mens of the rare *Juncus castaneus* were obtained. On the rocks at the head of Loch-na-cat, *Saussurea alpina* and *Erigeron alpinus* were gathered; and *Athyrium alpestre* was found among the boulders at the foot of the rocks.

The party now descended the Lawers Burn, gathering on the way *Cornus suecica* and *Vaccinium uliginosum.*

On Saturday the ground explored extended from Lochan-na-lairige to a point on the hills above Killin, whence a descent to the hotel was made. The chief plants seen during the day were *Woodsia hyperborea* and *Cystopteris montana. Kobresia caricina* was again seen, in two localities, and a Meadow Pipit's nest, containing four eggs, was found at an elevation of about 2500 feet.

During the three days spent at Killin the following mosses, besides other commoner ones, were gathered:—

Andreæa alpina, Cynodontium virens, Dicranella crispa, Dicranum fuscescens, Campylopus Schimperi, Distichium capillaceum, Barbula tortuosa, Encalypta ciliata, Grimmia torquata, G. funalis, Tetraplodon mnioides, Splachnum sphæricum, S. vasculosum, Meesia uliginosa, Conostomum boreale, Zieria julacea, Timmia norvegica, Neckera crispa, Habrodon Notarisii, Orthothecium rufescens.

One of the party took a number of photographs of interesting or beautiful scenes in and around Killin. The last detachment of the party, which at first had comprised members from Perth, Kirkcaldy, Forfar, Arbroath, and Montrose, left for Perth on Saturday night, having had a most enjoyable and interesting excursion, and having been favoured with excellent weather.

HISTORICAL SKETCH OF THE FRESH-WATER ALGÆ OF THE EAST OF SCOTLAND.

By John Roy.

(*Being the Presidential Address for 1887 to the E.S.U.N.S.*)

In trying to trace the progress of discovery in a particular district or portion of a country, one is constantly hampered by the carelessness of the older writers in the matter of localities. No doubt many of our plants were known to occur in the N.E. of Scotland at a very early date. But there is no getting hold of definite facts. Indeed, Robert Morrison, who flourished in the 17th century, and who

published descriptions and wonderfully good figures of a large number of plants, does not, so far as I can remember, give a single Scottish locality, notwithstanding that he was a native of Aberdeen, and Professor of Botany at Oxford.

The earliest name that I am able to cite as having done a little to localize a few of our plants is Dr. James Cargill, who died at Aberdeen, in 1614. He published nothing himself; but he was a correspondent of Gesner, Lobel, and Caspar Bauhin. The latter was Professor of Botany and Anatomy at Basil, which chairs were erected for him in 1589; and Cargill was one of his pupils. In his *Prodromus*, he mentions a few Algæ sent by Dr. Cargill prior to the year 1603. These are: *Alaria esculenta*, *Laminaria digitata*, *Rhodymenia palmata*, all of which are still abundant on our coasts; but he also sent, with description, what was at that time called *Fucus maritimus Gallopavonis*, a species which does not appear to have been found on our coasts since. It seems now to be confined to the S. and W. of England. This is the *Padina Pavonia* of modern writers. Lightfoot gives it without any note of doubt, while Hooker and Harvey think there must have been some mistake; though they cannot imagine what species could have been mistaken for it. Neither can I; and further, I am not disposed to think that any mistake was made. According to the testimony of his contemporaries Cargill was not the sort of man to make careless mistakes, such as this would have been. Lobel in his "*Adversaria*" (London Ed. of 1605, at p. 485), under *Lancastriensis Asphodelus luteus* (*i.e.*, *Narthecium ossifragum*) writes thus: "Aliquot mensibus elapsis Nortuegico luteo Asphodelo parem et similem ex Scotia huc Londinum ad me misit peretissimus vir Jacobus Cargillus, doct. medicus, philosophus, anatomicus et botanicus insignis." Other similar statements concerning him might be quoted. I infer that the plant, possibly never abundant on our coasts, has disappeared since his time. It would be easy to cite parallel instances of land plants having disappeared. I may be allowed to quote one example, viz., *Glaucium luteum*, which grew on the coast, a little south of Aberdeen, 120 years ago. It had disappeared 70 years since; and I don't think it is now to be found north of the Forth. As still better adapted to my purpose I shall mention the case of two marine plants. Harvey in *Phyc. Brit.*, vol. iii., figures and describes *Sphacelaria racemosa* Grev., which he states was found in the Firth of Forth, opposite Carolina Park, by Sir John Richardson, before he started on his first Arctic voyage. Only a solitary tuft was gathered and it has not been found there since. In the same work, under *Griffithsia equisetifolia* Ag., the following statement occurs: "First described

by Lightfoot in the year 1777, in his *Flora Scotica*, on the authority of a specimen communicated by Mr. Yalden from the Firth of Forth ; and it is not a little remarkable that, though the plant has been found on most parts of the English and Irish coasts since Lightfoot's time, yet no more recent instance of its occurrence in Scotland has been recorded, nor have I received it from any of my Scotch correspondents." These plants have disappeared from their original localities in comparatively recent times ; and I take it that the existence of the " Peacock's-tail Fucus," on our coasts nearly three hundred years ago, perhaps in much more recent times, is fairly well established. Cargill sent one other Alga to Bauhin, with description, this time a fresh-water one, *Alga bombycina*, which agrees very well with our *Conferva bombycina*, as far, at least, as a merely naked-eye description could be expected to agree ; and this is the first recorded fresh-water Alga from N.E. of Scotland of which I have been able to find any notice.

We then pass over a long interval without any note from the N.E. of Scotland. In 1777 Lightfoot's *Flora Scotica* appeared, but he only adds one to the small list given by Cargill, viz., *Laurencia pinnatifida*, Huds. But an earnest student had been hard at work there before Lightfoot wrote ; indeed he died, at the age of forty-two, the year before Lightfoot visited Scotland ; I refer to Dr. David Skene, who was a correspondent of Linnæus. He published nothing, though he had made extensive preparations. Fortunately, most of his MSS. are still in existence, and a small fragment of his Herbarium, comprising Cryptogams only. His MSS. contain careful descriptions in Latin of a large number of Phanerogams and Cryptogams, the localities being usually given. The whole of his papers and the small remnant of his plants came into the hands of the late Mr. Thomson of Banchory, who had the whole carefully bound in volumes. In a note at the beginning of the little vol. of specimens, Mr. Thomson states that in several cases the labels were lost, in others they had got mixed, in which case the names he had put down were not always to be relied on. I have gone carefully over the Algæ, numbering 43 specimens and embracing 25 species. They are all marine, except one (*Lemanea fluviatilis*). In his MSS. he notes, and in most cases describes, 40, of which four are freshwater species, viz., the *Lemanea*, a species of *Nostoc*, *Œdogonium capillare* and *Chara vulgaris*, which is scarcely a true Alga. Another long barren period follows, broken slightly by the publication of a small list of Marine Algæ, at Aberdeen, in 1814, by James Arbuthnot, jun., of Peterhead. From 1840, onwards, the study of Marine Algæ, always an attractive subject, went on apace ; and the results appeared in the publications of Mr. William

Gardiner, Dundee, Alex. Croall, Montrose, and Professer Dickie, Aberdeen. The publication of Hassall's *Fresh Water Algæ* in 1845, marks an epoch in the study of these obscure organisms, so far as English readers are concerned. This was followed, in 1848, by Kützing's *Species Algarum;* which was succeeded and illustrated by his nineteen volumes of plates. In his *Species Algarum*, he mentions a plant, *Hydrurus fœtidus*, as Scottish; but without citing authority or indicating locality. I have searched through all the books I can think of for information on this point. The plant is not uncommon in other countries, but I wanted the information in regard to our own. Strangely enough, two years ago Dr. Nordstedt, of the University of Lund, and I found it in a locality which is visited every year by numerous botanists, viz., the River Clunie, in the middle of the village of Braemar. Still, of course, that does not solve the difficulty as to Kützing's information. Since the publication of these works not a year has passed without additions of more or less importance being made to our stock of knowledge.

I shall now confine myself to Fresh Water Algæ, particularly to a few groups. I shall first make a remark or two on the *Protococcoids*, which embrace a number of so-called species. They are extremely simple in form, which is more or less spherical. Each plant consists of a single cell either floating freely by itself, or aggregated with others into a more or less mucous mass. And their life history appears to be equally simple with their form. They increase by cell-division; that is, the protoplasm in the cell separates into two divisions; the two halves are pushed apart, and each assumes the spherical form, and floats off free. This operation is repeated again and again. Now the question may be asked, and has been asked: Is this the whole life history of these minute objects, (only a few ten-thousands of an inch in diameter), or is this merely a stage in the history of some higher plant? On this subject Dr. Schaarschmidt, Lecturer in the Royal Hungarian University at Kolosvár, in a recent paper says: "What some years before many conjectured as possible, is by recent observers asserted as true not only for the *Cyanophyceous* but for the *Chlorophyllophyceous* Algæ, viz., that many, if not all, the unicellular species, and some of the composite species of the Cyanophyceous Algæ, and, perhaps, of the Chlorophyllophyceous, are merely stages in the life history of higher plants. These states being fixed, the different forms have been defined and distinguished as different species. It will, probably, be finally found that some of the so-called species of *Glœocapsa*, *Chroococcus*, &c., as also of *Cylindrocystis*, *Protococcus*, &c., have their

own peculiar species of the higher Algæ from which they spring, and into which alone they can develop. In the order of Cyanophyceous Algæ species of *Glœocapsa* are degraded by recent discoveries as subordinate forms of higher Cyanophyceous Algæ, as *Sirosiphon, Oscillaria*, &c. ; *Glœocapsa Itzigsohnii*, Bornet, for example, was proved to be a peculiar state or development of *Sirosiphon Bornettii*, Zopf.

"Whilst no proof whatever has, as yet, been furnished for the vast majority of the Cyanophyceæ, as regards the genus *Cylindrospermum* we will briefly characterize the interesting relation between a minute *Chroococcus* and *Glœothece* and a species of *Cylindrospermum*. The filaments of this plant are composed of cylindrical or more or less globular cells. The spores are much larger than the ordinary cells, from which, at first, they are not readily distinguishable ; but, when the frond has attained a certain age, the spore-cells begin to enlarge, and, finally, assume a form and size apparently fixed ; the matured spores are cylindrical, rounded at the ends, and surrounded with distinct yellowish coats. The relative position of spores and heterocysts is various. The contents of the heterocyst are paler, the colour of the cell-wall yellowish. The cell at first seems merely to elongate until it reaches nearly twice its original length ; then the division commences. A median constriction divides the cells into two daughter-cells, the filaments then assuming a moniliform aspect. The cells are closely connected, no nuclei being discernible, as in *Nostoc* cells. By this process the filament rapidly increases in length ; but at the ends the new joint become further separated until they are almost detached. The separated cells remain together, and form irregular masses, resembling *Synechococcus*. These changes were observed in dried material, but were traced from uninjured filaments, and remind us of the metamorphosis of *Polypothrix amphibia*, Zopf. Besides these filaments we have seen many of Conferva-like appearance, which are composed of cells three or four times as long as broad, filaments with swollen yellowish cell-walls, and filaments composed of thicker-coated cells. The cells of these filaments separate in a similar manner to that before described. The result of the fragmentation (at the ends of the filaments) is a *Chroococcus* or *Glœothece*-form. The *Glœothece*-form springs from the *Chroococcus*-form, that is, from the rounded cells by their repeated division."

The remarks of, and case cited by, Schaarschmidt, aid a little, a very little, in the development of this subject. It would have been more satisfactory had his observations been founded on fresh material. My own position in the matter is simply this : that, while heartily sympathizing with those who hold that these low forms of vegetable

life are stages in the life history of higher plants, and while quite prepared to accept this view, on sufficient evidence being adduced in its favour, still, in the course of my own investigations, extending over a good many years, I have met with nothing whatever to induce me to adopt this theory—nothing even pointing in that direction ; so that, while very willing to be convinced of its truth, my evidence, so far, is entirely negative.

The next group on which I would remark is the *Volvocineæ*. The point I wish to notice is this : that Kirchner and others claim this beautiful and most interesting group of organisms as belonging to the animal kingdom ! I have seen no evidence sufficiently strong to justify the proposed change. Indeed the evidence appears to me to point all the other way. A very good account of the development of *Volvox*, drawn up by Mr. Wills, Birmingham, will be found in Cooke's *Fresh Water Algæ ;* of *Stephanosphæra pluvialis*, by Mr. Archer, F.R.S., Dublin, in the *Proceedings of the Dublin Microscopical Club ;* and of *Sphærella nivalis* (the Red Snow plant of Arctic voyagers) by Dr. Wittrock of the University of Upsala, in Nordenskiold's account of his visit to Greenland. I think we have all the members of this group of plants in our division of Scotland, with one remarkable exception, viz., *Stephanosphæra pluvialis*, which, as far as I am aware, has never been found in these islands, except in one little rock-pool on Bray Head, near Dublin ; where I had the pleasure of gathering it last year in company with the discoverer, my valued friend Mr. Archer. The Red Snow plant, so abundant in many parts of the Arctic Regions, in West Greenland, for instance, where the snow for miles, was designated "The Crimson Cliffs," is exceedingly rare and local in this country. It has been found on Ben Muich Dhu, and was gathered two years ago on Ben Nevis, by Dr. Nordstedt. If there are any old enough snow-wreaths about the back of Ben Lawers they should be examined for it. *Volvox globator* occurs on Durdie Moor, near Perth. We have both it and *V. minor* in the north ; and also both species of *Gonium*, though one of them (*G. sociale*) has been found in one pool only.

Passing on to the *Conjugatæ*, an interesting question has been raised as to sexuality. Do certain filaments represent males, and certain others, females ? If so, are there any certain marks by which they may be distinguished ? These questions have often been raised, but are not easily answered. Mr. A. W. Bennett, in a recent paper, maintains the possibility of distinguishing the sexes in the *Zygnemeæ*. The points he relies on are these four :—1. The difference in the size of the cell ; in the *Zygnemeæ*, the supposed germ-cells being the

larger; while in the *Mesocarpeæ* the contrary is the case. 2. That the portion of the conjugating canal contributed by the germ-cell is shorter and wider than that contributed by the sperm-cell. 3. That the protoplasmic contents of the cells always travel in one direction, that is, that in scalariform conjugation the contents of the cells of one thread invariably pass over into the cells of the other thread with which it is conjugating; and 4. That in *Mesocarpus* the spore which is formed in the conjugating canal never occupies its centre, except in those cases where the spore is large enough to occupy the whole of that space. My valued friend, Mr. F. Bates, of Leicester, answered Mr. Bennett in a paper in "*The Journal of the Quckett Mic. Club*," in a manner so entirely in agreement with my own observations, that I have no hesitation in adopting the reply as expressing my own conclusions. He shows convincingly, as I think, that the points Mr. Bennett relies on to prove his case are untenable. The paper will be found in the part for March, 1885. Microscopists will learn with regret that Mr. Bates has been obliged to give up the use of the microscope.

Another exceedingly interesting group of the Fresh-Water Algæ is the *Œdogonieæ*. Since the investigation of these plants was put on a proper footing by Pringsheim, several years ago, they have been assiduously studied; and by no one more carefully than by Professor Wittrock, whose monograph is the standard work on the subject. Not much, I am sorry to say, towards the investigation of the species comprised in the two genera, *Œdogonium* and *Bulbochæte*, has been done in the district embraced by the Union; indeed, I do not know of any observations prior to my own; and mine are necessarily very fragmentary, and do not represent more than half the species found in Scandinavia, while, I feel sure, the numbers in the two countries should be nearly equal. Any one taking up the study of this beautiful family would enter upon a practically unoccupied field; and numerous interesting discoveries would reward his labours.

I return to the *Conjugatæ* for the purpose of making a few remarks on a remarkable division of that large and important order, one to which I have devoted a little attention, viz., the *Desmidieæ*. These elegant objects, I need hardly say, are very minute, the very largest of them being just barely visible to a sharp eye as a green point; and, therefore, fairly high magnifying powers are required for satisfactorily working them out. I may remind you that they are unicellular Algæ: *i.e.*, each individual consists of a single cell, usually more or less deeply constricted in the middle, and having its halves perfectly symmetrical. The surface is often highly ornate. It is usually

colourless; but is sometimes reddish brown, and is often variously ornamented with minute dots or puncta, shallow depressions, granules regularly arranged, or spines simple or compound. These markings are of specific importance, being practically uniform for the same species. The cell wall is composed of an outer and an inner membrane; and probably the markings are confined to the outer membrane; at least, in a curious species found by myself, which is reddish, and has the cell-wall punctate, the outer membrane slips off, and the inner is seen to be perfectly smooth and colourless. I have hitherto been unable to test this in any other case, but probably it will ultimately be found that what has been proved true in this case will hold good in all.

Desmids increase rapidly by division. At the constriction an outgrowth from each semi-cell is produced, which pushes them further apart as the growth goes on, until the new semi-cells thus formed are as large as the original ones, which they very soon come to resemble, both as to outline and ornamentation. Then the two Desmids, which till now remained attached, part company and float off, two perfect individuals, each composed of an old and a new half. We do not know how often this process may be repeated, or how many new *alter-egos* the original semi-cells may have had. In a few cases they remain attached after dividing, and form long ribbon-like filaments of great beauty. One of these, which I have frequently seen, from N. and S. America, India, and S.E. Asia, but which has not hitherto been found in Europe, *Micrasterias foliacea*, is a superb object. But while a few species form filaments in this manner, the great majority float freely as single individuals,—plants, without root, stem, branches, or leaves, but not always without fruit, though there are no flowers. Two individuals of the same species come near together in some mysterious fashion. A sort of light, transparent, often invisible, mucous veil is thrown around them, or rather exuded by themselves, —each opens slightly at the constriction,—the inner membrane pushes out, and forms a little tube closed outwards,—they soon meet and fuse together. There is now a direct opening from both, and a distinct union. The chlorophyll and protoplasm of each pour out, and the two streams meet in the middle of the joint tube, which rapidly swells, and forms a globular mass, with the now emptied and dead semi-cells attached to it. The cell-wall of this globular mass rapidly increases in thickness; and, though in many it remains smooth, in most species it emits spines, long or short, which are blunt, or acute, and frequently have their tips several times divided. The mass forms altogether a very beautiful, as well as interesting,

object. It is also of the greatest specific importance. For the zygospore, as it is called, presents uniformly the same characteristics for a given species. Hence, if two species of Desmids look so much alike that one might be disposed to consider them to be one and the same species, yet if we find them conjugated, and the zygospores of the two prove different, this shows that they are distinct. It will readily be admitted, therefore, that it is of no little consequence to the investigator to find species conjugated. Still, many species have never been found conjugated, though every year is reducing the number of these. In the vast majority of cases, however, there is little difficulty, with due care, in discriminating species, even when not conjugated. But, when perfected, what is the object of the zygospore, and what becomes of it? Wolle, the author of an important work on the Desmids of the United States (published three years ago), gives as his opinion that multiplication by cell-division tends to impoverish the species, and that the process of conjugation, and the consequent formation of a zygospore, is necessary for its regeneration. I am not prepared to controvert this idea; but I must remark on it that many species that I have never seen to conjugate show no signs of degeneration or impoverishment, by which, I suppose, he means a slight falling away from the type. There must be some reason why the two modes of increase are provided; but apparently it has still to be discovered. As to what becomes of the zygospore, Wolle very well summarizes the views of De Bary, as follows:—"The next step, so difficult to be traced, is the opening of the wall of the zygospore, setting free small spheres of sarcode; as they issue, they enlarge and acquire a gelatinous or thin membranous wall. The wall thickens and the sphere enlarges, the contents constrict, first in one direction, and then transversely to the plane of the first incision; these plants develop and set free two or four new plants, in size and form like the mother cell, except in the cytioderm or membrane; this is not granular, but smooth, and remains so until after the multiplication by division takes place. After the first division, the new semi-cells assume the characteristic granular surface; the result of this first division is two plants, each composed of one granulated and one smooth semi-cell. The second division will make two perfect cells, and two that retain the smooth semi-cell; the third division produces eight cells, all of which except the original two semi-cells will be of typical form."

These views of De Bary were published in his treatise on the Conjugatæ in 1858, and practically no advance has been made since. Notwithstanding the hundreds of zygospores observed by myself, I

have never seen anything like the processes described by De Bary; but I would be more inclined to hold, with Hofmeister, that the various transformations take place in the zygospore itself, and not that portions of the contents escape separately, division taking place afterwards.

A third supposed mode of increase is by means of zoospores. These were detected in one species, *Docidium Ehrenbergii*, by my valued friend, Mr. Archer of Dublin, and published by him in the *Natural History Review* for July, 1860. He describes them as being comparable in appearance and mode of formation to the Zoospores in *Cladophora*, where they undoubtedly propagate the plant, and form young colonies in abundance. He observed them in the month of September. The curious thing is that no one seems to have observed them since. Probably they are formed late in the season when these plants are seldom looked for, and they may therefore be more common than is generally supposed; at the same time, I am bound to state that, though I have collected Desmids at all seasons, I have never seen the zoospores.

The power of movement in Desmids is an interesting point in their history. Probably all their movements depend on the influence of light. It has long been known that if they are covered with mud, and exposed to the light, they will quickly make their way to the surface, which affords the opportunity of securing clean gatherings not otherwise easily made. A peculiarity of this process is a tendency to turn the longer axis towards the light, with the younger half of the cell next it. *Tetmemorus granulatus* often shows a forward movement, and some species of *Closterium*, resting themselves on their tips, sway backwards and forwards for a considerable time. The cause of these movements is not well understood, or rather is not understood at all. Another peculiar state of matters is equally obscure, that namely in which the cell contents become changed iuto a mass of granules moving with great rapidity. This state is best seen two or three days after they have been gathered. It is quite a different state from the movements of the granules seen near the extremities of *Closteria*, and of other genera, which are normal in these plants.

Desmids are to be found most abundantly, in comparatively small, shallow, permanent pools of clear water in open situations. They nestle among the leaves of such plants as *Myriophyllum*, *Utricularia*, *Chara*, *Sphagnum*, &c., or they attach themselves to submerged stems of grasses and other plants. Many interesting species occur in tufts of moss on wet rocks. Others occur abundantly in rapid streams, attached to tufts of *Fontinalis*, and other mosses. One species has

been found on *ice* only, on the glaciers of Greenland and Scandinavia; and a few are pretty much confined to snow, though not exclusively so. They have a very wide range of distribution. Many of our own species are identical with those of Greenland, Spitzbergen, and Novaia Zemlia, on the one hand, and with those of Brazil and India, on the other; and most of the species found in Japan are the same as the Scandinavian, that is, practically the same as our own.

Like the Diatoms, the study of the Desmids and the improvement of the microscope came together. I have been unable to ascertain that anything whatever was attempted in this way in our district, till the year 1840. Mr Ralfs began about that time to make preparations for his beautiful work on *British Desmidieæ*, which appeared in 1848. He had two able assistants in the north, to whom he very frequently refers, the late Professor Dickie, F.R.S., and Mr Peter Grant. The latter has been dead for many years, indeed I never met him. He was an indefatigable collector, and sent material to Ralfs from all parts of Aberdeenshire and Banffshire. Dr. Dickie examined for himself; but was in close communication with Ralfs, to whom he gave much assistance. From 1849 till 1860 he resided in Belfast, and before his return to Aberdeen in 1860 he had practically given up the study of Fresh Water Algæ, having found that of Marine Algæ much more congenial. In the latter department, I need hardly remind you, that for many years he had no superior. This statement satisfactorily accounts for the small list of *Desmidieæ* given in his "Botanist's Guide," amounting, I think, to only about 70. After Dickie and Grant, I am not aware of anyone having taken up this subject systematically, in this district till I began it myself, sixteen or seventeen years ago; and at that time the only other person I knew of who worked at Desmids was Mr. Archer of Dublin; we were mutually indebted to Dr. Dickie for bringing us into correspondence,—a correspondence which soon became close and valuable, especially to me. Since then, students of this subject have become more numerous, though still far too few.

Recently, with the object of perhaps publishing something on Scottish Desmids, and with a view to ascertaining their distribution through the country as accurately as possible, I have been searching for any lists that may have been printed for particular localities. In particular, I looked through the earlier volumes of the Transactions of the Botanical Society of Edinburgh, as likely repositories for such. There I found two lists, both for 1855; the first by Mr. Geo. Lawson, from West Lomond Hill, comprising 29 species, all common; the second from Breadalbane Mountains by Mr. Hugh C. Stewart, com-