected that he would have adopted some theory as to their probable import, and with regard to the epoch of time when they were executed. But I find him thus expressing himself: "Of the real object or meaning of these stone-cut circles and cups we know as yet nothing that is certain. They are archæological enigmata which we have no present power of solving; lapidary hieroglyphics and symbols, the key to whose mysterious import has been lost, and probably may never be regained." Several hypotheses as to their origin and objects are mentioned by Sir James which are only quoted to be rejected, and which need not be brought forward now. The most reasonable theory, which is said to have been adopted by Professor Nilsson, who has written on the stones found in Scandinavia, seems to be that the flat stones were heathen altars, cup-marked in order to receive part of the blood of the sacrifice. The cups on upright stones could not, of course, contain any fluid; but it is possible that these stones with cups may have been marked before they were placed upright. And on the stones now found in an erect position the ring marks are more frequent than the cups. The ring marks should, I think, be held to have a meaning entirely different from the cups; and it seems likely that they were the symbols for a heathen worship of which no written record is left to us in this country, but of which some trace may yet be found in relation to the symbols that have been adopted among the many religious cults that have existed in Eastern countries.

I may say that the theory of the stones with cup marks having been sacrificial altars gives quite a satisfactory explanation for the marks I saw on the stone at Gartan in Ireland, and on those at Rohallion and Grandtully in Perthshire, the marks in all being very irregular and without any meaning except to serve as cups. Sir James Y. Simpson discusses closely the proposition by some theorist that these marks are connected with the worship of the Syrian god

Baal, and that this worship was brought to England by Phœnicians who came for the tin in Cornwall; and he shows that the marks are not of common occurrence in Cornwall, as they would have been had this been the ground of their first introduction and of their extension to other parts of Great Britain which were never visited by the Phœnicians. His own theory is that the marks, being of the same character throughout the country, must have been the work of a people aboriginal to Britain; and he suggests that the Cimbri, of whom we have some knowledge as having preceded the Celts, and who peopled Scandinavia as well as Britain, may have been the cup-markers, who have, however, left us little else to know about them.

I have only one further remark to make on Sir James Y. Simpson's highly interesting paper, which is to point out that he has unfortunately not been able to bring forward any local tradition connected with any one of the many marked stones he has written about. May I claim for this small paper of mine that it has a special interest, insomuch that it shows the existence of a link we have with the unknown people of a very ancient time in the tradition which has lingered through the centuries around St Columba's "natal stone"?

REPORT OF THE MICROSCOPICAL SECTION.

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

The Section met regularly once a-fortnight during the winter session. The attendance was good, and we had pleasant and informing meetings. The subject studied was Algæ, and we went carefully over the Liverpool Marine Biological Memoir on Chondrus, and afterwards parts of Oltmann's splendid work on "Algæ." We intend to continue the study of the Algæ for some time next winter (1907-8), using Oltmann as our guide; afterwards, so far as time permits, we propose to take up the Protozoa, using vol. i. of 'The Cambridge Natural History' as a text-book.

EXHIBITS IN NATURAL HISTORY.

Books of Drawings; by Mr Charles W. Cowan. Concretionary Nodules, with shell as nuclei, from Muscat, on the Gulf of Omar; by Dr T. B. Sprague. Peziza aurantia; by Miss Beatrice Sprague. Lantern slides of littoral and other vegetation in Ireland; by Mr D. S. Fish. *Thyas venusta*, C. L. Koch, a living Hydrachnid found in a pool near Midcalder; stinging gnat (*Culex* ——?); and a miscellaneous collection of lantern slides; by Mr Williamson. Two fine specimens of the Bearded Tit (*Panurus biarmicus*); by Mr G. M. Brotherston. Kafir Piano; by Mr H. J. Harrison. Martin (*Mustela martes*) and Polecat (*Mustela putorius*); by Mr Charles Campbell. Living Mygale Spider from West Indies; cast skin of same, and several microscopic preparations from the skin of same spider; by Mr James Adams.

ADDRESS BY THE PRESIDENT,

Mr JAMES RUSSELL,

October 23, 1907.

On the first occasion I had the honour of addressing you from this chair, I sketched out a plan of study for your consideration; on the second occasion, I described at some length the development of the instrument which is needful for the scientific prosecution of that study; and to-night I propose to bring under your notice the practical results of a small part of that study, by means of photo-micrographs shown upon the screen by the projection - lantern. Before, however, these lantern transparencies are exhibited, I wish to fulfil a half-promise I made at the end of my last address, to give a few practical hints on working with the microscope, and on the illumination of objects under examination. From the time at my disposal the remarks must necessarily be short, and in making them I shall confine myself to my own experience.

Source of Illumination.— Diffuse daylight is the most pleasant source of illumination: a northern aspect with an open horizon is the best, and when this is available the operator should seat himself so that the window will be upon his left side. On no account must the direct rays of the sun be used for ordinary microscopical work. In a town, and in ordinary circumstances, it is very seldom that daylight can be employed, and hence it is needful for the microscopist to get a good artificial light. Among our present illuminants he has a choice, but he need seek for nothing better than a good paraffin lamp, with a flat wick half-an-inch broad: if he uses more powerful illuminants, he must modify the light in some way. The lamp should have a good steady foot, and be provided with means by which the flame can be fixed at different heights from the table on which it stands. Many good microscope lamps are on the market. Fig. 1, Plate XLVIII., is the illustration of a good cheap one, made by Messrs Swift & Son, opticians, London. The lamp moves upon an upright stem, and can be clamped at any height: it is provided with a porcelain shade and a metal peak, which shade the eyes from the glare of the flame.

In Fig. 2, Plate XLVIII., is shown the type of a more developed form of a microscope lamp: it is called the "complete" lamp, and is made by Messrs R. & J. Beck, Limited, opticians, London. The following is a condensed description of it, as given in their catalogue. The base, A, consists of a heavy ring, into which a square brass rod, B, is screwed. The square rod carries a socket, C, with an arm, D, to which the lamp is attached. This socket fits the square rod loosely, but is kept in any position by a lever, E. On each side of the burner, and attached to the arm, D, is an upright rod, G, to one of which the chimney is fixed independent of the reservoir of the lamp, but fitting closely over the burner, thus enabling the observer to revolve the burner and reservoir and obtain either a thin intense light or a broad and diffused one, without altering the position of the chimney. The chimney, F, is made of thin brass, with two openings opposite to each other into which slide 3×1 glass slips. A semicircle swings from the two uprights, G, to which it is attached by the pins, H, placed level with the middle of the flame: to this semicircle is fixed a dovetailed bar, L, carrying a sliding fitting, O, which

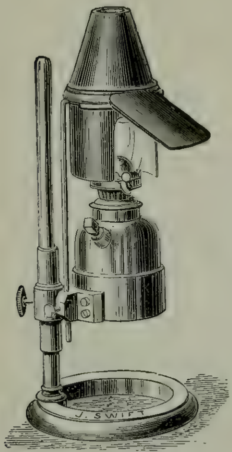

FIG. 1.—CHEAP MICROSCOPE LAMP.

(By kind permission of Messrs Swift & Sons, London.)

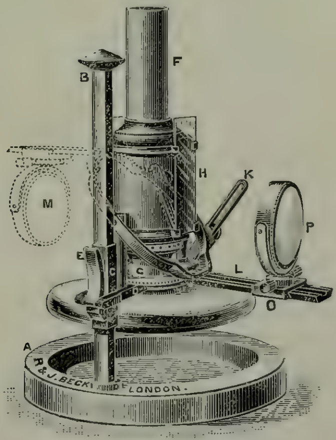

FIG. 2.—BECK'S COMPLETE LAMP.

(By kind permission of Messrs R. & J. Beck, London.)

BRITISH MUSEUM NATURAL HISTORY

bears a Herschel condenser, P. The condenser is fixed at any inclination by a milled head working in a slotted piece of brass, K, fixed to the arm, D, and it can also be used on either side of the chimney, as shown in the illustration at M. This is a lamp which meets every requirement of the microscopist. I have used both the foregoing lamps for many years, and have found them in every respect satisfactory.

Accessories for Illumination.—There are two modes of using illumination for the microscope—by reflected light and by transmitted light. The former is principally used for viewing opaque objects, and we will consider it first. The microscope being placed in position, the lamp is set on the left of the observer, about eight inches or so from the microscope, and raised on its support till the flame is somewhat above the stage of the microscope. A condensing-lens is placed between the lamp and the microscope: this condensing-lens may be on a separate stand or affixed to the stand of the microscope, and it is placed in such a position that the object to be viewed is in its focus—that is, where the light passing through the lens is brought to a point. If the condensing-lens is a bi-convex one, it is immaterial which of its sides is turned towards the lamp: it is otherwise if the condensing-lens is plano-convex, and this is the usual form of such lenses, in which case the *curved* side must be towards the lamp. The lamp and condensing-lens must now be adjusted till a brilliant light falls upon the object. The edge of the lamp flame should be used.

In Fig. 1, Plate XLIX., are shown the somewhat relative positions of the different things, in which L represents the lamp flame, C the plano-convex condensing-lens, and O the object to be viewed. A very efficient means of obtaining light for the examination of opaque objects is by the use of a *parabolic illuminator.* This is a small speculum of silvered metal which fits on to the object-glass of the microscope, and reflects the light from the lamp on to the object. For this purpose it is best to have the flame of the lamp on a level with the illuminator; and if a condensing-lens is interposed, it should be so placed as to render the rays of light *parallel.*

As we shall again have occasion to refer to parallel rays, it may not be amiss to mention here how the diverging rays of light from a lamp can be made parallel. We have seen that in order to make rays of light from a lamp converge to a point we must turn the *curved* side of a plano-convex condensing-lens to the lamp, but in order to render such rays parallel we must turn the *plane* side of the lens to the lamp, and further, that the lens must be so placed that the flame of the lamp is in the focus of the lens. When this is done, and a piece, say, of white cardboard or ground glass is held at some distance from the lamp, an enlarged and inverted image of the flame will be seen upon the cardboard. The size of this image is conditioned by the size of the condensing-lens; and the nearer the length of the image of the flame is to the diameter of the lens, so much the nearer will you have arrived at true parallel rays. Another way of ascertaining when the rays are parallel is to place the eye in the line of the rays and to look directly at the condensing-lens. When you do so, you will see one or other of the appearances shown in Fig. 2, Plate XLIX., according as the lens is placed correctly or incorrectly with relation to the lamp flame. A shows that the flame of the lamp is correctly *centred* with relation to the condensing-lens, but that it is *without* the focus of the latter. B, that the flame is correctly centred, but that it is *within* the focus of the lens. C, that the flame is in the correct focus of the lens, but not in its centre. D, that the flame is both correctly centred and focussed, and it is in this position that the nearest approach to parallel rays is obtained.

Another piece of apparatus for obtaining illumination for opaque objects is a "Lieberkühn," so called after the name of the microscopist who invented it. It is a small silvered metal cup, which fits on to the object-glass. Parallel rays of light are sent up to it from the flat side of the mirror below the stage of the microscope, and reflected by it down upon the object. A black patch no larger than the object to be viewed is placed underneath the slide to prevent light passing up through the object. This mode gives a very good illumination, but the drawback is that the lieberkühn can be used only with the one object-glass for which it has been made.

The foregoing modes of illumination are only for object-glasses of comparatively low power: they do well up to an object-glass of $\frac{2}{3}$-inch, and, of course, it is only such object-glasses which are used for the examination of opaque objects.

PLATE XLIX.—PRESIDENTIAL ADDRESS.

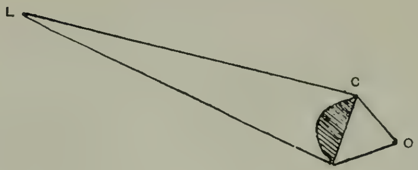

FIG. 1.

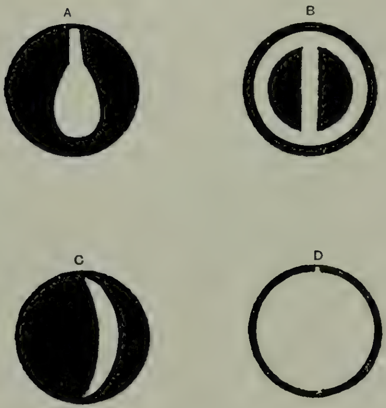

FIG. 2.

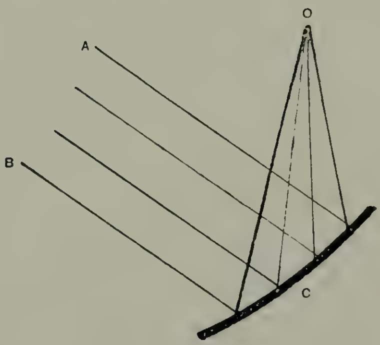

FIG. 3.

BRITISH MUSEUM
NATURAL HISTORY

It is, however, often desirable that minute objects, although transparent, should be viewed by means of reflected light by object-glasses of high power. To enable this to be done, a *vertical illuminator* was invented. This consists of a short tube which screws on to the microscope between the nose-piece of the latter and the object-glass. There is an aperture in the side of the tube for the admission of light, and in the inside of the tube is a small mirror which is controlled by a pin on the outside. The light from the lamp placed in front of the aperture is reflected by the mirror down through the object-glass to the object, and then re-reflected up through the tube of the microscope to the eyepiece. It is a mode of illumination somewhat difficult to manage, and is of use only with wide-angled homogeneous immersion object-glasses.

Transmitted Light.—The great majority of microscopic objects have to be viewed by transmitted light,—that is, light sent up through the object, not reflected from it, into the object-glass. Of course, all objects viewed by this mode must be transparent. To change the direction of the rays of light coming from the lamp and transmit them to the object, the mirror which is supplied with every microscope is used. The mirror has usually one side *plane* and one side *concave*. The former side is used when a weak diffused light is employed in examination of the object, and the latter side when a narrow brilliant light is required. A good distance of the lamp from the mirror is about nine inches. There is no great difficulty in working with the plane side of the mirror: we have only to keep in mind that the angle of the reflected rays is equal to that of the incident rays. The concave side of the mirror requires more attention. A concave mirror, in reflecting rays of light, acts in the same way as a convex lens does in refracting them—that is, it brings the rays to a point, renders them parallel, or makes them divergent, according to the position of the source of light. We must, then, so adjust the light and the mirror as to bring the rays reflected from the latter to a focus or point on the object under examination. Speaking generally, when *parallel* rays fall upon a concave mirror, the reflected rays are brought to a focus at a distance of about *half the radius* of the mirror. That is, if the radius of the mirror is six inches, the focal point of the reflected rays will be about three inches from the centre of the mirror. *Divergent* rays, such as the rays from a lamp, increase this distance. The rule for the calculation of the distance is: Multiply together the radius of the mirror and the focal distance of the radiant point, and divide the product by the difference between twice this focal distance and the radius, when the quotient will be the focal distance of reflected rays. Thus, if the radius of the mirror is six inches and the distance of the lamp flame twelve inches, the focal distance of the reflected rays will be four inches ($6 \times 12 \div 12 \times 2 - 6 = 4$). If the lamp is brought nearer to the mirror, the focal distance of the reflected rays is *increased*, and *vice versâ*. It will thus be seen how necessary it is to accurately adjust the lamp and the mirror in order to obtain the best results. This also shows how essential it is that the mirror should be mounted, so that it can be slid up and down upon the bar which carries it.

In Fig. 3, Plate XLIX., is represented the course of a pencil of parallel rays falling upon a concave mirror and reflected to the object. A and B are the extreme rays of the pencil, C the mirror, and O the object.

A great amount of microscopical work can be done by means of the mirror alone, but when object-glasses of high power have to be used, a stronger concentration of the light upon the object becomes necessary. This is accomplished by means of what is called a *sub-stage condenser*. This is a combination of lenses fitted under the stage of the microscope, which condenses the light reflected from the mirror more strongly upon the object. In this case the *plane* side of the mirror should always be employed. For such a condenser a sub-stage to the microscope is necessary, and it must be so fitted that it can be moved up and down, so that it can be made to approach nearer to or recede from the stage, as may be found necessary.

Sub-stage condensers are always provided with some means of controlling the amount of light transmitted by them. This is accomplished either by a turn-out arm with a cell for the reception of small discs of metal pierced with holes of different sizes, or by an iris-diaphragm, consisting of a series of thin metal plates actuated by a lever which contracts or increases the size of the aperture for the transmission of light.

Some sub-stage condensers have both these arrangements, in which case the cell in the turn-out arm is used for the reception of different coloured discs of glass for modifying the light, or of metal discs with small holes in different positions for obtaining *oblique* illumination — that is, a ray of light passing obliquely through the object.

The numerical aperture of the sub-stage condenser should correspond as nearly as possible to the numerical aperture of the object-glass used: the condenser should also be *achromatic*. On this point the late Sir David Brewster said, "I have no hesitation in saying that the apparatus for illumination requires to be as perfect as the apparatus for vision."

In using the sub-stage condenser, the first thing is to see that it is correctly centred with reference to the optic axis of the object-glass—that is, that the exact centre of the lens of the condenser is in line with the centre of the object-glass. This is most easily done by contracting to a small point the ray of light coming from the condenser. When the centring is made, open the aperture for the admission of as much light as is required, and then move the condenser up or down till *the image of the lamp-flame or other source of light is accurately focussed upon the object* under examination. It is in this way the most perfect image is obtained. Do not use more light than is necessary.

In Fig. 1, Plate L., is represented the course of the rays when the mirror only is used. L is the lamp flame, M the *plane* side of the mirror, S the sub-stage condenser, and O the object. But when working with the sub-stage condenser, I prefer to follow the advice of the late Mr Andrew Ross, and make the rays from the lamp parallel by means of a condensing-lens before they fall upon the mirror. The manner of doing this was formerly explained. The course of the rays in such an arrangement is shown in Fig. 2, Plate L., in which L is the lamp flame, C the condensing-lens, M the mirror, S the sub-stage condenser, and O the object.

It was before strongly insisted on that, in order to render the rays parallel, the lamp flame must be placed in the focus and the centre of the condensing-lens. If these conditions are not observed, a considerable loss of light is the result as shown in Fig. 3, Plate L., in which it will be seen how small a part of the sub-stage condenser is utilised. The letters represent the same things as in Fig. 2. This shows the advantage of having the condensing-lens *fixed to the lamp and correctly centred to its flame,* as is done in the Beck "complete" lamp and some lamps of other makers.

A good way to get excellent results is to turn aside the mirror and send the light direct from the lamp into the sub-stage condenser. This, however, can only be done when the microscope is placed sufficiently high on its trunnions to enable the proper inclination of the body to be made, and the lamp flame can be brought sufficiently low.

A very pleasant form of illumination for certain objects is what is called *dark-ground illumination*—that is, the whole field of the microscope is dark except the object, which is brilliantly illuminated. This is effected by placing in the turn-out arm of the sub-condenser a metal disc having parts of the margin cut away at regular intervals but the centre left entire. This entire centre must be larger or smaller according to the aperture of the object-glass used. By this arrangement the central rays from the sub-stage condenser are prevented from entering the microscope, while the object is illumined by the oblique rays only. The arrangement of the light, as shown in Fig. 2, Plate L., is the best for this kind of illumination.

I have said nothing about illumination by polarised light or illumination for photo-micrography, as these subjects would lead me far beyond my present limits. I cannot, however, close these remarks without acknowledging my indebtedness to Mr E. M. Nelson, who, by common consent, is recognised as one of the first experts in microscopical manipulation in the country, and at whose feet many years ago I sat as a learner.

I would just add a few words about the care of the microscope, which is an expensive instrument. Whatever kind of microscope you buy—large or small—let it be of the first quality, and take care of it, and you will derive satisfaction from its use. Most large microscopes require to be folded in some way to be put into the cases in which they are bought. If they are to be much in use, avoid this folding as much as

PLATE L.—PRESIDENTIAL ADDRESS.

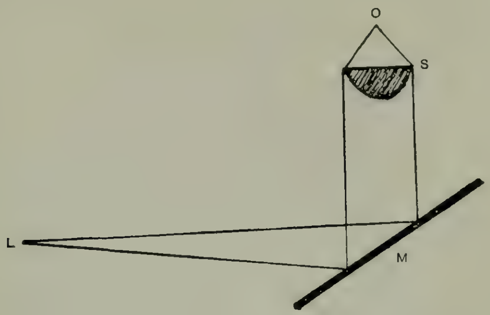

FIG. 1.

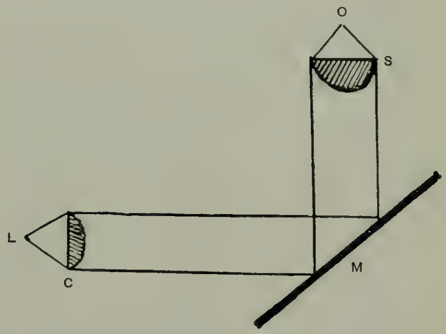

FIG. 2.

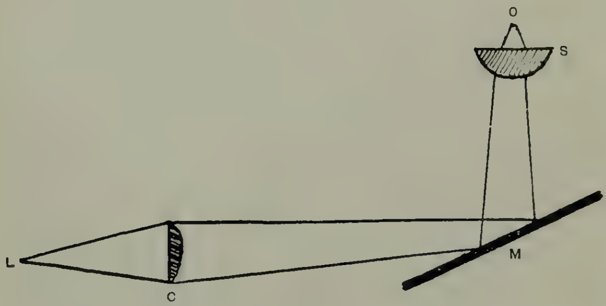

FIG. 3.

BRITISH MUSEUM NATURAL HISTORY

possible, and get some means of protecting them from dust when not in use. There is nothing better than a bell-glass with its rim fitted in a groove on a wooden stand, on which fittings could also be made for any additional eye-pieces or other apparatus.

The following photo-micrographs were then shown upon the screen :—

CELLULAR CRYPTOGAMS.

FUNGI.

Phytophthora infestans × 180.
Mucor mucedo × 23.
do. × 69.
Puccinia graminis—Teleutospores × 84.
do. Uredospores × 84.
do. Æcidiospores × 84.
Aregma bulbosum × 84.
Aregma gracile × 84.

ALGÆ.

Schizophyceæ (Fission Algæ)—
Chroococcus coherens × 540.
Nostoc commune × 540.
Cylindrospermum macrospermum × 270.
Glœotrichia natans × 195.

Diatomaceæ (Diatoms)—
Navicula didyma × 500.
Navicula lyra × 500.
Gomphonema geminatum × 450.
Coscinodiscus elegans (?) × 1000.
Systephania corona × 500.
Craspepodiscus elegans × 250.
do. (another view) × 250.
Asterolampra rotula.
Arachnoidiscus Ehrenbergii × 120.

Conjugatæ (Conjugating Algæ)—
Spirogyra in conjugation × 210.
Zygnema concinnum, showing protoplasm passing, × 195.
Spirogyra bellis, showing zygospores, × 270.
Spirogyra crassa, showing nucleus, × 540.

Chlorophyceæ (Green Algæ)—
Volvox globator × 30.
Sphæroplea annulina fruiting × 245.
Pithophora Kewensis fruiting × 23.
Œdogonium pulchellum, showing oogonia and male cells, × 220.
Œdogonium flavescens, showing oogonium and dwarf male, × 540.
Stigeoclonium fastigiatum in fruit × 270.
Vaucheria repens × 8.
Vaucheria terrestris, showing hornlet and sporogonium, × 540.

Phæophyceæ (Brown Algæ)—
Pelvetia canaliculata, showing receptacle, × 6.
Fucus vesiculosus, T.S. receptacles of male and female plants, × 8.
do., T.S. conceptacle, showing archegonia, × 200.
do., T.S. do., showing antheridia, × 200.

Rhodophyceæ (Red Algæ)—
Batrachospermum, showing trichogonium, × 1090.
do., showing glomerules, × 195.
Laurentia cæspitosa, with tetraspores, × 5.
do., showing tetraspores, × 280.

HEPATICÆ.

Marchantia polymorpha, showing antheridia, × 23.
do. do. archegonium, × 280.
do. do. gemmæ, × 34.
do. do. do. after 8 days' growth, × 34.
do. do. do. after 30 do., × 9.

VASCULAR CRYPTOGAMS.

Pteridophyta—
Selaginella Martensii, fertile spike, × 6.
Selaginella Kraussiana, young plant from spore, × 3.
do., T.S. of stem, × 30.
Male Fern, T.S. of rachis, × 9.
do., T.S. of vascular bundle, × 225.
Pteris aquilina, isolated tracheid, × 200.

PHANEROGAMS.

Pinus sylvestris, T.S. of leaf, × 30.
do., T.S. of stem, × 10.
Dracæna, T.S. of stem, × 9.
Lime-tree, T.S. of stem, × 13.

ANNUAL BUSINESS MEETING.

The Annual Business Meeting of the Society was held in the Hall, 20 George Street, on the evening of Wednesday, October 23, 1907 — Mr James Russell, President, in the chair.

The Honorary Secretary submitted his report, as follows:—

"During the Session 1906-7 seven indoor meetings of the Society were held. The attendance was small in comparison with the membership. It is hoped that an improvement will be seen during next Session. It is also desirable that members should voluntarily tender contributions, both of papers and exhibits, for next Session.

"During the summer twenty-three Field meetings were arranged, as follows:—

April	27.	Charlestown.
May	1.	Arthur's Seat.
"	11.	Borthwick Castle.
"	15.	Ravelston.
"	21.	Bamborough Castle.
"	25.	Longniddry to Prestonpans.
"	29.	Newbattle.
June	8.	Lennoxlove.
"	12.	Balerno.
"	15.	West Kilbride.
"	18.	Old Leith.
"	22.	Culross.
"	26.	Woodhouselee.
July	2.	Old Edinburgh.
"	6.	Dolphinton to West Linton.
"	10.	Chancelot Flour Mills.
"	13.	Jedburgh.
"	20.	The Whim.
"	24.	Davidson's Mains to Granton.
Aug.	24.	Firth of Clyde.
Sept.	16.	Cadzow Forest and Avon Glen.
"	28.	Donibristle.
Oct.	5.	Traquair House and District.

"The weather was not suitable for field work, several of the outings being held under very unfavourable conditions. This militated against the attendance. It was found impossible to carry out two of the excursions—viz., Cadzow Forest and Avon Glen, and Traquair House and District.

"Compared with last year, the membership is reduced by 5, the total number of ordinary members being 221. Of new names 23 were added to the list, while 28 names were withdrawn. Of these latter, 26 resigned, while 2—Mr D. Neish and Mr Alex. Scott—died. I regret also to have to report the death of an Honorary Member, Mr A. B. Herbert, who was President of the Society from 1882 to 1885, and of Mr Alex. Somerville, B.Sc., F.L.S., a Corresponding Member of the Society. These gentlemen were valuable members, and frequent contributors to the Society. The deepest sympathy is expressed with their relatives.

"The meetings of the Microscopical Section were, as formerly, held at the house of the Convener, Mr W. C. Crawford. Eleven meetings were held, and the work was both interesting and instructive. There is still room for a few more, and it is hoped that members will use their influence in this direction."

The Honorary Treasurer then submitted his report and statement of income and expenditure for the past year, copies of which were already in the hands of members, and which showed a substantial balance in favour of the Society.

The President, as a member of the Special Committee, submitted a "report of the Committee on proposed co-operation and possible future union with the Scottish Natural History Society." Mr W. C. Crawford moved—"That the report contains no suggestion as to co-operation, and that a union is at present not desirable or practicable." Mr John Lindsay seconded, and as no amendment was proposed, this became the finding of the meeting, and the Committee was discharged.

The retiring President then delivered his annual address, in which he dealt with the various methods of illuminating objects under the microscope and other matters (see *ante*, p. 423).

The election of office-bearers and councillors afterwards took place, the recommendations of the Council being approved of. The following is a complete list, the names printed in italics being those of members elected to fill vacancies. President—*A. B. Steele*; Vice-Presidents—W. C. Crawford, *E. Denson*, and *Rupert Smith*; Honorary Secretary—John Thomson; Honorary Treasurer—George Cleland; Editor of 'Transactions'—Dr A. E. Davies; Auditors—R. C. Millar and Charles Campbell; Councillors—John Laidlaw, *Thomas Wright*, Jas. B. Stewart, Miss Elizabeth Elliot, Miss Jane C. Crawford, Miss Katherine B. Macvicar, James P. Duncan, *T. C. Day*, *Miss Lily Huie*, *W. J. Pierce*, *Henry J. Pearce*, and *John Pursell*.

Mr Steele, the newly elected President, took the chair, and briefly thanked the Society for the honour conferred upon him. The meeting then closed with the usual votes of thanks.

INDEX.

PRESENTED
26 JAN. 1908
BRITISH MUSEUM NATURAL HISTORY

PRINTED BY WILLIAM BLACKWOOD AND SONS.

THE EDINBURGH FIELD NATURALISTS' AND MICROSCOPICAL SOCIETY.

COUNCIL, 1906-1907.

President.

JAMES RUSSELL, 16 Blacket Place.

Vice-Presidents.

WM. WILLIAMSON. | W. C. CRAWFORD. | Miss EDITH M. H. GRAY.

Editor of 'Transactions.'

Dr DAVIES, F.L.S.

Secretary.

JOHN THOMSON, 21 St Ninian's Terrace.

Treasurer.

GEORGE CLELAND, 61 Leith Walk.

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G. M. BROTHERSTON.
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JOHN LAIDLAW.
D. S. FISH.
JAS. B. STEWART.
Miss ELIZABETH ELLIOT.
Miss JANE C. CRAWFORD.
Miss KATHERINE B. MACVICAR.
A. B. STEELE.
JAMES P. DUNCAN.

Auditors.

R. C. MILLAR, C.A.; CHARLES CAMPBELL.

PAST PRESIDENTS.

Dr ROBERT BROWN (*deceased*), . .	1869.
Mr R. SCOT SKIRVING (*deceased*), . .	1869–1874.
Mr WILLIAM GORRIE (*deceased*), . .	1874–1877.
Rev. R. F. COLVIN (*deceased*), . .	1877–1879.
Mr JOHN WALCOT, .	1879–1882.
Mr A. B. HERBERT (*deceased*), . .	1882–1885.
Mr SYMINGTON GRIEVE,	1885–1888.
Dr WILLIAM WATSON,	1888–1891.
Dr T. B. SPRAGUE, F.F.A., . . .	1891–1895.
Dr A. E. DAVIES, .	1895–1898.
Mr W. C. CRAWFORD,	1898–1901.
Mr ARCHIBALD HEWAT, F.F.A., F.I.A., .	1901–1904.

LIST OF MEMBERS as at October 1, 1907.

Honorary Members.

Carphin, Mrs, Liberton.
Clarke, Wm. Eagle, The Royal Scottish Museum.
Henderson, Prof. John R., M.B., C.M., The College, Madras.
Macfarlane, Prof. J. M., University of Pennsylvania, Philadelphia, U.S.A.
Scott, Thos., LL.D., F.L.S., 280 Victoria Road, Aberdeen.
Traquair, Dr R. H., F.R.S., The Bush, Colinton.
Walcot, John, Craiglockhart Hydropathic, Slateford.

Corresponding Members.

Archibald, Stewart, Tomatin, Inverness.
Bennett, Arthur, F.L.S., 143 High Street, Croydon.
Boyd, D. A., Seamill, West Kilbride, Ayrshire.
Boyd, W. B., Faldonside, Melrose.
Cruickshank, T. M., South Ronaldshay.
Macvicar, Symers M., Invermoidart, Acharacle, Argyllshire.
Norman, Capt., Cheviot House, Berwick-on-Tweed.
Scott, Andrew, A.L.S., Marine Laboratory, Villa Marina, Piel, Barrow.
Service, Robt., Galloway Street, Maxwelltown, Dumfries.
Soar, Chas. D., F.R.M.S., 37 Dryburgh Road, Putney, London.

Ordinary Members.

Adam, Robt. M., 15 Brunswick Street.
Adams, James, Comely Park, Dunfermline.
Allan, Miss Margaret L., Public School, Currie.
Allan, Miss Mary N., 22 E. Preston Street.
Austin, William, Edgehill Cottage, Ravelston Terrace.
Barclay, James, 16 Roxburgh Street, Kelvinside, Glasgow.
Bell, A., 188 Dalkeith Road.
Bird, George, 33 Howard Place.
Blacklock, William, 19 Bruntsfield Avenue.
10 Bogie, D., M.A., 8 Blackwood Crescent.
Bonnar, William, 8 Spence Street.
Brotherston, George M., 13 Corrennie Drive.
Brotherston, Mrs G. M., 13 Corrennie Drive.
Bunce, Ernest, 90 Comely Bank Avenue.
Buncle, James, 93 Shandwick Place.
Calder, A. R., 2 James St., Portobello.
Cameron, Miss Annie D., 13 Panmure Place.
Campbell, Bruce, British Linen Company Bank, St Andrew Square.
Campbell, Charles, North British and Mercantile Insurance Company, 64 Princes Street.
20 Carswell, Miss Maggie S., 8 Corrennie Drive.
Carter, Albert, 4 West Holmes Gardens, Musselburgh.
Chapman, M., Torbrex Nursery, St Ninians, Stirling.
Clapperton, Robert H., Castlewood, Pomathorn Road, Penicuik.

Clark, A. B., M.A., Edinburgh University.
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Cleland, George, Bank of Scotland, 61 Leith Walk—*Treasurer.*
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Couston, Thos., Headmaster, Liberton Public School.
30 Cowan, Alex., Valleyfield, Penicuik.
Cowan, Charles Wm., Dalhousie Castle, Bonnyrigg.
Cowan, M'Taggart, jun., 33 Drummond Place.
Craig, Arch., 38 Fountainhall Road.
Craig, T. Herbert, 41 Gilmour Road.
Cran, J. D., 11 Brunswick Street.
Crawford, Francis Chalmers, 19 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.
40 Cumming, James.
Dallas, Miss Jane, 117 Warrender Park Road.
Davies, Dr, Tweedbank, West Savile Road—*Editor of 'Transactions.'*
Dawson, John D., 39 Morton Street, Joppa.
Dawson, Wm., 7 Warrender Park Crescent.
Day, T. C., 36 Hillside Crescent.
Denson, E., 83 Comiston Road.
Deuchar, Mrs, Harlaw, Hope Terrace.
Dickie, James, 4 Stanley Street, Portobello.
Dowell, Miss, 13 Palmerston Place.
50 Dowell, Mrs, 13 Palmerston Place.
Drummond, W. J. A., C.A., 37 George Street.
Drysdale, Miss Madge, 122 Braid Road.
Duncan, James Patrick, 3 Cobden Road.
Duncan, Mrs, 62 Craigmillar Park.
Durham, Frederick W., 2 Argyle Crescent, Portobello.
Edward, John, 99 Newbigging, Musselburgh.
Edwards, Robt., 39 Merchiston Crescent.
Elgin, Alex., 2 Albert Terrace.
Elliot, Andrew, 3 Palmerston Road.
60 Elliot, Miss E., 11 Abbotsford Park.
Elliot, Miss I., 11 Abbotsford Park.
Ewart, James, 14 Royal Circus.
Farquharson, Thos. K., 100 Thirlestane Road.
Field, John M'Dougal, 1 Hart Street.
Fish, D. S.
Forgan, John, S.S.C., 20 George Street.
Forgan, Wm., 3 Warriston Crescent.
Formby, A. M., 6 John's Lane, Charlotte Street, Leith.
Forrest, John L., 8 Glengyle Terrace.
70 Fraser, James, 18 Park Road, Leith.
Fraser, J. Elrick, 2 South Charlotte Street.
Fraser, Miss, 44 Polwarth Terrace.
Gardiner, Miss Mary, 23 Lutton Place.
Gibson, Mrs, 4 Colinton Road.
Gillespie, T. H., 8 Cameron Crescent.
Gloag, David, 9 Barnton Terrace.
Grant, Donald, M.A., 18 Upper Gray Street.
Grant, Mrs D., 18 Upper Gray Street.
Gray, Miss Edith M. H., 59 George Street.
80 Gray, James L., Elginhaugh, Dalkeith.
Greig, John M., 8 Spottiswoode Street.
Grieve, Sommerville, 21 Queen's Crescent.
Grieve, Symington, 11 Lauder Road.
Grieve, Mrs Symington, 11 Lauder Road.
Hamilton, Fergus, 4 Comely Bank Place.
Hamilton, G. R., 9 Mertoun Place.
Harrison, H. J., 10 Cluny Place.
Harvie-Brown, J. A., Dunipace, Larbert.

Hetherton, Miss, 13 Sciennes Road.
90 Hewat, Arch., F.F.A., F.I.A., 13 Eton Terrace.
Hogg, John, 6 Royal Crescent.
Huie, Miss Lily, Hollywood, Colinton Road.
Hunter, George, M.D., F.R.C.P., 33 Palmerston Place.
Hunter, John, 1 Straiton Place, Portobello.
Hunter, John, 39 Park Road, Leith.
Ingles, Miss A. J., 1 Lord Russell Place.
Jamieson, J. H., 54 Bruntsfield Gardens.
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Johnson, W. H., Tweed Villa, Relugas Road.
100 Johnston, Alex., Aros, Colinton.
Kennedy, Miss Margt., 95A George Street.
Kerr, Thos., 15 Gilmour Road.
Kinghorn, Hugh J. C., M.A., 28 Restalrig Terrace, Leith.
Laidlaw, John, 3 Argyle Place, Portobello.
Laidlaw, Mrs, 3 Argyle Place, Portobello.
Laidlaw, Thomas G., Bank of Scotland, Perth.
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Lawrie, Andrew, J.P.
Levack, D. R., 122 Gilmore Place.
110 Lewis, David, Roselea Villa, Grange.
Lindsay, John, 24 Montgomery Street.
Lindsay, William, 18 South St Andrew Street.
M'Andrew, James, 69 Spottiswoode Street.
M'Call, James, Loanstone, Penicuik.
M'Connell, Alexander, 4 Murieston Road.
M'Craw, Miss Jessie E., 44 Grange Terrace.
Macdonald, Miss Frances R., 1 Mardale Crescent.
M'Donald, J., 9 Brunstane Gardens, Joppa.
Macdonald, J. J., Commercial Bank, Comrie.
120 M'Intosh, Donald Cameron, M.A., Edinburgh Ladies' College.
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Macintyre, Miss K., Abercorn Terrace, Joppa.
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M'Kenzie, John, 90 Gorgie Road.
Mackenzie, John, 64 Ashley Terrace.
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M'Lean, John, Room 39, Sasine Office, Register House.
130 M'Lean, Miss, 5 Cambridge Street.
Macphail, Miss Susan Y., c/o Miss Martin, 130 Marchmont Road.
Macpherson, Alex., 1 Roseneath Place.
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Malloch, Jas. Jamieson, Schoolhouse, Juniper Green.
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Menmuir, W. Henry, L.D.S., R.C.S.E., 47 Comely Bank Road.
Millar, R. C., 6 Regent Terrace.
Millar, T. J., 30 York Place.
Mills, Fred., 188 Dalkeith Road.
140 Milne, Miss Marion, 20 Morningside Park.
Mitchell, Miss M., 153 Warrender Park Road.
Moir, Miss Margt. Jane, 4 Cockburn Street.
Moncur, James, West Garth, Colinton.
Monro, J. D., 44 Murrayfield Avenue.
Morison, Peter, 24 Great King Street.
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Morrison, Hew, LL.D., Librarian, Public Library, George IV. Bridge.
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Muir, Robt., 7 Mansionhouse Road.
150 Munro, Miss A. M., 35 London Street.
Munro, Alex., 41 Colinton Road.
Munro, John Gordon, 7 Howe Street.
Nesbit, John, 162 High St., Portobello.
Nichol, Alfred, St Mary's, Rosefield, Portobello.

Nicolson, J. Gregory, 15 Archibald Place.
Nisbet, Wm., 36 Elm Row.
Ogilvy, Mrs, Millburn, Argyle Crescent, Portobello.
Ogilvy, Wm., Millburn, Argyle Crescent, Portobello.
Paterson, Miss Agnes, 56 Lochrin Buildings.
160 Paton, John, 7 Albany Street.
Pearce, Henry J., 21 Joppa Road, Portobello.
Pierce, W. J., 16 Forrest Road.
Pinkerton, Allan A., 47 Viewforth.
Pittendrigh, T. M., 45 Comely Bank Road.
Pratt, Robert, 6 Newhaven Road.
Purdie, Miss Elizabeth S., 22 St Clair Terrace.
Pursell, John, Rhynd Lodge, Seafield Avenue, Leith.
Ranken, William, 11 Spence Street.
Reid, Andrew, 1 Laverockbank Terrace, Trinity.
170 Richardson, A. D., 1 West Brighton Place, Portobello.
Richardson, Mrs Ralph, 10 Magdala Place.
Ritchie, William, 75 Morningside Road.
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Robertson, Dr W. G. Aitchison, 26 Minto Street.
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Sconce, Colonel, 18 Belgrave Crescent.
Sillars, Duncan.
Sime, David, 27 Dundas Street.
180 Smith, Miss Ada, 137 Warrender Park Road.
Smith, Harry W., 23 Nelson Street.
Smith, Rupert, 38 Greenhill Gardens.
Smith, Wm. D., 43 Montgomery Street.
Smith, Wm. R., 4 N.-E. Circus Place.
Smith, W. W., M.A., 3 Warrender Park Terrace.
Somerville, Miss E. B., 2 Randolph Crescent.
Speedie, M. H., 2 Alfred Pl., Mayfield Terrace.
Speedy, Tom, The Inch, Liberton.
Sprague, Miss Beatrice, 29 Buckingham Terrace.
190 Sprague, Dr T. B., 29 Buckingham Terrace.
Sprague, Thomas Archibald, B.Sc., F.L.S., The Herbarium, Royal Botanic Gardens, Kew.
Steele, Miss Marion, 12 East Mayfield.
Steele, A. B., 16 London Street.
Steele, Mrs, 16 London Street.
Stenhouse, A. G., Whitelee, 191 Newhaven Road.
Stevens, Dr John, 2 Shandon Street.
Stewart, Miss Annie, 6 West Claremont Street.
Stewart, Jas. Bell, M.A.
Stewart, Geo. D., 96 Marchmont Road.
200 Stewart, Robert, S.S.C., 7 East Claremont Street.
Tait, Miss Eliza, 106 Thirlestane Road.
Tait, Miss Frances, 106 Thirlestane Road.
Tait, John Scott, C.A., 3 Albyn Place.
Terras, James A., B.Sc., 21 Teviot Place.
Thacker, T. Lindsay, Post Office, Little Mountain, Hope, British Columbia.
Thomson, John, 21 St Ninian's Terrace—*Secretary.*
Townsend, F. J., 20 St Catherine's Place, Grange.
Townsend, Miss E. A., 20 St Catherine's Place, Grange.
Turnbull, J. M., Craigcrook Road, Blackhall.
210 Waddell, James Alexander, of Leadloch, 12 Kew Terrace, Glasgow.
Wall, Wm., 3 Thorburn Road, Colinton.
Wardlaw, George, 14 St John's Hill.
Watson, Robert, M.A., 1 Warrender Park Crescent.
Watson, Dr Wm., The Lea, Corstorphine.
Watson, Mrs, The Lea, Corstorphine.
Watson, Miss B. J., 8 Scotland Street.

Watson, Wm., 6 Barnton Terrace.
Watson, Mrs Wm., 6 Barnton Terrace.
Webster, Miss H. H., 87 Brunswick Street.
220 Williamson, Wm., 4 Meadowbank Terrace.
Wilson, Rev. D. W., Stobhill Manse, Gorebridge.
Wood, T. A. D., Viewforth, Brunstane Road, Joppa.
Wright, Fred., 31A Minto Street.
Wright, Thomas, 12 Brunton Terrace.
Young, Miss A. N., 152 Morningside Road.
226 Young, David E., 60-62 High Street.

Edinburgh Field Naturalists' and Microscopical Society.

STATEMENT OF INCOME AND EXPENDITURE FOR YEAR TO 16th OCTOBER 1907.

INCOME.

To Balance from last Account			£28 5 8
" Annual Subscriptions—			
Session 1906-1907		£48 0	
" 1907-1908		0 5	
" New Members, 1907-1909		3 0	
			51 5 0
" Arrears of Subscriptions—			
Amount outstanding, 17th Oct. 1906		£4 5	
" irrecoverable	£1 5		
" still outstanding	1 5		
		2 10	
" recovered			1 15 0
" Donations for Publication Fund			8 17 6
" 'Transactions' sold			2 16 4
" Bank Interest			1 4 1
			£94 3 7

Arrears of Subscriptions outstanding—

Session 1905-1906	£1 5 0
Session 1906-1907	3 0 0
	£4 5 0

EXPENDITURE.

By Rent of Hall for Meetings, &c.		£6 15 0
" W. Blackwood & Sons—		
'Transactions' (Session 1905-1906)	£26 17 9	
Billets for Meetings	6 2 6	
		33 0 3
" Advertising Expenses		4 8 0
" Hire of Lantern and Slides		3 13 0
" Gratuities to Hall-keeper and at Excursions		1 15 0
" Stationery		4 19 10
" Millport Marine Biological Association		1 1 0
" Secretary's Railway Fares to Excursions		1 3 11
" " Postages, 'Transactions'	£0 6 6	
" " " Billets	3 13 5	
" " " Ordinary	1 3 7	
		5 3 6
" Treasurer's Postages		1 5 1
		£63 4 7
" Balance due by Bank of Scotland		30 19 0
		£94 3 7

PRIZE FUND.

To Balance from last Account	£5 0 0	*By* Balance due by Bank of Scotland	£5 0 0

GEO. CLELAND, *Hon. Treasurer.*

16*th October* 1907.—We hereby certify that we have audited the foregoing Statements of Income and Expenditure, and found them correctly stated and satisfactorily vouched, the balance in favour of the Society being Thirty-five pounds, nineteen shillings sterling.

R. C. MILLAR,
CHARLES CAMPBELL, } *Auditors.*