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North-East Land and Hinlopen Strait

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for Purple Sandpipers (*Erolia m. maritima*). In the previous year we had seen Sandpipers and Turnstones (*Arenaria i. interpres*) feeding on similar stretches of the ice-foot on the mainland of Reindeer Peninsula, doubtless in search of the same worm food. These worms must have been able to withstand freezing for long periods; it is worth noting in this connection that another small worm, *Enchytraeus crymodes*, found in salt-marsh mosses at Bruce City, was found to withstand freezing for some time in a glass tube (28, p. 1110).

III. NORTH-EAST LAND AND HINLOPEN STRAIT.

North-East Land, which is an island about the size of Wales, lies, as its name implies, to the north-east of the main island of Spitsbergen (which is called West Spitsbergen). Owing to its distance from the Gulf Stream drift and the fact that the northern, eastern, and southern sides are washed by a polar current, which carries pack-ice to its shores in summer, it is subjected to much more severe climatic conditions than the rest of Spitsbergen (Pl. XXVI, Phot. 5). A large ice-cap occupies the centre of the island, leaving an ice-free zone of variable width around the coast; owing to the prevailing low temperature and fog, frost action is very severe in this zone, and consequently the rocks, with the exception of extremely hard ones such as dolerite, are rapidly split up into small stones and finally mud. The country is everywhere very dreary, the ground being covered with rocky debris; while the vegetation, with one exception, is of a very stunted nature. Only in the neighbourhood of bird-cliffs, and in special localities at the heads of the longer fjords are plants at all well developed. In some places, as at Murchison Bay, it is possible to walk for miles over the frost-shattered surface without seeing more than an occasional tuft of poppies (*Papaver radicatum*); these form the exception noted above, for they are very common, and often form tufts of unusual size, covered with flowers, even in the most barren districts such as Ulve Bay and Cape Torell.

Owing to the fact that it was impossible to visit all the ice-free areas personally, we are unable to describe the vegetation of the whole in any detail. However, the islands, and parts of the coast of Hinlopen Strait (on the New Friesland side) are subjected to the same severe climate and here the plants were studied more carefully. The vegetation occurring on the igneous rock dolerite is described in detail, to give an idea of the plant communities found in this, the most barren and inhospitable part of the archipelago. (The following dolerite areas were visited: the Alkrange, Duym Point, Cape Eremite, Foster Islands, South Waigat Islands (including Von Otter Island and Nordenskiöld Island), Gylden Islands, Sledging Base, and Cape Idun. These are shown in detail on the map in Fig. 1.)

(a) THE FLORA OF THE DOLERITE AREAS.

Intrusions of dolerite, a basic igneous rock resembling basalt, are found mainly along Hinlopen Strait, most of the islands being composed of this rock, with raised beaches overlying it here and there. On the south side of the strait, there are two important outcrops at the Alkrange and Cape Eremite, while on the north side, Hyperite Point and Cape Idun are the chief areas, although there are also outcrops in Wahlenberg Bay and at Cape Torell. These dolerite areas occur in a region which is characterised by a very severe climate, and as a result the vegetation is exceedingly poor; in fact, the dolerite in Hinlopen Strait is one of the most barren types of soil in Spitsbergen, although where it occurs in more favourable situations (as at Anser Islands, in Icefjord) it may support a luxuriant flora. The photograph in Pl. XXIV, Phot. 2, gives a good idea of the scenery of the barren dolerite. Often the only animal life to be seen consists of a few chironomid flies, a snow bunting, or an occasional skua.

On the dolerite outcrops a well-marked succession may be traced from the bare rock to various semi-closed or, rarely, closed communities.

(a) **Rock surface.**

The vegetation of the dolerite rock surface consists almost entirely of lichens, of which the rusty red *Lecidea dicksonii* and the black *Parmelia pubescens*, together with several species of *Gyrophora*, are the most characteristic. A more complete list follows, but doubtless many less frequent species occur:

Acarospora lesdainii	L. sordida var. inflexa
A. chlorophana	Lecanora tartarea var. frigida
Alectoria jubata var. chalybeiformis	Lecidea confluens
Buellia disciformis var. saxicola	L. dicksonii
Caloplaca jungermanniae (on moss)	L. pantherina
Candelariella vitellina	Pannaria hookeri
Gyrophora cylindrica	Parmelia pubescens
G. erosa	Rhizocarpon geographicum
G. hyperborea	Usnea sulphurea
G. proboscidea	Xanthoria parietina vars. aureola and ectanea
Lecanora polytropa	X. lychnaea

Many of these species occur also on quite different rocks, but the association as a whole is characteristic of the dolerite. *Andreaea papillosa* is a rare though typical moss of the rock surfaces.

(b) **Rock crevices.**

With the weathering of the rock, mainly through frost-action, crevices are produced which immediately offer habitats for plants unable to grow on the rock surface itself. The crustaceous lichens are replaced by foliose and fruticose forms (Pl. XXVII, Phot. 7), and with them occur a number of



Phot. C. S. Elton

Phot. 7. Succession on dolerite on the Gylden Islands, Hinlopen Strait. The photograph shows rock-lichens on the surface of the rock, and, across the middle, a crevice being colonised by other lichens, such as *Stereocaulon alpinum*, and *Lecanora tartarea* var. *frigida*.

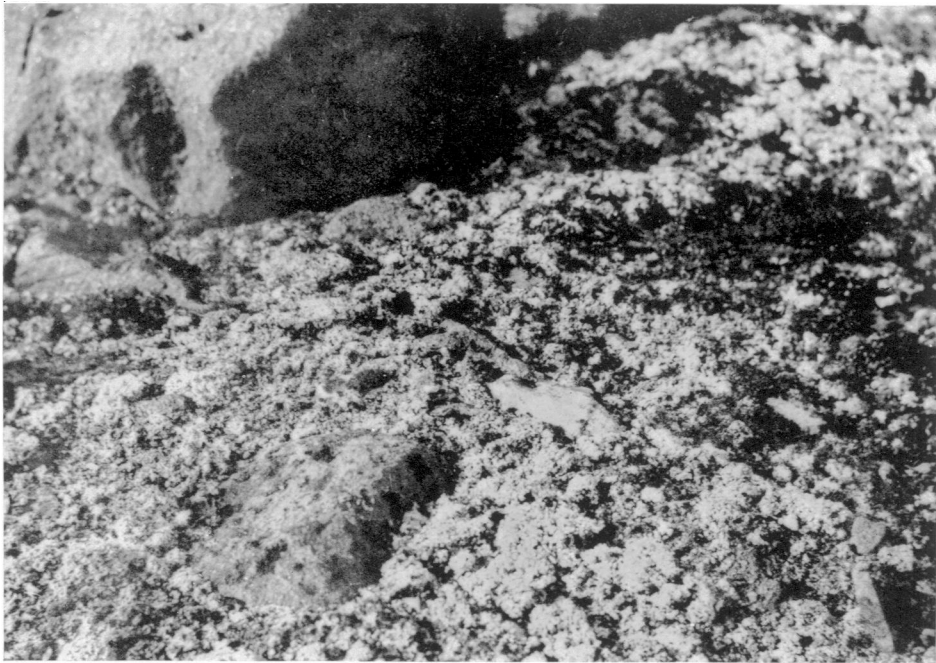


Phot. C. S. Elton

Phot. 8. Succession on dolerite on the Gylden Islands in Hinlopen Strait. The dry soil produced by the weathering of dolerite is being invaded by lichens, chiefly *Stereocaulon alpinum*.

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Phot. C. S. Elton

Phot. 9. Succession on dolerite on the Gylden Islands, Hinlopen Strait. A further stage in invasion of the soil, which has become covered by lichens, together with a few mosses. The species concerned are listed on p. 203.



Phot. C. S. Elton

Phot. 10. Succession on dolerite on the Gylden Islands, Hinlopen Strait. Final stage reached in this climate, consisting of a mat of Arctic Willow, *Salix polaris*, which has replaced the lichen carpet, of which the remains can be seen at the edges.

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mosses. The following list was made at the Foster Islands, and can be taken as typical of the dolerite areas in Hinlopen Strait.

LICHENS.

Alectoria ochroleuca	Collema sp.
Bilimbia subfuscula	Gyrophora erosa
Caloplaca cinnamomea	G. hyperborea
C. jungermanniae var. subolivacea	Lecanora tartarea var. frigida
Cetraria hiascens	L. upsaliensis
C. islandica	Lecidea limosa
Cladonia pyxidata and var. neglecta	Rinodina turfacea
C. furcata var. palamaea	

MOSSSES.

Hypnum uncinatum	Webera cruda
Polytrichum alpinum var. septentrionale	W. cucullata

Other mosses occurring in such places are *Bartramia ithyphylla*, *Dicranoweisia crispula*, *Grimmia apocarpa*, and *Swartzia montana*. As the cracks become deeper and wider and filled with soil, more and more species invade them and lichen heath tends to be slowly established, by the gradual fusion of the different foci of invasion. But at most places, such as the Gylden Islands and Cape Eremite, the rocks weather away faster than they are invaded, so that a rather dry, loose, crumbly soil is produced. This is colonised primarily by a few species of lichens, of which *Stereocaulon alpinum* is the most prominent, others being *Lecanora tartarea* var. *frigida* and *Rinodina turfacea* (Pl. XXVII, Phot. 8). These are followed by other lichens and mosses, together with scattered phanerogams, and lichen or moss heath is eventually produced (Pl. XXVIII, Phot. 9).

(c) Lichen or moss heath.

It is almost impossible to draw any line between the communities dominated by lichens and mosses respectively, and indeed often the groups appear in equal quantities. The composite community occupies large areas on ground between weathering outcrops and boulders, and varies from more or less open communities in an early stage of succession, to dense luxuriant carpets of vegetation. A remarkably luxuriant example of lichen heath is to be found at Duym Point, the sledging base of the party which crossed New Friesland in 1923.

Phanerogams occur in varying amount in the moss-lichen heath, but are always subordinate to the cryptogams. Of the lichens, *Cetraria islandica*, *C. hiascens*, *C. aculeata*, *C. nivalis*, *Stereocaulon alpinum*, and *Lecanora tartarea* var. *frigida*, are the most important, while *Rhacomitrium lanuginosum*, *Hypnum uncinatum*, and *Polytrichum alpinum* are the chief mosses. The most characteristic species of higher plants are *Luzula confusa*, which often appears early in the succession, *Papaver radicans*, *Salix polaris*, and *Saxifraga oppositifolia*. A general list of the flora of the moss-lichen heath, compiled from many different localities, is given below, the phanerogams in particular

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seem to vary considerably in different places, and while this may be due to different edaphic conditions, it is also probably due to chance dispersal, since many of the localities studied were islands.

PHANEROGAMS.

Alopecurus alpinus	Polygonum viviparum	v.l.
Cardamine bellidifolia	Potentilla emarginata	
Catabrosa algida	Ranunculus sulphureus	
Cerastium alpinum	Salix polaris	
C. regelii	Saxifraga caespitosa	
Cochlearia officinalis	S. cernua	
Draba lactea	S. flagellaris	
D. oblongata	S. nivalis	
Luzula confusa	S. oppositifolia	
Oxyria digyna	S. rivularis	
Papaver radiculatum	Stellaria longipes	

MOSSSES.

Bartramia ithyphylla	Hypnum uncinatum
Bryum crispulum	H. vaucheri
Cynodontium virens and var. arcticum	Orthothecium chryseum
Dicranoweisia crispula	O. strictum
Dicranum bonjeani var. juniperifolium	Polytrichum alpinum
D. elongatum	Rhacomitrium canescens
Ditrichum flexicaule var. densum	R. lanuginosum
Encalypta rhabdocarpa	Swartzia montana var. brevifolia
Fissidens osmundoides	Timmia austriaca
Grimmia apocarpa	Tortula ruralis
Hypnum polare	Webera cucullata
H. turgescens	W. cruda

LICHENS.

Alectoria ochroleuca	Cetraria nivalis
Biatorina cumulata	Lecanora tartarea var. frigida
Buellia disciformis var. insignis	L. upsaliensis
Caloplaca cinnamomea var. hypnophylla	Lecidea alpestris
C. jungermanniae var. subolivacea	Parmelia omphalodes
C. stilicidiorum	P. pubescens
Cladonia cariosa	Pertusaria dactylina
C. coccifera	Physcia pulverulenta
C. degenerans	Psoroma hypnorum
C. furcata var. palamaea	Rinodina turfacea
C. f. var. recurva	Solorina crocea
C. pyxidata and var. chlorophaea f. lepidophora	Sphaerophorus globosus
Cerania vermicularis	Stereocaulon alpinum
Cetraria aculeata	S. denudatum var. pulvinatum
C. cucullata	S. evolutum
C. hepatizon	S. paschale
C. hiascens	S. tomentosum
C. islandica and var. tenuifolia	Xanthoria lychnaea
	X. parietina var. ectanea

Of the mosses, most of the species are those preferring dry habitats; but some occur in damper places, while in certain regions damp sub-communities may be found making a transition to moss-bogs, *Salix polaris* being sometimes important in such places (see 29, p. 224). Among the lichens, some grow on the smaller stones imbedded in the moss-carpet, but most of the species are terrestrial. The extraordinary richness of the lichen flora is evident from the lists. Although the horns and dung of reindeer, which feed on such lichens and mosses, were found at Duym Point and on the Gylden Islands, no

signs whatsoever of them were noticed at the very inhospitable localities farther down Hinlopen Strait, in spite of the moss-lichen heaths occurring there. It is possible that the two places mentioned are visited only on migration, since they lie on the route from the comparatively fertile regions at the head of Wahlenberg Bay to those inside Lomme Bay.

The lichen or moss heath seems to be the climax community on dolerite in this region, although there is a suggestion in places of a transition to a very primitive type of dwarf-shrub heath, dominated by *Salix polaris*, which occurs in large, almost pure patches locally (Pl. XXVIII, Phot. 10). *Dryas octopetala*, however, is completely absent.

Eider Ducks (*Somateria mollissima borealis*) often find favourable nesting places among the rocky outcrops of the islands (see Hermannsen I. 29, p. 281), and here the lichen heath is replaced by phanerogams, especially grasses. The replacement is more complete with increase in the manuring, until the conditions occurring on bird-islands (see under Nitrophilous Communities) are reached, and a more or less complete grass-turf is found. *Catabrosa algida* and *Carex nardina* are the chief plants, while the presence of *Cochlearia officinalis*, *Cerastium alpinum*, *Saxifraga cernua* and *S. rivularis*, in increased quantity, connects these communities with true nitrophilous ones, to which some of these islands might be referred. "Skua hummocks," i.e. the grassy knolls produced by the nesting and watching Skuas, and bird-cliffs, occur in various places; these are dealt with under Nitrophilous Communities.

(d) Bogs.

Areas where the drainage is imperfect, generally associated with pools, occur on all the dolerite areas, and support the usual type of moss-bog community found in Spitsbergen. Eider Ducks and other aquatic birds frequent such places, with the result that the community is rarely free from the effects of manuring; Red-throated Divers (*Colymbus stellatus*) nest in the moss zone at the edge of tarns, and make their nests out of the mosses. We have not sufficient data to allow us to differentiate between the manured and unmanured bogs. The most characteristic phanerogam is *Saxifraga rivularis*, while others are *Ranunculus hyperboreus* (in the wettest parts) and various grasses.

Of the bryophytes, *Bryum crispulum*, *Hypnum brevifolium*, *H. sarmentosum*, *H. stellatum*, *H. uncinatum* and *H. zembiae*, have been noticed. It is significant that the extreme damp-loving or semi-aquatic species, such as *Hypnum cordifolium* and *H. giganteum*, do not figure in the lists, this being due to the fact that the trampling of the birds has destroyed the plants in the wetter parts. A few lichens are associated with the mosses, e.g. *Cetraria hiaseens*, *Lecanora limosa*, *L. tartarea* var. *frigida*, and *Caloplaca cinnamomea*; but generally they are of little importance.

(e) **Raised beaches.**

It will be fitting at this point to describe the raised beaches which occur on the dolerite islands in Hinlopen Strait, and also on the adjacent mainland. These beaches may contain fragments of dolerite itself, but are mainly composed of other and very diverse kinds of rocks, such as limestones, quartzites and shales. The community on these beaches is usually a fjaeldmark of the normal type, in which the plant covering is never closed, and consists mainly of phanerogams. Many species of lichens and mosses may be present, but they never play an important rôle in the community. In places the stones of the beaches have become mixed with mud, either from their own disintegration, or brought down from the slopes above, and in such places polygonal soils of various types are found, chiefly stone-polygons in a late stage of development, the borders having almost disappeared (see **8**). On the shale and limestone fragments the following lichens have been found, and although many of these occur on the dolerite, yet the rarity of *Lecidea dicksonii*, which is so characteristic of the latter rock, is significant, and the absence of the wealth of *Gyrophora* species found on dolerite is also interesting:

Buellia coniops	Lecidea arctica
Gyrophora erosa	L. confluens and var. oxydata
Lecanora alpina	L. pantherina
L. lesleyana	Parmelia pubescens
L. nikrapensis	Rhizocarpon geographicum
L. polytropa	Xanthoria parietina var. ectanea

This list is very incomplete, but gives an idea of the lichen flora of these non-dolerite areas.

Where the soil is not polygonally differentiated, the distribution of the phanerogams, etc., is more or less regular, but in polygon areas the rocky edges are often devoid of plants other than the lichens given above.

The phanerogams are a mixed assemblage with no particular dominant, but *Papaver radiculatum* and *Saxifraga oppositifolia* are the most abundant and striking species. A list embracing four localities is given below in order to show local variation, the localities being (1) the Gylden Islands, (2) Von Otter Island (South Waigat Islands), (3) Cape Eremite, (4) Ulve Bay. It should be mentioned that there is little dolerite at Ulve Bay, the rock being limestone and sandstone of Carboniferous age, but the raised beaches there are so similar to those in Hinlopen Strait that it was considered of value to include them in the account. At (2) and (3) polygon areas are abundant.

The species marked with an asterisk on p. 207 were found in a damp fjaeldmark society which was not noticed at the other three localities. The places are arranged in order of richness of the flora, and it will be seen that the raised beaches at Ulve Bay are much poorer in species than the other places; while the Gylden Islands, which are still less affected by the ice-pack in summer, possess an even richer fjaeldmark flora. It is thus clear that the climatic

gradient in the flora dealt with more fully on p. 252 is exhibited not only in a general manner, but may also be traced in a given community occurring within the range of one climatic zone. In other words the "zones" employed by us are to some extent arbitrary, and merely mark the arrival of certain important dominants into what is really a gradual change in the vegetation.

	Gylden Islands	Von Otter Island	Cape Eremite	Ulve Bay
<i>Alsine rubella</i>	x	—	—	—
<i>Cardamine bellidifolia</i>	x	x	x	—
<i>Carex</i> sp.	x	x	—	—
<i>Catabrosa algida</i>	x	x	—	x
<i>Cerastium alpinum</i>	x	x	—	x
<i>C. regelii</i>	x	x	x	—
<i>Cochlearia arctica</i> and/or <i>groenlandica</i>	x	x	x	x
<i>Draba lactea</i>	x	x	x	—
<i>D. oblongata</i>	x	x	x	x
<i>D. pauciflora</i>	x	—	—	—
<i>Glyceria angustata</i>	x	—	—	—
<i>Luzula confusa</i>	—	x	—	—
<i>Melandryum apetalum</i>	x	—	—	—
* <i>Oxyria digyna</i>	—	—	(x)	—
<i>Papaver radicatum</i>	x	x	x ab.	x ab.
<i>Poa abbreviata</i> f. <i>pallida</i>	x	—	—	—
<i>Potentilla emarginata</i>	x	—	—	—
* <i>Ranunculus sulphureus</i>	—	—	(x)	—
* <i>Salix polaris</i>	—	—	(x ab.)	—
<i>Saxifraga caespitosa</i>	x	? x	x	x
<i>S. cernua</i>	x	x	x	x
<i>S. nivalis</i>	x	x	x	—
<i>S. oppositifolia</i>	x	x	x ab.	—
<i>S. rivularis</i>	—	x	—	—
<i>Stellaria humifusa</i>	x	—	—	—
<i>S. longipes</i>	x	x	x	x
	21	16	11 (+3)	8

(b) THE FAUNA OF NORTH-EAST LAND.

Since the nature of the rock does not usually act as a limiting factor to the distribution of animals in Spitsbergen, we are describing the fauna of North-East Land as a whole. Therefore, in addition to the dolerite areas already mentioned, this account includes other places such as North Cape, Extreme Hook, Isis Point, Ulve Bay, and Murchison Bay, the whole possessing a rather distinctive fauna as a result of the severe climate. Longstaff (18) has already pointed out that North-East Land forms a special area for birds, differing from the rest of Spitsbergen in the abundance of the Ivory Gull and in the absence of many species. Longstaff's observations have been extended and confirmed by Montague (21).

In order to provide some background for showing the extreme poorness of the North-East Land fauna, and also for comparison with other localities which we shall describe later on, a list is given below of all the animals which are known to live and breed normally in the dry-land associations of Spitsbergen (omitting Bear Island). This list includes the animals normally inhabiting moss-lichen heath, fjaeldmark, *Dryas* communities and

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Cassiope heath, but *not* those of the grass-turf produced by the manuring of birds. It does not include sea-birds which come to land to breed, since these play no part in the life of the land communities, apart from their indirect influence in manuring the soil. As far as the more barren parts of Spitsbergen are concerned, the list is probably fairly complete, since Zones 1 and 2 (see p. 252) have been worked out fairly well. Further work will doubtless reveal more species to add to this list, especially from the inner parts of the big fjords (Icefjord, Bell Sound and Wijde Bay). A number of insects (e.g. parasitic Hymenoptera) have been recorded from such places as Advent Bay and Green Harbour by Scandinavian scientists (3, 13) who worked there in the beginning and middle of the nineteenth century; but it has only been possible to use for this list the species whose habitats are definitely known. Therefore anything up to a dozen more species may be added to the list, when their habits are better known.

The species marked with an asterisk are either local or rare in Spitsbergen.

MAMMALS:	Spitsbergen Reindeer (<i>Rangifer spitsbergensis</i>) Arctic Fox (<i>Canis lagopus</i>)
BIRDS:	Snow Bunting (<i>Plectrophenax n. nivalis</i>) Purple Sandpiper (<i>Erolia m. maritima</i>) Turnstone (<i>Arenaria i. interpres</i>) *Sanderling (<i>Crocethia alba</i>) Spitsbergen Ptarmigan (<i>Lagopus mutus hyperboreus</i>) Pink-footed Goose (<i>Anser brachyrhynchus</i>)
SPIDERS (Araneida):	*Coryphaeus holmgrenii Erigone arctica E. psychrophila *E. tirolensis Hilaira glacialis Leptyphantus sobrius *Micaria eltonii *Micryphantus nigripes Typhochrestus spetsbergensis
MITES (Acarina):	Bdella decipiens B. groenlandica B. littoralis B. pallipes *Ceratoppia bipilis *C. sphaerica Cyta brevirostris Halotydeus insulanus
SPRINGTAILS (Collembola):	Achorutes longispinus A. tulbergi A. viaticus Folsomia quadrioculata *F. sexoculata *Isotoma olivacea I. viridis *Lepidocyrtus lanuginosus Onychiurus armatus O. groenlandicus *Sminthurinus niger Xenylla humicola

FLIES (Diptera):	*Acroptera frontata Camptocladius curninervis var. polaris C. extremus C. ? lasiops C. longicosta Exechia frigida Limnophora hyperborea L. megastoma *Rhamphomyia caudata Scatophaga varipes Sciara holmgrenii S. pallidiventris S. sp. indet. S. tridentata *Syrphus tarsatus Trichocera lutea Also the adults of many aquatic flies
SAWFLY (Hymenoptera):	*Pristophora frigida
ICHNEUMONS and BRACONIDS (Parasitic Hymenoptera):	Hemiteles septentrionalis Bassus arcticus *Orthocentrus pedestris *Atractodes bicolor arcticus Mesoleius leucopygus *Ichneutes hyperboreus and several others
MOTHS (Lepidoptera):	*Plutella cruciferarum Another species of moth (not yet collected)
BETTERLES (Coleoptera):	*Tachyerges (Orchestes) saliceti *Atheta spp. Phytodecta sp. ?
APHID (Hemiptera):	*Aphis sp.
ENCHYTRAEID WORM (Oligochaeta):	Henlea brucei

Compared with the fauna of more temperate regions, this list is very meagre; compared with the fauna of North-East Land, it has a tropical luxuriance. During two expeditions to the North-East Land region (which here includes the dolerite islands of Hinlopen Strait, and the dolerite areas on the north coast of New Friesland) only *nine species* of animals were found on the dry fjaeldmark and lichen-moss heath. Doubtless more species exist, but not many more. There is one common spider, *Typhochrestus spetsbergensis*, and one other, *Hilaira glacialis*, which we only found at North Cape. Both are small black hunting spiders which probably prey on the two species of land-flies *Camptocladius ? lasiops* and *Sciara* sp., and on the springtail *Achorutes viaticus*. In addition there occurs the scarlet intertidal mite, *Bdella littoralis*, here invading the land. It seems fairly certain that this mite is distasteful to birds, since the latter are seldom seen feeding in the intertidal mud areas in other parts of Spitsbergen, where the mite is very numerous. This fact was especially noted at Klaas Billen Bay, with regard to the Purple Sandpiper. Whether the *Bdella* is eaten by spiders we do not know.

Not only is the fjaeldmark fauna very poor in species, but the number of individuals is extremely small. Careful collecting among the fjaeldmark plants of the islands, or at Cape Eremit, often yielded no animals at all, while only

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one or two were to be found on Low Island and North Cape. In fact, it seems quite certain that the insects mentioned above would not by themselves be sufficient to support a spider population, much less a bird population. The real source of food for the spiders is the comparatively large number of aquatic chironomid flies, of which there are three species, all fairly common: *Chironomus lugubris*, *Metriocnemus ursinus*, and *Orthocladius conformis*.

These flies pass their larval and pupal stages in permanent ponds, and fly about over the surrounding tundra, where they are caught by spiders and birds. The two land-birds are the Snow Bunting and the Purple Sandpiper. Here, again, the smaller animals already mentioned are not sufficiently numerous to support by themselves a population of Purple Sandpipers, so that the latter are compelled to feed also upon springtails (*Achorutes viaticus*) which occur in bogs, on pond margins, and on the surface of pools; they also eat the worms (*Lumbricillus aegialites*) found near the drift-line of the sea-shore.

The Snow Bunting subsists on flies, etc., but supplements this diet with the seeds and leaves of plants. It appears, however, to be limited in its distribution in North-East Land mainly by the presence or absence of chironomid flies, since wherever there were flies the buntings were also there, and where there were no flies the buntings were absent. This fact was noticed by Montague on his sledge journey to the north coast.

Finally, there is not a sufficiently dense bunting and sandpiper population to support even the ghost of an Arctic Fox, and the latter where it occurs, must be dependent for its food in summer upon sea-birds, their eggs, and upon carrion.

It is clear that in order to construct a food-cycle for the animals of the North-East Land region, we must include not only the species occurring on the fjaeldmark and lichen-moss heaths, but also those living in fresh-water pools, in bogs, and on the sea-shore. This is really the case in any country, but in the temperate zone the complication of food-cycles in any one plant community is so great that it obscures the fact that the animals in it are closely linked with those of all the other communities around it.

The statements made above about the food-habits of the animals depend mainly on field observations (which are fairly conclusive, e.g. when one sees sandpipers feeding in a place where there is only one species of springtail). These observations agree with what we already know of the food-habits of the animals in other parts of Spitsbergen.

The foregoing account requires qualifying in two ways, in order to give a correct picture of the fauna of this region. In the first place, the animal community described is that found in the barren parts of North-East Land and Hinlopen Strait, where climatic conditions are very severe. There is however good reason for believing that a rather richer fauna would be found at the heads of the fjords which run into the interior of North-East Land.

For instance, Wahlenberg Bay is very barren at its mouth (Cape Idun and the Gylden Islands), but Oxford Peninsula which lies right at the head of the fjord, seems in its vegetation to be much more like Reindeer Peninsula in Liefde Bay (e.g. presence of *Dryas*), and in its birds and mammals. There are Brent Geese (*Branta bernicla hrotah*) and Reindeer there, and our party shot one Bewick's Swan (*Cygnus bewickii*), a rare bird in Spitsbergen. Similar but more favourable conditions probably exist at the inner ends of Lady Franklin Bay and Brandywine Bay, but Murchison Bay appears to be quite barren throughout its length. In just the same way a better fjord climate is

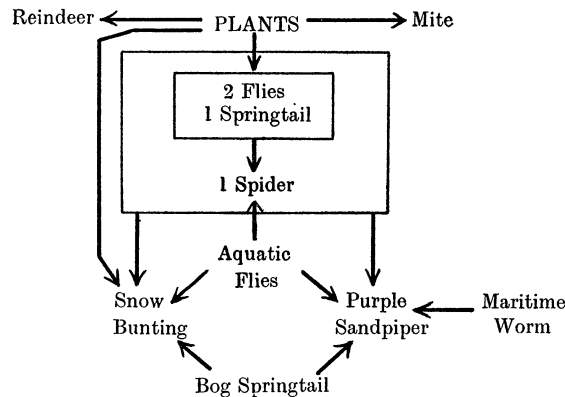


FIG. 2. Food-cycle for the animal community of the barren regions of North-East Land and Hinlopen Strait. Arrows point from species eaten to that which eats it. (The numbers refer to the number of species.)

found at Lomme Bay, on the other side of Hinlopen Strait, the mouth (Cape Fanshawe) being barren, but the inner part possessing *Dryas*, and *Cassiope* heath, together with a corresponding set of animals, e.g. the spider *Erigone psychrophila* and the mite *Rhagidia gelida* occur, and Brent Geese frequent the grass-swamps.

The second point is that the scarcity of land animals in the North-East Land area is to some extent compensated for by the immense abundance of sea-birds, which find a rich food-supply in the sea, and come to land in summer in order to breed. There are two huge colonies of Brünnich's Guillemot (*Uria l. lomvia*) in Hinlopen Strait, one on the Alkrange, and the other on Wahlberg Island. They nest in countless numbers on the dolerite cliff ledges, while above them in still more inaccessible places there are Kittiwakes (*Rissa tridactyla*), which also form independent colonies in other places. The Glaucous Gull (*Larus hyperboreus*) nests near the Guillemots, whose eggs and young form its chief food-supply; while the Kittiwakes are harassed by Skuas. Other sea-birds which form local nesting colonies on cliffs in various parts of this region are the Spitsbergen Puffin (*Fratercula arctica naumanni*), the Little Auk

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(*Plotus alle*), Mandt's Black Guillemot (*Uria grylle mandtii*) and the Ivory Gull (*Pagophila eburnea*). Fulmar Petrels (*Fulmarus g. glacialis*) are often seen flying about, but do not seem to nest much on the coast, preferring inland cliffs, often nunataks piercing the ice-cap of New Friesland. On low-lying areas there are colonies of Northern Eider Ducks (*Somateria mollissima borealis*) and Arctic Terns (*Sterna macrura*). Two more birds complete the list: the Arctic Skua (*Stercorarius parasiticus*) which divides its attention between eating the eggs of the Eider Ducks and chasing the Kittiwakes in order to rob them of their food; and, finally, the Red-throated Diver (*Colymbus stellatus*) which nests in bogs or on the fjaeldmark, but feeds at sea.

The sea-birds have in many places produced patches of richer vegetation by manuring the ground, and this usually takes the form of a grass-turf. This turf seems to support a slightly more varied fauna of invertebrates than that found on the normal fjaeldmark—a fact noticed in other parts of Spitsbergen also; this point is treated in more detail later on, under Nitrophilous Communities.

IV. LIEFDE BAY.

(a) REINDEER PENINSULA.

Reindeer Peninsula was visited for a short time in 1923, and for about nine weeks in 1924, when it formed the base camp of the expedition. This peninsula, which is about 10 miles long and nearly as broad, consists of gently rolling country, with a range of mountains on the western side, that is, at the base of the peninsula. The ground rises to about 200 ft. (60 m.) above sea-level to a watershed in the centre, from which there are radiating valleys to the coast. The underlying rock is more or less uniform, consisting mainly of red shaly sandstones of Devonian age, mixed with hard quartzites. Above these are various superficial deposits, the most important being boulder-clay, while in the valleys, alluvial deposits occur, derived from the rock or the boulder-clay or from both. There are also a large number of erratic blocks of hard gneiss, some of these being more than 10 ft. (3 m.) high or 20 ft. (6 m.) long. The climate is about the same over the whole of the Peninsula, being slightly more severe on the north side. Frost-action is very prominent in such a damp and open climate, so that a great proportion of the surface, as at Prince Charles Foreland (see 29, p. 242) is occupied by "polygonal soils" of varying types, some of the polygons being "mud-polygons," while others are "stone-polygons." The vegetation occupying these polygonal soils is often different from that on the normal well-drained ground, and this tends to complicate the course of succession and makes it difficult to follow the different stages. The communities on Reindeer Peninsula may best be divided into three series, whose distribution appears to be determined by differences of water-supply during