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Antarctic Botany : Its present state and future problems

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Daphnia.—In all the lochs where *Daphnia* occurred, it was as the variety *galeata*, a large form with the head angled.

Holopedium gibberum.—Only in Lochs Calavie and an Tachdaidh.

Leptodora kindtii.—Only in Loch Monar.

Polyphemus pediculus.—An Gead loch.

Cyclops strenuus.—Present in most of the lochs. The *Cyclops* in Loch Calavie were red-spotted.

Diaphanosoma brachyurum.—Found in four lochs—Tachdaidh, Bunacharan, Mullardoch, and Lungard.

Floscularia pelagica.—Loch Monar.

Conochilus.—Both species, *C. unicornis* (the common lake species) and *C. volvox*, were present in Loch Monar.

Sponge.—A fresh-water sponge, species not determined, came up attached to the sounding-rod, from depths of 6 or 8 feet, in Loch a' Mhuilinn. The pieces were long and finger-shaped.

ANTARCTIC BOTANY: ITS PRESENT STATE AND FUTURE PROBLEMS.

By R. N. Rudmose Brown, B.Sc., Scottish National Antarctic Expedition.

The botanical collections of recent antarctic expeditions having now been in the main determined and the results published either in forecast or in full, it is possible to take a survey of our existing knowledge of the botany of antarctic regions and to draw attention to some localities which especially require exploration, and to some of the more pressing problems that await study.

It is very generally supposed that the antarctic regions are almost destitute of botanical interest, and are the last place on the earth's surface where plants can be looked for, and in truth, until quite recent years, our botanical knowledge of these regions was so scanty that there was at least some ground for such a belief, for almost the only collections known were those of Joseph Hooker in Ross's expedition of the *Erebus* and *Terror* in 1839-1843.

The recent renewed interest in the antarctic as expressed in the expeditions of the last decade have by their various collections and observations shown that the south polar flora, poor as it may be, is nevertheless in some respects richer than was supposed, and gives the botanist good reason to hope for further results from future expeditions. The chief interest in these collections lies, of course, in the questions they give rise to in the problems of geographical distribution and the light they throw on the study of the former configuration of land and water in south polar regions. For at a time when geological and oceanographical evidence forces the scientist to abandon the old conception of the permanence of ocean basins, it is not impossible that a careful examination of the distribution of present-day floras, especially in the light of recent advances in palæobotany, may be productive of some evidence

towards a reconstruction of former land connections in the southern hemisphere.

The adaptations of the various species to their environment, a study particularly valuable in the case of cosmopolitan species, promises most valuable results, but is not likely to be seriously undertaken until the systematic and geographical interests of the collections have been worked out in full. For a newer study almost invariably has to wait until the older aspects of the science have been satisfied. It is, moreover, extremely desirable that such physiological and morphological questions should be studied on the spot; indeed, the impracticability of satisfactory investigation in any other circumstances is most obvious. The difficulty of laboratory accommodation in the isolated antarctic regions is naturally great, but not nearly so great as is generally supposed. Various expeditions which have recently wintered in the south have shown that the climatic conditions, though not exactly as favourable as in the north, offer no serious inconvenience to an ordinary robust constitution and cheerful disposition, even though one is not prepared to rough it in the manner of the geographical explorer. And, furthermore, it should be remembered that there are at the present time at least three habitable dwellings within the regions of south polar ice:—one, Omond House, at the South Orkney Islands, built by the Scottish National Antarctic Expedition in 1903, another at Wandel Island on the west of Graham Land, where the French Antarctic Expedition spent the winter of 1904, and a third at Snow Hill on the east of Louis Philippe Land, the station of the Swedish South Polar Expedition in 1902 and 1903. Of these the house at Scotia Bay, South Orkneys, is permanently inhabited as an Argentine Meteorological Observatory, while that at Wandel Island will be taken possession of next year for a similar purpose. Nordenskjöld's house at Snow Hill in the meantime stands vacant for whoever cares to make use of it. Thus it will be seen that laboratory accommodation on a small scale in the antarctic regions is far from impracticable, and should not be a matter of any very great cost. These stations, it may be remarked, are not very far to the south; but that is a distinct advantage, for while all are within the veritable polar regions and experience the real antarctic climate, they escape in very large measure the long night and its attendant drawbacks and, most important consideration of all, they are readily accessible, so that a relieving ship should experience little difficulty in gaining all or any of them every summer. The Danes have now established in north polar regions on Disco Island a fully equipped biological laboratory, and the extreme desirability of a similar station in south polar regions need not be further urged. But in the meantime, until this larger project can be put into execution, it would be most desirable that a biologist should be attached to each of these antarctic observatories during the coming year, though, of course, as the number of inhabitants at each observatory must be very strictly limited, he would combine his biological studies with the duties of a meteorological observer.

The most striking feature of the antarctic flora is, of course, its poverty compared with that of the arctic. Thus the arctic regions support about

four hundred species of flowering plants, while the antarctic regions support but two, and even these can hardly be said to flourish. The reasons which bring about this extreme contrast between north and south is one of the most interesting biological problems that await solution in these regions.

The amount of light available is of course the same in north and south at corresponding latitudes, and yet the contrast between the two vegetations is even more marked when one remembers that at Spitsbergen in 79° N., the ground is bright in summer with a hundred species of flowering plants, while at the South Orkneys in only 61° S. there is not a single species. Snow is probably not much more abundant in the south, and winter temperatures at least in the outermost south polar regions, neglecting for the moment comparative latitudes, are not more severe than in the north.

The real explanation is probably to be found in the short and inadequate antarctic summer with its remarkably low temperatures. Thus, for example, at the South Orkneys in 60° 44′ S. the mean of the summer months (December, January, and February) is only 31·7° F., or including March, 31·9° F., and in no month does the mean rise to 33° F., while the mean of the warmest day in 1903-4 was only 37·7° F.; at Snow Hill Island, Louis Philippe Land (64° 24′ S.), the mean of the warmest month (January) was found to be only 30·38° F., while at Cape Adare, Victoria Land, in 71° 18′ S., the summer mean is 30·4° F.

These temperatures may be compared with those of the arctic regions. Thus at Spitsbergen (79° 53′ N.) the mean temperature of July (the corresponding month to January in the south) is as high as 41·5° F., while in Franz Josef Land, in over 80° N., it is not lower than 35·6° F. in the same month. The mean of the Spitsbergen summer (June, July, and August) is 37·1° contrasted with the corresponding mean given above for the South Orkneys, 31·7°. Examples could thus be multiplied, but all would bring out the same important point, that while the arctic summer mean is well above 32° F., the antarctic summer mean is practically always below. This remarkably cold antarctic summer acts in two ways upon plant life: *firstly*, the winter snow lies late on the ground—all the later as the summer is a cloudy and somewhat sunless period, and December is well advanced before the majority of available sites are laid bare, while in February the winter[1] again begins; *secondly*, and this is the chief reason, it is doubtful if a flowering plant could obtain the requisite amount of heat needed for its various life functions even to reach the flowering stage, while the maturation of its fruit would be next to impossible. In fact, one could with much truth say that the antarctic summer is but an astronomical conception: those who have experienced it know well how little reality it has. Doubtlessly, then, in this want of a season of growth lies a quite adequate explanation of the poverty of the south polar vegetation, but I think that there is also another adverse influence at work. Even supposing that a species did obtain a footing

[1] Contrast this with the north, where, for example, at the northern part of the east coast of Greenland, the land is clear from snow from May or early June until September, dates which would correspond in the south to November to March.

on Antarctica, as is not impossible in the lands nearest Fuegia, considering the narrowness of Drake Strait, its continued existence would be at once menaced by the presence of the myriads of penguins which occupy almost every bare spot of ground during the nesting and breeding season. There is no parallel in the north to these penguins and the power they would have in destroying any vegetable life. Almost every spot where a plant might obtain a hold is covered with these birds in the proportion of at least one to a square yard, and nothing escapes their insatiable curiosity or fails to be examined with their beaks, while in a few weeks' time such a rookery is in an indescribable state of filth, being entirely covered with several inches of mud and manure through which the penguins are incessantly tramping hither and thither; circumstances which would render plant life quite out of the question. It is true that here and there one finds a small expanse—even as much as an acre I have once seen—of moss-covered rocks which by successive years' growth are covered with six to eight inches of vegetable soil, but these are spots much less accessible from the sea, and are very seldom suitable for rookeries—which is, of course, the sole condition under which this continuous growth of moss from year to year could continue. In such spots one might look, though in vain, for flowering plants, and perhaps in consequence conclude that the influence of the penguins, though potentially inimical to vegetable life, has never cause to operate. But it must be noted that these moss formations, though in many respects suitable for phanerogamic plant life, are yet always very late in losing their winter snow, and generally lie in sheltered places where wind-carried seeds would be little likely to arrive. That seeds of Fuegian species of phanerogams occasionally reach Graham Land and adjacent South Shetland and South Orkney Islands is more than probable considering the prevalence of winds from the north of west in that region: it is even possible, though far less likely, that wind-carried seeds from Kerguelen and Heard Island occasionally alight on parts of the coast of Wilkes Land. The likelihood of the transport of seeds by birds is lessened by the fact of there being only one true land bird (*Chionis alba*) in the antarctic, but it is not impossible that some seeds are occasionally carried adhering to the feet of such wandering birds as the southern black-backed gull, the skua, and the giant petrel, which range from sub-antarctic to antarctic lands. As regards floating ice, I do not think that in the antarctic it ever acts as an agency in the dispersal of species.

It is, therefore, not by reason of their isolation alone that the south polar regions have next to no phanerogamic vegetation, but because they are unsuited in one way or another to support it. If such a modest biological station, as I have advocated above, should be instituted, it would be of extreme interest to attempt to cultivate on certain of the mossy oases various species of hardy arctic plants, such as *Papaver nudicaule, Ranunculus sulphureus, Cerastium alpinum, Saxifraga oppositifolia,* etc. etc., which all prosper and produce seed at Spitsbergen.[1]

[1] I myself have attempted to make such an experiment by sending to the Argentine Station at the South Orkneys a supply of seeds of 22 arctic species of phanerogams, with a

Dr. Skottsberg, of the Swedish Antarctic Expedition, considers that the formidable antarctic winds must be another unfavourable condition for higher plant life.[1] While fully admitting the strength of the winds that sweep over certain localities the greater part of the year, I do not yet think they could have an inimical influence on any possible vegetation, partly because there are always certain sheltered spots, but largely because the antarctic summer is a relatively calm period, while the winds of winter could of course have no prejudicial influence through the covering of snow.

Before turning to a consideration of the actual vegetable life of the antarctic, especially as revealed by the expeditions of the last few years, it would be advisable to define the limits of the antarctic regions from a phytogeographic standpoint. On this subject there has been much diversity of opinion, largely attributable to an almost complete ignorance of the conditions obtaining in the south.

Dr. Skottsberg in a recent paper[2] has ably discussed the whole question, and he clearly points out the obvious error that phytogeographers commit in placing the boundary of the antarctic regions too far to the north so as to include, according to some, even part of South America: as untenable a position as that of those who would restrict the antarctic to the regions south of the astronomical antarctic circle. Dr. Skottsberg shows that the parallel of 60° S. forms a more or less natural limit, and in this proposition of his I quite agree.

The flora of the antarctic regions as thus defined contains only two phanerogams, namely *Descampsia antarctica* (Hook.) Desv., and *Colobanthus crassifolius*, Hook. f. var. *brevifolius*, Eng. The former of these has long been known from antarctic regions, having been collected by Eights about 1820 at the South Shetlands, and it also occurs on Danco Land, but its discovery, along with *Colobanthus crassifolius*, by Dr. Turquet, of the French Antarctic Expedition, at Biscoe Bay, Anvers Island, in 64° 50′ S. 68° 40′ W., is very interesting, for this is the most southerly record for flowering plants known. *Descampsia antarctica* was also found by Dr. Turquet at Wandel Island, 65° 5′ S. It is extremely probable that further exploration will somewhat extend the range of

request to have them planted in a certain spot which I chose as suitable during my stay at Scotia Bay in 1903. But whether this experiment has had any result, or even been attempted, I cannot yet say, and the fact of there being no biologist at present attached to the party in residence there will mitigate against the chances of the experiment being carefully watched. The seeds sent were all of arctic species, and it may be as well to publish the complete list, which is as follows:—*Papaver nudicaule*, L., *Draba alpina*, L.; *D. hirta*, L., f. *rupestris*, R. Br.; *Cochlearia officinalis*, L., var. *β*, Vahl; *Vesicaria cretica*, Poir.; *Silene acaulis*, L.; *Cerastium alpinum*, L.; *Potentilla nivea*, L.; *Alchemilla alpina*, L.; *Saxifraga oppositifolia*, L.; *S. nivalis*, L.; *S. rivularis*, L.; *S. hypnoides*, L.; *Sedum Rhodiola*, D.C.; *Erigeron alpinum*, L., var. *grandflorum*, Rahl.; *Hieracium alpinum*, L.; *Vaccinium uliginosum*, L.; *Arctostaphylos uva-ursi*, Spreng.; *Armeria pubescens*, L.; *Oxyria reniformis*, Hook.; *O. elatior*, R. Br.; *Luzula spicata*, Desv.

[1] *On the Zonal Distribution of South Atlantic and Antarctic Vegetation.* Carl Skottsberg. *Geog. Jour.*, Dec. 1904.

[2] *Some Remarks on the Geographical Distribution of Vegetation in the colder Southern Hemisphere*, Carl Skottsberg, *Ymer* (Stockholm), 1904, p. 402. This paper also contains a useful bibliography of antarctic and sub-antarctic botany.

these species. Reference has been made by me elsewhere[1] to the reputed grass of the South Orkneys, of whose occurrence we have no evidence except the vague report of a sailor, and which I know from personal search does not grow to-day in the place indicated. Ferns are entirely wanting in the antarctic, as was only to be supposed, but mosses are relatively abundant and form almost the chief constituent of the flora. Collections[2] of these are known from various points around the pole, including Graham Land, South Shetlands (*Belgica, Antarctic, Français*), South Orkneys (*Scotia* and Argentine Expedition), Emperor William II. Land (*Gauss*), and Victoria Land (*Southern Cross* and *Discovery*), but those from the Atlantic and American sides are incontestably the richer, no doubt largely because of the nearer proximity of extra-polar land and consequent possibility of migration, but also to some extent because that side of the antarctic regions has received more careful and serious exploration than any other. Dr. Jules Cardot, who has examined the mosses brought back by all the recent expeditions, places the total number of species at present known at 50. The *Belgica* collected 27 species on the west of Graham Land, and the *Southern Cross* 3 on Victoria Land. Among recent expeditions the *Antarctic* collected 23 species on Louis Philippe Land, among which are several identical with those the *Scotia* brought from the South Orkneys. The mosses collected by the *Français* number 13, all from Wandel Island, Hovgaard Island, and Wiencke Island in Gerlache Strait off Danco Land, and with the exception of four are all different to my South Orkney species. The *Discovery's* collections include, Dr. Cardot informs me, seven species of mosses from MacMurdo Strait and Mount Terror, only two of which are known from Graham Land, and one from the South Orkneys. From the South Orkneys 14 species are known, of which 10 are from the *Scotia* collection, and the remaining four from the collections of Señor L. H. Valette of the Argentine Observatory (1904).

A fuller discussion of the problems involved by these collections may soon be expected from the pen of Dr. Cardot, and in consequence it is better to refrain from discussing here certain questions of distribution; suffice to say that almost fifty per cent. are endemic in the antarctic, and about twenty-five per cent. are cosmopolitan in their distribution.

The life conditions for mosses are evidently not very unfavourable, for most of the species show a fairly vigorous growth and do not appear to suffer from the severe environment. This can especially be remarked in those species which have a wide distribution throughout other parts of the world, for in them it is possible to make a comparison of the effects of the antarctic climate and soil on the growth of the plant. In the South Orkneys I noticed that for at least seven months, and in

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1 *The Botany of the South Orkneys.* R. N. Rudmose Brown. *Trans. and Proc. Bot. Soc. Edin.*, XXIII. i. (1904-5).

2 *Résultats du Voyage du S.Y. Belgica, Mousses,* J. Cardot, *Anvers* (1901). *Report on the Southern Cross Collections,* London (1902). *Note prél. sur les mousses rec. par l'exped. ant. suédois.* J. Cardot, *Bull. Herb. Bois.*, vi. p. 13, and other papers quoted.

places eight, the moss was frozen as hard as rock, but this did not seem at all to impair its vitality on the return of spring: further south, and mosses have been collected in the far south of Victoria Land (78° S.), their frozen condition must last longer. This same occurrence has, of course, been previously well known in north polar regions. Vegetative reproduction among antarctic mosses seems to be the rule, and fruiting specimens of most species are very rare among the collections of all the expeditions: among my South Orkney specimens the only species with many and well-developed fruits was *Polytrichum subpiliferum*, Card., and Dr. Cardot says that among all the species of antarctic mosses he has seen only four in fruit: among the thirteen species of the French Expedition all were sterile.

The number of antarctic hepatics[1] is naturally not great, and includes not more than six species, of which three are found in Gerlache Strait, one at the South Shetlands, and three in Orleans Channel. In the South Orkneys no species was discovered. While several fungi are recorded from sub-antarctic islands, such as Tristan da Cunha, Gough Island, and others, the true antarctic regions support but a single species, the discovery of which was made by M. Racovitza of the *Belgica*; this is a new species, *Sclerotium antarcticum*, Bomm. et Rous,[2] and was found on Danco Land growing among *Aira antarctica*: apparently this is its only record.

Undoubtedly the predominant feature of the antarctic vegetation is the number of lichens, not as species, but as individuals. At the South Orkneys the lichen vegetation is very rich. In winter, when almost everything is deep in snow, a few precipitous rock faces still show a relieving touch of colour among the monotonous white, due largely to various orange-coloured species of *Placodium* (*P. fruticulosum*, Darbish. and *P. elegans*, Nyl.): when the snow begins to melt in spring almost all the rocks bared to view show a shaggy covering of *Usnea melaxantha*, Ach., a species which more than any other seems to luxuriate in the conditions of life to be found there, and produces good "fruits" in quantity: Dr. Skottsberg also mentions the frequency of *Placodium* and *Usnea* in the lands he visited. Two other species, *Rhizocarpon geographicum*, D.C., and *Lecidea fusco-atra*, Th. Fr., are less abundant, and owing to their more sombre colour and less striking appearance do not lend any very characteristic feature to the landscape. The number of species of antarctic lichens is relatively high, but the determinations of several recent collections are not yet published, and in their absence it is impossible to draw any deductions of a general nature. With regard to my South Orkney lichens, Dr. O. V. Darbishire remarks[3] that all the species, except, of course, the new one, were previously recorded from some part of the arctic regions, and that, taking into account all known collections, the proportion of arctic species is as high as 73 to 75 per cent.

[1] *Rés. du Voy. du S.Y. Belgica, Hépatiques*, F. Stephani, *Anvers*, 1901, and *Wiss. erg. der Schwed. Südpolar Exp. Hepaticae*, F. Stephani, *Stockholm*, 1905.

[2] *Rés. du Voy. du S.Y. Belgica, Champignons*, Bommer et Rousseau, *Anvers*, 1903.

[3] *The Botany of the South Orkneys, Lichens*, O. V. Darbishire (*loc. cit.*).

The lichens of Gerlache Strait as collected by the *Belgica*, numbered fifty-five, including another new species of *Placodium* (*P. regale*, Wain.), which would therefore seem to be a genus particularly adaptable to antarctic conditions. Of these fifty-five species 38·2 per cent. are known from arctic regions, and as many as 52·7 per cent. are new.[1]

The algological flora of the antarctic is far from poor in individuals, if perhaps the species are not very numerous. At the South Orkneys, for instance, I collected twenty-five species[2] (including five new), and this number would doubtless be increased by careful exploration in summer when the coast is free from ice. Calcareous algae are exceedingly common, especially two species (*Lithophyllum discoideum*, f. *aequabilis*, Fosl., and *L. decipiens*, Fosl.). M. Foslie has identified new forms among the collections of all recent antarctic expeditions.[3] In places these algae cover the rocks in a few feet of water with a fairly continuous incrustation that at first deceives one into the belief that it is an ice formation. The daily haul of the dredge which we took in Scotia Bay hardly ever failed to bring up specimens of calcareous algae. Among other algae the commonest species in Scotia Bay were the two red algae *Plocamium coccineum*, Lyngb., and *Acanthococcus spinuliger*, Hook. and Harv., extraordinarily abundant in ten fathoms, and the brown alga *Desmarestia Rossii*, Hook. and Harv., frequent in much shallower water: this latter species was also collected by the *Southern Cross* off Victoria Land. The southern kelp *Macrocystis pyrifera* has been proved to be absent from all ice-girt islands, and its existence is doubtlessly incompatible with the eternal wearing and tearing influence of the ice. Its place is to some little extent taken by *Lessonia grandifolia*, Gepp, a species with some similarities in habit to that of the "kelp," though which is anything but abundant, and has apparently only been found at Louis Philippe Land and the South Orkneys.

Only one species of fresh-water alga (other than unicellular algae) is so far known, namely the cosmopolitan *Prasiola crispa*, Ag., which is recorded from both Graham Land and the South Orkneys. In the latter place it was to be found in summer and autumn in several small gulleys where a quantity of melting snow above assured a continual supply of moisture. Unicellular algae naturally form the vast preponderance of the botanical treasures of the antarctic regions. When once the regions of ice are approached between 50° S. and 60° S. the plankton entirely changes its character; crustaceous and, in fact, all animals then become rare, and give place to increasing numbers of diatoms until, in the midst of the ice, the diatoms occur in such prodigious quantities that five minutes' haul of the tow-net (No. 20 miller's gauze) produces as much as a pint of gelatinous residue almost wholly diatomaceous. The fact that such a net used about thrice daily on the average ceases to be serviceable after about a week or ten days' use, owing to the clogging of the apertures in the silk, will give an idea

[1] *Rés. du Voy. du S.Y. Belgica, Lichens*, Ed. A. Waino. *Anvers*, 1903.

[2] *Antarctic Algae*, A. and E. S. Gepp, *Journ. Bot.*, April 1905 and May 1905, and *More Antarctic Algae*, *loc. cit.*, July 1905.

[3] See Foslie in *Kgl. Norske Vidensk. Sels* (1904), p. 3.

to any one used to plankton work of the wealth of diatomaceous life in these seas. The species are not very varied, but a large proportion of them bear spines and long arms, while simple forms are comparatively rare. Peridineans occur, but only rarely. The phytoplankton on the whole seems to favour deep water, for in the shallow water about the South Orkneys it was much scarcer. In winter the greater part is apparently frozen into the ice, for I failed to get any appreciable quantities from the water on the occasions when I bored the floe with this object in view. The first-formed pancake ice is always yellow, and the lower layers of the floe as revealed in the spring upheaval are uniformly discoloured by a layer of diatomaceous ice.

In no part of the antarctic seas visited by the *Scotia* did I observe the open water discoloured by diatoms, and I am not aware that other recent expeditions have recorded this occurrence, but Mr. W. S. Bruce in the cruise of the *Balaena* in 1892-93 between 62° and 63° S. off Louis Philippe Land, frequently remarked that the sea was olive green or olive brown from this cause, and that the most usual species in these discoloured parts was *Corethron criophilum*. This phenomenon is of much commoner occurrence in arctic seas.[1] Plankton collections well within antarctic seas and over a wide area are largely confined to the collections of the *Scotia*, which fortunately was able to traverse some 10,000 miles of unexplored south polar waters. The other recent expeditions, *Discovery*, *Antarctic*, *Gauss* and *Français* did comparatively little marine exploration within truly polar waters. The *Belgica's* results in this department should, however, be of great interest, and the *Valdivia's* collections,[2] though in more or less extra-polar waters, have important relations to antarctic plankton. A detailed report and discussion of the *Scotia's* plankton is in process of completion by Mr. R. M. Clark, B.Sc.

Of fresh-water unicellular algae little can be said as yet, but they play a very unimportant *rôle* in antarctic plant life. I succeeded in obtaining several diatoms in summer pools on Laurie Island, South Orkneys, while red snow, due to a species of *Sphaerella* and a few patches of yellow snow, due likewise to an alga, were observed at the South Orkneys in autumn. The red snow has previously been recorded from the south, but I am not aware whether the other expeditions observed this yellow snow.

Such in outline is the present state of our knowledge of the botany of antarctic regions, and it will be seen that by far the greater part is due to the labours of the expeditions of the last ten years. Of course such a survey as this must necessarily be incomplete, as several important papers on recent collections still remain to be published, and even when this is done our botanical knowledge of the antarctic will have many gaps: further collections are much to be desired, especially from the Pacific and Indian sides, whence practically nothing is known, beyond

[1] *On the Nature of the Discoloration of the Arctic Seas*, Robert Brown, *Trans. Bot. Soc. Edin.*, ix. p. 244.

[2] *Das Phytoplankton des Ant. Meeres nach dem Mat. der Deutschen Tiefsee Exp.*, 1898-99, G. Karsten, *Jena*, 1905.

of course the collections of the *Belgica* and *Français* on the west of Graham Land, and the various collections from Victoria Land. Among the antarctic lands from which no plants are known are Coats Land, Enderby and Kemp Lands, Termination Land (if this long-lost land is identical with Drygalski's reported "high land"), Wilkes Land, King Edward Land, and Alexander Land, though it is quite to be expected that their flora is very scanty since they are more or less covered with ice, and little bare rock appears.

Turning now from the true antarctic regions to the austral or sub-antarctic regions, comprising the many islands that gird the antarctic seas, it must be said that it is here that the most fruitful botanical collections of future expeditions will probably be made. This ring of circumpolar islands includes the following :—Falklands, South Georgia, South Sandwich group, Tristan da Cunha with Gough Island, Bouvet Island, Prince Edward and Marion Islands, the Crozets including Possession Island, Kerguelen, Macdonald and Heard Islands, St. Paul and Amsterdam, Campbell and Auckland Islands, the Macquaries, Dougherty[1] or Keates Island, and Peter Island, with a few others whose existence is somewhat hypothetical. In passing it may be as well to note that I have included all these islands in the general category of sub-antarctic merely for the sake of convenience in this place, and do not intend to imply that on botanical grounds they can be grouped in the same domain : for a discussion of the classification of these islands reference should be made to Dr. Skottsberg's paper (*loc. cit.*). Of these islands the Falklands have been well studied by various expeditions; South Georgia has been recently re-explored by the Swedish Antarctic Expedition; Tristan da Cunha has hardly been exhausted despite the visit of the *Challenger*; Gough Island, on which I had the privilege of being the first botanist to land, would well repay a visit; Prince Edward and Marion Islands, the Crozets, Kerguelen, Macdonald and Heard Islands, are far from well known, except perhaps Kerguelen ; St. Paul and Amsterdam Islands are better known, and the New Zealand group, including Campbell and Auckland Islands, the Macquaries and Antipodes, have lately received more attention. But all would be worth the attention of a careful explorer, especially as regards the lower forms of plant life. The South Sandwich group, Bouvet Island, Dougherty and Peter Islands, are entirely unknown from a botanical or almost any other standpoint. Bouvet Island, according to the *Valdivia's* reports, is entirely covered with ice and is devoid of vegetation : moreover, it offers no landing-place. On the other hand, previous voyagers have given the island a slightly better reputation, Bouvet (1739) and Lindsay (1808) both reporting trees or shrubs (? tussock grass), and Morrell (1823) speaking of small spots of vegetation. Whatever may be the case it well merits a visit, and in view of its probable accessibility at all times of the year, even in a steel vessel, it is to be hoped it will not be long before we have some definite knowledge of the natural history of the island and its surrounding waters. Gough Island, I can assure any intending botanical explorer,

[1] The *Discovery* reported that this island does not exist in its formerly assigned position.

will more than repay a visit, and is not difficult of access, though landing may be a little troublesome.[1]

The six islands lying in the extreme South Atlantic which were discovered and named by Cook in 1775 the South Sandwich group are probably the most neglected spot in all sub-antarctic regions, and no expedition since that of Bellingshausen in 1820 with the ships *Wostok* and *Mirny* has visited them, though several sealers report that they are quite accessible and contain some good harbours, especially one on Bristol Island. Forster, the German naturalist who accompanied Cook, says no vegetation was to be seen, though Cook himself mentions that he observed vegetation to the north end of Saunders Island. Morrell in his somewhat doubtful voyage of 1823, speaking of the islands, says they are "entirely barren." The *Scotia*, on her first antarctic voyage in 1903, passed within twenty miles of Southern Thule, the southernmost island of the group, but thick and boisterous weather prevented a nearer approach, and time was too precious for the southern cruise to admit of delay: on our return from Coats Land in 1904 an attempt was made to reach the group, but continual adverse gales and a shortage of coal caused the project to be abandoned. Nothing is therefore really known of this group, and a large field is open for some future explorer. It will probably be found that all the islands of the group are not barren of vegetation, while their extreme interest from a botanical point of view lies in their position intermediate between antarctic and sub-antarctic zones, the southernmost islands approximating to the antarctic conditions, though doubtlessly not quite so rigorous, and the northernmost islands no doubt having a climate somewhat similar to that of South Georgia, or perhaps a little more severe. In this chain of islands extending through three degrees of latitude one should be able to study the gradual transition from sub-antarctic to antarctic flora in a way which no other part of the south polar regions permits. There is every reason, therefore, to expect that the vegetation of the northern islands will approximate to that of South Georgia, and that of the southern islands, at least Thule and Bristol Islands, will show some similarity to the true antarctic facies. The floral statistics should also prove of great interest, and may throw some light on the vexed question of the origin of southern floras and former land connections. The flora, especially of Traversey and Candlemas Islands, will probably show a distinct South Georgian and consequently South American relationship, but the point of extreme interest to be looked for is whether it will show near relationships to the flora of the Crozets on the one hand, or to that of the Tristan da Cunha group on the other, and it will be interesting to find out how far this Sandwich group flora has evolved, and whether any new and distinct species have originated. The flora of South Georgia has practically no relationships to that of Tristan da Cunha or Gough Island, but a certain affinity with that of the Crozets and other islands to the east, and with

[1] *Diego Alvarez or Gough Island*, R. N. Rudmose Brown, *Scot. Geog. Mag.*, xxi. p. 430, and *The Botany of Gough Island*, R. N. Rudmose Brown, *Journ. Linn. Soc. Bot.*, xxxvii. p. 238.

the antarctic regions properly speaking (of its eighty species of mosses thirteen are also found in the antarctic); its Magellan affinities are naturally very pronounced, yet considering its nearness to Fuegia and the prevailing westerly winds, it is a matter for wonder that more of the South Georgian species are not found there, and that the proportion of endemic species should be so high in respect of mosses, viz. fifty per cent. according to Dr. Cardot's latest determinations. Among its thirteen species of phanerogams are none which are endemic, a fact not a little remarkable considering how, in similarly isolated islands, such as Tristan da Cunha and Gough Island, the endemic species and varieties form a conspicuous element of the flora, while Kerguelen and other islands to the east are also not wanting in this respect. Possibly the relative accessibility of South Georgia to the Magellan Lands accounts for its want of peculiar species, but if this is so the number of endemic mosses does not become easier of comprehension.

The affinities of the flora of the New Zealand group of southern islands with that of Fuegia is another extremely striking fact, and one whose explanation is yet far from being satisfactorily found; but reference must be made to a recent paper of Dr. L. Cockayne's on "A Botanical Excursion during Midwinter to the Southern Islands of New Zealand." (*Trans. N.Z. Instit.*, xxxvi. p. 225).

To a fuller discussion of the relationships of the floras of these southern islands in their possible bearing on the former distribution of land, I hope to return at a later date. In the meantime enough has been said to indicate the nature of the botanical problems awaiting solution in antarctic and sub-antarctic lands, and while future expeditions will naturally choose their routes largely for oceanographical and geographical reasons, there will always be in any land touched at, or for that matter in any sea, sufficient material of botanical interest to be found. The pole-circling islands are more likely to be well explored as the importance of the study of the vast southern oceans begins to attract attention and when the day of simple boyish pole-hunts is over, as will surely soon be the case.

THE TEACHING OF GEOGRAPHY.[1]

By Professor ALEX. DARROCH.

I HAVE been asked to say a few introductory words in reference to the aims and intentions of the promoters of the exhibition which opens to-night across the way at the Outlook Tower. Before doing so, I think we ought to thank both the organisers of the exhibition, and also those who have forwarded exhibits, for the opportunity afforded us of becoming acquainted with what must be done if we are to make the Geography teaching of our schools real, concrete, and truly educative. For the questions as to the proper place of Geography teaching in schools, and

[1] An address delivered at the opening of the Geographical Exhibition in Edinburgh on July 6.