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of

Arctic Flowering Plants.

I.

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Saxifragaceæ.

1. Morphology and Biology.

By

Eug. Warming.

June 1909.

Principal literature.

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The species of Saxifragaceæ mentioned in the following are: —

Saxifraga aizoides L.

Warming, 1886 a, p. 26. Lindman, 1887, p. 61. Ekstam, 1894 b, p. 426; 1897, p. 129; 1898, p. 15. Jungner, p. 237. Abromeit, p. 37. G. Andersson och Hesselman, p. 28. Dusén p. 34. A. Cleve, p. 48. Lindmark, p. 27, pl. I, figs. 22—23; pl. II, figs. 1—3. Günthart, p. 75, pl. II, fig. I. Sylvén, p. 230.

Material in alcohol from South Greenland (Kornerup, A. Berlin, Mrs. Lundholm); from Norway: Tromsø, Finmark (Warming); Sweden; Siberia (Kjellman); Nova Zembla and Spitzbergen (Nathorst).

A creeping herb, the primary root of which dies in the course of a few years. By means of the creeping stems, which are furnished with many slender, adventitious roots, it may spread rather thickly over fairly large areas, by preference over those which are watered by a stream, or by melted snow. Many lateral shoots may be developed from a single stem, and there is no regularity as regards the situation and strength of the lateral shoots. Vegetative propagation takes place abundantly by the lateral shoots becoming independent, the connecting stems gradually dying away at the hinder end.

The lateral shoots put forth foliage-leaves from the first; scale-leaves proper are absent. The year's-shoots are not distinctly differentiated. The youngest leaves remain green during winter. The fresh leaves pass gradually into decayed ones which persist a long time.

As regards the germination see LINDMARK and SYLVÉN. The primordial leaves are close-set, somewhat like a rosette. The plant may flower in its third year. It flowers late in summer.

The flowers appear to be quite similar to those from the Alps. The size is the same (10—13 mm.), perhaps they are somewhat smaller in Spitzbergen (Fig. 1 *E*, *F*).

The colour varies considerably. Among the specimens from Tromsö in Norway, some had pale green sepals, pale yellow petals with orange-coloured spots, and a pale green pistil; some, dull-purple-coloured sepals, dark-orange-coloured petals without spots, and a yellowish-red pistil with dark-red disk; and many intermediate forms were found between these. LINDMAN has made similar observations.

The petals have one vein with two lateral branches (Fig. 1 A). Scent is absent.

Protandry. The flowers are distinctly protandrous, not only those from the Alps, but also those I examined from Greenland, Norway, Sweden, Spitzbergen, and Siberia. At first the stamens are almost horizontally spread out, but afterwards they bend inwards in succession, first the antisepalous and then the antipetalous (Fig. 1 *A*, *C*). All the stamens again are widely outspread, and have been more or less emptied of their pollen, when the styles spread out and the stigmas ripen. There is, however, a short time when the stigmas and the anthers are functional simultaneously. In specimens from Spitzbergen it appeared as if the time of the development of the stigmas and the stamens did not differ very greatly, but no definite conclusion could be arrived at on the basis of the material at hand.

The nectary in all the specimens consists of a massive, ring-shaped swelling around the base of the styles, on the finely pitted surface of which numerous drops of honey may be seen to occur (Fig. 1 A, C, E, F).

Fig. 1. *Saxifraga aizoides.*

A, Flower from the north of Norway; distinctly protandrous. *B*, Pistil of the same. *C*, Flower from South Greenland (Ivigtut); all the anthers are open, the stigmas are still unripe. *D*, Styles of the protandrous stage. *E, F*, Small-flowered form (Spitzbergen; Aug. 1, 1882; A. G. Nathorst); there are still four stamens with open anthers; the other anthers have been lost. *G* (from the same locality), Pistil of a flower which has quite finished flowering, and all the anthers of which have fallen off. *H*, Trimerous pistil, from the north of Norway. (E. W.)

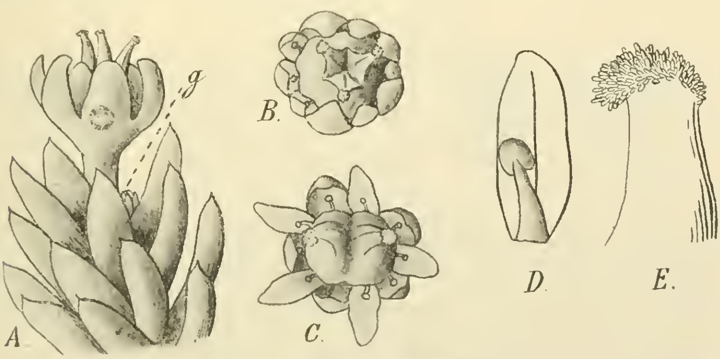

Fig. 2. *Saxifraga aizoides.*

From pistillate plants (Spitzbergen: July 27. 1882; A. G. Nathorst). *A*, Apex of a flowering shoot with trimerous pistil; *g*, a lateral shoot. *B*, Flower of same seen from above. *C*, Another flower. *D*, Petal and barren stamen. *E*, Style; there was no pollen upon the stigma. (E. W.)

Trimerous pistils often occur, especially in the terminal flowers (Fig. 1 *H*; Fig. 2 *A*, *B*). The latter are often developed much earlier than are the other flowers.

Pistillate flowers. A peculiar form has been gathered by Nathorst in Spitzbergen; its flowers are very small and have erect sepals, and small erect petals, which are about the length of the sepals (Fig. 2). The stamens are very small, smaller than the petals, and appear to be sterile (Fig. 2 *D*). As the pistils seem to be normal and have functional stigmas (Fig. 2 *E*), the flowers must be regarded as pistillate. One had a trimerous pistil (Fig. 2 *A*, *B*).

Insect-pollination appears to be the rule. Lindman observed the following insects visit the flowers in Norway (Dovre): flies, *Scæva* sp., *Bombus alpinus, B. nivalis, Vespa saxonica, Teuthredo olivacea,* and *Anaspis*. Ekstam in Sweden (Jemtland) noted the visits of flies and ants; and in Nova Zembla, of several small flies.

The fruit ripens in West Greenland, South Greenland, East Greenland (Franz Joseph's Fjord), and in Norway (Dovre), but it is not known whether it ripens in Spitzbergen and in Nova Zembla.

Saxifraga Aizoon L.

Warming, 1886, p. 27. Abromeit, p. 37. Lindmark, p. 53, pl. II, fig. 22; pl. III, figs. 5—7.

Material in alcohol from West Greenland.

The well-known rosette-shoots with short internodes in Greenland seem usually somewhat spherical, like a bulb (Fig. 3). The foliage-leaves remain fresh, either green or reddish, during winter. After dying, they persist for a long time upon the stem in a black and decaying condition (Fig. 3). Their marginal glands, which secrete carbonate of lime, are well-known (Fig. 4). The shoots obtain nourishment from adventitious roots and may live several years before they flower. After flowering, all the leaves of the shoot die; but vegetative propagation takes place by means of the lateral shoots; the lower part of the stem of the parent shoot, which bears them, appears to be able to keep alive for a long time.

Fig. 3. *Saxifraga Aizoon.* A small plant from West Greenland (July 17, 1884); almost natural size. An inflorescence is developed upon the primary shoot. (E. W.)

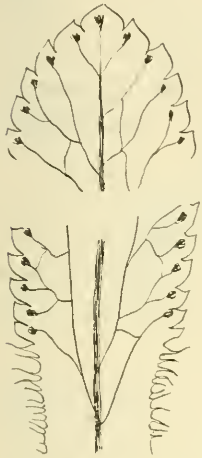

Fig. 4. *Saxifraga Aizoon.* Portions of a foliage-leaf (mag.). (E. W.)

The lateral shoots do not arise in any fixed order in the leaf-axils, and are observed most distinctly in the axils of the lower, already dead, leaves of the rosette. They often occur gathered closely together around the parent shoot, but may also be removed to a distance from the latter by a slender stem which runs along the ground and may be as much as 2—4 cm. long.

In Greenland this plant appears to belong to the very late-flowering species (July).

Fig. 5. *Saxifraga Aizoon.*
Parts of flowers from West Greenland. *A*, A young flower, 9 mm. in diameter. The antipetalous petals are not yet functional. *B*, The same flower. *C*, Pistil of same. *D*, An older flower; the styles are spreading; the stigmas are ripe and have germinating pollen (*E*, *F*) upon them. (E W.)

The flower appears to agree with those from the Alps. In its first stage it is 6—7 mm. in diameter; subsequently it increases to as much as about one cm. The petals are white with many small purple dots. Around the base of the styles there is a yellow, glistening disk which secretes honey abundantly.

Marked protandry. The terminal flower is the first to expand, and is often far in advance of the others, all of which are at about the same stage of development. First the antisepalous stamens bend over the middle of the flower, then they bend back and make room for the antipetalous stamens (Fig. 5 *A*). Rarely more than 1 or 2 stamens are seen functional at the same time over the middle of the flower (Fig. 5 *A*).

The styles are at first very small and turned decidedly inwards, with the plane-surfaces of the stigmas facing each other (Fig. 5 *B*, *C*); when at the height of their development, they are out-spread, and the stigmas are set with short, almost club-shaped hairs (Fig. 5 *D*, *E*).

Self-pollination may now take place, by the stigmas reaching over towards, and touching, the anthers, in which there may still be some pollen left (Fig. 5 *D*). In this feature, the arctic flowers appear to differ from those from the Alps, self-pollination, as regards the latter, being according to H. Müller, impossible or almost so.

Fruit ripens in West Greenland (Godhavn, and other places).

Saxifraga cernua L.

J. Lange, Conspectus, pp. 61, 256. Th. Holm, pp. 46, 50. Warming, 1886, p. 3, figs. 18—20. Lindman p. 61, pl. III, fig. 28. L. Kolderup Rosenvinge, p. 678. N. Hartz, 1894, p. 36; 1895, p. 288. Ekstam, 1897, p. 133; 1898, p. 15. Abromeit, p. 34. G. Andersson och Hesselman, p. 28, figs. 13, 14. A. Cleve, p. 49. Dusén, p. 32. Lindmark, p. 74, pl. V, figs. 7—17. Simmons, p. 75. Sylvén, p. 233. Knuth, p. 452.

The plant has a short, vertical rhizome which bears both scale-leaves and long-stalked foliage-leaves (Fig. 6 *A*, *E*). The primary root most probably dies early (Th. Holm). Many bulbils may be seen to occur in the axils of the leaves on the rhizome, both of the scale-leaves and the foliage-leaves, and also of the upper foliage-leaves, and of the bracteoles of the inflorescence (Fig. *C*). Often bulbils are produced so abundantly that the terminal flower on the main axis may be the only one

Fig. 6. *Saxifraga cernua.*

A, Basal part of a plant, about nat. size. Decayed remains of leaves on the rhizome among the fresh bulbs (northernmost Norway; Aug., 1883). *B*, A scale-leaf from the rhizome, mag. *C*, A branch of an inflorescence, about $^2/_1$; in the axils of its two uppermost bracteoles are bulbils (Norway: Finmark; July 7, 1885; E. W.). *D*, In the axil of a bract (*a*) are numerous small bulbils which belong to several generations; in the axil of *m* is a bulbil the first leaf of which is marked *α*; *1* and *2*, its first two larger scale-leaves (West Greenland). *E*, Rhizome from East Greenland (Scoresby Sound; Aug. 31, 1891; N. Hartz); *a* dead and *b* living scale-leaves. *F*, A bulbil from the axil of one of the leaves on the rhizome. (E. W.)

which is fully developed (Fig. *C*). Sometimes, however, besides the terminal flower, normal flowers are also found to occur on one or two of the uppermost lateral branches of the inflorescence (Fig. 9 *A*).

Rhizomes may be found which have internodes elongated to an unusual extent, several cm. in length (they have probably grown between moss or in shifting sand), and these afford an example of the fact that scale-leaves may both precede and

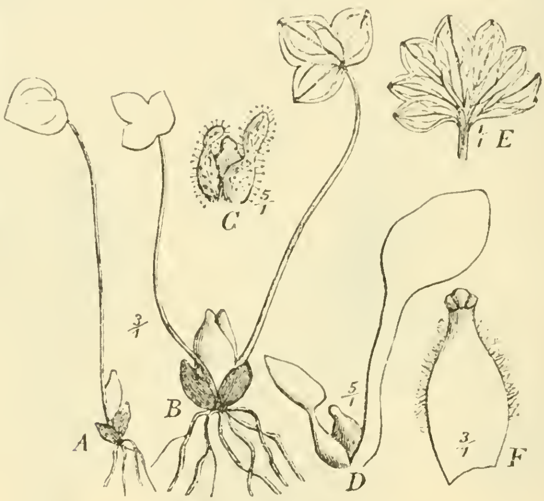

Fig. 7. *Saxifraga cernua.*
A, B. Bulbils, probably from an inflorescence, germinating.
C, A bulbil from an inflorescence with its covering of glandular hairs.
D, A bulbil of an inflorescence; the hairs are omitted. *E,* The lamina of a basal leaf.
F, Scale-leaf from the bulbil of a rhizome. (E. W., 1886.)

succeed the foliage-leaves (Fig. 6 *E*). The formation of scale-leaves indicates probably that the plant has a winter-stage. Horizontally-growing, slender runners, several cm. in length, which bear scale leaves, also occur.

In the inflorescence the bulbils are dark-red; otherwise they are white, and consist of small, thick, solid scale-leaves (Figs. 6 and 7) containing starch, which are homologous with the bases of the foliage-leaves, and often have at their apex a small lamina, which, however, in most of them, is very inconsiderable and never develops more fully (Fig. 6 *B*, *D*, *E*; Fig. 7 *F*; Fig. 8); but in others, especially in those situated upon the floral stem, the laminæ may be fairly large and well-developed, without any indications being present of the bulbils germinating (Fig. 7 *D*). Intermediate forms between true scale-leaves and true foliage-leaves occur abundantly (Fig. 8 *A*, *C*). The bulbils are small shoots which begin with two transversely placed leaves (Fig. 6 *D*, see *a*; Fig. 8 *A*, *B*; Fig. 9 *A*), then other leaves follow spirally; but in the floral part of the shoot these leaves develop new, small, starch-containing shoots so quickly, that in a leaf-axil may occur a complex of shoots of several generations (Fig. 6 *D*), whose reciprocal relation it is very difficult, if not impossible, to unravel.

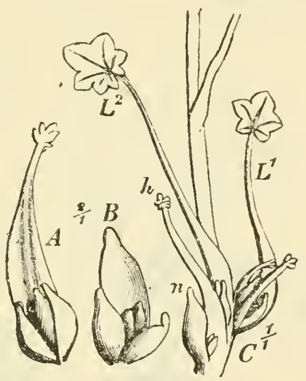

Fig. 8. *Saxifraga cernua*. *A*, An imperfect foliage-leaf subtending a bulbil. *B*, A scale-leaf which is also subtending a bulbil. *C*, A portion of the basal part of a plant; *n*, a scale leaf; *h*, an imperfect foliage-leaf; both are subtending buds; L^2 does not subtend a bud. (E. W., 1886.)

The bulbils upon the inflorescence are much smaller than are those which occur upon the rhizome.

That the starch-containing leaves of the bulbils serve as food for the growing shoots, may be taken for granted; those occurring lowest on the rhizome shown in Fig. 6 *E* have been emptied, while the uppermost are fresh and filled with starch; after the scale-leaves, which have been emptied, follow foliage-leaves, and after them new scale-leaves. The small bulbils on the floral shoot readily fall off and serve as organs of propagation. Lindmark, who has given an exhaustive and accurate description of the vegetative organs of *S. cernua*, has seen them and figured them germinating. The same must be assumed regarding those figured in Fig. 7 *A*, *B*.

(A "*phylloman*" form, the scale-leaves of which had developed small laminæ, was gathered by Porsild along a stream on Disko).

It can scarcely be said to be the rule for the leaves to pass the winter fully developed and in a green condition; but yet there is some possibility of this occurring — the leaves being sometimes very large and fresh during the flowering period.

The flowers are snow-white, large and fairly conspicuous. According to Lindmark 6- or 7-merous flowers are often found.

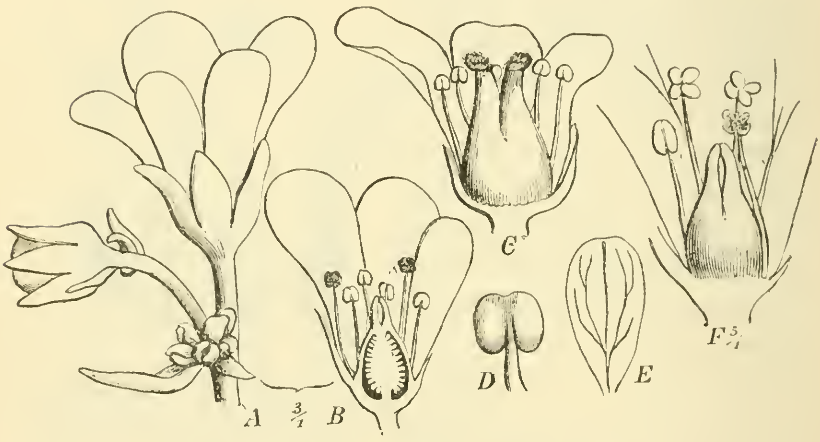

Fig. 9. *Saxifraga cernua.* (From Greenland.)
A, The upper part of an inflorescence (the hairs are omitted). *B*, Longitudinal section of the terminal flower; two antisepalous stamens have their anthers open. *C*, A protogynous flower (perhaps a transitional form to pistillate flowers). *D*, Anther. *E*, Petal; the venation may be less profuse. *F*, A decidedly protandrous flower; the anthers of the antipetalous stamens have been emptied, an open anther of a antipetalous stamen may be seen situated over the stigmas, but the latter are still unripe. (E. W., 1886.)

At first, when the petals are fairly erect, the diameter is small, 12—15 mm.; but as the petals gradually bend further out, and the corolla becomes more funnel-shaped, the diameter increases, almost to 20 mm.

The terminal flower is usually more or less irregular, as the petals of the one side are smaller than those of the other (Fig. 9 *A*, *B*, *C*). The petals may be emarginate, or rounded-off at the apex (Fig. 9 *E*).

Scent. The corolla has a faint perfume (Ekstam).

Honey is secreted at the base of the pistil. On account of the erect position of the flower, raindrops may be seen standing between the stigmas.

Protandry is the rule in specimens from Greenland, Norway and Spitzbergen, as also in cultivated specimens in the Botanic Garden of the University of Copenhagen. In the recently expanded flower the stamens stand closely against the still almost erect petals; then the antisepalous stamens bend inwards over the middle of the flower, where the styles are still short and bent towards one another (Fig. 9 *B*, *F*). Then the antipetalous stamens ripen. Almost simultaneously with the ripening of these, the styles bend outwards and the stigmas develop. Self-pollination is then possible, as the relative length of the stamens and styles is such that the stigmas may come into contact with the anthers. But nevertheless self-pollination must be difficult, and I never observed the pistils actually come into direct contact with the anthers.

Fruit does not appear to be developed; the flowers die without setting fruit. This must undoubtedly be in causal relationship to the abundant vegetative propagation. The same observations have been made by others, e. g. by Lindmark, but I am not quite sure whether we are therefore justified in regarding these flowers as staminate; this needs to be experimentally verified, and the pollen and the ovules more closely investigated.

Protogyny possibly occurs in Greenland. The stigmas in the flower shown in Fig. 9 *C* are well developed and pollen occurs upon them; some of the anthers are open, but are full of pollen, which, however, it was difficult to remove from them. Perhaps we have here a transitional form to pistillate flowers. According to Ekstam (p. 183) the flower is usually protogynous-homogamous.

Pistillate flowers occur in West Greenland, and G. Andersson and H. Hesselman also found pistillate flowers in

Spitzbergen; they were small (diam. 5—8·5 mm.), had pure-white petals, and their stamens were reduced to gland-like bodies (l. c. Fig. 13). They also found flowers, the anthers of which contained only 56 % of functional pollen. LINDMARK, also, found pistillate flowers with pistils and anthers of almost equal length (l. c. p. 79).

F. cryptopetala Rosenvinge, 1892, Conspectus floræ Grönl.; Supplement II, p. 678. This form has been described as having petals half as long as the sepals, and "organa fructificationis abortiva;" it is founded upon material from Egedesminde, gathered by N. HARTZ. ABROMEIT found, in West Greenland, forms transitional between this and the principal form. At Holstensborg I found specimens which also had very short petals, and the sepals of which were more foliaceous.

Insects visit the flowers. In Nova Zembla EKSTAM saw a medium-sized fly in them.

Ripe fruit is set scarcely anywhere. SIMMONS writes: "the bulbillæ are probably its only organs of propagation, as the fruit was never developed so far as I have seen."

Saxifraga flagellaris Willd.

BUCHENAU et FOCKE, p. 382. WARMING, 1884, p. 52; 1886, p. 25, fig. 27. TH. HOLM, p. 50, pl. IX, figs. 1—7. EKSTAM, 1897, p. 128; 1898, p. 13. G. ANDERSSON och HESSELMAN, p. 26. DUSÉN, p. 34. SIMMONS, p. 62. HOOKER, Flora Boreali-Americana, I, tab. 87. Flora Danica, tab. 2353.

Material from East Greenland (N. HARTZ), Spitzbergen (A. G. NATHORST) and Siberia (KJELLMAN).

Rosette-plant; usually the difference between the basal part of the rosette and the rest of the shoot which terminates in the flower is greater than is shown in my Fig. 10, as the leaves in the upper part are much smaller than the rosette-leaves, much more bract-like, and occur more widely separated from each other (cf. Holm's figures).

From the leaf-axils of the rosette, thread-like runners (Fig. 10) are given off which may attain a length of 15 cm. and consist only of a single internode; they terminate in a rosette

Fig. 10. *Saxifraga flagellaris* Willd.
A, A flowering plant with some of its offsets (nat. size). *B*, An older isolated offset. *C*, One of the lowest leaves of an offset. *D*, Leaf from the elongated stem (twice nat. size). From Siberia; Preobraschenii Island (KJELLMAN, July 24, 1878). (E. W., 1884.)

which is more or less spherical because its leaves are curved upwards and inwards and are closely imbricated. The young rosettes are fixed in the soil by means of adventitious roots, and on the decay of the runners they become separated from the parent plant (Fig. 10 *B*).

The foliage-leaves are almost obovate, and have cilia or small pointed teeth along their margin which may be more or less glandular (Fig. 10 *D*). They undoubtedly remain green through the winter. A shoot may probably remain upwards of two years in the rosette-stage before it flowers, and then the whole of it dies.

True scales-leaves are absent; and the only indications of such are the less well-developed foliage-leaves which occur basally in the rosettes (Fig. 10 *C*).

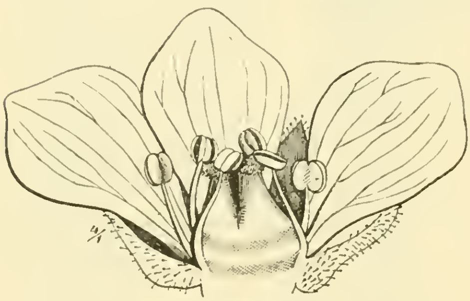

Fig. 11. *Saxifraga flagellaris.*
A flower from Spitzbergen (Tempelbay, July 17, 1882: A. G. Nathorst). (E. W., 1886.)

The corollas vary in size (the petals are from 8 to 11·5 mm. long; Andersson and Hesselman); the petals have a swelling on each side at their base. The flowers are bright yellow and scentless (Ekstam).

Judging from spirit-material, the specimens from Spitzbergen were protogynous. In the flower shown in Fig. 11 the antipetalous stamens were not yet functional, but reclined against the petals; on the other hand, the anthers of all the antisepalous stamens were open, excepting one, and were lying over the stigmas, which were fully ripe and had pollen-grains upon them. Self-pollination was in this case almost inevitable, even if the flower was protogynous at first.

Ekstam (1897, p. 128) reports that self-pollination also takes place in Nova Zembla and says: "Diese Art ist fast homogam oder schwach protandrisch." Andersson and Hesselman, like myself, found protogyny with subsequent self-pollination.

Fruit ripens in Nova Zembla (Ekstam) and in Spitzbergen (Th. Holm's Fig. 2; Anderss. and Hesselm.).

Saxifraga groenlandica L.

S. cæspitosa, Fl. Dan. *S. decipiens* Ehrh.

Lange, Conspectus, p. 62, Supplement I, p. 257. Rosenvinge p. 679.

Th. Holm, pp. 40, 51. Warming, 1886, p. 18, fig. 25. Lindman, p. 57, pl. III, fig. 25. H. Jonsson, p. 284, fig. 2. Rosenvinge, 1896, p. 107. Ekstam, 1897, p. 133; 1898, p. 18. Abromeit, p. 35. Andersson och Hesselman p. 30, fig. 15. Dusén p. 33. A. Cleve p. 49. Lindmark, p. 24, pl. 1, figs. 16—21. Günthart, p. 69. Sylvén, I, 233. Simmons, pp. 70 and 73.

This species grows in tufts, the leaves of which are numerous and close-set (Figs. 12 *A* and 14 *A*). The tufts may consist

Fig. 12. *Saxifraga groenlandica.*
A, A small tuft (natural size) from West Greenland (Disko) gathered by M. Porsild in spring (drawn by Inger Kroge). *B*, Two leaves from the same tuft. *C*, A seedling, copied from Lindmark.

of a complex of richly branched shoots, which, according to the prevailing conditions, are either crowded together so that the tuft becomes compact and pulvinate (in exposed, dry localities) or else grow loosely and have longer internodes (e. g. among damp moss). Usually each tuft obtains nourishment only from the primary root which lives a long time and becomes thick and strong; adventitious roots may occur, but they are weak and few in number.

Vegetative propagation does not appear to take place at all, as is stated also by Lindmark and Ekstam.

The most vigorous shoots occur in the axils of the uppermost foliage-leaves and develop basipetally. But shoots may also develop lower down, even among the decaying leaves of old stems. The shoots may live several years in a vegetative condition before they flower; all the leaves on the fruit-bearing shoot die simultaneously with the setting of the fruit, but the lower parts of the stem remain alive.

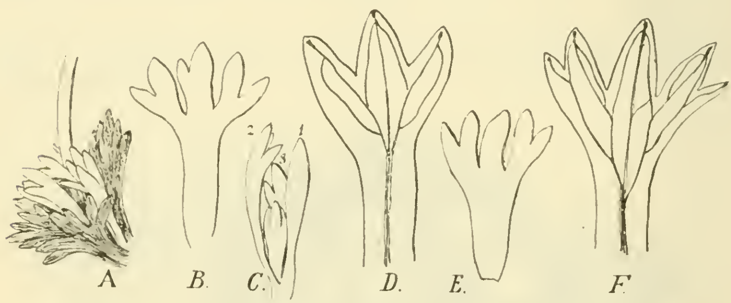

Fig.13. *Saxifraga groenlandica.*
A, A flowering shoot, between the old leaves of which the new leaves are peeping out. *B, D, E, F*, Different forms of leaves, in some the venation has been drawn. *C*, An axillary shoot; *1, 2, 3*, its first leaves. (E. W.)

The leaves are all foliage-leaves (Figs. 12, 13, 14); they persist for several years in a decayed condition, and may be found upon the stems right down to the root without the occurrence of intermediate leafless portions. The upper leaves on the shoots remain quite green throughout the winter (Fig. 12); see H. Jonsson, Fig. 2; Lindmark.

In the beginning of spring, fresh leaves and flowers are seen appearing among the older ones at the apex of the shoots (Fig. 13 *A*). The flowers are formed during the year previous to that in which they open, and they pass the winter with well-developed anthers and pistils (Fig. 15 *E*); but according to Jonsson the integuments of the ovules are not yet developed.

Andersson and Hesselman write: "When winter comes and interrupts the work in the plants, numerous flowers are found in this species."

The germination of the seed has been described and

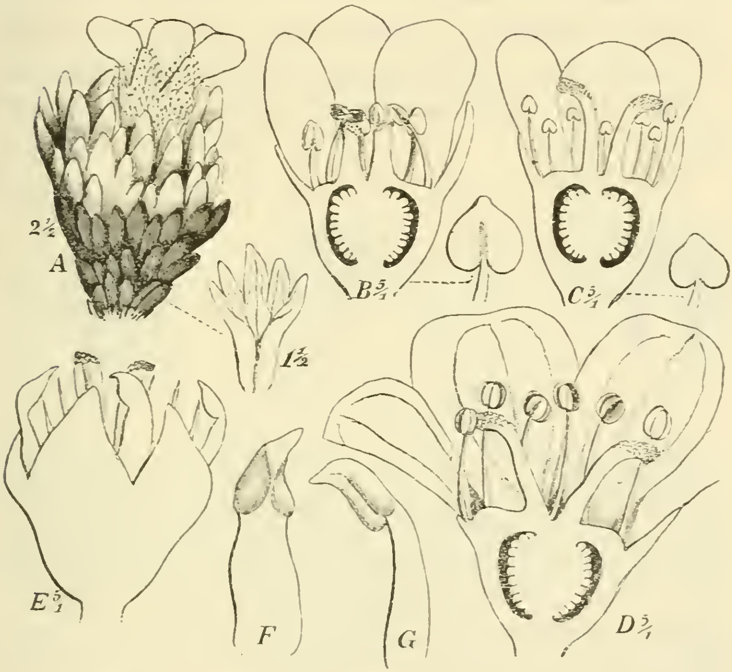

Fig. 14. *Saxifraga groenlandica.* (From Greenland.)
A, A shoot gathered early in spring (June 29, 1884) at Godthaab; the hairs are partially omitted; in the flower the stigmas and anthers were fully developed and in contact with each other; the accompanying leaf belongs to this shoot. *B*, From the same locality; four antisepalous stamens are bending over the stigmas, with their anthers open; the stigmas are not yet full-sized, but nevertheless, they are able to retain the pollen-grains. *C*, a pistillate flower from Godthaab; although young, its stigmas are well-developed; the anthers are abnormally small (compare the accompanying figure with that corresponding to it in *B*). *D*, Flower from Umanak (Eberlin, July 15, 1885); the stigmas are thrust in between, and in contact with the anthers which still contain pollen.
S. groenlandica var. *cryptopetala* Berlin. from Holstensborg (Aug. 6, 1884). *E, F, G*, A flower, and two petals. The anthers of the normal stamens have been lost. (E. W., 1886.)

figured by Lindmark; lateral shoots are developed at an early stage in the axils of the lower primordial leaves (Fig. 12 *C*, after Lindmark).

The flowers vary greatly as regards their size (5—15 mm.)

and colour. The petals may be white, yellowish-white, greenish-yellow or reddish, and have three yellowish-green stripes (Fig. 14 *D*); they are erect or bent somewhat outwards, hence the rain-drops may collect among them. During rain the flower is wet down to its base.

Scent. According to Ekstam it has a faint, pleasant scent in Nova Zembla, but no scent has been noticed in Spitzbergen.

Honey is secreted abundantly by the yellow, glistening base of the pistil.

The flowers vary greatly as regards their development,

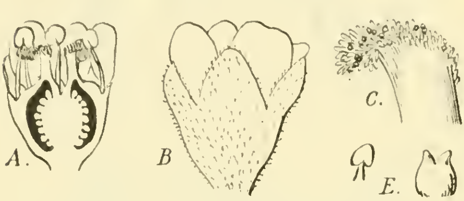

Fig. 15. *Saxifraga groenlandica.*
A, *B*, Small-flowered form with greenish-yellow petals, homogamous or perhaps protogynous flowers. The anther of one of the antisepalous stamens is open (Spitzbergen July 1, 1882; A. G. Nathorst). *C*, Ripe stigma; there are many pollen-grains upon the stigma (West Greenland (Godthaab); June 29, 1884). *D*, The flower is still small; it is protandrous. The antisepalous stamens are erect and some of their anthers are open. The styles are quite unripe. *E*, Stamen and pistil (about $^8/_1$) of a flower gathered Dec. 31, 1893, in East Iceland; H. Jonsson). (E. W.)

some being protandrous, some protogynous, and some homogamous.

Protandry. In Greenland I found slight protandry to be the rule. In the recently expanded flower all the stamens are erect or bent somewhat outwards and lie against the petals; but afterwards the antisepalous stamens begin to bend inwards towards the middle of the flower, so that the open anthers are placed above the still unripe stigmas. Then those stamens bend backwards and the antipetalous stamens perform the same movements, but before the stamens have finished making these movements, the styles have spread out and the stigmas have become ripe. In Fig. 14 *B* it is only the anthers of the four antisepalous stamens which are open, but even at that time the stigmas, as yet not fully developed, are able to retain the pollen-grains; self-pollination will even at that time be able to take place.

In other cases the flowers were more highly protandrous. In cultivated specimens (Hortus Hafniensis) the terminal flower was so protandrous that self-pollination was impossible; here the corolla had attained a diameter of as much as 15—20 mm.[1] From Spitzbergen Ekstam reports "homogamy, with marked inclination to protandry."

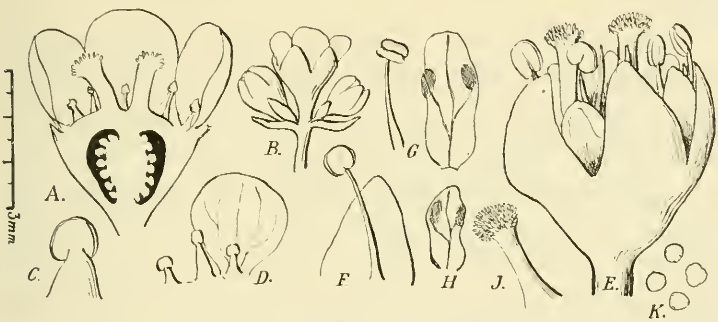

Fig. 16. *Saxifraga groenlandica.*

A—D, Pistillate flower from Iceland (Dyrefjord; June 10, 1895; C. H. Ostenfeld); *A*, flower in longitudinal section (with the accompanying scale): *B*, part of an inflorescence ($^3/_1$); *C, D*, petal and stamens of Fig. *A*.

E—K, forma *cryptopetala* from West Greenland (Egedesminde; leg. N. Hartz). *E*, A flower (about $^8/_1$); the petals are considerably smaller than the sepals. *F*, A sepal with antisepalous stamens. *G, H*, Petals and an antipetalous stamen, *J*, Style. *K*, Pollen-grains appear to be quite normal. (E. W.)

Protogyny occurs also, at any rate in Spitzbergen (Warming, 1886). According to Andersson and Hesselman the f. *uniflora* is "always protogynous" in Spitzbergen. In Nova Zembla the flowers were "in numerous cases protogynous-homogamous" (Ekstam, 1897).

Homogamy. Lindman reports that in Norway (Dovre) the flower is homogamous; in Nova Zembla Ekstam found some flowers which were "almost homogamous." With regard to

[1] Günthart found cultivated specimens in Switzerland so highly protandrous that "between the staminate and the pistillate stage a short neutral, i. e. sexless intermediate condition occurred."

Spitzbergen he says: "The autumn-flowers differ in being more markedly homogamous." NATHORST has already reported that, in addition to the usual form, another occurs with greenish-yellow flowers, which are considerably smaller (generally only 5—6 mm. in diameter), are homogamous, and are self-pollinated; compare Fig. 15 *A*, *B*.

Insect-visitors. EKSTAM found many different species of flies and other *Diptera* in the flowers in Nova Zembla and in Spitzbergen; LINDMAN similarly found *Formica fusca*, on the Dovre.

Self-pollination. I wrote in 1886: "In few species is self-pollination so evident as here; at a time of the year when the greater part of the country is still covered with snow, and when there is scarcely any sign of insect-life, the anthers may be found open and in immediate contact with the stigmas, with germinating pollen-grains upon the latter; even on the 2200 feet high plateau on the island of Disco, near the perpetual snow, did I observe this, and, also, the remains of ripe fruit from the previous year."

Self-pollination is mentioned by LINDMARK as taking place regularly, and it is reported and figured by LINDMAN; EKSTAM says that self-pollination occurs frequently in the protogynous-homogamous flowers in Spitzbergen, but is "prevented" in the protandrous and homogamous ones.

Pistillate flowers. I have often found the terminal flower in the inflorescence to be differently developed from the other flowers; its styles developing quickly and bending outwards, and its stigmas becoming highly papillose while the anthers are still entirely closed (Figs. 14 *C*; 16). But as these anthers are smaller than usual, are never opened, and appear to have abnormal pollen, the flower must be regarded as a pistillate flower with large staminodes. I have observed such terminal flowers in material from Greenland, Spitzbergen and Norway, as also in cultivated specimens (Hortus Hafniensis).

EKSTAM found similar pistillate flowers in Nova Zembla; he writes: "During autumn, closed or half-closed flowers are often put forth, in which only the pistils are developed, while the anthers are rudimentary." ANDERSSON and HESSELMAN also found pistillate flowers in Spitzbergen and in Beeren Eiland; they write: "the anthers never open," and LINDMARK writes: "Truly pistillate flowers are common; it is almost the rule for the terminal flower to be more or less pistillate" (see his Fig. 21, Pl. I).

Forma *cryptopetala* Berlin (Sv. Vetensk. Akad. Öfversikt, 1884, p. 38). BERLIN found in West Greenland (Egedesminde, Auleitsivikfjorden), and in East Greenland, a form with ovate-lanceolate petals of the same length as the sepals, the stamens of which are longer than the sepals. "The petals are swollen at the somewhat drawn-out apex, which suggests that they are being transformed into stamens." An exactly similar monstrous form I examined in material from West Greenland (Holstensborg, Aug. 6, 1884; see Fig. 14 *E*, *F*, *G*). On the same individual may be found quite normal flowers and «cryptopetalous" ones such as that figured, the petals of which have, towards their apex, thick, yellowish margins, indicative of anthers.

Another form showing similar instances of abnormality, but with smaller petals, was gathered by N. HARTZ in West Greenland (Egedesminde); it appears to have ordinary hermaphrodite flowers with normal pollen and stigma; only the petals are being transformed into stamens (Fig. 16 *E*—*K*). In regard to this point HARTZ writes: "sets ripe fruit; on two large tufts which have been examined, only cryptopetalous flowers were found. Protogyny was found. Self-pollination must easily be able to take place."

This cryptopetalous abnormality was also met with in Spitzbergen with "the petals transformed into stamens" (ANDERSSON and HESSELMAN, Fig. 15); easy transitional stages between petals and stamens occurred.[1]

[1] ROPER has in *Saxifraga granulata* observed a form "*apetala deca-*

Other deviations were also met with. In South Greenland Mrs. LUNDHOLM found double flowers.

Fruit ripens abundantly in Greenland, Jan Mayen, Iceland, the Færöes, Spitzbergen, Beeren Eiland, Siberia and in Arctic Scandinavia. It ripens so regularly that fertilization must be absolutely certain, probably by means of self-pollination.

Saxifraga hieraciifolia Waldst. et Kit.

LANGE, Conspectus, p. 59. TH. HOLM, p. 52. WARMING, 1886 b, p. 17. EKSTAM, 1898, p. 132; 1897, p. 10. G. ANDERSSON och HESSELMAN, p. 21. DUSÉN, p. 31. LINDMARK, p. 49.

KNUTH, p. 448.

Only alcohol-material from Spitzbergen and Siberia has been at my disposal.

A herb of the *Primula*-type; agrees altogether fairly closely with *S. nivalis*. The rhizome is erect or somewhat oblique; fairly thick and robust, and furnished with long, vigorous adventitious roots; it gradually dies away at the hinder end. It may either be branched, or set with buds.

Branching. The shoots may remain for several years in the rosette-stage before they flower. On a flowering shoot the principal lateral bud, which is situated in the axil of one of the uppermost leaves of the rosette, may be so fully developed while the parent shoot is flowering, that its foliage-leaves principally serve to form the rosette at the base of the inflorescence, the foliage-leaves of the parent shoot being for the most part dead.

The leaves are all foliage-leaves, which are often more or less red.

The flowers are small and rarely open in a stellate manner, but remain more or less closed with small, erect or slightly inwardly-bent, petals (Fig. 17). The diameter is 5—10 mm.

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pentandra", the petals of which were also metamorphosed into stamens (Botan. Zeltg., 1856).

(Nova Zembla; Ekstam). The petals are shorter than the sepals or equal them in length; they are dark-red. The stamens perform the usual movements. Honey is secreted by the pistil-base which recalls that of the Umbelliferæ, each style having at its base a sinuously-angular nectary disk (Fig. 17 *B*). This is also the case in *S. nivalis* and *S. pensylvanica*. Scent is absent (Ekstam).

The flowers are reported by Ekstam to be in Nova Zembla "decidedly protandrous; even in the bud one or several of the anthers may sometimes be open;" but from Spitzbergen he reports "protogynous-homogamous; the stigmas move away

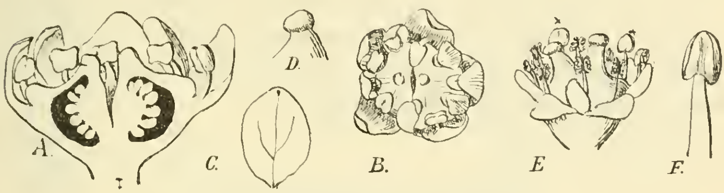

Fig. 17. *Saxifraga hieraciifolia.*

A, A young flower (5/1); its anthers have not yet opened and its stigma does not appear to be ripe. From Siberia (Chabarova; July 31, 1878; Kjellman). *B*, A similar flower, magnified as *A*; from Spitzbergen (July 1, 1882; A. G. Nathorst). As yet none of the anthers have opened. *C*, Petal. *D*, Style with stigma. *E*, A flower from Spitzbergen (July 27, 1882; A. G. Nathorst). All the anthers are open except those of the two antipetalous stamens, marked x. *F*, Stamen. (E. W.)

from each other and become glistening-papillose, even before the anthers have reached their full development." On spirit-material from Spitzbergen and Chabarova I found the flowers to be homogamous or perhaps slightly protandrous.

According to Ekstam (p. 132) self-pollination is sometimes possible by the styles bending outwards simultaneously with an inward movement of some of the stamens (Nova Zembla). In his paper he writes of Spitzbergen: "In the greater number of cases, self-pollination is probably prevented by the fact that the stigmas are situated considerably above the level of the anthers, owing to the length of the styles. Sometimes, however, they stand on the same level." The flowers figured by me (Fig. 17) are homogamous and illustrate the latter condition. I have found the anthers to be in contact with the stigmas, but as only spirit-material is at hand and I have had no opportunity of examining living flowers, there is no certainty that this has not been occasioned by violence.

Insect-visitors. In Spitzbergen Ekstam saw a fly visit a flower. It is noteworthy that the stigmas are not highly papillose, as is the case in most of the other species, but are spherically rounded off without papillæ and covered by mucilage (Fig. *D*). In this feature this species resembles *S. nivalis.*

Several times I found trimerous pistils in terminal flowers. Lindman and Ekstam also found 3- and 5-merous pistils.

Fruit. According to Ekstam, Kjellman found ripe fruit in Arctic Siberia; and Andersson and Hesselman report that the seed ripens regularly in Spitzbergen.

Saxifraga Hirculus L.

Lange, Conspectus p. 64. Warming, 1886 b, p. 25. Ekstam, 1897, pp. 130, 180; 1898, p. 14. G. Andersson och Hesselman, p. 27; Dusén, p. 34. Lindmark, p. 32. Silén, p. 86. Simmons, p. 64.

The Arctic plants are often low and somewhat tufted. From the base of the erect flowering shoots are given off, in Danish specimens, slender runners in basipetal succession, and with a more or less subterranean course. These runners may be either short or long; they form many slender roots and their leaves are developed to a varying extent as foliage-leaves. The runners, whose course is most subterranean, are very slender and bear scale-leaves (Fig. 18). The primary root probably dies early. Vegetative propagation takes place by the lateral shoots becoming isolated when the irregularly-branched rhizomes gradually die away at the hinder end.

According to Lindmark the rhizome may have 2—3 or several year's-shoots.

The shoots may remain for a few years in a vegetative condition before they flower.

According to Lindmark the youngest foliage-leaves remain green during the winter; on the flowering shoots, either the greater part, or all of the foliage-leaves of the previous year are brown and dead. Of the rejuvenating shoots, some may come into flower soon after the parent shoot itself flowers.

The flower. I myself only examined material from Spitzbergen and Denmark. The diameter of the flower from Spitz-

Fig. 18. *Saxifraga Hirculus* L.
A, A flowering plant (almost nat. size) from Spitzbergen (July 7, 1882; A. G. Nathorst). *B*, Part of a flowering plant from Denmark (almost nat. size); *a*, dead runner; *b. c*, living runners. *C*, Apex of the living runner *c*. (Drawn by E. W.)

bergen is, in its staminate stage 10—15 mm., in its pistillate stage, 13·5—18 mm. (Andersson and Hesselman), and from Nova Zembla 12—25 mm. (Ekstam).

The petals are bright yellow with lemon-coloured dots, and have at their base a peculiar swelling on each side (Fig. 19 *C*). They are 2—3 times longer than the sepals.

Scent. The flower is scentless, and honey does not appear to be secreted, "unless perhaps in very small quantities at the base of the stamens or in the folds of the two protuberances at the base of the petals" (Ekstam).

Protandry. The flower is markedly protandrous, as is also the case with the Danish specimens (Fig. 19 in which the antisepalous stamens are bent inwards, and have some of their anthers open; one stamen (marked x) has already bent backwards; the antipetalous stamens and the pistil are still unripe). All the antipetalous stamens may be bent forwards with their anthers open, before the pistil is ripe.

Pistillate flowers with small anthers devoid of pollen, and forms showing all the transitional stages between these and the usual flowers, occur in Spitzbergen (ANDERSSON and HESSELMAN).

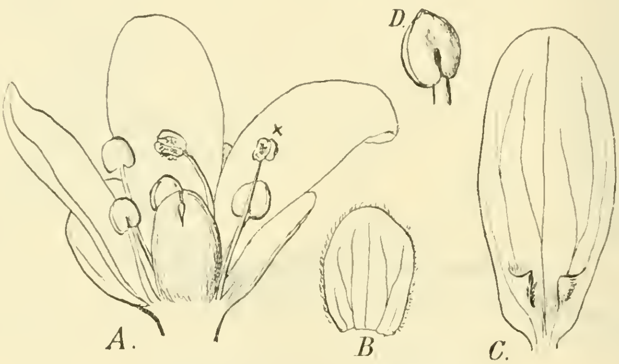

Fig. 19. *Saxifraga Hirculus* L.
Spirit-material from Spitzbergen (Recherche-Bay; July 7, 1882; A. G. NATHORST). *A*, A distinctly protandrous flower; one of the stamens is bending over the middle of the flower; the one marked x has already bent backwards. *B*, Sepal, *C*, Petal. *D*, Anther. (Drawn by E. W.)

Ripe fruit is said to be developed in Spitzbergen, but probably not every year (ANDERSSON and HESSELMAN). Almost ripe fruit was found in Nova Zembla (EKSTAM).

Insects-visitors. In Nova Zembla and in Siberia EKSTAM and KJELLMAN saw different kinds of small, large, and medium sized flies and other *Diptera* visit the flowers.

Saxifraga nivalis L.

LANGE, Conspectus, p. 59. ROSENVINGE, 1892, p. 177. TH. HOLM, 1885, p. 52. WARMING, 1886 b, p. 14, fig. 24. LINDMAN, p. 58, tab. II; fig. 24. N. HARTZ, 1894, p. 4; 1905, p. 288. ROSENVINGE, 1896, p. 107. Ekstam, 1897, p. 131, 1898, p. 11. Abromeit, p. 32. G. Andersson och Hesselman, p. 22. Dusén, p. 32. A. Cleve, p. 48. Lindmark, p. 45, tab. II, figs. 18—20; tab. III, fig. 1. Simmons, p. 67. Sylvén, p. 230.

Knuth, p. 452.

A herb of the *Primula*-type, tufted in habit, with an erect or else more or less oblique rhizome (Fig. 20), which is

Fig. 20. *Saxifraga nivalis.*
A, A specimen (slightly reduced) from Disko, gathered by M. Porsild; *K*, a lateral shoot. *B*, A leaf (somewhat mag.) from Iceland. *C*, A leaf of *S. nivalis*, f. *tenuis* from Jan Mayen. (E. W.; drawn by J. Krogh.)

usually short, but sometimes attains a length of as much as 5—6 cm. and is thick and strong, and may be rather densely branched. Numerous adventitious roots occur. The specimens from Cape Tcheljuskin (Siberia) formed dense tufts, the numerous thick, short, erect rhizomes being united into a single mass, and bearing many adventitious roots.

All the leaves are foliage-leaves and occur in a rosette. They may live through the winter in a fresh, green condition. At Upernivik in places recently freed from snow, erect, green leaves occurred, surrounded by the dead parts. The leaves are sometimes reddish, especially on their undersides.

Lateral shoots are developed in the axils of the flowering shoots even from the commencement of their flowering-period, the principal bud being in the uppermost leaf-axil, and the others in basipetal succession. The principal bud may develop so quickly that it makes the inflorescence appear lateral, and may flower simultaneously with the parent shoot. The shoots may remain several years in a vegetative stage before flowering. Specimens with several inflorescences, produced by rapid growth of the lateral shoots of a flowering shoot, occur fairly frequently.

Seedlings are described and figured by Lindmark. In 1877 I sowed seed in April, and in August 1878 the seedlings had close-set rosette-leaves and fibrous roots, but were not yet branched.

The flowers pass the winter well-developed, and are among the first to open in spring. Specimens from the north coast of Siberia had inflorescences for the next year distinctly developed even by the end of August. The flowers are small and inconspicuous, the diameter is only 5—8 mm.; in Siberia some measured 10 mm. across (Kjellman, according to Ekstam). The calyx is often brownish-red in colour, and the petals are whitish, or greenish yellow, or reddish to light pink or white with red tips. They are erectly-spreading, and of the same length as the calyx or somewhat longer (Figs. 21, 22). The stamens have reddish or yellowish filaments and pale minium-red anthers. The styles often become dark-red in older flowers.

Honey is secreted by the glistening, greenish base of the styles which is usually sinuate along its margin (Figs. 21, 22). After rain a large collection of water, evidently containing nectar, can be seen at the bottom of the flower. Scent is absent (EKSTAM).

According to field-notes made by me, the Greenland spe-

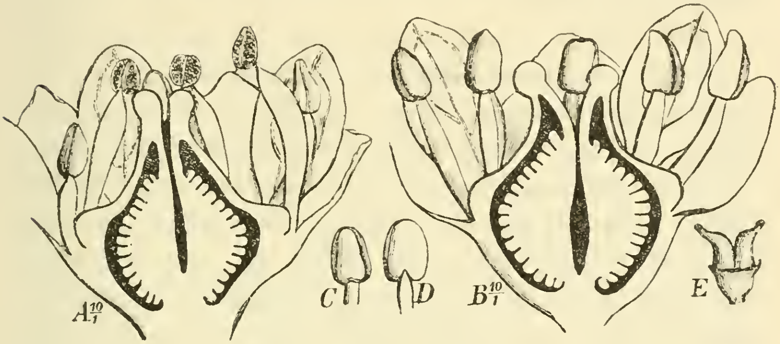

Fig. 21. *Saxifraga nivalis.*

A, A flower from West Greenland (July 6, 1884). The antisepalous stamen to the left, has its open anther just above the stigma, which has germinating pollen-grains. The anthers of the antipetalous stamens are closed. *B*, A younger flower which is protogynous (north of Norway: Tromsö; June 27, 1885); all the anthers are closed, but the stigmas are ripe. *C, D*, Anthers from the ventral and the dorsal side. *E*, Unripe fruit (West Greenland). (E. W., 1886.)

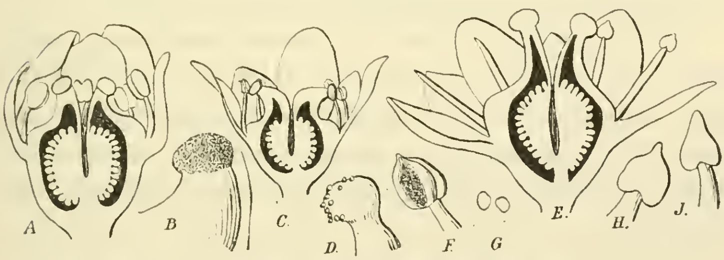

Fig. 22. *Saxifraga nivalis.*

A, Young flower of *S. nivalis* var. *tenuis* from Spitzbergen (July 11, 1882; A. G. NATHORT); the anthers are still closed; the stigmas appear to be ripe. *B*, Style and stigma from *A*. *C*, An unusually small flower (magnified as *A* and *E*); all the anthers are open; the styles are spreading so that the stigmas touch the anthers; self-pollination will take place (Norway; Aug. 20). *D*, A stigma with pollen-grains; the antipetalous stamens in this flower were still closed, the antisepalous were open, but still contained some pollen. Gathered by KJELLMAN in Siberia: Cape Tscheljuskin.

E—J, Flower from West Greenland (July 28, 1885; S. HANSEN); some of the anthers (*H, J*) are barren; others (*F*) are open, but the pollen-grains (*G*) do not appear to be quite normal. (E. W., 1886.)

cimens do not appear to differ from those from Scandinavia, Spitzbergen and northern Asia.

Protandry has been observed in Greenland, Norway (LINDMAN), Sweden (AXELL), and Nova Zembla (EKSTAM), and I found cultivated specimens (Hortus Hafniensis) which were slightly protandrous.

Protogyny. It appears to be the rule for the flowers to be slightly protogynous (Greenland and Nova Zembla), but if so, homogamy ensues very soon. The styles bend outwards but slightly, and the stigmas, which in this species, as in *S. hieraciifolia*, are evenly rounded, glistening and without papillæ (Fig. 22 *B*), are usually able to retain pollen before any of the anthers of the still quite erect stamens are open (Fig. 21 *B*). The plant appears, however, to be homogamous during the greater part of the flowering-period, and self-pollination seems to be very common, and is, at any rate, easily possible in case cross-pollination does not take place. The movements of the stamens are those usual in the other species. But the stamens almost always stand fairly erect, or else they lean slightly forward over the middle of the flower, and even touch the stigmas with their anthers (Figs. 21 *A* and 22 *C*).

In other flowers I found the stamens somewhat spreading when they began to be functional (as in Fig. 21 *B*), so that here, self-pollination by direct contact does not seem to take place. The specimens from Norway appear to me to be less distinctly self-pollinating than are those from Spitzbergen and Greenland.

Insects, according to EKSTAM flies, visit the flowers.

Fruit usually ripens in West Greenland, in Ellesmere Land (SIMMONS: "fruited richly"), Jan Mayen, Iceland, Norway, the Færöes and Siberia. Half-ripe fruit was found by DUSÉN and BAY in East Greenland, by EKSTAM in Nova Zembla, and by ANDERSSON and HESSELMAN in Spitzbergen.

Pistillate flowers. In some specimens gathered by

Dr. S. Hansen in West Greenland, the styles were considerably longer than the stamens, and as the anthers were also smaller than usual, but yet were open, and as the pollen-grains appeared to be abnormal and imperfect these should probably be regarded as pistillate flowers or as transitional in that direction (Fig. 22, *E—J*).

Saxifraga oppositifolia L.

Lange, Conspectus, pp. 66, 257. Rosenvinge, 1892, p. 680. Th. Holm, p. 40. Warming, 1886 a, p. 29, fig. 28; 1886 b, pp. 113, 118. Lindman, p. 56, pl. II, fig. 21. Bonnier, p. 513. N. Hartz, 1894, p. 4; 1895, pp. 242, 287. H. Jonsson, p. 283, fig. 1. Rosenvinge, 1896, p. 107. Ekstam, 1897 a, p. 127 (Nova Zembla); 1897 b, p. 12 (Spitzbergen). Vanhöffen, p. 38. Abromeit, p. 38. G. Andersson och Hesselman, p. 23, figs. 8—12. Dusén, p. 35. A. Cleve, p. 48. Lindmark, p. 19, pl. I, figs. 8—15. Sylvén, p. 229. Simmons, p. 60.

H. Müller, p. 98, fig. 31. Knuth, p. 444. C. Schröter, p. 540.

Material from West Greenland (Kornerup, Holm, Warming, Ryder, Hartz), East Greenland (Hartz, V. Eberlin, Deichmann, Knutzon), Iceland (Hj. Jensen, Helgi Jonsson, Stefansson), the Færöes (Warming, Börgesen, Helgi Jonsson), Nova Zembla (Th. Holm), Norway (Warming).

This *Saxifraga* is the one with the most extreme Arctic distribution, and it flowers earliest in spring; scarcely has the snow melted — indeed, it may not yet have done so — when the flowers, which have passed the winter in a well-developed condition (Fig. 26 *D*), expand. Even in March, open flowers may be found in West Greenland (March 26; J. Vahl).

This species is a perennial herb, which has a tendency to become a sub-shrub as the branches become woody; it varies somewhat in form, hence Andersson and Hesselman even established a forma *reptans* and a forma *pulvinata*. These are probably only modifications occasioned by circumstances pertaining to locality (cf. also Simmons).

In some plants the stems are prostrate, have more or less elongated internodes, and attain a length of from 10 to 30 cm. (Fig. 23; Fig. 24 *H—J*); many lie quite freely upon the ground, but some are attached to the soil by adventitious roots. The primary root remains alive for several years, ordinarily, no doubt during the whole life of the plant, but sometimes the adventitious roots become strong and the plant may multiply

Fig. 23. *Saxifraga oppositifolia.*
(From the East of Iceland; Dec., 31, 1893.)
A prostrate shoot with two erect floral shoots bearing the dehisced capsules of the previous year and also several younger floral shoots, the fully-developed flowers of which are enclosed between the fresh green leaves (Helgi Jonsson, 1895; drawn by C. Thornam).

by vegetative propagation. This, however, appears to occur comparatively rarely. In forma *reptans* (Andersson and Hesselman) the adventitious roots appear to be more abundant than is usual.

The prostrate shoots give off erect floral shoots the leaves of which are usually so close-set, and the internodes so short, that they become square (Fig. 24 *B*, *E*; Fig. 25 *A*). The leaves are generally opposite and decussate (Fig. 25 *A*, Fig. 24 *F*), sometimes, however, the leaf-pairs do not cross each other exactly at right angles (Fig. 24 *G*). The stems of this form may form a low carpet of greater or lesser extent.

The form with a pulvinate habit, has usually only a primary root; it gives off lateral branches, more or less erect, forming dense, semi-globular cushions which, according to ANDERSSON and HESSELMAN, may attain a diameter of 20—30 cm. and a height of 10 cm. Prostrate branches appear sometimes to be quite absent. I have gathered similar specimens, cushion-like in habit and richly-flowering, in Finmark; and in the "Riksmuseum" in Stockholm, there is a specimen in spirit (in a glass measuring 5 cm. in width) gathered by NATHORST, which, is as large as a clenched fist, and has about 120 flowers.

Fig. 24. *Saxifraga oppositifolia.*

A, Flowering shoot (West Greenland; July 12, 1884; slightly above nat. size). *B*, A shoot (West Greenland; May 18; a little above nat. size) with a terminal flower; at x the fresh green leaves begin. *C*, Branch from Norway (Finmark); July 7. *D*, Shows a lateral shoot which begins with an elongated internode. *E*, Plant from West Greenland, reduced (July 17); leaves very close-set. *F*, *G*. Diagrams to show the position of the leaves on the erect short shoots. *H*, *J*. Branches of the same plant (Norway; Aug.); internodes fairly elongated; *a*, limit of the year's-shoot, slightly reduced. (Drawn by E. W.)

The shoots branch irregularly; there is no principal bud. The erect shoots with short internodes rarely branch before flowering; the prostrate shoots give off branches which are also prostrate. Between loose moss the internodes of the shoots may become greatly elongated.

The leaves are foliage-leaves; scale-leaves do not occur.

The structure of the leaves will be described by GALLÖE in the anatomical portion of this work. The shoots terminate during winter with fresh green, or sometimes reddish, leaves which do not decay until late in the ensuing summer. In a decaying condition the leaves may persist for many years (Fig. 25 *A*). During winter they serve as food for ptarmigans and other animals.[1]

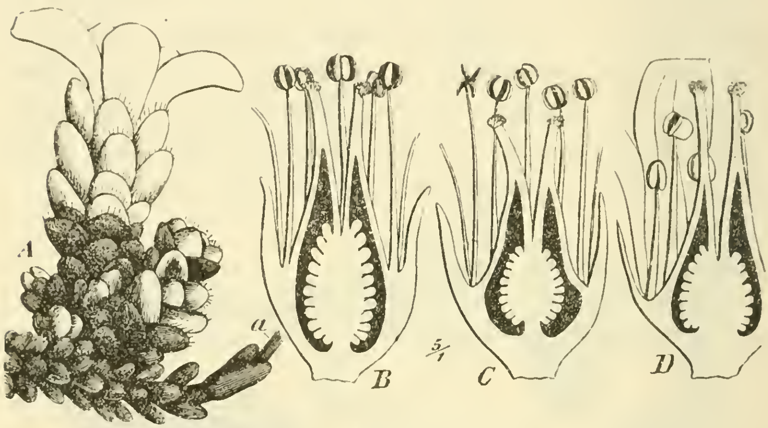

Fig. 25. *Saxifraga oppositifolia.*

From Greenland (*A*—*C*) and Norway: North Cape (*D*).

A, From Holstensborg (July 16, 1884); a dead stem bearing the fruit of the previous year is seen to arise at *a*; between the leaves of the previous year new shoots (the white ones) are being developed. *B*, Longitudinal section of a flower, in which all the stamens are erect and have their anthers open; the stigmas are ripe and stand quite close to the anthers or are even in contact with them. *C*, The stamens are erect, and are longer than the styles; all the anthers are open; germinating pollen-grains occur upon the stigmas. *D*, All the antisepalous stamens are open, but the antipetalous stamens are closed; pollen-grains are seen germinating upon the stigmas. (E. W., 1886.)

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[1] During NARES's Polar-Expedition, on February 19, 1876, a hare was shot in 82°—83° N. lat., of which the following account was given: — "It is in excellent condition, and has been feeding on the leaves of the purple Saxifraga, willows and lichens. It is extraordinary how these animals find sufficient food with which to support life during the dark season, or how the buds of the plants can withstand such a low temperature." In the same work referring to Febr. 7, 1876, we read: — "On examining a plant of *Saxifraga oppositifolia* which has not been protected by any snow, and therefore has been exposed to the severest temperature, green buds were distinctly visible. In 1853 we killed a ptarmigan at Melville Island in February with green buds of willows in its crop.'

Seedlings have been described and figured by Lindmark. During the first year an epicotyledonary shoot is formed, about 5 mm. in height, and with short internodes; during the second year this becomes prostrate, its internodes elongate and it branches.

The shoots evidently may remain for several years in a vegetative stage until they terminate in a (usually) solitary flower. But they may also flower during the second year. The flowers which first expand often occur embedded between the foliage-leaves of the shoot (Fig. 25 *A*); the succeeding flowers may be raised into the air to a greater or lesser height, upon stems with elongated internodes (Fig. 24, *A*, *H*).

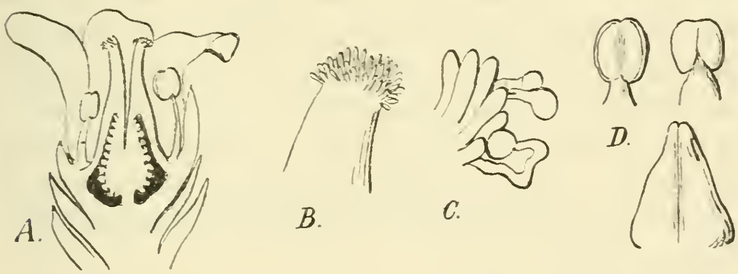

Fig. 26. *Saxifraga oppositifolia.*
A, A flower with very short stamens (about $^3/_1$). *B*, Stigma of the same flower, ripe, but without pollen (West Greenland; June 29, 1884). *C*, Germinating pollen from another flower. *D*, Stamens and pistil (about $^6/_1$) from a closed bud (West Greenland; May 18). (Drawn by E. W.)

The flowers pass the winter in a well-developed condition (Fig. 26 *D*). H. Jonsson found, in December, petals and stamens which were already coloured.

The diameter and the size of the flower vary on the whole widely. From Spitzbergen Ekstam reports 9—11 mm., and, exceptionally, 18—20 mm.; Andersson and Hesselman as much as 18; similar measurements were made in Greenland. This must evidently be connected not only with a difference of age, but also with the conditions of life.

The colour of the petals varies greatly. Some of the flowers are pale red, others purple-coloured, or dull violet-red. White flowers also occur.

Scent. From Spitzbergen and Nova Zembla it is reported that the flowers have a strong scent (Holm, Ekstam); Nathorst even writes "almost sickening" in cases where the flowers occurred abundantly. I have not noted down any observation regarding the scent in Greenland.

Honey is often secreted abundantly by the base of the ovary. The flower is so widely expanded, that in rain or melting snow it may be filled with water. The flower is usually protogynous at first, but very soon becomes homogamous (Greenland, Scandinavia, Spitzbergen, Hortus Hafniensis, the Alps); I have found the styles bending outwards and the stigmas highly papillose, while the stamens were still short and had not opened one of their anthers. According to Lindman the stigmas ripen even before the flowers have fully expanded. At first the styles are longer than the stamens, but gradually the anthers of the latter attain the level of the stigmas and gather so closely around them that self-pollination takes place (Fig. 25 *B*, *C*, *D*).

The usual staminal movements of the *Saxifraga* occur here, but not with the usual vigour; Andersson and Hesselman even report that the stamens do not perform any movements at all (Spitzbergen), but remain sub-erect or even somewhat bent inwards. Lindman distinguishes between a form with larger flowers (see his Fig. 21 *A*, *B*) and one with smaller flowers (see his Fig. 21 *C*); the latter appears to be protogynous to a somewhat lesser degree. Transitional forms occur. The relation in length between the stamens and the pistils varies greatly; in flowers at the same stage of development, the stigmas may be situated above the anthers (Fig. 25 *D*), or at a level with them (Fig. 25 *B*), or at a lower level (Fig. 25 *C*). In the flower figured in Fig. 25 *D*, the styles are unusually long.

Protandry is evidently rare. Ekstam observed it in Nova

Zembla, and Dusén reports it in var. *Nathorsti* from East Greenland; he writes (p. 37): "Die vollkommen entwickelten Staubblätter ragen etwas über die Frucktknoten; diese reifen später als jene." But immediately afterwards he reports protogyny.

Staminate flowers occur. Lindmark describes and figures such a flower, in which the pistil is very small, while the stamens are of the usual length. It did not set fruit.

Pistillate flowers, more or less closed, were found by Ekstam in Spitzbergen, late in summer. The stamens were almost rudimentary or were sterile. According to Schröter (p. 541) similar flowers were also found in the Alps by Schulz. The flower figured in my Fig. 26 *A* is perhaps a pistillate one.

Insect-visitors. Ekstam saw flies, and in Nova Zembla also many humble-bees, visit the flowers.[1] Lindman never saw insects visit the flowers, neither did I observe any in Greenland.

Self-pollination by contact of anther and stigma, is no doubt common everywhere in Arctic countries; it is also recorded from the Alps by H. Müller (p. 98). Stigmas and anthers are often found clustered close together in the middle of the flower, and frequently in intimate contact with each other (Fig. 25 *B*).

Fruit ripens in many places, in West and East Greenland, Iceland, the Færöes, Spitzbergen, Nova Zembla and Scandinavia. I found fruit set very early in Greenland, as early as June 28th, when the whole landscape around Godthaab was still very winterly, with snow even down to the sea; the fruit was in evident development.

According to Ekstam, 4- and 5-merous pistils occur.

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[1] "The occurrence of *Saxifraga oppositifolia* was an invariable evidence of humble-bees being present, and they were also seen in great quantities whirling over the plant-clusters as soon as the temperature was above +4° C., and the wind not too sharp."

Saxifraga rivularis L.

Lange, Conspectus, pp. 61, 256. Rosenvinge, p. 679. Warming, 1886, p. 7, figs. 21—22. Lindman, p. 57, pl. II, fig. 22. N. Hartz, 1894, p. 37; 1895, p. 288. Jungner, p. 275. Ekstam, 1898, p. 17 (Spitzbergen). Abromeit, p. 34. G. Andersson och Hesselman, p. 29. Dusén, p. 33. Lindmark, p. 55, pl. III, figs. 8—14. Simmons, p. 76. Sylvén, p. 233.

Knuth, p. 449.

Primula-type, combined with runners and bulbs. The species has a very abbreviated, vertical rhizome with short internodes and many slender adventitious roots (Figs. 27 *A*; 28 *A*); when growing in damp moss the internodes become fairly elongated (Fig. 28 *C*); the rhizome dies away at the hinder end. At the base it bears sometimes several, sometimes a few dead leaves; and above these, a rosette of fresh, long-stalked foliage-leaves, which are palmately-reniform, 5—7 lobed, and set with glandular hairs (Fig. 27 *A*, *D*,; Fig. 28 *A*).

Runners. From the axils of the basal leaves may be seen to arise (as many as 5) pale, slender, horizontally-growing runners having on them glandular hairs (Fig. 27 *E*). They may attain a length of 6 cm., and generally bear scale-leaves which are sometimes succulent and may have small laminæ at their apices. The runners ultimately bend upwards, producing foliage-leaves and forming roots, and a new vertical rhizome arises (Fig. 27 *A*). The runners soon die. In some cases they are seen to be bent even somewhat downwards. Sometimes they bear foliage-leaves only. They may branch and form new runners.

Bulbils are also formed; they consist of a few, thick scale-leaves, which represent, in the main, the sheath of the foliage-leaves (Fig. 27 *B*; Fig. 28 *B*). The bulbils are formed in the leaf-axils of the rhizome simultaneously with, and in immediate proximity to, the runners (Fig. 27 *C*). According to Lindmark, who is a very careful observer and whose paper contains valuable observations, bulbils may also arise terminally upon lateral shoots which bear foliage-leaves. The same is stated with regard to the runners, and I am able to confirm the statement (Fig. 28 *G*).

Foliage-leaves. The typical form and venation of the foliage-leaves are shown in Fig. 29 *A*, *B*. Entire (*D*) and nar-

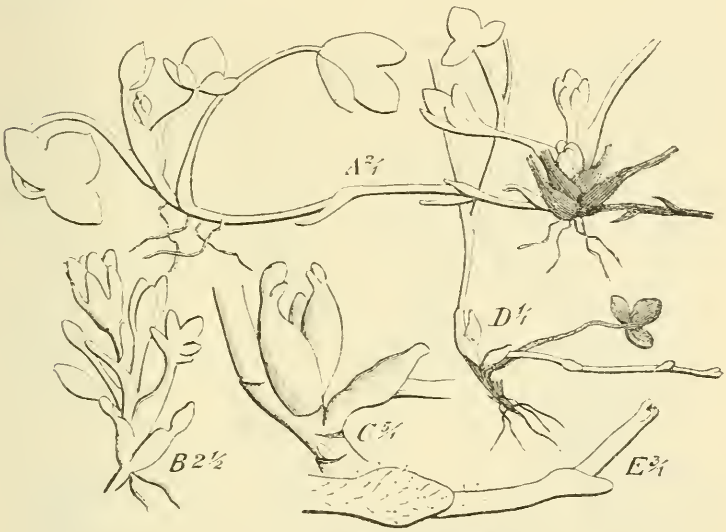

Fig. 27. *Saxifraga rivularis.*

A, A runner from an older shoot which is in the act of expanding, bearing at first scale-leaves, and in the part turned upwards, foliage-leaves; at the point of transition between the horizontal and erect parts, roots are formed. *B*, Apex of a flowering shoot (from Spitzbergen: July 6. 1882; Nathorst). *C*, *D* (from West Greenland; Aug. 16, 1884), A bud with fleshy scale-leaves and a runner which at first bears similar leaves are both situated at the base of an erect shoot with elongated internodes which bears two foliage-leaves (the stalk of the lower, and the whole of the upper leaf is shown), a bract, and a flower. *E*, The apex of a runner; the covering of hairs, everywhere else omitted, is indicated here. (E. W., 1886.)

rowly-lobed (*C*) leaves occur. The venation is characteristic, the veins being curving and united at the apex. The leaf-base consists of a broad sheath which in form sometimes resembles the stipules of many *Rosaceæ* (Fig. 28 *D*).

The germination of the seed, and the seedlings are mentioned and figured by Lindmark. Ostenfeld also gathered seedlings in Iceland (Fig. 28 *E*, *F*). The primordial leaves form a rosette. Lindmark thinks that the plants can flower in their second year.

Branching. Lateral shoots which, from the first, put forth imperfect foliage-leaves, are quickly developed into small

Fig. 28. *Saxifraga rivularis.*
A, From Disko (July 20, 1884). From the base of a shoot five white, rootless, slender runners are seen to proceed (slightly mag.). *B*, A runner; slightly mag. (Norway); the leaves *a* and *b* are fairly thick and fleshy; *c* and *d* have small entire laminæ; *e* a tripartite lamina. *C*, A slender, erect runner (West Greenland; Aug. 16, 1884); in the axils of the three leaves — which have been cut off — new runners have arisen (slightly reduced). *D*, A leaf with evident stipules. *E*, Seedling from Iceland; about $^2/_1$ (Ostenfeld; June 8, 1895). *F*, A cotyledon of it ($^8/_1$). *G*, A runner which terminates in a foliage-leaf and a bulbil. (Drawn by E. W., 1908.)

foliage-bearing rosette-shoots at the base of a flowering shoot. The greater number of the foliage-leaves which during the flowering-period, are seen at the base of the flowering-shoot often belong to lateral shoots. In unfavourable localities the lateral shoots become close-set, and the whole habit of the plant becomes tufted. Abromeit mentions "very low, densely bushy plants, often only 15 mm. high," of Lange's f. *purpurascens*. I have also seen dense tufts, 2 cm. high, from Siberia.

Probably frequently a shoot remains only one year in the vegetative stage, and dies the second year, after flowering. But in unfavourable localities the shoots may remain vegetative several years.

The flowers are formed during the year previous to that in which they open. In specimens gathered by C. Ryder in West Greenland (Upernivik) from under the snow on July 18, 1887, the flowers had large anthers and a large pistil.

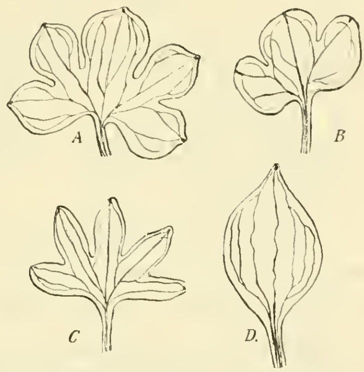

Fig. 29. *Saxifraga rivularis*. Forms of leaves from Greenland; slightly mag. *A*, A typical leaf. *B*, A similar leaf, but three-lobed. *C*, A narrowly-lobed leaf; *D*, An entire leaf. (Drawn by E. W., 1908.)

Sometimes only one, terminal flower occurs; sometimes a few-flowered inflorescence is developed.

The diameter of the flowers is small (5—8 mm., or sometimes, according to Ekstam, 10 mm.) because the petals are fairly erect (Fig. 30 *A*, *C*). Probably the flowers are always scentless. The petals are white, but red or dark-red examples occur (Lange writes regarding f. *purpurascens* "sepala atropurpurea; petala rubella." Andersson and Hesselman write (Spitzbergen): "sepals reddish-brown, petals white with a narrow band of reddish-violet colour; the gynoeceum reddish-violet." As is the case in *Saxifraga cernua*, irregular flowers occur, the petals on the one side of the flower being smaller than those on the other; this is seen especially in the young flower (Fig. 30 *C*).

The stamens perform the usual movements, but less markedly, and remain on the whole fairly erect.

Slight protogyny or decided homogamy is the rule

(Greenland, Norway, Sweden). In the buds, the styles are erect or bent a little inwards, and the stigmas are slightly papillose. When the corolla begins to open, the stigmas are seen to be larger and more strongly papillose, and the anthers, then, stand closely around them (Fig. 32 *A*): they may at that time, still be closed, but there are also cases where I saw them evidently functional simultaneously with the stigmas. In 1886 (p. 8) I wrote: "I have noted down, e. g. from Sermersut at Sukkertoppen (July 5): even in the still half-closed flower the antisepalous stamens are open and the stigmas retain the pollen-grains."[1] The styles afterwards become more spreading, and as the anthers remain erect or even bend inwards over the middle of the flower, they will easily be able to come into contact with the stigmas. As a matter of fact, they are sometimes found in very close contact with them.

Self-pollination has been observed in Greenland (Warming), Norway (Lindman), Sweden (Lindmark). That it also causes true fruit-setting is evident from the fact that it is a constant rule for the inconspicuous and small flowers of these species to set fruit in regular succession one after the other; usually every flower on a plant sets fruit. This species, like *S. cæspitosa* and *S. oppositifolia*, is among the earliest flowering species; I found it fruiting on June 28th—30th in West

[1] Ekstam can scarcely have read this with care, as he writes "nach Warmings an Spiritusexemplaren gemachten Untersuchungen ist die Pflanze schwach proterogyn oder homogam." As he also speaks elsewhere of my observations as made upon alcohol-material, and evidently, for that reason, considers them less reliable, I repeat what I wrote on pp. 3—4 regarding the Ericineæ, namely that, as may also be seen from my statement cited above, I have made numerous observations on living material in Greenland and Norway, in many cases in the field, and made sketches of the flowers after this material, and that the spirit-material was only used for the verification of the forms, and as a basis for the figures. It is true, in some cases, that it was spirit-material alone which I had for examination, e. g. from Spitzbergen, but I am not aware that Ekstam has ever proved that many biological facts may not be observed on such material.

Greenland in very winterly surroundings, and as early as on July 10th Kornerup gathered it with ripe fruit in West Greenland. Ripe fruit is to hand from almost all our colonies in West Greenland. Bay, Kruuse and Hartz found ripe fruit in East Greenland. In the literature dealing with the subject, as well as in herbarium and spirit-material from many Arctic countries we find the same constancy in the fruit-setting (Iceland: Jonsson, Feddersen and Stefansson; Norway: Lindman; Sweden: Lindmark;

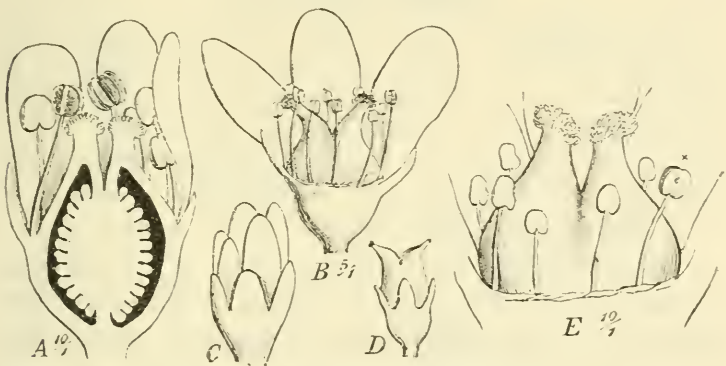

Fig. 30. *Saxifraga rivularis.*

A, In a flower with erect petals (and consequently rather closed, see Fig. *B*) the anthers of the antisepalous stamens and the stigmas are fully functional; the former are placed just above the latter (from Spitzbergen; July 6, 1882; A. G. Nathorst). *B*, An older flower, with expanded petals and spreading styles; here also the stigmas are in contact with the open anthers, which are filled with pollen (from West Greenland, Godhavn; July 20, 1884). *C*, Shows the obliquity which sometimes occurs in the flower. *D*, Young fruit (nat. size) from Spitzbergen. *E*, A flower (from Spitzbergen) with rudimentary stamens; the one marked × held a little pollen. (E. W., 1886.)

Lapland: Brotherus; Spitzbergen: Andersson and Hesselman; Siberia (the north coast): Kjellman; the Færöes and Jan Mayen: all who have collected material).

Insect-visitors. In Spitzbergen Ekstam observed flies visit the flowers.

I found the flowers from Spitzbergen to be somewhat smaller than those from Greenland, but otherwise they agreed entirely with the latter.

Pistillate flowers. On a specimen, gathered by Nathorst in Spitzbergen, with ordinary hermaphrodite flowers, a flower (terminal?) was found with normal stigmas, but with stamens which were much shorter than usual, nine of which had no pollen in their anthers, and were decidedly sterile, but in the tenth there was a little pollen (Fig. 32 *E*).

According to Lindmark, the seeds do not germinate until the year after they have been formed, unless they are exposed to hard frost.

Saxifraga stellaris L.

Lange, Conspectus, pp. 60, 256. Rosenvinge, 1892, p. 678. Th. Holm. p. 51, pl. X, figs. 4—7. Warming, 1886, p. 10, fig. 23. Lindman, p. 59, pl. III, fig. 26. Ekstam, 1894 b, p. 426; 1897, p. 131; 1898, p. 12. G. Andersson och Hesselman, p. 23. A. Cleve, p. 48. Dusén, p. 32. Lindmark, p. 36, pl. II, figs. 4—17. Abromeit, p. 33. Skottsberg, p. 16. Sylvén, p. 230. Simmons, p. 69.

H. Müller, p. 90. Günthart, 1902, p. 73. Knuth, p. 447.

Observations and alcohol-material from: — West Greenland (Warming, Th. Holm, Rosenvinge, N. Hartz, C. Ryder, Ostenfeld: Sukkertoppen, Egedesminde, Upernivik, Godthaab, Holstensborg, Frederikshaab, Kristianshaab); East Greenland (P. Eberlin: Dronning Louises Ø, Nunatsuk). Nova Zembla (Th. Holm). The Færöes (F. Börgesen: Kirkebö, 1000 feet). Norway (Warming, Kindberg: Tromsö, West Finmark, Dovre). Sweden (Bohlin: Härjedal; Forssell: Saltdal).

A herb of the *Primula*-type. It has a short (one to a few cm. long) rhizome, vertical or slightly oblique (Fig. 31 *A*, *B*, *F*). This dies away gradually at its lower end, so that vegetative propagation takes place by the lateral shoots becoming independent. The rhizome lives scarcely more than 2—3 years; the adventitious roots are slender and numerous. The primary root can live at least 2 years, and is found even on flowering specimens (Lindmark). The length, branching, etc. of the rhizome varies according to the diverse habitats (cf. Lindmark).

The foliage-leaves are in a rosette, but are fairly erect (Figs. 31, 32). Where the rhizome grows between moss, the internodes are elongated. Scale-leaves are absent. The shoots may remain one or several years in a vegetative stage, before they terminate in an inflorescence.

During winter, fresh foliage-leaves may be met with, but they wither quickly during the second year. According to

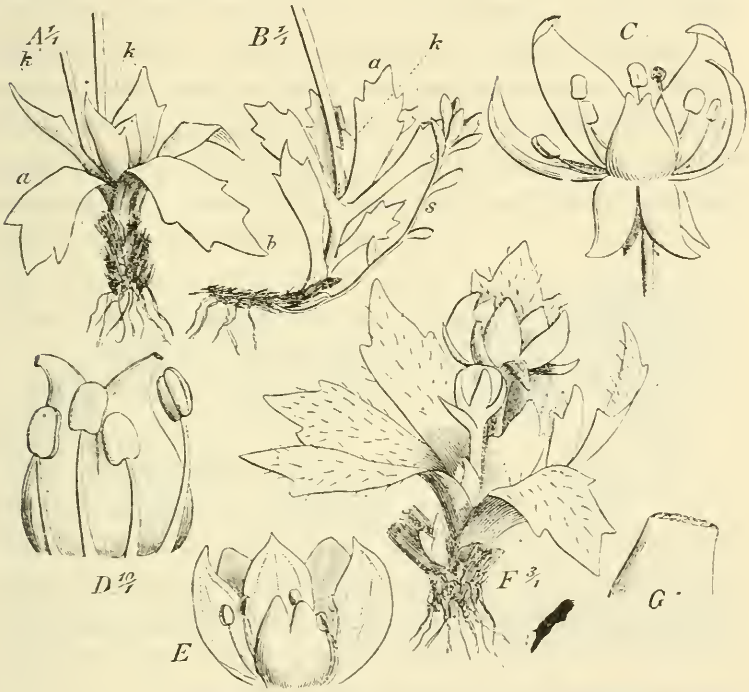

Fig. 31. *Saxifraga stellaris* L.
A, Basal portion of a plant from Sukkertoppen (Aug. 16, 1884); *k′* is the shoot axillary to the uppermost foliage-leaf *a*; it bears an inflorescence and one foliage-leaf; *k″* is the shoot axillary to the leaf *b*, which is next below; it is the principal shoot, i. e. next year's rejuvenating shoot. *B*, The principal shoot is sublended by *a*, its first leaves are indicated by *k*; *s* is a runner. *C*, Protandrous flower from Alten. *D*, Pistil and anthers of a protogynous flower from Åreskutan. *E*, Protandrous flower, with short stamens and erect petals (from a wet ravine at Nenese, East Greenland; Sept. 4, 1884; P. Eberlin). *F*, forma *acaulis* from Åreskutan (July 25, 1884; leg. O. Juel). *G*, Apex of style with stigma. (E. W., 1886.)

Lindmark the plant, especially in the higher regions of Scandinavia, turns more or less red in colour.

The branching. The rhizome may branch fairly freely, so that a dense tuft is formed. The most vigorous shoot occurs in the axil of the uppermost leaf of the rosette; or, in case an inflorescence is developed in this, then in the axil of the leaf which is the next below (see Fig. 31 *A*, *B*); its leaves expand even during the flowering-period of the parent shoot. A few other shoots, usually 1—2, are developed in basipetal succession from the axils of the two next lower leaves of the rosette.

On older rhizomes, according to Lindmark, small buds occur which do not develop. All the branches begin with foliage-leaves, but when the plant grows in moss these become small and less perfect (Fig. 31 *B* at *s*). Small runners may occur (Fig. 31 *B*); they bear very small, entire leaves, and appear to be developed only under certain conditions, viz. in deep damp moss. The time for their flowering depends on the prevailing conditions (Lindmark).

Fig. 32. *Saxifraga stellaris* f. *acaulis*. From Strömö (the Færöes), at 1000 feet above sea-level; about $^2/_1$. (June; leg. F. Börgesen).

The germination of the seed, and the seedlings have been described and figured by Lindmark. During the year in which germination takes place a leafy shoot with rather short internodes is developed which, like all the other shoots, passes the winter with its buds open. The seeds do not germinate until the year after they ripen.

The inflorescence is terminal on a long leafless peduncle. The uppermost lateral shoot sometimes flowers simultaneously with the parent shoot, and with or without a rosette of foliage-leaves (Fig. 31 *A*). In unfavourable localities the inflorescence remains sessile among the leaves of the rosette (f. *acaulis*; Fig. 31 *F*, Fig. 32).

Saxifraga stellaris f. *comosa* Retz. In the regions of the extreme north, a form *comosa* occurs, upon which only the terminal flower, or at most only a few normal flowers, are fully developed, and instead of flowers bulbils occur, far more abundantly, indeed, than do the flowers on the principal form (Fig. 33 A). The bulbils consist of small, green, close-set rosettes of leaves which are lateral shoots of the 1st and 2nd order, the branches terminating either blindly or in a rudimentary flower. The bulbils are borne in the axils of the bracts. In the axils of the rosettes, other small rosettes are developed (axes of 2nd and perhaps higher order) so that the bulbils become compound shoots (see TH. HOLM: Pl. X, Fig. 5; and my figure 33).

In 1886 I expressed doubt as to how far they fell off and germinated; but that they do this has since been recorded by ANDERSSON and HESSELMAN, according to whom, in Spitzbergen, they begin to fall in August; by LINDMARK, who has given good

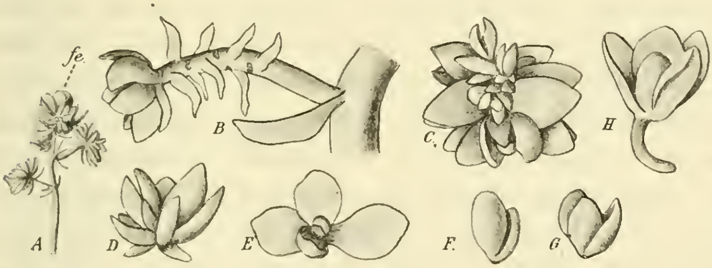

Fig 33. *Saxifraga stellaris* f. *comosa*.
A, A branch of an inflorescence; *fe*, the terminal flower (mag. 1½). *B*, A bulbil; most of its lateral shoots have fallen off. *C*, *D*, Bulbils; the leaves are seen to be partially opposite, the leaf-pairs representing the first leaves of shoots .*E*, A young bulbil, the leaves have been spread out. *F*, *G*, Small detached bulbils. *H*, A germinating bulbil. (E. W.)

figures of germinating specimens; and by EKSTAM and KERNER; it has also been observed by PORSILD, who like LINDMARK found them even developing roots while they where still seated upon the parent plant (June 30, 1892); Fig. 33 *H*. These bulbils had lived through the winter in a fresh green condition.

All the observations indicate that this form is an adaptation to the extreme Arctic climate. LINDMARK even writes: "there, where the principal form ends, *comosa* begins." In the regions of the far north (Spitzbergen and northernmost Greenland) it is the only form met with, or the most common; but the further we proceed southwards, the more common is the flower-bearing form; and in central Scandinavia, and in the Alps, that is the only one which occurs, or at least, the most common.

The flowers are 6—9 mm. in diameter. Scent appears to be absent, but honey is secreted by the base of the entirely superior ovary, which I found to be greenish in Greenland, while according to H. Müller it is "purple-coloured" in the Alps. The honey is quite unprotected.

The petals are ovate-lanceolate with short claws, pointed at the apex, white or slightly yellowish-white in colour, with two decidedly greenish-yellow, or ultimately pure yellow, spots at the base. At first the petals are rather erect (Fig. 31 *E*, *F*), then they expand in a more stellate manner, while the sepals are turned right back (Fig. 31 *C*). I, also, observed the want of symmetry in colouration mentioned by H. Müller and Lindman, but did not find it so strongly marked. The anthers are usually of a red colour, which may be called decidedly yellowish-red, or by others purple-red, carmine-red, or minium-red.

Protandry. I found the flowers to be distinctly protandrous (in Norway), and this has also been recorded by others (Lindman, Ekstam (Nova Zembla), Lindmark, H. Müller, Günthart). Günthart states that the anthers usually begin to open even in the bud; according to him, protandrous flowers become afterwards homogamous, so that self-pollination becomes possible, and often takes place at the end of the flowering period. The stigmas are remarkably inconspicuous; they are neither of the very common form, with large papillæ; nor are they smooth and glistening, as in *S. nivalis*, and *S. hieraciifolia*. At first, the apices of the carpels are gently rounded and quite smooth (Fig. 31 *C*, *E*); when the stigmas are fully developed, a small, rough, somewhat glistening flat surface covered with small papillæ (Fig. 31 *G*) may be seen at each apex. The carpels are sometimes quite open, if viewed from the ventral side.

Homogamy. The flowers were found to be almost homogamous in Scandinavia also (LINDMAN, EKSTAM), with possibilities of self-pollination.

Protogyny. A flower gathered by JUEL in Sweden (Åreskutan; July 25) appeared to be protogynous (Fig. 31 *F*). The stigmas were distinctly ripe, but all the anthers were closed (Fig. 31 *D*); the same was the case with specimens from Hærjedalen (Sweden).

Regarding the specimens from Greenland, I have no notes on living specimens, but the flowers appear to agree closely with those from the north of Norway, and to be protandrous like them. The one from East Greenland, shown in Fig. 31 *E*, is evidently decidedly protandrous; all the anthers were open except one, and the stigmas were unripe; but otherwise it appears to differ somewhat, in its shorter stamens and small pollen-grains, which seem, however, to be quite normal. The petals were only slightly longer than the sepals, but the flower is evidently still very young.

Other specimens from the east coast of Greenland (gathered by EBERLIN) appeared to be either homogamous or protogynous. Self-pollination must be able to take place, as the anthers were lying across the stigmas.

A forma *cryptopetala*, with petals smaller than the sepals, making the flowers very inconspicuous, and scarcely to be distinguished from the leaf-rosettes, is mentioned by ABROMEIT.

Pistillate flowers occur in East Greenland. In a specimen (gathered by EBERLIN, Aug. 11, 1883) the antisepalous stamens were quite transparent and empty, while the pollen-grains in the antipetalous stamens were shrunken and abnormal.

A trimerous pistil often occurs in the terminal flower of the inflorescence (Greenland and Scandinavia), and this flower may sometimes be 6—7- or 8-merous instead of 5-merous.

Fruit is set in West, South and East (Angmassalik) Greenland, in Scandinavia, Iceland (where it ripens), the Færöes, and in Arctic America (King William's Land).

Saxifraga tricuspidata Retz.

Lange, Conspectus, p. 63. Rosenvinge, 1892, p. 679. Warming, 1886, p. 22, fig. 26. Abromeit, 1899, p. 35, pl. V, fig. 3. Günthart, 1902, p. 75. Simmons, 1906, p. 66.

Material in alcohol, and observations on living plants from West Greenland (Godhavn, Godthaab, Upernivik and Holstensborg) by Rosenvinge, Warming, Th. Holm and C. Ryder.

This plant has a tendency to become a sub-shrub. The ascending stems may attain a length of as much as 15—20 cm.

Fig. 34. *Saxifraga tricuspidata.*
A, From Upernivik (May 10, 1887; C. Ryder), from a spot bare of snow (about nat. size); *i*, *i*, two old inflorescences. *B*, From West Greenland (July 11, 1884); *i*, floral stem. *HK*, the principal bud; F^1, its subtending leaf; F^2, the leaf below it, with its axillary shoot K^2. *II*, *II*, two older lateral shoots (slightly reduced). *C*, Leaf, mag.
(Drawn by E. W., 1908.)

They grow in loose tufts, which no doubt in most cases have only one strong root, the primary root. The adventitious roots are weak and few in number; tufts, however, are sometimes met with which by centrifugal growth, as in certain lichens, become dead in the middle, while the periphery keeps on growing in a circular or semi-circular form; in this case it is no doubt only the numerous, slender, adventitious roots, which nourish the plant.

The vegetative shoots bear only foliage-leaves, which are often more or less dark-red in colour. Scale-leaves are absent, but the branches bear, at first, entire foliage-leaves, and only higher up do the characteristic three points appear on the leaves (Fig. 34 C). In West Greenland, Vanhöffen found a form *subintegrifolia* Abrom. (l. c. Pl. V, Fig. 3) of which almost all the leaves were entire.

The leaves are seated very closely together upon a long, slender stem; sometimes a shoot is developed which has longer internodes.

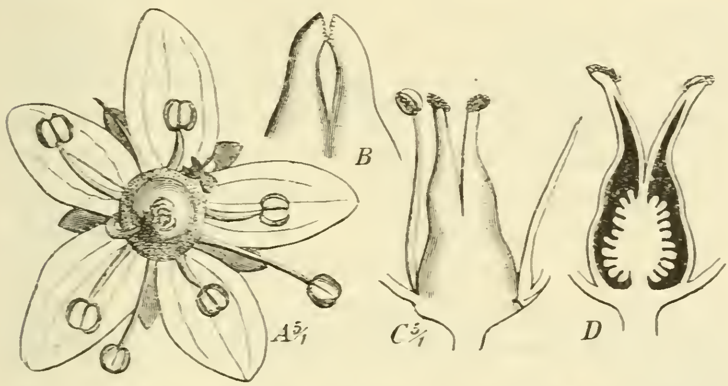

Fig. 35. *Saxifraga tricuspidata.* (From Holstensborg in West Greenland.) *A*, A flower in its first stage of development; two antisepalous stamens are bending over the middle of the flower, and have their anthers open; the stigmas are in the same stage of development as those shown in Fig. *B*. *C*, From a flower, the stigmas of which are functional; there is already pollen upon them. *D*, Longitudinal section of pistil at a somewhat later stage of its development. (E. W., 1886.)

The leaves remain green throughout one winter, but stay upon the branches a long time after death, colourless or black (Fig. 34 *A*, *B*). During winter (May 10, 1887), at Upernivik, in places bare of snow, judging from the material gathered by C. Ryder, the leaves are more erect (Fig. 34 *A*); during summer they are more spreading, and at that time the young leaves pass gradually into the old ones; often also the young leaves are red-coloured, as are those that have outlived the winter.

The branching. Below the terminal inflorescence one to three new shoots are developed in the upper leaf-axils, but not always in the three uppermost; the uppermost shoot is the most vigorous, the others are weaker in basipetal succession (Fig. 34 *B*).

The shoots may pass several years in a purely vegetative condition before flowering begins.

The flowers and the inflorescences droop before opening (Fig. 36 *A*), but are erect during expansion. The diameter of the flower is 9—11 mm.

The petals spread out in a stellate manner (Fig. 35, 36 *B*); they are oval and have three veins (Fig. 36 *D*). The colour is evidently rather variable. I have noted and figured them as pale yellow, or whitish yellow with many small reddish-yellow spots which are darker the closer they occur towards the apex, where they may become almost purple. But other observations have also been recorded (cf. Abromeit). According to Vanhöffen there are two varieties, characterised by their different colour; the more common is white-flowered, with yellow or purple dots on the petals, which are long; the other, which is smaller, has distinctly yellow flowers with a few yellow, or more rarely red, dots.

Honey is secreted abundantly by the thick yellow base of the ovary (Fig. 35 *A*). It occurs in numerous small drops, even before the anthers open, and the secretion is continued for a very long time, even in old flowers. Scent was not noticed by me. Insect-visitors I did not observe.

Protandry occurs, but often not to any marked degree, and sooner or later homogamy usually ensues. The stamens perform the ordinary movements; first the antisepalous stamens bend forwards (Fig. 35 *A*), then the antipetalous; both kinds of anthers may be found simultaneously in the middle of the flower above the still unripe stigmas. Then they bend outwards, even if all the pollen-grains have not been shed. The styles bend outwards and the stigmas usually ripen before all the antisepalous anthers have opened. Homogamy lasts throughout the greater part of the life of the flower. In cultivated specimens in Switzerland, GUNTHART observed the same order of development: autogamy always ultimately set in.

Self-pollination appears to take place. In Fig. 35 *C* the styles are somewhat spreading and the stigmas ripe; 1—2 antipetalous stamens were still erect and had their anthers close to the stigmas. None of the flowers with well developed stigmas and far-spreading styles (Fig. 35 *D*) had their anthers close to the stigmas.

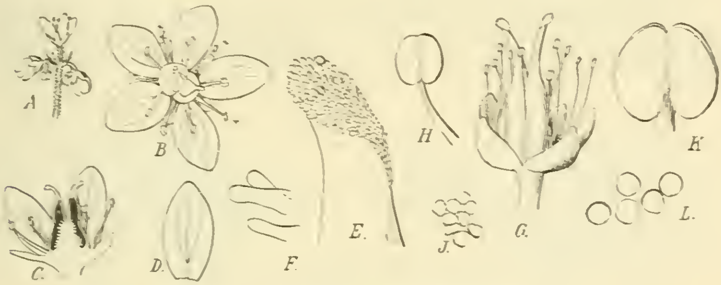

Fig. 36. *Saxifraga tricuspidata.*

A, Inflorescence; somewhat reduced. *B*, Small flower (about $^3/_1$) from West Greenland (Aug. 5, 1884); the anthers of three of the stamens are open. *C*, The same in longitudinal section. *D*, Petal of the same. *E, F*, Style and stigmatic papillæ of the same. *G*, A pistillate flower from West Greenland. *H, J*, Stamen and pollen-grains of the same. *K, L*, Stamen and pollen-grains of a hermaphrodite flower, magnified as *H* and *J*. Drawn by E. W., 1908.

Fruit usually ripens in West Greenland. PARRY gathered ripe fruit even at Duke of York Bay.

Forma *micrantha* Sternb. Pistillate flowers. A small-flowered form approaching this, was found at Holstensborg (July 13). Another (Aug. 5) is shown in Fig. 36 *B—F*. The stamens are unusually short, and the anthers very small. Three of the anthers (marked ×) were open and appeared to be normal. The stigmas were normal and one pollen-grain occurred upon them.

The form shown in Fig. 36 *B—F* appeared to be on the point of becoming pistillate. This is more decidedly the case with the form shown in Fig. 36 *G—J*, the anthers of which were unusually small, not open, and filled with angular, and evidently not normal, pollen; for comparison, the anther and pollen of an ordinary hermaphrodite flower has been figured (Fig. 36 *K*, *L*), with the same magnification. Also GÜNTHART found specimens "with extremely small stamens."

I found trimerous pistils in some terminal flowers.

Chrysosplenium alternifolium L. et var. **tetrandrum** Lund.

WARMING, 1886 b, 3. LINDMAN, p. 56. EKSTAM, 1897 a, p. 135. ANDERSSON and HESSELMAN, p. 31. SIMMONS, p. 59. SILÉN, p. 125. SYLVÉN, p. 233, pl. II.

KNUTH, 1898, pp. 453, 455.

Chrysosplenium alternifolium L. var. *tetrandrum* Lund was established in 1846 by N. LUND in Norway. TH. FRIES (1858)

Fig. 37. *Chrysosplenium alternifolium* var. *tetrandrum*.
A, A runner terminating in a flowering shoot; about nat. size (Spitzbergen; June 25, 1882; NATHORST). *B*, A leaf from the same plant (mag.). *C*, Basal leaf from a cultivated specimen mag.). *D*, Leaf from one of the lower branches of an inflorescence; the venation, on the whole, resembles that of several of the *Saxifragae* (see Fig. 29). (Drawn by E. W.; 1908.)

regards it as a distinct species, *Ch. tetrandrum*. According to SIMMONS it is connected with the principal form by intermediate forms, and he agrees with FRANCHET in considering it a variety (Monographie du genre Chrysoplenium, Nouv. Archives du Museum, Ser. 3, X, 1890, p. 107). It should be regarded as a smaller and self-pollinating form of *C. alternifolium*, adapted to Arctic conditions of life.

The material I have had for examination was partly spirit-material from Spitzbergen, gathered by NATHORST, and partly living specimens, which I observed in the Hortus Bergianus (Stockholm).

The rhizome is creeping and has many adventitious roots which are arranged without order upon the internodes (Fig. 37 A). It branches, and produces runners which bear scale-leaves. The runners proceed principally from the base of the ascending stem. The reason why it remains more tufted and crowded than does *C. alternifolium* in temperate climates, should probably be sought in the fact that its runners are generally shorter than are those in our plants.

The rosette-leaves are long-stalked foliage-leaves (Fig. 37). From the axils of these also, runners are given off. Vegetative propagation takes place by the runners becoming independent.

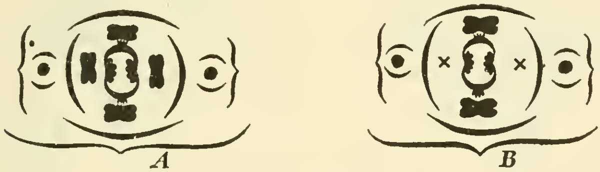

Fig. 38. *Chrysosplenium alternifolium* var. *tetrandrum*.
Diagrams of a complete (*A*) and of a diandrous flower (*B*) with the adjacent parts of the inflorescence (nat. size). (E. W., 1886.)

In the diagram of the flower shown in Fig. 38, the different parts are seen arranged in 5 alternating pairs. The two lateral stamens are often aborted (Fig. 38 *B*), in which case they become smaller than the normal ones, and their anthers differ in form and may be quite transparent and pale (Fig. 39 *E*, *F*). In a more closely-investigated specimen it was observed that the pollen-forming cell-layer had begun to extend itself, but had stopped, even before the primary mother-cells of the pollen were developed (Fig. 39 *G*).

In the spirit-material which I have had for examination, the perianth-leaves were not spreading, but erect (Fig. 39 *A*—*C*); in the principal form, from Denmark, they are spreading, as shown in Fig. 40. The diameter of the flower is consequently greater in the latter form.

Also the inflorescence in the var. *tetrandrum* comprises fewer flowers.

Colour. Th. Fries states that the perianth-leaves are yellowish-green with brown dots. I found cultivated specimens (Hortus Bergianus) in which they were greenish. Scent is absent.

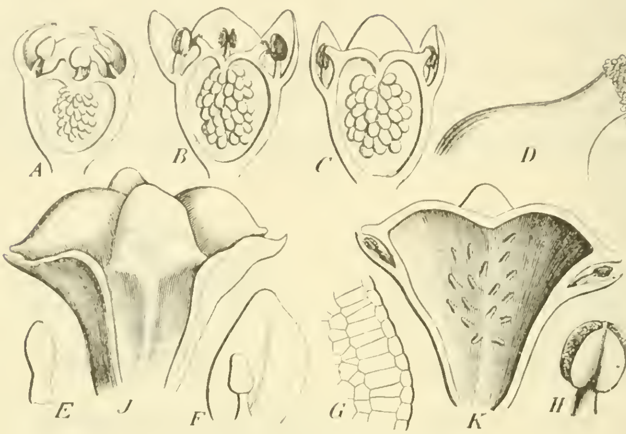

Fig. 39. *Chrysoplenium alternifolium* var. *tetrandrum*.
A, *J*, *K*, from cultivated specimens. *A*, Longitudinal section of a flower which is still almost a bud; the anthers are closed; the styles are short erect cones. *B*, Longitudinal section of a young, but fully expanded flower; the stigmas are partially in contact with the anthers which are shedding quantities of pollen upon them (*D* is from this same flower). *C*, A fertilised flower; the fruit- and seed-setting have begun; the free parts of the carpels are rising higher into the air, and the perianth-leaves are more closed. *D*, Style from *B* (more highly mag.); upon the stigmas are seen numerous pollen-grains. *E*, *F*, Sterile anthers, the latter in connection with its perianth-leaf. *G*, Longitudinal section through a sterile anther. *H*, Normal anther (magnified as *E* and *F*). *J*, Fruit, not yet quite ripe. *K*, Longitudinal section of a similar fruit; the seeds have been removed, but the funicles only partially. (E. W., 1886.)

The large yellow honey-secreting area of the principal form is no doubt entirely wanting from var. *tetrandrum*. If honey is secreted it must be in a small quantity only. All these things result in the flowers being far less conspicuous than are those of the principal form. In younger flowers, the free part of the carpels in the middle of the flower is very slight, but as the flower grows older it becomes larger, the styles bending outwards (Fig. 39 *C*, *J*, *K*).

Homogamy is the rule; perhaps slight protandry may occur, as the anthers sometimes appear to open before the stigmas are ripe. Self-pollination is no doubt inevitable and very common; it takes place by the stamens being always somewhat bent inwards or erect (Fig. 39 *A—C*); and as the styles very soon bend outwards the stigmas come into direct contact with the anthers of the two outermost stamens. I have found so many pollen-grains upon the stigmas (Fig. 39 *D*), that this must be due to self-pollination. In Danish specimens of the principal form the styles are not so decidedly bent outwards, and I never observed the stigmas to be in direct contact with the anthers; also, this would be difficult, owing to the length and position of the different parts (Fig. 40).

Fig. 40. *Chrysoplenium alternifolium.* Flower in longitudinal section; the ovules have been omitted. (E. W.; 1886.)

Homogamy was observed in the principal form, in Scandinavia by Lindman, and in Germany by H. Müller and Knuth. Near Kiel, Knuth found only homogamous flowers, and they were visited, for their honey, by many flies, which effect cross-pollination, but may also effect self-pollination; this latter may also be effected by other means.

Protogynous-homogamous flowers were found by Ekstam in Nova Zembla. Protandrous-homogamous flowers were also recorded from there by Ekstam.

Fruit-setting. Judging from the material at hand, fruit-setting in v. *tetrandrum* appears to take place so invariably that no doubt every flower sets fruit and bears quantities of seed, which, on account of the prevailing circumstances, we cannot doubt is due to self-pollination. Insect-visitors have not been recorded. The carpels have brown dots. The fruit is said to open before the seeds are entirely ripe.

On account of the styles being directed towards the two outer (median) stamens, it is these only, which will be instrumental in effecting pollination. The two lateral stamens will scarcely ever come into contact with the stigmas; they become useless organs, which may, perhaps, be connected with the fact that they sometimes become rudimentary.

Chrysosplenium alternifolium v. *tetrandrum* is the most reduced type among the *Saxifragaceæ*; here, as in other instances, there is correlation between this and the small size of the flower.

Summary.

As the more general results of the investigations given in detail above, the following points may be mentioned.

I. Structure of stem. The species belong to several growth-forms, viz. the following: —

A. To the *Primula*-type belong: *S. hieraciifolia*, *S. nivalis* and *S. stellaris*. They have, as is the case in many species of *Primula*, a vertical, sympodial rhizome, with leaves in a rosette. The primary root dies early, and numerous adventitious roots are developed. The inflorescence is borne upon a leafless peduncle. The age and length of the rhizome here, as in other instances, is evidently dependent upon the dampness of the soil; the damper it is, the quicker does the rhizome die away at the hinder end. The rejuvenating shoots occur in the axils of the upper leaves of the rosette, the most vigorous in the axil of the uppermost leaf, while the others are weaker the farther down they occur. Sometimes, in the axil of the uppermost foliage-leaf, a lateral, floral shoot is developed even in the year the parent shoot flowers; this relegates the uppermost rejuvenating shoot to the axil of the leaf next below.

B. Nearest to this type come: *S. cernua, S. rivularis, S. Hirculus*, and *Chrysosplenium*. Here, also, are developed vertical rhizomes with foliage-leaves in a rosette, but the *Primula*-type is less pronounced, and is combined with the development of bulbils or of runners with scale-leaves or imperfect foliage-leaves, and adventitious roots.

C. To the *Sempervivum*-type belong: *S. Aizoon* and *S. flagellaris*. The principal stem is vertical and bears a close rosette of foliage-leaves; it has many adventitious roots and dies away entirely after flowering. Lateral shoots arise from the leaf-axils in no fixed order, they run more or less horizontally along the ground for some distance and terminate in a new rosette. In *S. flagellaris* the runner is very slender and consists of a single internode; in *S. Aizoon* it is short and includes several internodes.

D. Species with "rhizoma multiceps," a many-headed rhizome, are: *S. groenlandica* and *S. tricuspidata*. Their primary root remains alive a long time, which should probably be correlated with the dry localities in which they grow (crevices of rocks and bare stony ground in fell-fields). The adventitious roots, which are few in number, are usually of little importance; vegetative propagation, by the lateral shoots becoming independent, therefore takes place either rarely or not at all. The principal rejuvenating shoot is usually developed in the axil of the uppermost leaf, and other lateral shoots occur in basipetal succession. The first foliage-leaves of the lateral shoots may become so fully developed, even during the flowering of the parent shoot, that most of the foliage-leaves of the shoot-complex consist of them.

E. To the *creeping-herb*-type belong: *S. oppositifolia* and *S. aizoides*. The shoots are prostrate, and have their internodes more or less elongated. There is no regularity as regards the situation of their branches; no principal rejuvenating bud occurs. The primary root appears to be able to live several — perhaps many — years, especially in *S. oppositifolia*; in *S. aizoides* it undoubtedly dies more quickly, in the course of a few years; this feature should probably be connected with the greater dampness of the habitat. In both species adventitious roots occur, and vegetative propagation takes place by the shoots becoming independent. *S. oppositifolia* has a tendency to become a sub-shrub, as its stems become more woody than do those of *S. aizoides*.

II. The leaves of the vegetative shoots are in all the species foliage-leaves. Buds, protected by true scale-leaves, do not occur. Only in those species which have bulbils and runners, do scale-leaves occur. Sometimes several, sometimes a few, leaves remain alive and green (or reddish) during winter; the following species have been noted as evergreen: — *S. aizoides*, *Aizoon*, *cernua*, *groenlandica*, *Hirculus*, *hieraciifolia*, *nivalis*, *oppositifolia*, *stellaris*, and *tricuspidata*. But they are not evergreen to the same extent, and this is probably also dependent in part on the nature of the locality.

The old, dead leaves persist for a long time upon the stems of some of the species, especially upon those which belong to the driest habitats (e. g. *S. tricuspidata*, *S. groenlandica*, *S. oppositifolia*, and *S. Aizoon*).

III. The flowers are developed the year previous to that in which they open, in perhaps all the species. This has been observed in the following: — *S. groenlandica*, *S. hieraciifolia*, *S. nivalis*, *S. oppositifolia*, and *S. rivularis*.

They are so fully developed that both stamens and pistils are distinctly formed, but pollen is scarcely formed, nor are the ovules developed. *S. oppositifolia* is the most developed.

There is undoubtedly a causal connection between this and the fact that the vegetation-period of the plants is so short in Arctic countries: the flowering of the plants must as a natural consequence be placed in early spring to enable the seeds to get sufficient warmth to ripen.

IV. Staminate flowers occur rarely (*S. oppositifolia*), but pistillate flowers appear to be common in a great many species, e. g., in *S. aizoides*, *cernua*, *groenlandica*, *Hirculus*, *nivalis*, *oppositifolia*, *rivularis*, *stellaris*, and *tricuspidata*. I also observed them in cultivated specimens (Hortus Hafniensis) of *S. groenlandica*, *S. Cymbalaria*, *S. Rocheliana*, *S. moschata* var. *glandulosa* and, to all appearance, in *S. cotyledon*. The pistillate flowers are smaller than the hermaphrodite ones; stamens are always present, but are smaller than usual, the anthers especially being small; pollen-grains are sometimes developed, but smaller than usual, and imperfect. In some cases the anthers dehisce, in others they do not. It appears especially to be the terminal flower in the inflorescence which thus develops.

In some species, deformed flowers with small petals have been observed — in systematic works named "*cryptopetala*" — e. g. in *S. cernua*, *S. groenlandica*, and *S. stellaris*. In some cases the petals at the same time that they were becoming small, were in the act of developing anthers at their apices.

Other numbers in the flowers than the normal five with two carpels have been observed; for instance, 6 and 7-merous flowers in *S. cernua*. It is especially the terminal flower in the inflorescence which shows a tendency to increase in the number of the carpels (probably because that flower is better nourished and therefore becomes larger and has room for a greater number of carpels). Thus, trimerous pistils have been found in *S. aizoides*, *groenlandica*, *hieraciifolia*, *stellaris*, and *tricuspidata*, 4- and 5-merous in *S. oppositifolia*. The terminal flower in the inflorescence may also be seen to differ in another point from the other flowers, viz. in the fact of its being far in advance of the others in regard to development, e. g. in *S. Aizoon*, and among cultivated species, in *S. geranioides* and *rotundifolia*. In *S. Geum* I found the pistil of the terminal flower to be formed somewhat differently from those of the other flowers, and in *S. cernua* the terminal flower is often the only one which is developed.

Irregular flowers occur in *S. cernua*, *S. oppositifolia* and *S. rivularis*.

V. Pollination. The flowers have colour, and honey is secreted by the base of the pistil; in some instances scent has been noted. Insect-visitors have been observed in several of the species in Spitzbergen and Nova Zembla, especially by Ekstam, and in the mountain regions of Northern Europe by Lindman, Silén, Skottsberg and Sylvén.

Protandry is so common in the genus *Saxifraga* that Engler (Bot. Zeitung, 1868, and in his "Monographie der Gattung Saxifraga") even gives it as a generic character; that is also one of the reasons why he refers *S. crassifolia* and other protogynous species to the genus *Bergenia*. The nine species of *Saxifraga* mentioned by H. Müller in "Alpenblumen" are also nearly all decidedly protandrous, some protogynous species are however mentioned (*S. muscoides*, *S. androsacea*, *S. Sequieri*), and one, viz. *S. oppositifolia*, oscillates between slight protogyny, slight protandry, and homogamy. To these Müller afterwards added *S. tridactylites* as protogynous, while Sprengel found it to be protandrous.

The above-mentioned Arctic species give further proof that protandry is not a generic character; true, it occurs most commonly, but, firstly, it appears usually to be somewhat slighter — at least than it is in many cultivated species which I have observed in the Hortus Hafniensis, almost all of which were decidedly protandrous; usually, they become very soon homogamous: I have observed protandry in *S. aizoides*, *Aizoon*, *cernua*, *groenlandica*, *hieraciifolia*, *Hirculus*, *nivalis*, *rivularis*, *stellaris* and *tricuspidata*, as also in *Crysosplenium*. Secondly, the same species often varies, being either protandrous-homogamous, or homogamous from the first. *S. groenlandica*, *hieraciifolia*, *nivalis*, *rivularis*, *stellaris*, *tricuspidata* and *Chryso-*

splenium are homogamous or oscillate around homogamy; it is especially the small-flowered species, which are homogamous.

Protogyny occurs in *S. cernua*, *groenlandica*, *hieraciifolia*, *nivalis*, and *stellaris*, but usually slightly Most distinctly and decidedly protogynous is *S. oppositifolia*.

I may add that Asa Gray ("Notes on some North American Species of Saxifraga," in Proceedings of the American Academy, XX) states that most of the individuals of *S. peltata* have protandrous flowers; but that it is not rare to find some which are truly protogynous, and that the species shows a decided tendency to become gynomonoecious. In the Hortus hafniensis *S. peltata* is seen to be protogynous. Regarding *S. granulata*, Gaston Bonnier says: "On peut voir chez ce Saxifraga des fleurs presque mâles, des fleurs presque femelles, et en outre tous les intermediares." (Bulletin de la Soc. botan. de France, VI, 1884, p. 240).

The staminal movements are those usual in the *Saxifraga* (see, e. g. p. 174).

Self-pollination is evidently very common. The small-flowered species are all more or less distinctly self-pollinating. Among the larger-flowered, several are evidently distinctly self-pollinating, if not in the first stage of the flower, then somewhat later. In the Botanic Garden of the University of Copenhagen *S. groenlandica* is more distinctly protandrous than in Greenland; it is true that, in the latter place it is also decidedly protandrous, but there the flower soon becomes homogamous and self-pollinating. The possibility of self-pollination will most probably always ultimately occur by the flower becoming homogamous, and stigma and anthers approaching and possibly touching each other, e.g. in *S. Aizoon*, *cernua*, *flagellaris*, *groenlandica*, *hieraciifolia*, *nivalis*, *oppositifolia* and *Chrysosplenium*.

VI. Fruit-setting and seed-formation is common in many species everywhere in the Arctic countries, and rare or even very rare in other species; the latter fact is distinctly in causal relationship to their abundant vegetative propagation. In the species in which this is very scarce — therefore, especially in the species belonging to the types D and E, but also in those of the types C and A — the seed ripens, although perhaps not every year in every locality; this therefore occurs especially in the following species: — S. *groenlandica*, *tricuspidata*, *oppositifolia* and *hieraciifolia*, but also in *aizoides*, *Aizoon*, *Hirculus*, *flagellaris* and *nivalis*. The species which either do not set seed at all or do so rarely, are those which by bulbils or similar means have an abundant vegetative propagation; therefore especially *S. cernua*, *rivularis* and *stellaris* f. *comosa*. The most interesting species in this connection is *S. stellaris* with its form *comosa* (see above pp. 218—220). For the rest, how abundant and common fruit-setting is, e. g. in *S. flagellaris*, *S. Hirculus*, and other species, requires to be more fully investigated.

9.—9.—1909.

Arbejder fra den Botaniske Have i København. Nr. 51.

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 1

SÆRTRYK AF »MEDDELELSER OM GRØNLAND« XLIII

LIST OF VASCULAR PLANTS

FROM

NORTH-EAST GREENLAND

(N. OF 76° N. LAT.)

COLLECTED BY THE DANMARK-EXPEDITION

BY

C. H. OSTENFELD AND ANDR. LUNDAGER

WITH PL. I—VI

KØBENHAVN

BIANCO LUNOS BOGTRYKKERI

1910

INTRODUCTION.

The flora of East Greenland north of 76° N. Lat. has hitherto been very little known. The only paper dealing with the flora of that part of Greenland is a short list, compiled by one of us, of the few plants gathered by Mr. E. Koefoed during the Oceanographic Expedition of the Duke of Orleans in 1905 (see the list of literature, p. 5).

On the other hand, the flora of the north of East Greenland, south of 76° N. Lat., is well known through the researches of Scoresby, jun., E. Sabine, Clavering and Pansch, N. Hartz, A. G. Nathorst, P. Dusén, C. Kruuse, etc. Mr. C. Kruuse has compiled a list of all the data concerning the flora of East Greenland between 75° and 66° 20′ N. Lat., and in this paper that list will be quoted under each species, provided that the species occurs therein.

On comparing our list with that of Kruuse it appears that only one species is quite new to the flora of East Greenland, viz. *Alsine Rossii*, which is new to the flora of the whole of Greenland. Another species, *Draba subcapitata* Simm., has not previously been recorded from East Greenland, but specimens of it are contained in Kruuse's collection under other names.

Our list contains 92 species, which is a rather poor number, but several more species will undoubtedly be found by further investigations.

The material collected originates mostly from the district around Danmarks Havn (Harbour), 76° 46′ N. Lat. and 18° 43′ W. Long., on Germania Land. The area thoroughly investigated extends from 76° 43′ N. Lat. to 77° N. Lat. and from 17° 30′ W. Long. to 21° W. Long. From outside this area small collections have been brought home from different points along the coast northwards to Hyde Fjord on Peary Land and from some places more landward, especially from Ymers Nunatak in the land-ice.

The greater part of the material has been collected by one of the authors, A. Lundager, but we are indebted to the sledge-expedition of Captain J. P. Koch in the spring of 1907 for the few plants (19 species) collected along the coast northwards, to another sledge expedition over the land-ice for the species (26) from Ymers Nunatak and Kulhøj, and to different members of the expedition for scattered specimens from different places, e. g. to Mr. P. Freuchen for *Pedicularis flammea* and *Carex incurva* from Rypefjeld.

The collecting places, arranged from north to south, are given under each species: —

Peary Land, Fr. Hyde Fjord ...	83° 15′ N. Lat.	
Mallemukfjeld	80° 10′ - -	
Lamberts Land	79° 8′ - -	
Bjørneskær	ca. 77° 30′ - -	
Cape St. Jacques	77° 36′ - -	18° 05′ W. Long.
Cape Amélie	77° 32′ - -	19° 15′ - -
Cape Marie Valdemar	ca. 77° 20′ - -	18° 50′ - -
Ymers Nunatak	77° 24′ - -	24° - -
Germania Land: —[1]		
Kulhøj, Valley between Annexsø and Sælsø, Fuglenæbsfjeld, Rypefjeld, Bastionen, Hvalrosodde, Dove Bugt, Moskusoksefjelde, Lille Snenæs, Snenæs, Stormkap, Harefjeld, Danmarks Havn, Basiskær, Termometerfjeld, Cape Bismarck	Between 77° — 76° 43′ N. Lat. and 21° — 17° 30′ W. Long.	
Maroussia Island	76° 39′ N. Lat.	18° 43′ W. Long.
St. Koldewey Island	ca. 76° 30′ - -	18° 50′ - -

The three places whence Mr. Koefoed of the Duke of Orleans Expedition brought plants home are Cape St. Jacques (Ile de France), Cape Bismarck and Maroussia Island; they are inserted in the list

[1] The localities given here have been arranged from NW. to SE.

of localities above, and in the enumeration they are mentioned under the species recorded in the list of Mr. Koefoed's plants.

We have divided the work between us in the following manner: Mr. A. Lundager undertook the provisional determination of most of the plants, and has added the localities, the time of flowering and the other biological notes. Dr. C. H. Ostenfeld has finally determined the whole material and is responsible for the correctness of the determination, has written the synonymy, and has added the systematical notes.

The dates concerning the time of flowering indicate the first time a species was observed in flower during the years 1907 and 1908.

List of papers dealing with the Vascular Plants of northern East Greenland.

1. Buchenau, F. u. Focke, W. O.: Gefässpflanzen, in Zweite Deutsche Nordpolfahrt, II. 1872.
2. Dusén, P.: Zur Kenntniss der Gefässpflanzen Östgrönlands. — Bih. Sv. Vet. Akad. Handl., Stockholm, Bd. 27. III. 3. 1901.
3. Hartz, N.: Fanerogamer og Karkryptogamer fra Nordöst-Grönland, c. 75° — 70° N. Br. og Angmagsalik, c. 65° 40′ N. Br. — Medd. om Grönland. XVIII. 1896.
4. Hooker, W. J.: List of plants from the east coast of Greenland, in Scoresby, jun. Journ. of a voyage to the northern whale fishery, etc. 1823.
5. Hooker, W. J.: Some account of arctic plants found by Edw. Sabine. — Transact. Linn. Soc., XIV, 1825.
6. Kruuse, C.: List of the phanerogams and vascular cryptogams found on the, coast (75° — 66° 20′ N. Lat.) of East Greenland. — Medd. om Grönland, XXX, 1905.
7. Ostenfeld, C. H.: Plantes récoltées à la côte nord-est du Grönland, in Duc d'Orléans, Croisière océanographique dans la mer du Grönland en 1905. Resultats scientifiques. Bruxelles, 1908.

General works.

Lange, Joh. Conspectus Florae Groenlandicae. — Meddelelser om Grönland, III, Kjøbenhavn. 1880.

Ostenfeld, C. H. Flora Arctica. Part I. Copenhagen 1902.

SYSTEMATICAL LIST OF THE VASCULAR PLANTS.

Polypodiaceae.

Cystopteris Bernh.

1. **Cystopteris fragilis** (L.) Bernh., Vers. Anordn. Farnkr., 1806, p. 27; Gelert, in Ostenfeld, Fl. Arct., I, p. 6.

Kruuse, East Greenland, p. 206.

Loc. Germania Land: Danmarks Havn, and landward.

Note. Owing to the unfavourable nature of the surface this species occurs only very sparingly around Danmarks Havn; but more landward where the higher hills afford more favourable conditions, specimens were found about 25 cm. high.

Woodsia R. Br.

2. **Woodsia glabella** R. Br., in Richardson, App. Franklin Journ., p. 754, 1823; *W. ilvensis*, var. *glabella* Trautv., Acta Horti Petropol., X, 1887, p. 546; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 7.

Kruuse, East Greenland, p. 207.
Duc d'Orleans, Cape Bismarck (Ostenfeld, p. 10, 1908).

We think it more convenient to give this *Woodsia* as a separate species, and not as a form of *W. ilvensis* (cf. H. G. Simmons, Sec. arct. exp. Fram, 1898–1902, No. 2, 1906, p. 184). It is an interesting fact that only this species has been found by the Danmark Expedition, and it seems that *W. ilvensis* does not occur as far north, but it has been brought home from the Sabine Island a little to the south, and consequently we are just north of its northern limit.

Loc. Germania Land, in crevices of the cliffs and hidden between stones on open rocky-flats.

Equisetaceae.

Equisetum L.

3. **Equisetum arvense** L. Sp. pl., 1753, p. 1061; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 10.

Kruuse, East Greenland, p. 208.

The specimens collected bear simultaneously, in July, both fertile stems with ripe spores, and sterile stems; they may be named f. *riparia* (Fr.) Milde (Monogr. Equiset., tab. 1, figs. 9—10).

Loc. Germania Land: Danmarks Havn.

Note. Is rather rare and occurs always in clayey soil, excepting a single specimen of a peculiar form which was found on "Bastionen" in a sheltered place (June 27th 1908).

4. **Equisetum variegatum** Schleich., Catal. Plant. Helvet., 1807, p. 27; Gelert, in Ostenfeld, Fl. Arct. I, 1902, p. 9.

Kruuse, East Greenland, p. 207.

Small sterile specimens belonging to f. *anceps* Milde (Verhandl. zool. bot. Ges. Wien, XIV, p. 14, 1864) have been collected, but only in one single spot.

Loc. Germania Land: Moskusoksefjeldene in a dried-up tarn on a gravelly hill.

Lycopodiaceae.

Lycopodium L.

5. **Lycopodium selago** L. Sp. pl., 1753, p. 1102; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 12.

Kruuse, East Greenland, p. 205.

The specimens collected belong to f. *appressa* Desv.

Loc. Germania Land: Danmarks Havn. Very rare and always in the Cassiope-association; snow-covered during winter.

Liliaceae.

Tofieldia Huds.

6. **Tofieldia coccinea** Richards., App. Franklin Journ., 1823, p. 736; Ostenfeld, Fl. Arct., I, 1902, p. 32.

Kruuse, East Greenland, p. 187.

Seems to be a very rare plant in East Greenland, which is its eastern limit of distribution.

Loc. Germania Land: Dove Bugt.

Flow. July 11th 1908.

Note. Only one specimen was flowering. Snow-covered during the winter.

Juncaceae.

Juncus L.

7. **Juncus castaneus** Sm., Fl. Brit., I, 1800, p. 383; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 24.

Kruuse, East Greenland, p. 188.

Loc. Germania Land: below Termometerfjeld at Danmarks Havn, along a little water-course.

Flow. Aug. 31st 07.

8. **Juncus biglumis** L. Sp. pl., 1753, p. 328; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 25.

Kruuse, East Greenland, p. 187.

Loc. Ymers Nunatak; Germania Land, rather common; St. Koldewey.
Flow. June 27th 08.

Note. Is the most common Juncus-species within the area.

9. **Juncus triglumis** L. Sp. pl. 1753, p. 328; Gelert in Ostenfeld, Fl. Arct., 1902, p. 25.

Kruuse, East Greenland, p. 188.

Only collected in two localities. The specimens must be referred to the chestnut-coloured form: f. *Copelandi* Buchenau (Zweite Deutsche Nordpolarfahrt, 1869—70, Botanik, p. 51).

Loc. Germania Land: Danmarks Havn.
Flow. July 15th 08.

Note. It grows in humid places, e.g. in hollows with stagnant water. Associated with Carex pulla and Arctagrostis latifolia.

Luzula D. C.

10. **Luzula arcuata** (Wahlenb.) Sw., var. **confusa** Lindeb., in Botan. Notis., Lund, 1855, p. 9; Gelert, in Ostenfeld, Fl. Arct., I, p. 29.

Kruuse, East Greenland, p. 189.
Duc d'Orleans, Cape Bismarck (Ostenfeld, 1908, p. 9).

The rich material collected shows that the plant is rather variable; some of the specimens approach the principal form, *L. arcuata* (Wb.) Sw., which has not been found in Greenland.

Loc. Lambert Land; Cape St. Jaques; Ymers Nunatak; Cape Marie Valdemar; Germania Land: common around Danmarks Havn.
Flow. Beginning of July.

11. **Luzula nivalis** (Læstad.) Beurlin, in Botan. Notiser, Lund, 1853, p. 55; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 30.

Kruuse, East Greenland, p. 190.
Duc d'Orleans, Cape St. Jacques (Ostenfeld, 1908, p. 9).

Loc. Cape Marie Valdemar; Germania Land: Stormkap, not common; St. Koldewey.

Cyperaceae.

Eriophorum L.

12. **Eriophorum Scheuchzeri** Hoppe, Bot. Taschenb., 1800, p. 104, App. t. 7; Ostenfeld, Fl. Arct. I, 1902, p. 41; Fernald, in Rhodora, 7, 1905, p. 82.

Kruuse, East Greenland, p. 190.

Loc. Germania Land, common. It forms associations at the margins of tarns and pools.

13. **Eriophorum polystachyum** L., Sp. pl., 1753, p. 52; Ostenfeld, Fl. Arct., I, 1902, p. 53; Fernald, Rhodora, 7, 1905, p. 88.

Kruuse, East Greenland, p. 191.

The specimens collected all belong to the high-arctic (and high-alpine) form: f. *elegans* Bab. (Man., 1843, p. 333; cf. Fernald, l. c., p. 89).

Loc. Germania Land, very common.

Flow. At the end of June.

Note. A prominent species which occurs everywhere, when there are gently-sloping sandy surfaces and water flowing from snow-drifts.

Cobresia Willd.

14. **Cobresia Bellardii** (All.) Degland., in Loisel., Fl. gall., II, 1807, p. 626; Kükenthal, Caricoideae, in Das Pflanzenreich, 1909, p. 37; *Elyna Bellardi* (All.) K. Koch, in Linnæa 1848, p. 616; Ostenfeld, Fl. Arct., I, 1902, p. 44.

Kruuse, East Greenland, p. 191.

Loc. Germania Land: Danmarks Havn, rather common.

Flow. Latter half of June.

Note. In exposed places it forms dense tufts like those of Carex nardina; there it is often snowless during winter and distinctly wind-affected. In more sheltered places which are snow-covered during winter and rather wet during summer, it forms grass-sward in association with Carex rupestris.

15. **Cobresia bipartita** (All.) Dalla Torre, Anleit. Best. Alpenpfl., 1882, p. 330; Ostenfeld, Fl. Arct., I, 1902, p. 44; *C. caricina* Willd.; Kükenthal, Caricoideae, in Das Pflanzenreich, 1909, p. 45.

Kruuse, East Greenland, p. 191.

Loc. Germania Land, in the depression W. of Termometerfjeld at Danmarks Havn; only one tuft found.

Carex L.

16. **Carex nardina** Fries, Mantissa II, 1839, p. 55; Kükenthal, Caricoideae, in Das Pflanzenreich, 1909, p. 70; Ostenfeld, Fl. Arct. I, 1902, p. 48.

Kruuse, East Greenland, 1905, p. 191.

Loc. Ymers Nunatak; Cape Marie Valdemar; Germania Land: Danmarks Havn, very common.

Flow. End of June.

Note. Often snowless during winter.

17. **Carex rupestris** All., Fl. pedemont., II, 1785, p. 264, tab. 92, fig. 1; Kükenthal, Caricoideae, in Das Pflanzenreich, 1909, p. 86; Ostenfeld, Fl. Arct., I, 1902, p. 86.

Kruuse, East Greenland, 1905, p. 192.

Loc. Germania Land: Danmarks Havn, Snenæs, not common.
Flow. June 25th 08.
Note. Prefers sheltered localities, snow-covered during winter.

18. **Carex incurva** Lightf., Fl. scotic. II, 1777, p. 544, tab. 24; Kükenthal, Caricoideae, in Das Pflanzenreich, 1909, p. 113; Ostenfeld, Fl. Arct., I, 1902, p. 49.

Kruuse, East Greenland, p. 193.

The specimens collected belong to the f. *erecta* O. F. Lang (Linnæa, 24. 1851, p. 507) with stiff and erect culms.

Loc. Germania Land: found only at Rypefjeld.

19. **Carex rigida** Good. in Transact. Linn. Soc. II, 1794, p. 193, tab. 22; Kükenthal, Caricoideae, in Das Pflanzenreich, 1909, p. 299; Ostenfeld, Fl. Arct., I, 1902, p. 77.

Kruuse, East Greenland, 1905, p. 195.

The specimens collected at Rypefjeld are in several respects different from the type and resemble *C. aquatilis*, var. *stans*; but the anatomy of the leaves corresponds better with that of *C. rigida*, although the papillae on the under side of the leaves are very slightly developed, not so conspicuous as in typical *C. rigida*. The terminal spikelet bears female flowers in its lower part.

Also the specimens from Moskusoksefjelde bear some resemblance to *C. aquatilis*, var. *stans*.

Loc. Germania Land: Rypefjeld, Moskusoksefjelde, Lille Snenæs.
Flow. Beginning of July.

20. **Carex salina** Whbg., var. **subspathacea** (Wormskj.) Tuckerm., Enum. Method., 1843, p. 12; Ostenfeld, Fl. Arct., I, 1902, p. 73; *C. subspathacea* Wormskj., Fl. dan., 1816, tab. 1530; Kükenthal, Caricoideae, in Das Pflanzenreich, 1909, p. 361.

Kruuse, East Greenland, p. 194.

Loc. Germania Land: Danmarks Havn in only one place, viz. Basiskær, among damp moss and together with Pleuropogon.
Flow. July 17th 07.

21. **Carex misandra** R. Br., Chloris Melvill., 1823, p. 25; Ostenfeld, Fl. Arct., I, 1902, p. 89; *C. fuliginosa*, *β*, *misandra* (R. Br.) O. F. Lang; Kükenthal, Caricoideae, in Das Pflanzenreich, 1909, p. 557.

Kruuse, East Greenland, p. 194.

In the typical specimens the colour of the scales of the female spikelets is very dark, nearly black ("*atrofusca*"), but in a single series of specimens from Danmarks Havn it is light brown (pale chestnut-brown); this form (f. *ochrolochin* Ostf., nov. forma) corresponds with f. *ochrostachys* Schur of the true *C. fuliginosa* Schkuhr (cf. Kükenthal, l. c.); it has been mentioned by W. J. Hooker (Bot.

Append. Parry 2nd. voy., 1825, p. 406) under the name *C. fuliginosa, β, squamis capsulisque pallide fuscis.*

Loc. Bjorneskær; Germania Land, common; St. Koldewey.

Flow. June 25th 08.

Note. The most common of all the sedges in the area investigated.

22. **Carex pulla** Good., Transact. Linn. Soc., III, 1797, p. 78, tab. 14; Ostenfeld, Fl. Arct., I, 1902, p. 95; *C. vesicaria*, subsp. *saxatilis* (L.) Almq.; Kükenthal, Caricoideae, in Das Pflanzenreich, 1909, p. 727.

Kruuse, East Greenland, p. 196.

Loc. Germania Land: Danmarks Havn and landward around Dove Bugt.

Flow. End of July.

Note. The most common sedge in the bog, grows together with Eriophorum polystachyum; very conspicuous on account of its fresh-green colour.

Gramineae.

Hierochloë Gmel.

23. **Hierochloë alpina** (Liljebl.) Roem. & Schult., Syst. Veget., vol. 2, 1817, p. 515; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 97; *Savastana alpina* Scribn., Mem. Torr. Bot. Club, V, 1894, p. 34.

Kruuse, East Greenland, p. 197.

Loc. Germania Land, common everywhere.

Flow. June 16th 07; June 21th 08.

Note. High and vigorous tufts often mark the burrows of the lemmings and show at a distance where such are to be found.

Alopecurus L.

24. **Alopecurus alpinus** Sm., Engl. Bot., 1802, tab. 1126; Fl. Brit., III, 1804, p. 1386; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 99.

Kruuse, East Greenland, p. 196.

Duc d'Orleans, Cape St. Jacques (Ostenfeld, 1908, p. 9).

All the specimens collected belong to the f. *mutica* Sommerf., with awns not projecting beyond the pales.

Loc. Lambert Land; Bjørneskærene; Germania Land, very common.

Flow. June 22nd 07.

Aira L.

25 a. **Aira caespitosa** L., var. **arctica** (Trin.) Simmons, Rep. Arct. Exp. Fram, 1898—1902, No. 2, 1906, p. 173; *A. arctica* Trinius; *A. brevifolia* (R. Br.) Lange, Consp. Fl. Groenl., 1880, p. 163; *Deschampsia brevifolia* R. Br., Chloris Melvill., 1823, p. 33.

Kruuse, East Greenland, p. 198.

In his memoir on the Ellesmere Land flora Dr. H. G. Simmons has fully elucidated the synonymy of the high-arctic *Aira*, which R. Brown has named *A. brevifolia.*

The material of *Aira* brought home by the Danmark Expedition is very interesting in many points. Some of the numbers (1283, 1287, 1609, 1620) answer well to *A. caespitosa*, var. *arctica* as H. G. Simmons regards it, and must bear that name. It is a low, but rather coarse plant, with short, often somewhat involute leaves, and coarse more or less inflated sheaths, those of the culms bearing sometimes very short blades, sometimes almost none (see Pl. I and Pl. II, fig. 1).

Trinius (Sp. Gram. icon. et descript., III, 1836, Petropolis, Pl. 256, A et B) has given very good figures of this plant, and his analysis of the spikelet (Pl. 256, 1—3) is also correct. The glumes are shorter than or nearly as long as the spikelet, with tips bitten off; awns about as long as the pales.

Besides this variety the Danmark Expedition has collected another still more aberrant form of the *caespitosa*-group which must be referred to: —

25 b. **A. caespitosa** L. var. **pumila** Ledeb., Fl. Ross., IV, 1853, p. 422; *A. brevifolia* Nathorst, Öfv. K. Sv. Vet. Akad. Förh., 1884, p. 27; *A. flexuosa*, var., Simmons, l. c., 1906, p. 175, et ibid., No. 16, 1909, p. 105.

Trinius (l. c., Pl. 256, C) has given a description and a rather good illustration of it, based upon a specimen from Kamtchatka, and Simmons (l. c.) describes its habit and characters very well.

Trinius's description runs as follows: — Fig. C plantulam depingit pumilam, caespites densissimos formantem, panicula parva, angusta, foliis angustissimis, nunc planiusculis nunc fere capillaceo-involutis, brevissimisque insignem, spiculis vero omnino cum A. caespitosa communi congruentem.

It forms dense mats or tufts with numerous very thin, often involute and setaceous leaves, which are much softer than those of var. *arctica*; the culms are low, but generally longer than the leaves; the culm leaves are almost without blade, and with large sheaths (see Pl. II, fig. 2 and Pl. III). The branches of the panicle are thin and usually not so contracted as in var. *arctica*. The glumes are long and acute, as long as or nearly as long as the spikelet, not white-membraneous in the margins; awns about as long as the pales, straight or slightly twisted.

In many of its characters it comes near *A. flexuosa* L., but I cannot follow Simmons when he regards it as a form of that species; the characters of the spikelet, especially of the awns makes it a necessity to refer it to the *caespitosa*-group, and I follow Ledebour and Trinius in this point. It appears always to grow along the margins of ponds or of tarns, and perhaps some of its peculiar characters are adaptations to the habitat.

It is known, moreover from N. E. Greenland, from N. W. Greenland[1] (Ivsugigsok, A. G. Nathorst), Ellesmereland (Fram Harbour, H. G. Simmons) and Kamtchatka (Trinius), while the var. *arctica* is more widely distributed over the whole Arctic region.

Loc. Germania Land: Danmarks Havn, rather common.

Note. It grows in clayey and wet soil at the margins of tarns which dry up during summer, develops late, and is not seen in flower before August.

Phippsia R. Br.

26. **Phippsia algida** (Soland.) R. Br., Chloris Melvill., 1823, p. 27; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 101.

Kruuse, East Greenland, p. 200.

Duc d'Orleans, Cape St. Jacques (Ostenfeld, 1908, p. 9).

Loc. Mallemukfjeldet; Lambert Land; Germania Land, rather common; St. Koldewey.

Flow. June 27th 08.

Note. Grows on flat sandy shores and around small tarns and bogs on rocky-flats.

Arctagrostis Griseb.

27. **Arctagrostis latifolia** (R. Br.) Griseb., in Ledeb., Fl. Ross., IV, 1853, p. 434; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 107.

Kruuse, East Greenland, p. 200.

Loc. Germania Land, common.

Flow. July 21st 07.

Note. It flowers rarely and has not been found with ripe seed; often the uppermost part of the panicle begins to wither before the flowering has begun. It grows in bogs and at margins of ponds. Leaves as much as 9·5 mm. broad.

Trisetum Pers.

28. **Trisetum spicatum** (L.) P. Richter, Pl. Europ. I, 1890, p. 59; *T. subspicatum* (L.) P. Beauv.; Gelert in Ostenfeld, Fl. Arct., I, 1902, p. 110.

Kruuse, East Greenland, p. 199.

Loc. Germania Land, rather rare.

Note. Prefers sheltered localities, as also pointed out by H. G. Simmons with regard to individuals occurring in Ellesmere Land; snow-covered during winter.

Pleuropogon R. Br.

29. **Pleuropogon Sabinei** R. Br., Chloris Melvill., 1823, p. 31, tab. D; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 116.

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[1] To this variety I refer also a very interesting *Aira* collected in West Greenland on the Island of Disco (N. W. coast, Giesecke's valley, 1902, Nr. 307) by M. P. Porsild. It is much higher than the true var. *pumila* (culms 20—30 cm. high), but has the setaceous leaves in common with it, also the characters of the spikelets agree with it. In habit it comes very near *A. setacea* Huds. (*A. discolor* Thuill.; *A. uliginosa* Weihe).

Kruuse, East Greenland, p. 199.

Loc. Germania Land, rather common in coast regions and landward.

Flow. July 17th 07.

Note. It occurs both as f. *terrestris* Simm. and f. *aquatica* Simm. with leaves more than 20 cm. long. (cf. H. G. Simmons, Rep. Sec. Nom. Arct. Exp. Fram, 1898—1902, No. 2, 1906, p. 170). Is a very conspicuous and characteristic plant in bogs and swamps.

Glyceria R. Br.

30. **Glyceria angustata** (R. Br.) E. Fries, Mantissa III, 1842, p. 176; Gelert in Ostenfeld, Fl. Arct., I, 1902, p. 128.

Kruuse, East Greenland, p. 202.

The whole of the rich material of *Glyceria* (the following species excepted) must be referred to *Gl. angustata*, although it varies greatly in many respects, e. g. in the shape of the panicle, the flat or convolute leaves. Quite another question is, whether it is possible to draw a boundary line between this species and *G. distans* (L.) Wahlenb. in its arctic aspect.

Loc. Hyde Fjord in Peary Land; Mallemukfjeld; Kulhoj (the only occurring plant on the moraine toward the border of the ice); Germania Land, common.

Note. Occurs often in beds of water-courses, but most frequently in wet clayey soil, where the tufts spread themselves, and the culms and leaves occur closely pressed to the bottom.

31. **Glyceria maritima** (Huds.) Wahlenb., f. **reptans** (Hartm.) Simmons, Rep. Sec. Arct. Exp. Fram, 1898—1902, No. 2, 1906, p. 159; *G. mar.* f. *vilfoidea* (Anderss.) Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 126.

Kruuse, East Greenland, p. 201.

Loc. Germania Land, rather common.

Note. Grows on low, flat sea-shores and forms occasionally a nearly coherent grass-sward. Only found sterile.

Poa L.

32. **Poa pratensis** L., f. **colpodea** (Th. Fries) Gelert, in Ostenfeld, Fl. Arct. I, 1902, p. 122.

Kruuse, East Greenland, p. 204.

The few specimens collected bear viviparous spikelets in a contracted panicle and agree well with Spitzbergen specimens named *P. colpodea* Th. Fr. (Öfv. K. Sv. Vet. Förh., Stockholm, 1869, p. 138) by Th. Fries himself.

Loc. Germania Land: Hvalrosodde.

33. **Poa cenisia** All., Auct. Fl. Pedem., 1789, p. 40; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 122.

Kruuse, East Greenland, p. 204.
Duc d'Orleans, Cape Bismarck (Ostenfeld, 1908, p. 9).

As usual, this species is rather variable. The tufted form occurs among others.

Loc. Cape Saint-Jacques; Cape Marie Valdemar; Germania Land: Danmarks Havn; St. Koldewey.

34. **Poa abbreviata** R. Br., Chloris Melvill., 1823, p. 29; Gelert in Ostenfeld, Fl. Arct., I, 1902, p. 124.

Kruuse, East Greenland, p. 202.
Duc d'Orleans, Maroussia Isl. (Ostenfeld, 1908, p. 9).

Rich material of this high-arctic species was brought home. It is evidently a well-defined species, and it is hard to understand how Kruuse (l. c.) can "look on it as a high-arctic form of *P. laxa*."

Loc. Hyde Fjord in Peary Land; Mallemukfjeld; Lambert Land; Cape Saint-Jacques; Ymers Nunatak; Germania Land: Danmarks Havn, common everywhere; St. Koldewey.

35. **Poa glauca** M. Vahl, Flora dan., 1790, fasc. 17, p. 3, tab. 964; Gelert, in Ostenfeld, Fl. Arct., I, 1902, p. 124; *P. caesia* Sm., Fl. Brit., I, 1800, p. 103.

Kruuse, East Greenland, p. 203.

Loc. Ymers Nunatak; Germania Land: Dove Bugt, Lille Snenæs, Danmarks Havn.

Festuca L.

36. **Festuca ovina** L., subsp. **brevifolia** (R. Br.) Hackel, Botan. Centralbl., 1881, p. 406; Gelert, in Ostenfeld, Fl. Arct., I, p. 130, 1902.

Kruuse, East Greenland, p. 204.
Duc d'Orleans, Cape St. Jacques (Ostenfeld, 1908, p. 10).

I think it is allowable to refer all the specimens to subsp. *brevifolia* (R. Br.) Hack., but I must admit that I have not been able to find any definite distinguishing character between this form and subsp. *supina* Schur, as it has been defined by Scandinavian authors. In one locality the species was viviparous (dunes at Dove Bugt).

Loc. Germania Land, rather common.

Note. It prefers fairly sheltered places and is usually snow-covered during winter.

Salicaceae.

Salix L.

37. **Salix arctica** Pall., Fl. Ross. II, 1790, p. 86; A. N. Lundström, Weiden Nowaja Semljas, Upsala, 1877, p. 31, fig. 1; *S. groenlandica* (Anders.) Lundstr., l. c., p. 36; Lange. Consp. Fl. Groenl., 1880, p. 108; *S. Brownii* (Anders.) Lundstr., l. c., p. 37.

Kruuse, East Greenland, p. 186.

Duc d'Orleans, Cape St. Jacques, Maroussia Isl. and Cape Bismarck (Ostenfeld, 1908, p. 8).

The material brought home varies greatly with regard to the shape of the leaves. The most common form is var. *Brownii* Anders. with ± broadly obovate leaves, but the extreme form, the broad-leaved, true *S. arctica* Pallas was also found, as well as the narrow-leaved var. *groenlandica* Anders.

Loc. Hyde Fjord (var. Brownii); Mallemukfjeld; Bjørneskær; Cape Marie Valdemar; Germania Land: Danmarks Havn, very common, but always as an "espalier-plant."[1]

Flow. Middle of June.

38. **Salix herbacea** L. Sp. pl. 1753, p. 1018; Lange, Consp. Fl. Groenl., 1880, p. 106.

Kruuse, East Greenland, p. 186.

Loc. Germania Land: Danmarks Havn, in one place.

Flow. July 3rd 08.

Note. Was found in a boggy moor together with Empetrum and Cassiope; only female specimens were observed.

Polygonaceae.

Polygonum L.

39. **Polygonum viviparum** L. Sp. pl. 1753, p. 360; Lange, Consp. Fl. Groenl., p. 105, 1880.

Kruuse, East Greenland, p. 185.

Duc d'Orleans, Cape Bismarck (Ostenfeld, 1908, p. 8).

This species has been collected only around Danmarks Havn. Two forms occur: —

(1) a form with both bulbils and flowers, and with hairs on the under side of the leaves

(2) a form with bulbils only, and with leaves glabrous on the under side.

Loc. Germania Land, rather common.

Flow. July 7th 08.

Oxyria Hill.

40. **Oxyria digyna** (L.) Hill, Hort. Kew., 1768; Lange, Consp. Fl. Groenl., 1860, p. 105.

Kruuse, East Greenland, p. 185.

Duc d'Orleans, Cape Bismarck (Ostenfeld, 1908, p. 8).

Loc. Germania Land, common everywhere.

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[1] Warming's term for plants with prostrate, outspread growth.

Caryophyllaceae.

Melandrium Röhl.

41. **Melandrium apetalum** (L.) Fenzl, in Ledeb., Fl. Ross., I, 1842, p. 326; Lange, Consp. Fl. Groenl., 1880, p. 19.

Kruuse, East Greenland, p. 154.

The specimens collected belong to f. *arctica* Th. Fries (Öfv. K. Sv. Vet. Akad. Förh., 1869, p. 133) with petals projecting beyond the calyx.

Loc. Bjørneskærene; Germania Land, rather common.

Flow. June 29th 08.

Note. Grows by preference in humid places near lake-margins or running water; snow-covered during winter.

42. **Melandrium affine** J. Vahl, Fl. dan., fasc. 40, 1843, p. 5; *M. involucratum* (Cham. & Schltd), β, *affine* Rohrb.; Lange, Consp. Fl. Groenl., 1880, p. 20.

Kruuse, East Greenland, p. 154.
Duc d'Orleans, Cape Bismarck (Ostenfeld, 1908, p. 5).

This species appears always to be easily distinguishable from *M. apetalum* and *M. triflorum*, and its white petals and more or less white calyx (with dark veins and teeth) are very characteristic.

Loc. Germánia Land, rather common.

Flow. Beginning of July.

43. **Melandrium triflorum** (R. Br.) J. Vahl, Fl. Dan., fasc. 40, 1843, p. 5, tab. 2356; Lange, Consp. Fl. Groenl., 1880, p. 20.

Kruuse, East Greenland, p. 154.

Petals mostly pink or rose-coloured; calyx with a dense covering of long glandular hairs.

Loc. Germania Land, common; Maroussia Isl.

Flow. June 22nd 08.

Note. Grows on rocky-flats where high, vigorous specimens mark the burrows of lemmings.

Silene L.

44. **Silene acaulis** L. Sp. pl., ed. 2, vol. I, 1762, p. 603; Lange, Consp. Fl. Groenl., 1880, p. 19.

Kruuse, East Greenland, p. 153.

Loc. Germania Land, common everywhere.

Flow. July 3rd 07; June 24th 08.

Arenaria L. (ex pte).

45. **Arenaria ciliata** L., var. **humifusa** (Wahlenb.) Hartm. Handb. Skand. Flora, ed. 11, p. 243, 1879; Lange, Consp. Fl. Groenl., 1880, p. 27.

Kruuse, East Greenland, p. 157.

Loc. Germania Land, common.

Flow. June 29th 08.

Note. Grows on gravelly, rather flat ground near the shore. It forms dense and large tufts with numerous flowers which attract the observer by their snow-white colour and by their strong odour, — so rare in arctic regions.

Alsine Wahlenb.

46. **Alsine verna** (L.) Wahlenb., Fl. Lappon., 1812, p. 128; Lange, Consp. Fl. Groenl., 1880, p. 24.

Kruuse, East Greenland, p. 156.

Most of the specimens collected may be referred to f. *rubella* Wahlenb. (l. c., p. 128, pro sp.), but the forms seem to be indistinguishable.

Loc. Ymers Nunatak; Germania Land, rather common on table-lands; snow-covered during winter.

Flow. June 21st 08.

47. **Alsine biflora** (L.) Wahlenb., Fl. Lapp. 1812, p. 128; Lange, Consp. Fl. Groenl., 1880, p. 23.

Kruuse, East Greenland, p. 155.

Loc. Germania Land: Danmarks Havn, in only one place.

Flow. July 17th 08; no flowers in 1907.

Note. It was found on a sheltered, humid slope facing south, near the sea-shore.

48. **Alsine Rossii** (R. Br.) Fenzl, Verbr. d. Alsin., Wien, 1833, p. 18; Lange, Consp. Fl. Groenl., 1880, p. 25; Simmons, Medd. Grönl., vol. 26, 1904, p. 470; Simmons, Sec. Arct. Exp. Fram 1898—1902, No. 2, 1906, p. 116, tab. 6, figs. 4—6; *Arenaria Rossii* R. Br., Chloris Melvill., 1823, p. 14.

As Simmons (1904, l. c.) had proved that Taylor's records of *A. Rossii* from West Greenland were improbable, it was a find of great phyto-geographical importance when the Danmark Expedition brought home a specimen of this species from N. E. Greenland, thus giving the first certain record of it as a Greenland plant.

The small bits collected are sterile (see fig. 1), but by comparison with Ellesmere Land specimens not the slightest doubt as to its identification remains.

Loc. Germania Land: Hvalrosodde.

Sagina L.

49. **Sagina intermedia** Fenzl, in Ledeb., Fl. Ross., I, 1842, p. 339; Simmons, Sec. Arct. Exp. Fram 1898—1902, No. 2, 1906, p. 119; *S. nivalis* (Lindbl.) Fries, Mantissa 3, 1842, p. 31 ex pte; Lange, Consp. Fl. Groenl., 1880, p. 22.

Kruuse, East Greenland, p. 155.

Loc. Germania Land, rather rare.

Flow. July 17th 08.

Note. Grows in the black clay at the bottom of dried-up tarns and also near the shore, when the ground has been covered with snow till late in the summer.

Stellaria L.

50. **Stellaria humifusa** Rottböll, Kiöbenhavn, Selsk. Skrifter, Deel 10, 1770, p. 447, tab. 4, fig. 14.

Kruuse, East Greenland. p. 157.

Loc. Germania Land, common everywhere near the sea-shore.

Flow. Middle of July.

Fig. 1. *Alsine Rossii* (R. Br.) Fenzl. (2/1 nat. size).

51. **Stellaria longipes** Goldie, Edinb. Philos. Journ. 6, 1822, p. 327; Lange, Consp. Fl. Groenl., 1880, p. 29.

Kruuse, East Greenland, 1905, p. 157.

Duc d'Orleans, Cape St. Jacques and Cape Bismarck (Ostenfeld. 1908. p. 6).

Loc. Hyde Fjord (Peary Land): Bjorneskær (f. humilis Fnzl.); Cape Marie Valdemar, Germania Land: Kulhoj. Danmarks Havn. common everywhere; St. Koldewey.

Flow. July 10th 07.

Cerastium L.

52. **Cerastium alpinum** L. Sp. pl. 1753, p. 628; Lange, Consp. Fl. Groenl., 1880, p. 31.

Kruuse, East Greenland, p. 158.

Duc d'Orleans. Cape St. Jacques. Maroussia Isl. and Cape Bismarck (Ostenfeld, 1908, p. 6).

Numerous quite typical specimens (some of them very hairy) were collected.

Besides the principal form the curious sterile glabrous, small-leaved, densely cæspitose form which Simmons (Sec. Arc. Exp. Fram 1898—1902, No. 2, 1906, p. 122) has named f. *pulvinata* Simm., and which has erroneously been taken for *C. Edmondstonii*, var. *caespitosum* Malmgr. (cf. Kruuse, l. c., p. 159) was found around Danmarks Havn.

Loc. Mallemukfjeld; Bjorneskær; Ymers Nunatak; Germania Land: valley between Annexso and Sælso; Danmarks Havn, common everywhere; St. Koldewey.

Flow. June 20th 07; June 21st 08.

Note. In low-lying, humid soil it occurs as large tufts with decumbent flowering stems, pressed close to the ground. When the flowering plant in the autumn is suddenly covered with snow which remains during the winter, all the parts of it are so well preserved, that in the spring when the snow has melted, they appear again and apparently are as fresh as if they had quite recently unfolded themselves.

Ranunculaceae.

Ranunculus L.

53. **Ranunculus glacialis** L. Sp. pl., 1753, p. 553; Lange, Consp. Fl. Groenl., 1880, p. 54.

Kruuse, East Greenland, p. 167.

Loc. Germania Land, common.

Flow. June 22nd 07, June 18th 08.

Note. Around small ponds where the snow has melted early, it is one of the spring flowers. On the other hand, where the snow-drifts are perennial and irrigate the lower-lying, evenly sloping ground, it follows the drifts as they melt and flowers here till the frost begins towards the end of August or in the beginning of September.

54. **Ranunculus sulphureus** Soland. in Phipps, Voy. N. Pole, London 1774, p. 202; *R. altaicus* Laxman; Lange, Consp. Fl. Groenl., 1880, p. 56.

Kruuse, East Greenland, p. 168.

Duc d'Orleans, Cape St. Jacques (Ostenfeld, 1908, p. 6).

The Expedition has brought home very rich material of this species, while *R. nivalis* L., which has been recorded as far north as Little Pendulum Isl., is completely absent from the collection.

Loc. Bjørneskærene; Germania Land: Danmarks Havn, common.

Flow. June 18th 07, June 15th 08.

55. **Ranunculus pygmaeus** Wahlenb., Fl. Lappon., 1812, p. 157; Lange, Consp. Fl. Groenl., 1880, p. 55.

Kruuse, East Greenland, p. 167.

Loc. Germania Land: Danmarks Havn, rather common.

Flow. July 9th 08.

Note. Prefers sheltered localities with clayey soil.

56. **Ranunculus hyperboreus** Rottböll, Kiöbenhavn, Selsk. Skrifter, Deel 10, 1770, p. 458, tab. 4, fig. 16; Lange, Consp. Fl. Groenl., p. 55, 1880.

Kruuse, East Greenland, p. 168.

In Maroussia Isl. typical specimens were collected in fairly large quantities, and a single specimen occurred from Danmarks Havn.

At the border of a small tarn near Danmarks Havn a curious

Fig. 2. *Ranunculus hyperboreus* Rottb., var. (Nat. size).

little form (fig. 2) was found among moss. At first sight it greatly recalls *R. pygmaeus* Whb. The stem is much shorter than is usual in *R. hyperboreus* and has only 1—2 rooting nodes, or is, in smaller specimens, not at all creeping; the leaf-blades are deeply 3—5-lobed and the lobes are broadly linear or oblong. Perhaps it is a hybrid between the two species.

Loc. Germania Land: Danmarks Havn; Maroussia Isl.
Flow. July 21st 08.

Papaveraceae.

Papaver L.

57. **Papaver radicatum** Rottböll, Kiöbenhavn, Selsk. Skrifter, Deel 10, 1770, p. 455, tab. 8, fig. 24; *Papaver nudicaule*, Lange, Consp. Fl. Groenl., 1880, p. 52.

Kruuse, East Greenland, p. 166.

Duc d'Orleans, Cape St. Jacques, Maroussia Isl. and Cape Bismarck (Ostenfeld, 1908, p. 6).

Often with white petals (f. *albiflora*, Lange, l. c.).

Loc. Hyde Fjord (Peary Land); Mallemukfjeld; Lambert Land; Bjørneskær; Ymers Nunatak; Cape Marie Valdemar, Germania Land: Danmarks Havn, very common.

Flow. June 27th 07, June 20th 08.

Cruciferae.

Cochlearia L.

58. **Cochlearia officinalis** L., var. **groenlandica** (L.) Gelert, in Andersson & Hesselman, Bih. Sv. Vet. Akad. Handl., 26, III, No. 1, 1900, p. 37; *C. groenlandica* (ex pte) et *C. fenestrata*, Lange, Consp. Fl. Groenl., 1880, pp. 34—36.

Kruuse, East Greenland, p. 160.

The material collected belongs to var. *groenlandica* as defined by Gelert (l. c.) and a part of it to its form f. *minor* (Lge.) Gelert.

Loc. Germania Land: Danmarks Havn, common.

Flow. June 23rd 08.

Note. It thrives very well, sheltered by the stones on a level sea-shore. In late summer it is often found landward in dried-up water-courses, and then as f. *minor*.

Eutrema R. Br.

59. **Eutrema Edwardsii** R. Br., Chloris Melvill., 1823, p. 9, tab. A; Lange, Consp. Fl. Groenl., 1880, p. 46.

Kruuse, East Greenland, p. 164.

Collected in two places, but only one specimen gathered in each place.

Loc. Germania Land: Danmarks Havn.

Flow. July 9th 07.

Cardamine L.

60. **Cardamine pratensis** L. Sp. pl., 1753, p. 656; Lange, Consp. Fl. Groenl., 1880, p. 48.

Kruuse, East Greenland, p. 165.

Loc. Germania Land: Danmarks Havn.

Note. Only found in two places. A single specimen was found in flower in Aug. 1907, but no fruit-setting was observed when the frost began on Aug. 25th.

61. **Cardamine bellidifolia** L. Sp. pl., 1753, p. 654: Lange, Consp. Fl. Groenl., 1880, p. 47.

Kruuse, East Greenland, p. 164.

Duc d'Orleans, Cape St. Jacques (Ostenfeld, 1908, p. 6).

Loc. Germania Land: Danmarks Havn, rather common.

Flow. June 27th 08.

Lesquerella S. Wats.

62. **Lesquerella arctica** (Wormskj.) S. Watson, Proc. Am. Acad. 1888, vol. 23, p. 254; *Alyssum arcticum* Wormskj., Fl. Dan., fasc. 26, 1818, p. 3, tab. 1520; *Vesicaria arctica* Richards.: Lange, Consp. Fl. Groenl., 1880, p. 34.

Kruuse, East Greenland, p. 159.

Loc. Germania Land: valley between Annexso and Sælso, Hvalrosodde, Dove Bugt, Snenæs, Stormkap.

Flow. June 22nd 08.

Note. Members of this species were not found around Danmarks Havn, excepting one specimen from Harefjeld. Further landward from Stormkap to Dove Bugt very common in dry, gravelly soil, usually as isolated specimens. But it was found here and there in tufts of grasses and thrives well in such conditions, at least the leaves become larger. Only once found in an association of *Cassiope*. It has the same distribution as *Potentilla pulchella*, and like this species it develops into a peculiar "pillar-form" (fig. 3) when growing on the wind-side of gravelly slopes, where it is snowless in winter. The "pillar" consists of freely projecting stems covered with old, wind-blown remains of leaves, and at the top a small rosette of green leaves which protect the buds during winter.

Fig. 3. *Lesquerella arctica* (Wormskj.) S. Wats., "pillar." (1½ nat. size).

Draba L.

63 a. **Draba hirta** L. Sp. pl. ed. 2, vol. II, 1763, p. 897: Lange, Consp. Fl. Groenl., 1880, p. 42.

Kruuse, East Greenland, p. 163.

The true *D. hirta* seems to be very rare in the area investigated, only some few and young specimens have been referred to it. It is replaced by the following variety.

Loc. Germania Land: Danmarks Havn, Snenæs.

Flow. June 29th 07.

Note. At Snenæs well developed specimens were found near the burrow of a lemming; the 25 cm. high, year-old stems had borne fruit abundantly, but now on June 25th 08 the flower-buds were not open.

63 b. **Draba hirta** L., var. **arctica** (J. Vahl), S. Watson, Proc. Am. Acad. Sc., vol. 23, 1888; *D. arctica* J. Vahl, Fl. Dan., fasc. 39, 1840, p. 5, tab. 2294; Lange, Consp. Fl. Groenl., 1880, p. 43.

Kruuse, East Greenland, p. 163.

Very common in the area and varies greatly, but is never as high as the authentic specimens from West Greenland.

Loc. Ymers Nunatak; Germania Land: Hvalrosodde, Dove Bugt, Danmarks Havn.

Flow. June 16th 07; June 13th 08.

Note. It grows in gravelly and stony places, often in sheltered depressions with rich grass.

64. **Draba fladnizensis** Wulf, in Jacq. Misc., I, 1778, p. 147; Gelert, in Botan. Tidsskr., 21, 1898, p. 302; *D. Wahlenbergii* et (ex pte) *D. corymbosa*, Lange, Consp. Fl. Groenl., 1880, pp. 40—41.

Kruuse, East Greenland, p. 162 (saltem ex pte).

Duc d'Orleans, Cape Bismarck (Ostenfeld, 1908, p. 6).

Loc. Germania Land: Hvalrosodde, Snenæs, Danmarks Havn.

Flow. June 22nd 07.

65. **Draba subcapitata** Simmons, Sec. Arct. Exp. Fram 1898—1902, No. 2, Kristiania, 1906, p. 87, tab. 1, figs. 3—8.

Kruuse, East Greenland (sub nom. diversis).

This species seems to be rather widely distributed in the area investigated.

We owe to Dr. H. G. Simmons, (l. c.) a clear definition of this badly-treated species, of which no certain record from Greenland has hitherto existed.

Loc. Mallemukfjeldet (?); Ymers Nunatak; Cape Marie Valdemar (?); Germania Land: Lille Snenæs, Danmarks Havn.

Flow. June 22nd 08.

66 a. **Draba alpina** L. Sp. pl. 1753, p. 642; Lange, Consp. Fl. Groenl., 1880, p. 37; Gelert in Bot. Tidsskr., Bd. 21, 1898, p. 299.

Kruuse, East Greenland, pp. 160—161 (incl. D. glacialis).

Duc d'Orleans, Cape St. Jacques (Ostenfeld, 1908, p. 6).

This species is very common in the area investigated and varies greatly. The more distinct forms are: *α*, *genuina* Lindbl. and *β*, *hebecarpa* Lindbl., the latter with hairy pods.

The most divergent form is: —

66 b. **D. alpina** L., var. **glacialis** (Adams) Dickie, Journ. Linn. Soc., XI, 1871, p. 33; Simmons, Sec. Arct. Exp. Fram 1898—1902, No. 2, Kristiania, 1906, p. 82.

Loc. Lambert Land (in flower June 14th 07); Ymers Nunatak; Germania Land, common everywhere; St. Koldewey.

Flow. June 16th 07, June 14th 08.

Note. Among the specimens of *Draba* we have found two individuals which, with some hesitation, we have identified as hybrids. They stand between *D. alpina* and *D. fladnizensis*. No. 1143, Danmarks Havn, 8, VII, 1908; and No. 166, Cape Bismarck, 22, VI, 1907).

Braya Sternb. & Hoppe.

67. **Braya purpurascens** (R. Br.) Bunge, in Ledeb., Fl. Ross., I, 1842, p. 195; Lange, Consp. Fl. Groenl., 1880, p. 46.

Kruuse, East Greenland, p. 163.

In the material collected occur specimens both with stellately hairy, and with glabrous pods (f. *siliculis glabris* Hartz, Medd. Grönl., XVIII, 1895, p. 329 sub *B. glabella*).

Loc. Ymers Nunatak; Germania Land: Hvalrosodde, Dove Bugt, Danmarks Havn.

Flow. And with young fruit June 22nd 08.

Note. Rare around Danmarks Havn, but common more landward around Dove Bugt. It grows in gravelly, dry soil and also in clayey soil in tarns, which have dried up in early summer.

Saxifragaceae.

Saxifraga L.

68. **Saxifraga oppositifolia** L. Sp. pl., 1753, p. 402; Lange, Consp. Fl. Groenl., 1880, p. 66.

Kruuse, East Greenland, p. 173.

Duc d'Orleans, Cape Bismarck and Cape St. Jacques (Ostenfeld, 1908, p. 7).

Loc. Hyde Fjord (Peary Land); Mallemukfjeld; Lambert Land: Bjørneskær (flowering June 19th 07); Cape St. Jacques; Ymers Nunatak; Cape Marie Valdemar; Germania Land: Danmarks Havn, common.

Flow. June 4th 07, June 7th 08.

Note. In some places around Danmarks Havn an unusually large-flowered form was found, the flowers reaching a diameter of 18—23 mm. (see Pl. IV).

69. **Saxifraga flagellaris** Willd., in Sternberg, Revis. Saxifr., 1810, p. 25; *S. flag.*, var. *setigera* (Pursh) Engler; Lange, Consp. Fl. Groenl., 1880, p. 65.

Kruuse, East Greenland, p. 172.

Loc. Ymers Nunatak; Germania Land: Danmarks Havn, common.

Flow. June 20th 07.

Note. Around Danmarks Havn it was very common; in the interior only one specimen was found, on the Ymers Nunatak. It grows in humid, clayey soil on gentle slopes which are irrigated until late in summer by melting snow-drifts. During the flowering period the stolons produce new rosettes, and in the course of time a colony or association is formed consisting of closely placed individuals.

70. **Saxifraga cernua** L. Sp. pl., 1753, p. 403; Lange, Consp. Fl. Groenl., 1880, p. 61.

Kruuse, East Greenland, p. 170.
Duc d'Orleans, Cape Bismarck and Cape St. Jacques (Ostenfeld, 1908, p. 7).

Loc. Lambert Land; Cape Marie Valdemar; Germania Land: common around Danmarks Havn.
Flow. July 3rd 07.

71. **Saxifraga rivularis** L. Sp. pl., 1753, p. 404; Lange, Consp. Fl. Groenl., p. 61, 1880.

Kruuse, East Greenland, p. 170.
Duc d'Orleans, Cape St. Jacques (Ostenfeld, 1908, p. 7).

Loc. Germania Land: Dove Bugt, Danmarks Havn, common.
Flow. July 10th.

72. **Saxifraga groenlandica** L. Sp. pl., 1753, p. 404; Simmons, Sec. Arct. Exp. Fram 1898—1902, No. 2, 1906, p. 70; *S. decipiens* Ehrh.; Lange, Consp. Fl. Groenl., 1880, p. 62; *S. caespitosa* L. Sp. pl., 1753, p. 404 (saltem ex pte).

Kruuse, East Greenland, p. 171.
Duc d'Orleans, Cape Bismarck, Maroussia Isl. and Cape St. Jacques (Ostenfeld, 1908, p. 7).

All the specimens collected must be referred to var. *uniflora* (R. Br.) Simm., l. c., p. 71.

Loc. Germania Land, common; St. Koldewey.
Flow. Middle of June.

73. **Saxifraga stellaris** L., var. **comosa** Retz., Fl. Scand. Prodrom., 1779, p. 79; Lange, Consp. Fl. Groenl., 1880, p. 60.

Kruuse, East Greenland, p. 170.

Loc. Bjørneskærene; Germania Land: common around Danmarks Havn.

74. **Saxifraga nivalis** L. Sp. pl., 1753, p. 401; Lange, Consp. Fl. Groenl., 1880, p. 59.

Kruuse, East Greenland, p. 169.
Duc d'Orleans, Cape St. Jacques (Ostenfeld, 1908, p. 7).

Besides the type the var. *tenuis* Wahlenb. (Fl. Lapp., 1812, p. 114) has been collected around Danmarks Havn.

Loc. Lambert Land; Germania Land: common everywhere around Danmarks Havn.
Flow. June 21st 08.

Rosaceae.

Potentilla L.

75. **Potentilla pulchella** R. Br. in Ross, Voy., ed. 2, 1819, p. 193; Lange, Consp. Fl. Groenl., 1880, p. 4; Th. Wolf, Monogr. Potentilla, 1908, p. 151.

Kruuse, East Greenland, p. 149.

Among the specimens collected there are some with very small and densely hairy leaves; they represent the extreme limit of f. *humilis* Lange (l. c.); others are more typical and some approach the f. *elatior* Lange.

Loc. Hyde Fjord (Peary Land); Cape St. Jacques; Ymers Nunatak; Germania Land: Dove Bugt, Snenæs, Stormkap, Harefjeld; Maroussia Isl.; St. Koldewey.

Flow. June 28th 08.

Note. It was rather common on Maroussia Island which is a large, manured nesting-place of sea-fowl. With this exception it does not occur near the coast, and was not found more outward than Stormkap (a single individual from Harefjeld excepted), whence it increases in frequency until, on the gravelly banks at Dove Bugt, it becomes a character plant, just as *Lesquerella* (see p. 23). — It is a hardy species which endures well both sand-drifts and snow-storms, but it varies greatly in habit; the wind-affected individuals from the gravelly banks do not bear much resemblance to large sheltered tufts which have been snow-covered during winter; they form compact "pillars" with a few living leaves in the dense top-rosette (see Pl. V).

76. **Potentilla nivea** L. Sp. pl. 1753, p. 499; Lange, Consp. Fl. Groenl., 1880, p. 8; P. Rydberg, Monogr. N. Am. Potent., 1898, p. 84; Th. Wolf, Monogr. Potentilla, 1908, p. 233.

Kruuse, East Greenland, p. 150.

The specimens collected vary somewhat, as is usual with specimens of arctic *P. nivea*. But I think that they may all be named var. *pinnatifida* Lehm. (Pugill. plant. IX, Hamburg, 1851, p. 67; Th. Wolf (l. c., p. 239) emendavit) under which variety I place f. *subquinata* Lange (l. c., p. 9). I fully agree with Th. Wolf in not following P. Rydberg (Bull. Torr. Bot. Club., 28, 1901, p. 181), who makes a separate species of Lange's form.

As to the var. *prostrata* (Rottböll) Lehm., Monogr. Potent., 1820, p. 184 (*P. prostrata* Rottböll, Kiöbenhavn, Selsk. Skrifter, Deel 10, 1770, p. 453) much has been written about it, and it has puzzled the authors highly. We have in the Copenhagen Herbarium a specimen collected by Holböll at Umanak in West Greenland, and this belongs without doubt to the specimens upon which Rottböll's has based his description. This specimen is a very coarse and large-leaved plant with ternate, deeply incised leaves. I think it is a luxurious form of var. *pinnatifida* Lehm., which had been growing in manured soil. It seems as if Th. Wolf (l. c., p. 238) has supposed something like this, but he gives it as related to var. *macrophylla* Ser. (D. C., Prodrom. II, 571, 1825), which is nearer to the typical *P. nivea*, than is Holböll's plant.

Loc. Ymers Nunatak; Germania Land: valley between Annexsø and Sælsø, Dove Bugt, Danmarks Havn; St. Koldewey.

Flow. June 22nd 08.

Note. Rather common around Danmarks Havn, but still more frequent landward; it grows on gravelly slopes, snow-covered during winter.

77. **Potentilla emarginata** Pursh, Fl. Am. Septentr., 1814, p. 353; Lange, Consp. Fl. Groenl., 1880, p. 8; Th. Wolf, Monogr. Potentilla, 1908, p. 533.

Kruuse. East Greenland, p. 150.
Duc d'Orleans, Cape Bismarck (Ostenfeld, 1908, p. 5).

Both low and hairy, and higher and less hairy forms were collected, thus corresponding to f. *typica* and f. *elatior* Abromeit (Bibl. Botan., 42, 1899, p. 8) respectively.

Loc. Cape St. Jacques; Cape Marie Valdemar; Germania Land: Danmarks Havn, common; Maroussia Isl.

Flow. June 27th 07; June 17th 08.

Dryas L.

78. **Dryas octopetala** L. Sp. pl., 1753, p. 717; Lange, Consp. Fl. Groenl., p. 2, 1880; N. Hartz, Medd. Groenl., 18, 1895, p. 319.

Kruuse, East Greenland, p. 148.
Duc d'Orleans, Cape St. Jacques, Cape Bismarck (Ostenfeld, 1908, p. 5).

Among the plants brought home by the Danmark Expedition I did not find any belonging to the typical *D. integrifolia* M. Vahl. The whole material from Germania Land is true *D. octopetala* L. in its small-leaved high-arctic form: f. *minor* Hook. (Transact. Linn. Soc., 14, 1825, p. 387); some specimens are hairy on the upper side of the leaves and may be referred to subf. *hirsuta* N. Hartz (l. c.), and in some localities the subf. *argentea* A. Blytt (Norges Flora, vol. 3, 1876, p. 1176), with leaves silver-white lanate on the upper side was observed.

The fragmentary specimens collected by Captain Koch on Peary Land (Hyde Fjord) stand between *D. octopetala* and *D. integrifolia* and may be *D. octopetala*, var. *intermedia* Nathorst (Öfv. K. Vet. Akad. Förh. 1884, No. 1, p. 24), but the material is too scanty for definite decision of the question.

Loc. Hyde Fjord (var. *intermedia*); Cape St. Jacques; Ymers Nunatak; Cape Marie Valdemar; Germania Land: Dove Bugt, Danmarks Havn, common; St. Koldewey.

Flow. June 27th 07, June 16th 08.

Note. It is one of the few species which flowers during the whole summer, more or less early according to its different habitats. — The large-leaved specimens (leaves as much as 75 mm. broad) grow in places that are snow-covered; they are the first to develop in spring, as they have plenty of water and utilize the warmth of the sun even before the snow has melted.

Empetraceae.

Empetrum L.

79. **Empetrum nigrum** L. Sp. pl., 1753, p. 1022; Lange, Consp. Fl. Groenl., 1880, p. 18.

Kruuse, East Greenland, p. 153.

Loc. Germania Land: Danmarks Havn, Stormkap.

Note. It was found on August 1st 1907 with small unripe fruits, which did not mature during that summer; nor did the year-old fruits found in the specimens appear to have ripened. Near Danmarks Havn it occurred on heather-moor together with *Cassiope* and *Salix herbacea*. Further, some half-withered and stunted fragments were seen on a gravelly bank near Stormkap, but only sterile (Sept. 1st 07).

Onagraceae.

Epilobium L.

80. **Epilobium latifolium** L. Sp. pl., 1753, p. 347; *Chamaenerium latifolium* Sweet, Hort. Brit., ed. 2, 1830, p. 90; Lange, Consp. Fl. Groenl., 1880, p. 16.

Kruuse, East Greenland, p. 152.

Loc. Germania Land: Danmarks Havn and landward around Dove Bugt.

Flow. Beginning of July.

Note. Rather common in stony and gravelly soil near water-courses and on slopes with running water; it is sometimes so conspicuous that it catches the eye from a distance.

Halorrhagidaceae.

Hippuris L.

81. **Hippuris vulgaris** L. Sp. pl., 1753, p. 4; Lange, Consp. Fl. Groenl., 1880, p. 13.

Kruuse, East Greenland, p. 151.

The specimens collected belong to the true *H. vulgaris* and cannot be referred to the broad-leaved form: *H. tetraphylla* L. fil. (= *H. maritima* Hell.), although they bear some resemblance to it (see Pl. VI).

Loc. Germania Land: Danmarks Havn.

Note. Occurs here and there in ponds in shallow water, and flowers.

Ericaceae.

Cassiope D. Don.

82. **Cassiope tetragona** (L.) D. Don, Edinb. New Philos. Journ., 17, 1834, p. 157; Lange, Consp. Fl. Groenl., 1880, p. 87.

Kruuse, East Greenland, p. 179.
Duc d'Orleans, Cape Bismarck (Ostenfeld, 1908, p. 8).

Loc. Cape Marie Valdemar; Germania Land: Dove Bugt, Danmarks Havn, common.
Flow. June 29th 07, June 27th 08.
Note. Snow-covered during winter. Prefers rather humid slopes; in flat ground only in depressions and in the furrows formed by the water from melting snow and ice.

Rhododendron L.

83. **Rhododendron lapponicum** (L.) Wahlenb., Fl. Suec., 1824, p. 249; Lange, Consp. Fl. Groenl., 1880, p. 88.

Kruuse, East Greenland, p. 180.

Loc. Germania Land, only in the interior: Rypefjeld, Fuglenæbsfjeld, Hvalrosodde, Moskusoksefjelde.
Flow. July 2nd 08.
Note. Grows on heather-moors with long-lasting snow-covering.

Vacciniaceae.

Vaccinium L.

84. **Vaccinium uliginosum** L. (Sp. pl., 1753, p. 350), var. **microphyllum** Lange, Consp. Fl. Groenl., 1880, p. 91 (pro subspecie).

Kruuse, East Greenland, p. 181.

Loc. Germania Land: rather common from Danmarks Havn landward to Dove Bugt.
Flow. July 3rd 07, June 27th 08.
Note. It grows by preference on slopes facing south that are sheltered and snow-covered during winter and sufficiently humid during summer. It often forms a belt between *Dryas* and *Cassiope*. It was found with ripe berries, rather sparingly, on the last days of August 1906 and 1907.

Plumbaginaceae.

Statice L.

85. **Statice armeria** L. (Sp. pl., 1753, p. 274), var. **sibirica** (Turcz.) Rosenvinge, Medd. Grönland, III, 3, 1892, p. 683 (sub Armeria vulgari Willd.); *Armeria sibirica* Turcz.; Lange, Consp. Fl. Groenl., 1880, p. 70; *Statice maritima* Mill., var. *sibirica* Simmons, Sec. Arc. Exp. Fram 1898–1902, No. 2, p. 34, 1906.

Kruuse, East Greenland, p. 174.

Loc. Germania Land: common around Danmarks Havn.
Flow. July 11th 07.

Scrophulariaceae.

Pedicularis L.

86. **Pedicularis flammea** L. Sp. pl., 1753, p. 609; Lange, Consp. Fl. Groenl., 1880, p. 75.

Kruuse, East Greenland, p. 176.

Loc. Germania Land: in only one place, Rypefjeld.

Flow. July 8th 08.

87. **Pedicularis hirsuta** L. Sp. pl., 1753, p. 609; Lange, Consp. Fl. Groenl., 1880, p. 76.

Kruuse, East Greenland, p. 176.

Duc d'Orleans, Maroussia Isl. and Cape St. Jacques (Ostenfeld, 1908, p. 7).

Loc. Hyde Fjord (Peary Land); Bjørneskær; Germania Land: common everywhere around Danmarks Havn.

Flow. June 22nd 07, June 26th 08.

Campanulaceae.

Campanula L.

88. **Campanula uniflora** L. Sp. pl., 1753, p. 163, Lange, Consp. Fl. Groenl., 1880, p. 92.

Kruuse, East Greenland, p. 181.

Loc. Germania Land, here and there.

Flow. July 10th 07, July 5th 08.

Note. Grows both in sheltered places and on rocky-flats between stones, which retain the snow during winter.

Compositae.

Erigeron L.

89. **Erigeron compositus** Pursh, Fl. Am. Septentr., II, 1814, p. 535; Lange, Consp. Fl. Groenl., 1880, p. 101.

Kruuse, East Greenland, p. 183.

Loc. Cape Amélie; Germania Land, rather common.

Flow. July 10th 07, July 5th 08.

Note. Grows in gravelly places on the rocky-flats.

Arnica L.

90. **Arnica alpina** (L.) Olin, Disser. Arnica, Upsala, 1799; Lange, Consp. Fl. Groenl., 1880, p. 103.

Kruuse, East Greenland, p. 184.

Loc. Germania Land: Fuglenæbsfjeld, "Bastionen," Danmarks Havn, rare.

Flow. July 3rd 08.

Note. Grows always in the higher parts of the country on rock-ledges which are sheltered and densely snow-covered during winter.

Taraxacum L.

91. **Taraxacum arcticum** (Trautv.) Dahlstedt, Ark. f. Botanik, Stockholm, IV, No. 8, 1905, p. 8; Ostenfeld, in Duc d'Orleans, Croisière Oceanogr. mer du Grönland 1905, Bruxelles, 1908, p. 8.

Kruuse, East Greenland, p. 182 (*T. phymatocarpum* ex max. pte).

Duc d'Orleans, Cape St. Jacques and Maroussia Isl.

Both the principal form and the f. *albiflora* Kjellman (Vega Exp. vet. iakt., Stockholm, I, 1882, p. 505, sub *T. phymatocarpo*) were collected.

Loc. Germania Land, rather common.

Flow. July 10th 07.

Note. It occurs on low slopes and similar sheltered places which have been snow-covered during the winter.

92. **Taraxacum phymatocarpum** J. Vahl, Fl. dan., XIII, fasc. 39, 1840, p. 6, tab. 2298; Dahlstedt, Ark. f. Botanik, Stockholm, IV, 8, 1905, p. 22.

Kruuse, East Greenland, p. 182 (ex min. pte).

Loc. Germania Land: Rypefjeld, Snenæs and Stormkap (finished flowering Aug. 19th 1906), not common around Danmarks Havn.

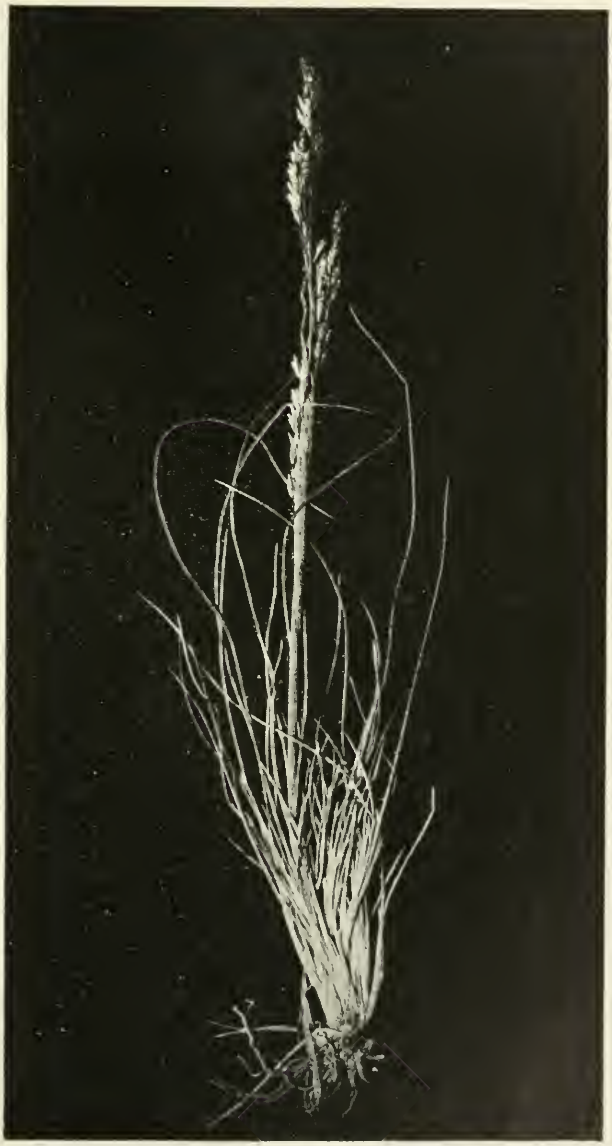
Flow. July 7th 07; June 30th 08.

10—12—1909.

Aira caespitosa, var. *arctica* (Trin.) Simm. (3/4 nat. size.)
A high and coarse form.

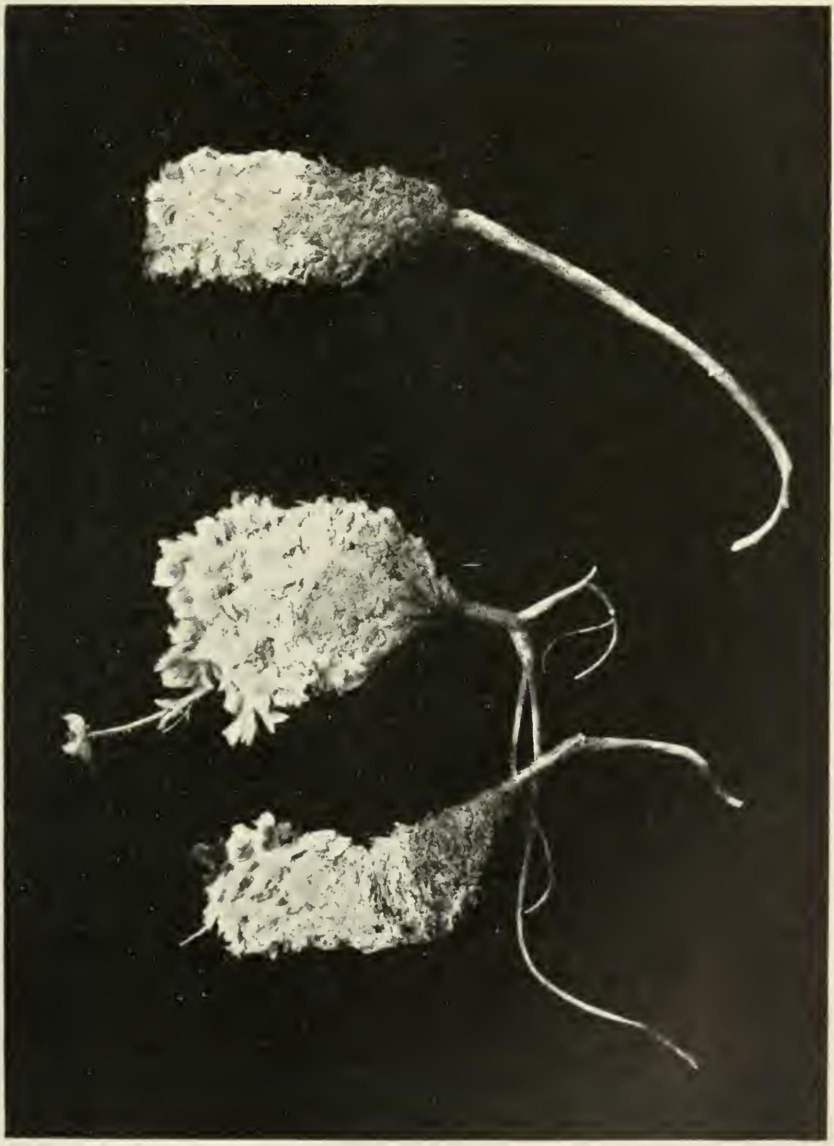
Fig. 1. *Aira caespitosa*, var. *arctica* (Trin.) Simm. (3/4 nat. size.)
The form answering to *A. brevifolia* R. Br.

Fig. 2. *Aira caespitosa*, var. *pumila* Ledeb. (3/4 nat. size.)
The form answering to TRINIUS'S illustration.



Aira caespitosa, var. *pumila* Ledeb. (3/4 nat. size.)
A form resembling *A. setacea* in habit.

Large-flowered *Saxifraga oppositifolia* L. (Nat. size). Photo. of living specimens by A. LUNDAGER.



Potentilla pulchella R. Br., "pillars." (Nat. size.)

Hippuris vulgaris L., flowering specimens. (1/2 nat. size.)

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Observations on the corrugated rim of Nepenthes.

(With 16 Figures in the Text and a Danish Summary).

By

Fr. Heide.

The leaf of *Nepenthes* has always attracted the attention of morphologists and in the course of time the most various morphological explanations have been tried on this organ; nevertheless we must confess that the results have always been more or less problematical, and the opinions on this difficult subject differ very much. In some of these efforts to find new morphological explanations a few of the pitcher-organs, as the lid and the lateral wings, have been assumed to be able to yield a sort of foundation, and the anatomy as well as the mode of development of these organs have therefore been studied more in details. This has never been the case with the corrugated rim. The interesting pitcher-margin has always been treated most superficially, and what we find about it in literature is imperfect or erroneous. I have felt inclined to publish my results so much the more as former deficiencies and errors on this point have not been altered in a modern work: "Nepenthaceae", by Dr. Macfarlane, Octob. 1908, a book which otherwise will be reckoned among our best compendia in the study of *Nepenthes*.

The materials for my investigations are fetched, partly from the species and hybrids growing in the Botanic Gardens of the University (*N. Allardi, N. Dormanniana, N. gracilis, N. Mastersiana, N. mixta, N. Paradisiae*) partly from the collections in the Copenhagen Botanic Museum (*N. melamphora and N. ampullaria*).

I beg to express my most respectful thanks to Professor Eug. Warming for the great interest, which he has always shown to my work. Likewise I wish to thank Professor V. A. Poulsen for his many valuable hints.

I. Development and Morphology of the Collar.

The development of the collar has formerly been mentioned by Faivre and Macfarlane. Faivre's (3) description is very unclear, and contains no explanation at all of the question, as to where in the adult pitcher-rim the primary margin is to be found. He says: "De chaque côté de la saillie médiane (of the lid), un arceau se prononce et isole, en formant voûte, l'opercule d'avec la paroi urnaire; celle-ci se déjette en dedans, formant de chaque côté de l'opercule comme une saillie en corne d'abondance; telle est l'origine du bourrelet qui borde l'ouverture operculaire et dont, au début, la constitution histologique semble la même que celles des autres parties de la paroi" (pag. 196). The stage of development shown in Faivre's paper is the same as that in my Fig. 1.

Macfarlane (11) says more peremptorily, in 1889: "The mode of formation of the corrugated margin is easily explained. It results from flattening out the orifice rim externally and internally and curving over of each upon itself" (pag. 259). Macfarlane here evidently takes all the corrugated rim to be the primary margin, but there is also, besides this, the possibility of the latter existing either in the outer or in the inner border of the collar. This question is so much the more interesting, as Macfarlane (13), in 1908, explains the mode of formation of the collar in a manner, quite different from that of 1889. He says: "The typical peristome (or corrugated rim) is formed in part from incurving of the margin, which up to the period of opening of the young pitcher is a uniform rim that projects upward under the closely fitting lid. In part also it results from growth and recurving of a circular area below the rim, that appears as a circular swelling, below and outside of the lid in the young pitcher" (pag. 9). On investigating but a few stages of the development of the young rim, it will be absolutely clear that the two said explanations are not only quite erroneous, but that they are arrived at without any preceding investigation.

As the figures 1—7 show, the primary pitcher-margin is to be found at the outer margin of the adult collar, while the inner margin of this organ, which later on is furnished with marginal glands, arises as a circular swelling on the inner side of the young pitcher. The corrugated surface of the rim must, consequently, be considered as part of the inner wall, which thus appears in three modifications: 1. corrugated surface of the rim, 2. conducting, and 3. detentive surface of the pitcher cavity.

On investigating the margin of the young pitchers, yet included in the bud, one will never find any trace of a collar. As shown in Bower's (1) and Hooker's (7) figures, the margin is here of a smooth, chubby shape all around the pitcher orifice. In young stages it is erect, in older a little more inclined towards the middle-keel of the lid.

Fig. 1 (*N. Mastersiana*) shows a section through the lid and margin of a young pitcher, which has recently left the bud. From this it will be seen that the development of the collar, as well as that of the glands, from the pitcher cavity etc., takes place entirely outside the bud. At *c* is seen a sharp furrow, in which the border of the lid is pressed. The swelling beneath this point is, as mentioned above, supposed to be the first stage of the outer part of the collar (Macfarlane (13), 1908). The other characters of this stage are: The outer surface of the pitcher and lid is covered with long, branched hairs; peltate hairs do not exist here. On the other hand, they are abundant on the part *a—c*, where they are mingled with the long, branched ones. The same is the case on the part of the inner side of the lid turning towards *a—c*. On the other part of the inner lid-surface peltate hairs are seen here and there, and somewhat dispersed also stomata, lifted by little swellings above the surrounding level (Fig. 15—16). As far as I know, it has not been mentioned before that stomata exist here[1]): on the contrary

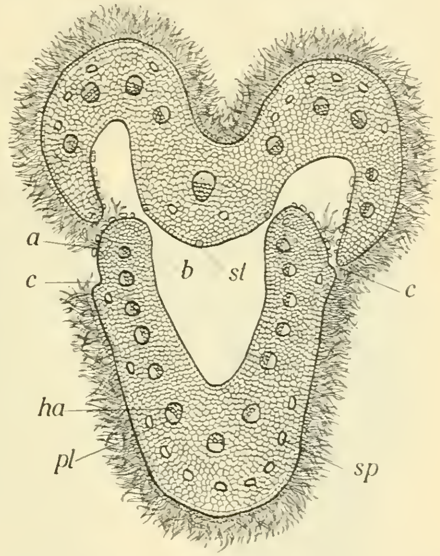

Fig. 1. *N. Mastersiana.* This section, as well as the following (Fig. 2—7), are vertical through the lid and parallel with the corrugations of the collar. The young pitcher has recently left the bud. The letters of the figures 1—7 have the same meaning throughout: *ha* = hadrome; *pl* = plerome; *sp* = spiral cells; *a* = the outer border of the collar; *b* = the inner border of the same, later on furnished with marginal glands; *c* = the furrow, in which the border of the lid is pressed; *a—b* = the corrugated surface; *st* = stomata; *mg* = marginal glands.

[1]) Se the note on page 147.

Wunschmann (14) (1872) maintains that they are absent from all the inner side of the pitcher. (On the "lid" of Sarracenia they are found on both sides). (Hooker (8) 1874. Zipperer 1885). Their absence from the inner surface of the pitcher — and the inner surface of the cavity and that of the lid must evidently be regarded as morphologically identical — was, in the opinion of Wunschmann, a confirmation of the explanation that the inner pitcher-surface was corresponding to the upper surface of the "phyllodium", and the outer surface of the former to the lower of the latter. He says: "Diese Vermuthung findet in der Entwickelungsgeschichte des Blattes ihre Stütze und stimmt auch überein mit einer anatomischen Thatsache. Ich fand nämlich, dass die äussere Fläche der Becher stets Spaltöffnungen besass, während solche auf der inneren Fläche nie vorhanden waren; ein Verhältniss, wie es bekanntlich für die Unter- und Oberseite der Blätter die Regel ist" (pag. 7). On this stage of *N. Mastersiana* they are only found on that swelling of the lid, which is placed in the pitcher cavity. Attractive lid-glands are not yet developed. In the parenchyma, as well in the pitcher as in the lid, especially near the outer walls of both, some edged empty cells are found; it is undoubtedly these which are given by Fenner (4) in his Fig. 13, Tab. X, and are mentioned there as "Intercellularräume". They are, however, cells which later on are developed as spiral cells, and are studied in details by Kny and Zimmermann (10). Already on this stage there is a beginning spiral-shaped thickening of their walls. Fig. 2 shows a stage, a

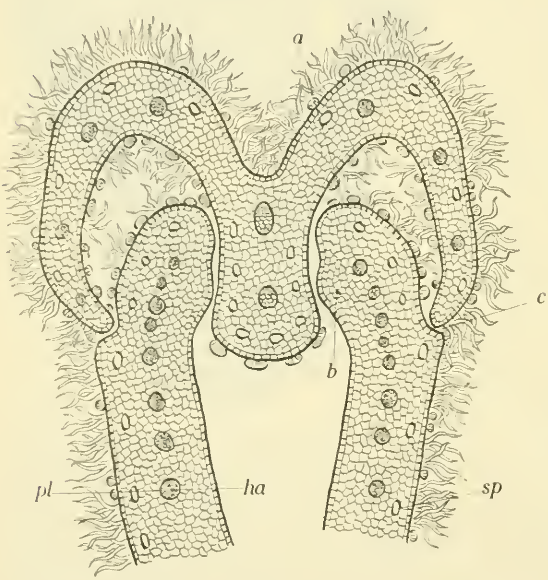

Fig. 2. *N. Allardi.* The stage a little older than that in Fig. 1.

little older, of *N. Allardi.* By growth in the sub-epidermal layers a swelling, at *b*, has risen. This is the first beginning of the inner part of the rim. The surface *a—b*, later on developed as the corrugated surface, is here a little concave.

As in Fig. 1, the outer surface is covered with long, branched hairs. Here and there are also seen peltate hairs, which are likewise in majority on the face *a—c*, and on the adjacent part of the lid. On the swelling of this, which is here greatly developed, they are of a considerable size. Stomata on the inner side of the lid are not seen here. Spiral-cells, not yet fully developed, exist as in Fig. 1. It was remarkable, that all the sections, treated with Potassium hydrate at once showed a deep brown hue, especially in the hairs; even with a weak solution of the said liquor the phenomenon appeared. The supposition that the contents might be Tannin, was to be confirmed by treatment of the objects with 1. Sulphate of Iron, 2. Bichromate of Potassium, 3. Chlorzink of Iodine, 4. The Reagent of Gardiner-Rose.

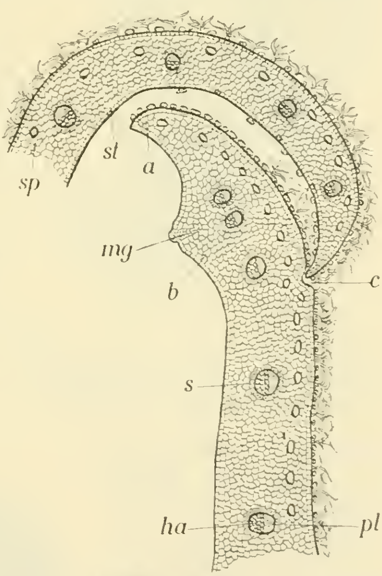

Fig. 3. *N. Mastersiana.* *s* = sheath, filled with Amylum.

In young stages the Tannin occurs both in the hairs, and in the outer and inner undifferentiated epidermis of the pitcher. As to what biological part the Tannin plays in these organs of Nepenthes, it has hitherto been quite impossible to say the decisive word.

Fig. 3, a section through the rim of *N. Mastersiana*, shows plainly the two parts of the collar, *a* the outer, *b* the inner; the level *a—b* is more concave. The outer surface of the pitcher and its lid is furnished with comparatively few of the long, branched hairs; peltate hairs, on the other hand, appear abundantly. It seems, also with regard to other species, that the peltate hairs develop, when the long, branched ones begin to fall, peltate hairs being seen in various young stages of development. The face *a—c* and the inner side of the lid are covered as in the younger pitchers. Numerous spiral cells with a fully developed spiral fibre are found. The fibre gives here, as in the adult plants, reaction of Cellulose with Chlorzink of Iodine, a fact already stated by Kny and Zimmermann (10). The vascular bundles, studied in details by Zacharias (15), are surrounded by a sheath, filled with Amylum, which probably yields material to the later developed sclerenchyma-cortex around the bundles. Young stages of lid glands, with their flaps, are seen here, and stomata occur dispersed all over the inner side of the lid. The surface *a—b* is yet uncorrugated, whereas the first trace of marginal glands has appeared.

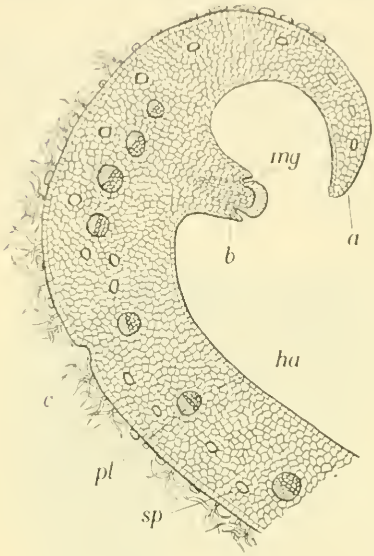

Fig. 4. *N. mixta*. The pitcher was but half open. Section through the incurved part of the collar.

The swelling, bearing them, is of the largest extension between them, on the spots where the teeth are formed later on.

In the stage shown i Fig. 4 (*N. mixta*) all the organs of the adult pitcher are developed and nearly qualified to function. The time chosen, was when the pitcher was but half open, and the section was laid through the part of the collar, which was yet incurved. When the lid rises and uncovers the pitcher orifice, the outer border of the collar *a*

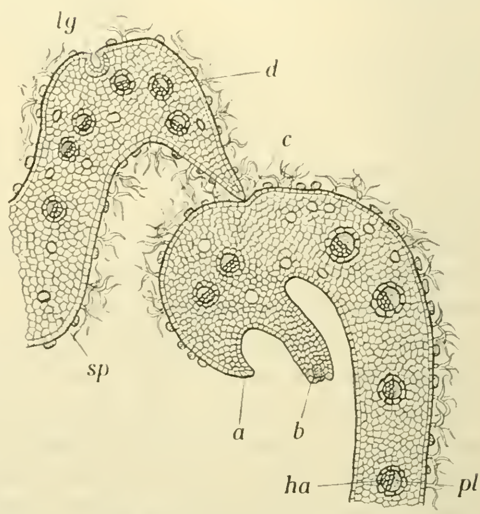

Fig. 5. *N. ampullaria*. Young stage. *d* = sclerenchyma; *lg* = attractive gland of the outer lid-surface.

bends outward and takes its place near the outer wall of the pitcher. In this part of my investigations the development is studied on species, where the outer and inner part of the collar were of almost equal size. As to *N. gracilis* and *N. ampullaria* the question will be treated in Part II: The epidermal formations on the corrugated rim.

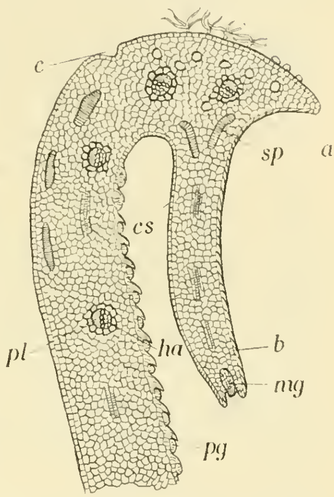

Fig. 6. *N. ampullaria.* Nearly adult stage. *pg* = peptic glands; *cs* = conducting surface.

To what degree the collar is developed in seedling-leaves, I have not been able to investigate, and likewise my materials have not allowed a close examination of the development of the marginal glands. Literature contains but very little about this matter, though the glands have been investigated by authors like Gibbons-Hunt, Faivre, Al. Dickson and Macfarlane. Gibbons-Hunt (9) discovered them in 1874; Faivre (3) mentioned them in greater length, certainly without knowing anything of Hunt's paper. Alexander Dickson (2) has reached the same result as Faivre, but speaks nowhere of the two preceding investigations. Macfarlane seems likewise not to take notice of Faivre; in 1893 he has a short remark on the development of these glands (13), about the exactness of which one cannot help feeling a little doubt. The marginal glands are supposed to secrete honey (Hooker (8), Goebel (5), Heinricher (6), Macfarlane (13) etc.); but in one case only (*N. gracilis*) I have succeeded in indicating it by Fehling's liquor.

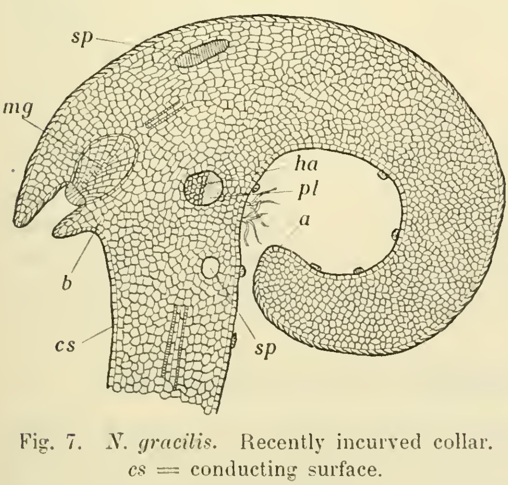

Fig. 7. *N. gracilis.* Recently incurved collar. *cs* = conducting surface.

A few further peculiarities in Macfarlane's new book must be mentioned. In *N. bicalcarata* the collar, as it is well known, bears, near the place where it is connected with the lid, two long spines, turning their points against the cavity of the pitcher. The utility of these has been explained in several odd fashions, one of which in a renovated form appears in (13): "Burbidge's explanation of their significance seems good. He observed in North Borneo that the pitchers of many species are visited by the small rodent *Tarsius spectrum*. Perched on the pitcher margin, it bends in its head and neck, scoops out the caught insects and devours them. But if it attempts such action with *N. bicalcarata* the two sharp spines often transfix it by the nape of the neck, and tumble it into the pitcher, or frighten it from attempting such action on other pitchers of the species. Another suggested explanation of the spines has recently been made, by supposing that they exude honey drops by their tips from a few marginal glands that are so placed as to cause an insect that attempts to sip, to drop off into the pitcher cavity. Such may be a partial reason for their gradual evolutionary selection and development, but Burbidge's view seems more natural" (pag. 10).

Dr. Macfarlane does not seem very particular in choosing his explanations. Also in the following remark the author shows a more than ordinary confidence in the power of the natural selection: "That these alluring nectar glands should wholly or mainly be confined to the lower laminar surface is appropriate and explicable on principles of natural selection, when one remembers that insects in the tropics usually run along that area, and so shelter themselves from the observation of enemies" (pag. 17).

Such explanations do not, in the slightest degree, contribute to clear up the causes of the said phenomena, and this tendency to regard "Natural Selection" as an explanation of all difficult problems was, as far as I know, foreign to Darwin's train of ideas.

II. Epidermal Formations on the Corrugated Rim.

The corrugated surface of the collar is of a special interest. Besides the great corrugations, which as well on the outer as on the inner border of the collar are pointed, and of which Faivre says that they are "placés comme à cheval sur la paroi de l'urne", there runs over each row of epidermal cells, along the large ones, a smaller corrugation, shaped in a peculiar manner. All this exceedingly combinated surface reflects the light looking, as if it were covered with honey. In connexion with the colours of the rim this circumstance perhaps may serve to allure the prey. The great corrugations have been explained by Wunschmann (14) in a more surprising than correct fashion.

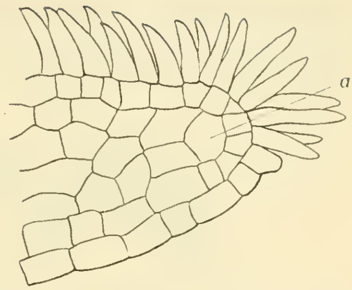

Fig. 8. *N. mixta.* Section parallel with the corrugations of a young collar. *a* = the outer border of the collar. The stage of development is corresponding to that in Fig. 4.

He says: "Charakteristisch für den Habitus der Becher sind auch noch die Ränder ihrer Mündungen. Hier nämlich treten die Gefässbündel aus dem Parenchym des Bechers hervor und bilden den geringelten Saum der Bechermündung,

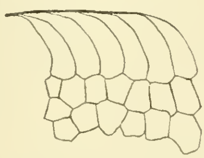

Fig. 9. *N. mixta.* Section parallel with the corrugations in the middle of the collar. Cuticle removed. Stage of development: Fig. 4.

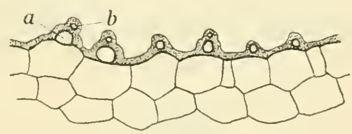

Fig. 10. *N. mixta.* Vertical section through the small corrugations. Cuticle pointed. *a, b* = prolongations; stage of development: Fig. 4.

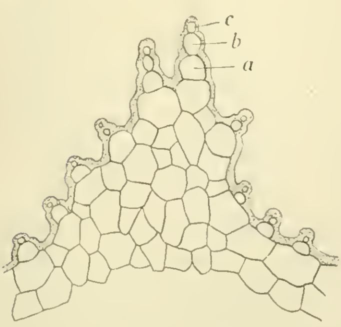

Fig. 11. *N. mixta.* Vertical section through the large corrugations. Cuticle pointed. *a, b, c* = prolongations of the three adjacent cells. Stage of development: Fig. 4.

der bei den verschiedenen Arten in verschiedenen Modificationen auftritt" (pag. 7). Macfarlane has already in 1893 given a figure of the large corrugations, and later on, in 1908, he has made a further short remark on the epidermal cells of the corrugated part: "The corrugated surface of the peristome consists of highly cuticularized epidermal cells arranged in radial rows, and neatly fitting into each other by oblique walls. The surface of each cell is delicately striated radially, while the end of the cell that is towards the mouth of the pitcher may slightly overlap the adjacent end of the next cell within" (pag. 18). To this view I shall make a few additions.

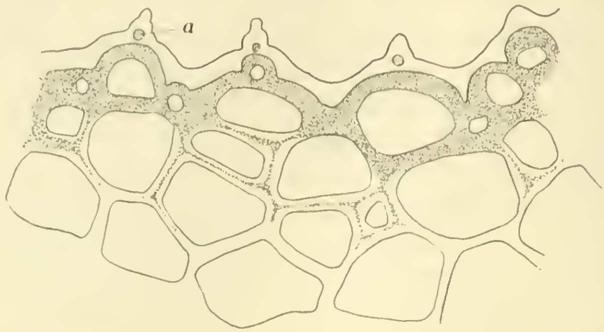

Fig. 12. *N. Allardi.* Section through the small corrugations. Lignification pointed; *a* = prolongation of the adjacent epidermal cell. Adult pitcher.

Fig. 8 shows a section parallel with the corrugations of a young pitcher of *N. mixta* (stage of development corresponding to Fig. 4). The pitcher was not quite open: The foremost part of the lid was free, and the collar was here partly incurved to its final position. *a* is corresponding to the outer border of the collar. Here is plainly seen the change from the ordinary epidermal formation of the outer wall to the corrugated surface. The cells on this border are prolonged, without having formed, however, any connecting face; the cuticle is here extremely feeble. The nearer the cells are placed to the inner border, the more pronounced is the bending towards the cavity of the pitcher and overlapping of the adjoining cells; a thick cuticle is here formed on their upper part (Fig. 9). The prolongations overlapping the adjacent cells are awl-shaped, and quite imbedded in the cuticle. They form long continuous lines, which are seen as the low corrugations. On the large corrugations they are much longer than in the valleys

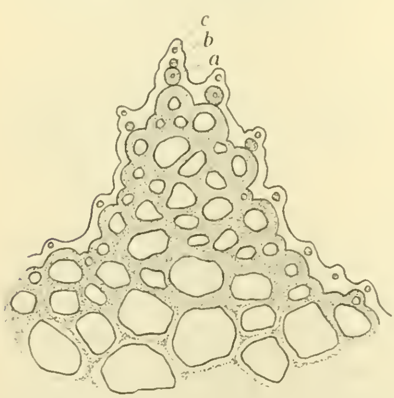

Fig. 13. *N. Allardi.* Section through one of the large corrugations. Lignification pointed *a*, *b*, *c* = prolongations. Adult pitcher.

between these, as shown in Fig. 10 and 11, two sections across the corrugations. *a* is the epidermal cell, *b* the prolongation from the adjacent one, etc. Later on the cells, and especially their prolongations, are thickened and lignified, a phenomenon otherwise somewhat rare in epidermal cells. In Fig. 12 (a section across the corrugated rim of *N. Allardi*), the lignified parts are shown by punctions. The lignification indicated by Phloroglucin-muriatic-acid, occurs in the epidermis and the middle lamellæ of the subepidermal layer; in the large corrugations, however, the lignification also stretches through all the parenchyma (Fig. 13). No doubt as well the shape of the collar and its surface as the lignification may augment the inflexibility of the rim. On the surface of the rim below the marginal glands, the prolongations from the epidermal cells are directed towards these, away from the cavity of the pitcher. Here the corrugated formations turn into the typical conducting surface, extending in the various species over more or less considerable part of the inner pitcher-wall. In *N. gracilis*, where the inner part of the collar is very short, the conducting surface is large (Fig. 7); in *N. ampullaria* quite the reverse takes place (Fig. 6). Here, as Macfarlane (12) states, most of the inner part of the collar evidently functions as a conducting surface, affording a very insecure foothold for insects, but his description of

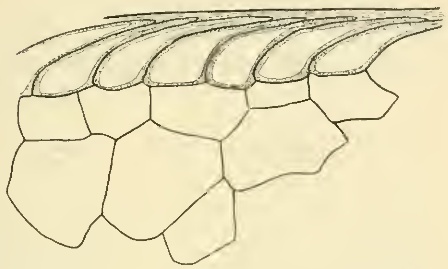

Fig. 14. *N. gracilis.* Section parallel with the corrugations. Lignification pointed. Stage of development: Fig. 7.

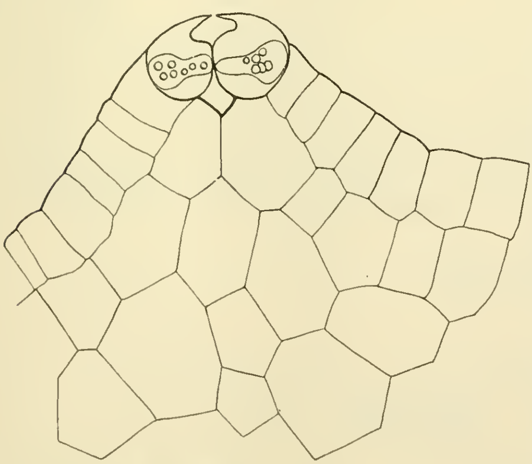

Fig. 15. *N. Mastersiana.* Stomata of the inner side of the lid. Stage of development: Fig. 1.

the real conducting surface in this species seems to me a little erroneous. He says: "The conducting surface, represented by a narrow glabrous band internally at the top of the tube, is functionless, and small digestive glands thickly cover the whole inner cavity". (pag. 421). No doubt small digestive glands cover almost all the inner pitcher-wall, beginning close at the spot where the collar rises, and the conducting surface likewise is functionless, but, stretching however over the lower surface of the inner part of the collar, it is not limited to a narrow band at the top of the tube (*b—c*, Fig. 6). There seems to exist a sort of correlation between the extension in depth of the conducting surface and the size of the inner part of the rim, a correlation of which *N. gracilis* and *N. ampullaria* are here taken as types. In the former the growth at *b* (Fig. 7) is greatly limited, and the conducting surface stretches along the inner pitcher-wall, whereas in the latter an important growth at *b* forces the conducting surface out on the lower side of the incurved rim.

Fig. 16. *N. Mastersiana*. Stomata of the inner side of the lid. Stage of development: Fig. 3.

Unquestionably the constitution and development of the collar in the various species must be taken into account, when the genealogical connection of the *Nepenthes*-species shall be traced, as Macfarlane has done; but I do not think that he is quite right in regarding the collar of *N. ampullaria* as a more primitive form than that of *N. gracilis*.

Copenhagen, 17. April 1909.

Résumé.

I. Kravens Udvikling og Morphologi.

A. To fejlagtige Meninger om Kravens Udvikling er tidligere anført:

a. Hele den rillede Overflade skulde svare til Kandens oprindelige Rand, som under Væksten blev fladet ud. (Macfarlane (11) 1889).

b. Den oprindelige Rand skulde findes, forsynet med Randkirtler, i Kravens indadbøjede Del, og den udadbøjede Del fremkom da ved

Vækst af Partiet under Laagets Tilhæftningssted (*c*. Fig. 1) (Macfarlane (13) 1908).

Fejlen skyldes i begge Tilfælde, at Forf. overhovedet ikke har undersøgt Udviklingsgangen.

B. Kandens oprindelige Rand maa paa den voksne Kande søges i den udadbøjede Del (*a*. Fig. 1—7); den indadbøjede fremkommer ved Vækst af en ringformet Hævning paa den unge Kandes Inderside (*b*. Fig. 1—7).

C. Kravens rillede Overflade skal saaledes betragtes som en ny Modifikation af Kandens Inderflade.

D. Spalteaabninger findes paa Laagets Inderside, saavel i unge som voksne Stadier. Medens de tidligere var kendt fra Indersiden af Sarraceniakandens Dække (Hooker (8) 1874, Zipperer (16) 1885), har dette ikke været Tilfældet med Nepenthes [1]). For Wunschmann spillede deres Fraværelse en Rolle ved Tydningen af Kandens morphologiske Værd. (Wunschmann (14) 1772).

E. Skjoldhaar uddannes først paa Ydersiden af det unge Kandeanlæg, naar de lange, grenede Haar begynder at falde af.

F. De endnu ikke færdigdannede Tracheïdeceller, som findes i unge Kandeanlæg, er tidligere opfattede som Intercellulærrum. (Fenner (4) 1904).

G. Garvesyre forekommer i de unge Kanders Haar, samt i deres indre og ydre Epidermis; dens biologiske Betydning er endnu ukendt.

II. Kravens Overhudsdannelser.

A. Paa Kraven findes tre Former for Overhudsceller:

a. Celler af samme Beskaffenhed som paa Kandens Ydervæg beklæder Undersiden af Kravens udadbøjede Del (morphologisk lig med Kandens ydre Overflade); Overgangen gennem uregelmæssigt forlængede Celler ved den ydre Kant (Kandens oprindelige Rand) ses i Fig. 8.

b. Tykvæggede, forveddede Celler med sylformede Forlængelser rettede mod Randkirtlerne findes paa hele Kravens Overflade og en Del af den indadbøjede Parts Underside. Disse dækkes af en tyk Cuticula (Fig. 9—14).

c. Flade, voksklædte Celler som Glidefladens, med hvilke de staar i jævn Forbindelse, beklæder Resten af Kravens Underside. De to sidste Celleformer tilhører morphologisk Kandens Inderside.

B. Rillerne paa Kravens Overflade er to Slags:

a. Lave Riller, dannede udelukkende af Overhudscellerne med deres Forlængelser.

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[1]) Se Noten Side 147.

b. Høje Riller, tillige dannede af de underliggende Parenchymlag; (af Wunschmann fejlagtig opfattede som Karstrengdannelser). Begge Slags er forveddede gennem hele deres Udstrækning, hvorved de aabenbart tjener Afstivningen af Kandens Munding.

C. *N. gracilis* og *N. ampullaria* viser to Typer af Kraven:

a. Stor udadbøjet Del, kort indadbøjet; Glidefladen strækker sig langt ned paa Kandens Inderside (Fig. 7).

b. Lille udadbøjet Del, stor indadbøjet, med funktionsløs Glideflade paa sin Inderside (Fig. 6).

D. Kravens morphologiske Forhold faar Betydning for Forstaaelsen af Nepenthesarternes Systematik. Macfarlane's Tydninger i denne Henseende maa anses for delvis upaalidelige, da de ikke hviler paa noget Kendskab til Kravens Udviklingshistorie.

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Note to page 135. In his 4th edition of „Physiologische Pflanzenanatomie", Dec. 1909, Haberlandt mentions some new investigations on the conducting surface of the *Nepenthes*-pitcher. He maintains. partially after Bobisut, that the small cells, here found dispersed over all the wax-covered conducting surface of the pitcher, are deformed stomata. The case is very interesting, and without doubt he is quite right. But Haberlandt says, that these small cells already were seen by Goebel — already De Bary (1877) and Wunschmann (1872) mentioned them.

F. H.

28—2—1910.

KBHVN. BIANCO LUNO

Arbejder fra den Botaniske Have i København. Nr. 53.

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 3
SÆRTRYK AF »MEDDELELSER OM GRØNLAND« XLIII

FRESHWATER ALGÆ

FROM

THE "DANMARK-EXPEDITION" TO NORTH-EAST GREENLAND (N. OF 76° N. LAT.)

BY

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KØBENHAVN
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1910

INTRODUCTION.

Our knowledge of the Freshwater Algæ of East Greenland is based so far as I know upon the following papers:

ROBERT BOLDT, Desmidieer från Grönland (1888).
— Några Söttvattensalger från Grönland (1893).
F. BØRGESEN, Ferskvandsalger fra Østgrønland (1894).
E. LARSEN, The Freshwater Algæ of East Greenland (1904).

The first-mentioned paper deals, as is already shown in the title, only with Desmids and these originate from the whole of Greenland; from East Greenland 44 species are reported; they are found in the collections of A. G. NATHORST and J. A. BERLIN from "Kung Oskars hamn" near Angmagsalik, 65° 31′ N. Lat.

In the second paper, on the other hand, BOLDT deals with several freshwater algæ belonging to other groups which he had found on studying the Desmids in the above-mentioned collections. He mentions 4 species from East Greenland, all from the same locality.

In my paper, based upon material collected by N. HARTZ during the expedition to East Greenland, 1891—92, are described a little more than 150 *Chlorophyceæ* and *Cyanophyceæ*; they were mostly gathered in the environs of "Hekla Havn" at "Danmarks Ø" in Scoresby Sound (ca. 70° 30′ N. Lat.); some of the material also originates from "Hold with Hope" in Hudson Land (ca. 73° 30′ N. Lat).

Finally, in LARSEN's paper 125 *Chlorophyceæ* are mentioned. The material collected by KRUUSE and N. HARTZ comes from localities from Kap Dan (65° 31′ N. Lat.) up to Sabine Island (74° 30′ N. Lat.). In his paper LARSEN brings together all the *Chlorophyceæ* hitherto known from East Greenland and they amount to 189 species in all; of these no less than 144 are Desmids.

The present list is based upon collections from the Danmark-Expedition to the North-east coast of Greenland in 1906—1908. They all originate from the district around Danmarks Havn, 76° 46′ N. Lat. and 18° 43′ W. Long., on Germania Land.

The material was collected by Mr. A. LUNDAGER with exception of a single sample taken by Dr. LINDHARD.

It consists of 20 samples preserved in spirit and 10 dried specimens. The localities from which the collections come are arranged from north to south in the following list.

Germania Land: —[1]
Rypefjeld,
Hvalrosodde,
Dove Bugt,
Lille Snenæs,
Snenæs,
Stormkap,
Vester Elv, } Danmarks Havn,
Basiskæret, }
Termometerfjeld,
Kap Bismarck,
Yderbugten,
} Between 77°—76° 43′ N. Lat. and 21°—17° 30′ W. Long.

In general the material collected may be regarded as rather poor, both as to quantity and quality. Certainly a few samples from "Vester Elv" (river) contained a great number of species but on the other hand the number of individuals was for most species very few; of several species I have only found one single specimen. This has made the determination decidedly troublesome.

The reason why the material upon the whole is so comparatively poor and the collections so small, often only consisting of a trifle at the bottom of the glass, of which even a great part was earth particles etc., is certainly that the manner of collecting was not the best one: a plankton-net was placed in running water and left there for several hours. In this way nearly all the Desmids named in the following list were collected and also several of the other species. Of course some bigger algæ e. g. *Nostoc* and clumps of algæ are collected along the sides of some lakes. On the other hand there are scarcely any collections made of small fixed algæ.

Judging from the really rather rich collections from Vester Elv gathered in this somewhat unpractical way I think it beyond doubt that a skilled algologist would be able to find a considerably greater number of species.

From this point of view I do not think it would be worth while to try and make a detailed comparison of the Freshwater alga flora from West Greenland and the surrounding lands with that of East Greenland. I shall restrict myself to pointing

[1] The localities here given are arranged from N. W. to S. E.

out the discovery of the genus *Spirotænia*, which up to the present had not been recorded from East Greenland or Greenland on the whole. The species found was *Sp. condensata* Bréb. which is well-known in arctic countries, e. g. in Nova Zembla and Spitzbergen.

Of high-arctic species hitherto not found in Greenland may be mentioned *Euastrum tetralobum* Nordst. which is known only from Spitzbergen and Nova Zembla.

Further may be named *Cosmarium spetsbergense* Nordst. also a true arctic species, which has earlier only once been found in East Greenland (Hurry Inlet); elsewhere it is only known from Jan Mayen, Spitzbergen and Nova Zembla.

Of the genera which I have mentioned in my above-mentioned paper, namely: *Mesotaenium* (1 species), *Penium* (5 species), *Cylindrocystis* (1 species), *Closterium* (6 species), *Pleurotænium* (1 species), *Cosmarium* (42 species), *Arthrodesmus* (2 species), *Xanthidium* (1 species), *Staurastrum* (29 species), *Euastrum* (6 species), *Gonatozygon* (1 species), *Desmidium* (1 species), *Gymnozyga* (1 species), *Hyalotheca* (1 species), *Sphaerozosma* (1 species) the following genera have not been discovered here: *Mesotaenium, Arthrodesmus, Xanthidium, Gonatozygon, Gymnozyga* and *Sphaerozosma*. Of *Closterium* only two species were present and of *Euastrum* 4 species only: 3 of the 6 species mentioned in my earlier paper have disappeared but in return the quite arctic species *Euastrum tetralobum* has been added and this confirms the fact first pointed out by BOLDT, later by me, that the large *Euastrum*-species are wanting in the true arctic regions; the interesting find of *E. oblongum* in Jameson Land by LARSEN makes this species an exception.

With regard to the most of the above-named genera the complete disappearance of some and the reduction in the number of species of others is in good accordance with what we know about the distribution of the plants in question, which all disappear or are very seldom in the arctic regions[1].

The remaining green algæ are of little interest. Of bluish-green algæ *Nostoc commune* seems to be common. Even very large specimens are found along the border of lakes or on places quite laid dry in summer. Stones on the bottom of lakes when dry were found covered by blackish crusts of different bluish-green algæ e. g. *Glœocapsa*-species and *Calothrix* etc.

No material of snow-algæ was brought home.

[1] ROBERT BOLDT, Grunddragen af Desmidieernas Utbredning i Norden (Bihang till k. svenska Vet.-Akad. Handl. Bd. 13, Afd. III, No. 6, Stockholm 1887).

List of papers most referred to.

Boldt, Robert, Desmidieer från Grönland. Bih. Sv. Vet. Akad. Handl. Bd. 13, Afd. III, Nr. 5, Stockholm 1888.

— Några sötvattens-alger från Grønland. — Bot. Notiser, 1893, Lund.

Børgesen, F., Ferskvandsalger fra Østgrønland. — Medd. om Grønland. XVIII, Kjøbenhavn 1894.

— Algues d'eau douce (C. Ostenfeld-Hansen, Contribution à la flore de l'île Jan Mayen). — Bot. Tidsskr. Bd. 21, Kjøbenhavn 1897.

Larsen, E., The Freshwater Algæ of East Greenland. Medd. om Grønland, XXX. København 1904.

— Ferskvandsalger fra Vest-Grønland. — Medd. om Grønland, XXXIII. København 1907.

Nordstedt, O., Desmidiaceæ ex insulis Spetsbergensibus et Beeren Eiland in expeditionibus annorum 1868 et 1870 suecanis collectæ. — Öfvers. k. Vet. Akad. Förh. 1872. No. 6. Stockholm.

— Desmidieæ arctoæ. Öfvers. k. Vet. Akad. Förh. 1875. No. 6. Stockholm.

— Desmidieer samlade af Sv. Berggren under Nordenskiöld'ska expeditionen till Grönland 1870. — Öfvers. k. Vet. Akad. Förh. 1885. No. 3. Stockholm.

Wille, N., Ferskvandsalger fra Novaja Semlja samlede af Dr. F. Kjellman paa Nordenskiölds Expedition 1875 (Öfversigt af kongl. Vet.-Akam. Förhandl. 1879, No. 5, Stockholm).

Myxophyceæ.

Chroococcaceæ.

Chroococcus Näg.

1. **C. turgidus** (Kütz.) Näg., Gattung. einz. Algen, p. 46.

Børgesen, Ferskvandsalg. Østgrønland. p. 6 (Hekla Havn. Gaasefjord).

Found in two collections, one from a bog, the other from a small lake.

Loc. Hvalrosodde: Lomsøen, Rypefjeld.

Gloeocapsa Näg.

1. **G. ambigua** Näg., Gattung. einz. Algen, p. 50.

Børgesen. Ferskvandsalg. Østgrønland. p. 6.

Found together with other bluish-green algæ in blackish crusts upon stones from the bottom of a dry mountain-lake.

Loc. Lille Snenæs.

2. **G. ianthina** Kütz. Nägeli, Gattung. einz. Algen, p. 51.

Børgesen. Ferskvandsalg. Østgrønland, p. 6.

Found together with the above-mentioned species under similar conditions.

Loc. Lille Snenæs, Thermometer Fjeld.

3. **G. Magma** (Bréb.) Kütz., Tab. Phycol. I, tab. 22, fig. 1.

Børgesen, Ferskvandsalg. Østgrønland, p. 6.

Found among other Algæ (*Nostoc* etc.) and Musci near the foot of a glacier and in blackish incrustations on stones.

Loc. Lille Snenæs, Thermometerfjeld.

Coelosphaerium Näg.

1. **C. lacustre** (Chodat) Ostenf., Beitr. z. Kenntnis d. Algenflora des Kossogol-Beckens (Hedwigia, Bd. 46. p. 396, tab. IX, fig. 6—7).

The pear-shaped cells in the colony were somewhat closer together than in the figure of Ostenfeld.

Lat. cell. = 2,5 μ.

Dr. Ostenfeld has most kindly seen the plant in question and told me that it seems to him identical with this species.

Found in a collection from Vester Elv.

Loc. Danmarks Havn.

Merismopedium Meyen.

1. **M. glaucum** (Ehrb.) Näg., Gattung. einz. Algen, p. 55.

Børgesen, Ferskvandsalg. Østgrønland, p. 7 (Hekla Havn).

A few specimens were found in collections from Vester Elv.

Loc. Danmarks Havn.

Oscillariaceæ.

Phormidium Kütz.

1. **Ph. autumnale** (Ag.) Gom., Monograph. Oscill. p. 207, tab. V, fig. 23—24.

Børgesen, Ferskvandsalg. Østgrønl., p. 7 (Hekla Havn .

Found as blackish crusts among other algæ and mosses on wet earth near a glacier.

Loc. Thermometerfjeld.

Rivulariaceæ.

Calothrix Ag.

C. parietina (Näg.) Thur., Bornet et Flahault, Revision des Nostoc. héter. I, p. 366.

Found together with *Gloeocapsa*-species as blackish crusts on stones from the bottom of a dry mountain lake.

This species was not earlier found in East Greenland but in West Greenland it is known from Karajak (Richter, Süsswasseralgen aus dem Umanakdistrikt, p. 4).

Loc. Lille Snenæs.

Scytonemaceæ.

Scytonema Ag.

1. **Sc. Myochrous** (Dillw.) Ag., Bornet et Flah., Revision des Nostoc. hétérocyst. p. 104.

Børgesen, Ferskvandsalger. Østgrønland, p. 8.

A few filaments most probably belonging to this species were found in a small lake.

Loc. Hvalrosodde: Lomsøen.

Tolypothrix Kütz.

1. **T. lanata** (Desv.) Wartm. Bornet et Flahault, Revision des Nostoc. hétérocyst., p. 120.

Børgesen, Ferskvandsalg. Østgrønl., p. 8 (Hekla Havn).

The filaments were a little thicker than the measurements given by Bornet et Flahault, l. c., namely 10—14 μ. But after having examined specimens referred by Bornet et Flahault to this species, e. g. No. 184 in Wittrock & Nordstedt, Algæ Exsicc., I have also here found filaments reaching this thickness and I have therefore no doubt as to the correctness of the determination.

Found in small lakes.

Loc. Hvalrosodde: Lomsøen.

Nostocaceæ.

Nostoc Vauch.

1. **N. commune** Vauch. Bornet et Flahault, Revision des Nostoc. hétérocyst. p. 203.

Børgesen, Ferskvandsalg. Østgrønl., p. 8.

This species seems to be common. It is found partly in the form of a large gelatinous membrane, partly also as more crumpled masses.

It occured in bogs and also in places laid dry.

Loc. Basiskæret, Stormkap, Kap Bismarck, Rypefjeld.

Young small colonies of *Nostoc* were found in several collections. They were e. g. common as blackish crusts, composed of fragments of Algæ and Musci etc. on ground near the foot of a glacier at "Thermometerfjeld" and on damp ground at "Yderbugten".

Conjugata.

Desmidiaceæ.

Penium Bréb.; De Bar.

1. **P. Libellula** (Focke) Nordst., Desm. Bornh. p. 184. *Penium closteroides* Ralfs, Børgesen, Ferskvandsalg. Østgrønland, p. 9, tab. 1, fig. 1.

Boldt, Desm. Grønland, p. 40 (sub. nom. *Penium closteroides*) (Kung Oskars hamn). Børgesen, Ferskvandsalg. Østgrønland, p. 9 (Hekla Havn).

Long. = 70—80 μ; lat. = 17 μ.

A single specimen seen in a collection from "Vester Elv".

Loc. Danmarks Havn.

2. **P. margaritaceum** (Ehrenb.) Bréb., Ralfs, Brit. Desm. p. 149, tab. 25, fig. 1; tab. 33, fig. 3.

Børgesen, Ferskvandsalg. Østgrønland, p. 9 (Hekla Havn).

Larsen, Freshw. Alg. East Greenl. p. 94 (Kordlortok, Amaka, Kap Dalton, Jameson Land, Sabine Ø).

Lat. = 25 μ.

Found in two collections from "Vester Elv".

Loc. Danmarks Havn.

3. **P. curtum** Bréb., in Kütz Spec. Alg. p. 167. *Cosmarium curtum* Ralfs, Brit. Desm. p. 109, tab. 32, fig. 9. *Dysphinctium* (*Actinotaenium*) *Regelianum* Näg., Gatt. einz. Alg. p. 110, tab. VI E.

Børgesen, Ferskvandsalg. Østgrønland. p. 9, 10 (Hekla Havn, Hold with Hope).

Larsen, Freshw. Alg. East Greenl., p. 94 (Kap Dalton, Jameson Land, Kap Borlase Warren, Sabine Ø).

The specimens found quite agreed in size with those I have mentioned in my earlier paper (l. c.).

Long. = 43 μ; lat. = 22 μ.

Loc. Danmarks Havn: Vester Elv.

Cylindrocystis Menegh.

1. **C. Brebissonii** (Menegh.) De Bary, Conjug. p. 35, tab. 7, fig. E 1—22.

Børgesen, Ferskvandsalg. Østgrønland, p. 10 (Gaasefjorden).

Larsen, Freshw. Alg. East Greenl. p. 90 (Kingorsuak, Kap Dalton).

Some few specimens were seen in a collection from "Vester Elv".

Lat. = 15 μ.

Loc. Danmarks Havn.

Spirotænia Bréb.

1. **Sp. condensata** Bréb. in Ralfs, Brit. Desm. p. 179, tab. 34, fig. 1.

Long. = 90 μ; lat. = 17 μ.

The size of the plant corresponds closely with that Nordstedt gives for the plant found at Mosel Bay in Spitzbergen (Nordst., Desm. arct. p. 15) but it is much smaller than the size West gives for the plant in his Monograph of the British Desmidiaceæ, vol. I, p. 38.

This species has not earlier been found in East Greenland and it is also not mentioned from West Greenland (cfr. Larsen, II). Only found in few specimens in Vester Elv.

Loc. Danmarks Havn.

Closterium Nitzsch.

1. **Cl. acutum** (Lyngb.) Bréb., in Ralfs' Brit. Desm., p. 177, tab. 30, fig. 5.

Børgesen, Ferskvandsalg., Østgrønland, p. 10 (Hekla Havn).
Larsen, Freshw. Alg. East Greenl. p. 81 (Kordlortok, Liverpool Kyst in Hurry Inlet).

Loc. Danmarks Havn. Only a few specimens found in Vester Elv.

Lat. cell. = 11 μ.

2. **Cl. striolatum** Ehrenb., Entw. d. Inf. p. 68. Ralfs, Brit. Desm., p. 170, tab. 29, fig. 2.

Boldt, Desm. Grønl. p. 42 (Kung Oskars hamn).
Børgesen, Ferskvandsalg. Østgrønland, p. 10 (Hekla Havn, Røde Ø).
Larsen, Freshw. Alg. East Greenl., p. 82 (Amaka, Liverpool Kyst in Hurry Inlet).

Only a single specimen was found, the breadth of which was 50 μ.

Loc. Danmarks Havn: Vester Elv.

Pleurotænium Näg.

1. **P. truncatum** (Bréb.) Näg., Gatt. einz. Alg., p. 104.

Only a single specimen found in a collection from Vester Elv.

Long. = 400 μ; lat. = 54 μ.

In size it agrees very well with the measurements given by Nordstedt for plants found in Spitzbergen and Bear Island (Nordstedt, Desm. Spetsb. p. 26).

This species was not earlier recorded from East Greenland but it is known from West Greenland (Larsen, II, p. 346).

Loc. Danmarks Havn.

Tetmemorus Ralfs.

1. **T. lævis** (Kütz.) Ralfs, Brit. Desm. p. 146, tab. 24, fig. 3.

β **attenuatus** Wille, Ferskvandsalg. Nov. Semlja, p. 58, tab. 14, fig. 77.

Boldt, Desm. Grønl. p. 42 (Kung Oskars hamn).
Larsen, Freshw. Alg. East Greenl. p. 101 (Amaka Kap Dalton).

Only one half-cell was found; the cell-membrane was minutely punctate.

Lat. cell. = 28 μ.

Loc. Danmarks Havn: Vester Elv.

Cosmarium (Corda) Ralfs.

1. **C. bioculatum** Bréb., in Ralfs, Brit. Desm. p. 95, tab. 15, fig. 5.

Boldt. Desm. Grønl., p. 16 (Kung Oskars hamn).
Børgesen, Ferkvandsalg. Østgrønland, p. 18 (Røde Ø, Hekla Havn).
Larsen, Freshw. Alg. East Greenland, p. 88 (Kap Borlase Warren. Sabine Ø).

A form agreeing well with that mentioned by Nordstedt, Desm. arct., p. 20, tab. 6, fig. 8 was found in Vester Elv.

Long. = 29 μ; lat. = 27 μ; lat. isthm. 9 μ.

Loc. Danmarks Land.

2. **C. Botrytis** (Bory) Menegh., Synops. Desm. p. 220.

Boldt, Desm. Grønl., p. 28 (Kung Oskars hamn).
Børgesen. Ferskvandsalg. Østgrønland, p. 13 (Hekla Havn, Danmarks Ø).
Larsen, Freshw. Alg. East Greenland, p. 83 in several localities from Kordlortok (65° 40′)—Kap Borlase Warren (74° 1′).

Some few specimens were found in collections from Vester Elv.

Loc. Danmarks Havn.

3. **C. conspersum** Ralfs, Brit. Desm., p. 101, tab. 16, fig. 4.

β **rotundatum** Wittr., Skandin. Desm., p. 13, tab. I, fig. 4.

Børgesen, Ferskvandsalg. Østgrønland, p. 13 (Hekla Havn, Røde Ø).
Larsen, Freshw. Alg. East Greenland, p. 84 (Jameson Land, Kap Borlase Warren).

A form rather near that mentioned by Boldt (Desm. Grønl. p. 26, tab. 2, fig. 27) was found in a collection from a small lake at Hvalrosodde.

Long. = 80 μ; lat. = 65 μ; lat. isthm. = 24 μ; crass. = 39 μ.

Loc. Hvalrosodde.

4. **C. crenatum** Ralfs, Ann. Nat. Hist., vol. 14, p. 394, tab. 11, fig. 6; Brit. Desm., p. 96, tab. 15, fig. 7.

Boldt. Desm. Grønl., p. 18 (Kung Oskars hamn).
Børgesen, Ferskvandsalg. Østgrønland, p. 14 (Hekla Havn).

Forma "**Crenæ laterales 3**", Nordstedt, Desm. Spetsberg. p. 30, tab. 6, fig. 7.

One specimen was found in Vester Elv.

* **costatum** Nordstedt, Desm. Spetsberg, p. 30, tab. 6, fig. 9.

Long. = 41 μ.

Found in the same locality.

Loc. Danmarks Havn.

5. **C. cyclicum** Lund., Desm. Suec., p. 35, tab. 3, fig. 6.

* **arcticum** Nordst., Desm. Spetsb., p. 31, tab. 6, fig. 13.

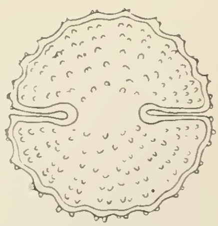

Fig. 1. *C. cyclicum* Lund. **arcticum* Nordst. (270/1).

Børgesen, Ferskvandsalg. Østgrønland, p. 15 (Hekla Havn).
Larsen, Freshw. Alg. East Greenl. p. 84 (Amaka, Falkefjæld, Kingorsuak, Kap Dalton, Liverpool Kyst in Hurry Inlet, Sabine Ø).

This species was absolutely the most common in the collections and the only one of which I have seen a great number of specimens. It seems to be rather variable as to size and form of the cell. Most of the individuals seen quite agreed with the above-cited figure of Nordstedt, the cells being quite circular.

Long. = 62 μ = lat.

Other specimens were more hexagonal, coming near to the form which Boldt in Desm. Grønl., p. 23, tab. I, fig. 24 has called var. *subarcticum*.

Long. = 67 μ; lat. = 70 μ.

This variety seems to come rather near to *Cosm. Nordstedtianum* Reinsch, which Nordstedt in "Hedwigia", 1876 has referred as a form to *Cosm. cyclicum* (cfr. W. West and G. S. West, Monogr. of the Brit. Desm., vol. II, p. 146, pl. LVIII, fig. 12).

Loc. Danmarks Havn: Vester Elv.

6. **C. Debaryi** Arch. in Pritch. Infus., p. 735.

Børgesen, Ferskvandsalg. Østgrønland, p. 21 (Hekla Havn).

β **Novæ Semliæ** Wille, Ferskvandsalg. Nov. Semlja, p. 48.

The form observed seems to agree quite well with forma *minor* Wille, l. c. tab. XIII, fig. 47; but as I have only found a single specimen without chlorophyll I may mention that the determination is not at all certain. Perhaps we have to do with a form of *C. Cucumis* Ralfs (cfr. Nordstedt, Desm. arct. p. 29, tab. VIII, fig. 28, 29) or with a big form of *C. quadratum* Ralfs.

Long. = 90 μ; lat. = 47 μ; lat. isthm. 31 μ.

The specimen was found in Vester Elv.

Loc. Danmarks Havn.

7. **C. granatum** Bréb. in Ralfs, Brit. Desm. p. 96, tab. 32, fig. 6.

Boldt, Desm. Grønl. p. 12 (Kung Oskars hamn).
Børgesen, Ferskvandsalg. Østgrønland, p. 18 (Hekla Havn).
Larsen, Freshw. Alg. East Greenl. p. 85 (Kordlortok, Amaka).

Loc. Hvalrosodde.

8. **C. hexalobum** Nordst., Desm. Spetsb., p. 33, tab. VII, fig. 16.

Børgesen, Ferskvandsalg. Østgrønland, p. 15 (Hekla Havn).
Larsen, Freshw. Alg. East. Greenl. p. 85 (Kap Dalton, Liverpool Kyst in Hurry Inlet).

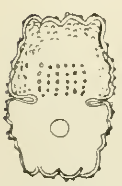

Fig. 2. *C. hexalobum* Nordst. (270/1.)

This arctic and alpine species has been found in several collections from Vester Elv. The form observed (Fig. 2) agreed rather well with Nordstedt's description, the only difference being that it was not quite so broad. Boldt in Desm. Grønl. p. 24 has also mentioned such a narrow form.

Long. = 54 μ; lat. = 37 μ; lat. isthm. = 14.

Loc. Danmarks Havn.

9. **C. Holmiense** Lund., Dem. Suec., p. 49, tab. 2, fig. 20.

β **integrum** Lund., Nordst. Desm. Spetsb., pag. 28, tab. 6, fig. 5.

Børgesen, Ferskvandsalg. Østgrønland, p. 20 (Hekla Havn, Røde Ø, Hold with Hope).

Larsen, Freshw. Alg. East Grenl. p. 85 in different localities from Kingorsuak (60° 5') to Sabine Ø (74° 30').

A few specimens were found in Vester Elv.

Long. = 58 μ; lat. = 30 μ.

Loc. Danmarks Havn.

10. **C. Meneghinii** Bréb.

Børgesen, Ferskvandsalg. Østgrønland, p. 16 (Hekla Havn, Røde Ø.

Larsen, Freshw. Alg. East Greenl., p. 86 (found in several localities from Kordlortok 65° 40'—Sabine Ø 74° 30').

Forma De Bary, Conjugaten, p. 72, tab. 6, fig. 34.

Found once in a small lake.

Loc. Hvalrosodde.

11. **C. microsphinctum** Nordst., Desm. Ital. p. 33, tab. 12, fig. 9.

Børgesen, Ferskvandsalg. Østgrønland, p. 16, tab. 1, fig. 6.

Larsen, Freshw. Alg. East Greenl., p. 86 (Kap Dalton, Sabine Ø).

The observed form quite agreed with that mentioned and figured in my above-quoted paper. I propose to call it f. *groenlandica*.

Long. = 48 μ; lat. = 32 μ; lat. isthm. = 20 μ.

Found once in Vester Elv.

Loc. Danmarks Havn.

12. **C. nasutum** Nordst., Desm. Spetsb. p. 33, tab. VII, fig. 17.

Forma **granulata** Nordst., l. c. p. 34, Wille, Ferskv. Alg. Nov. Semlja. p. 42, tab. XII, fig. 30.

Børgesen, Ferskvandsalg. Østgrønland, p. 14 (Hekla Havn).

Larsen, Freshw. Alg. East Greenl. p. 86 (Kordlortok, Kap Dalton, Liverpool Kyst in Harry Inlet).

The form observed was in good accordance with the above-mentioned figure by Wille.

Long. = 40 μ; lat. = 32 μ.

It was found in two collections from Vester Elv.

Loc. Danmarks Havn.

13. **C. ochtodes** Nordst., Desm. arctoæ, p. 17, tab. VI, fig. 3.

Boldt, Desm, Grønl. p. 29 (Kung Oskars hamn).

Børgesen, Ferskvandsalg. Østgrønland, p. 13 (Hekla Havn).

Larsen, Freshw. Alg. East Greenl. p. 87 (in several localities from Kordlortok 65° 40' to Sabine Ø 74° 30').

Found in several collections from Vester Elv.

Long. = 88 μ; lat. 59 μ.

Loc. Danmarks Havn.

14. **C. pseudoprotuberans** Kirchner, Alg. Schles. p. 150.

Børgesen, Ferskvandsalg. Østgrønland, p. 18, tab. 1, fig. 12 (Hekla Havn).
Larsen, Freshw. Alg. East Greenl., p. 88 (Amaka).

Forma *isthmo latiore* Børgs. l. c.

A few specimens like this form were found in Vester Elv.

Long. = 38 μ; lat. = 30.

Loc. Danmarks Havn.

15. **C. pulcherrimum** Nordst., Desm. Brasil., p. 213, tab. 3, fig. 24.

β **boreale** Nordst., Desm. Spetsb. p. 32, tab. 6, fig. 14.

A few specimens were found in collections from Vester Elv and Lille Snenæs.

Long. = 54 μ; lat. = 39 μ.

Loc. Danmarks Havn, Lille Snenæs.

16. **C. quadratum** Ralfs in Ann. Mag. Nat. Hist. p. 395, tab. 11, fig. 9; Brit. Desm., p. 92, tab. 15, fig. 1 a.

Boldt, Desm. Grønl., p. 10 (Kung Oskars hamn).
Børgesen, Ferskvandsalg. Østgrønland, p. 20 (Hekla Havn, Røde Ø).
Larsen, Freshw. Alg. East Greenl. p. 88 (in several localities from Kordlortok 65° 40′ to Sabine Ø 74° 30′).

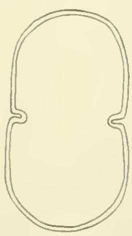

Fig. 3. *C. quadratum* Ralfs, forma *Willei* West (350/1).

Forma *Willei* West, Monograph. Brit. Desm., vol. III, p. 59, C. quadratum Ralfs forma "Semicellulæ lateribus nonnumquam latissime rotundatis l. rectis, nec retusis" Wille, Ferskvandsalg. Nov. Semlja, p. 37, tab. XII, fig. 20 et forma "major" ibidem fig. 21.

The form found had a somewhat thinner membrane than Wille's. (Fig. 3). Compare "Forma semicellula in apice magis rotundata quam in forma typica", Borge, Sib. Chlorophyllophycé-Flora, p. 12, fig. 6.

Long. = 57—67 μ; lat. = 35—38 μ; lat. isthm. = 28 μ.

Loc. Vester Elv, Hvalrosodde.

17. **C. reniforme** (Ralfs) Archer in Journ. of Bot. 1874, p. 92. Cosm. margaritiferum Menegh. var. reniformis Ralfs, Brit. Desm. p. 100, tab. 16, fig. 2 a.

Børgesen, Ferskvandsalg. Østgrønland, p. 13 (Hekla Havn).

A few specimens of this species were found in Vester Elv.

Long. = 50 μ; lat. = 47 μ.

Loc. Danmarks Havn.

18. **C. speciosum** Lund., Desm. Suec. p. 34, tab. III, fig. 5.

var. **biforme** Nordst., Desm. Spetsb. p. 30, tab. VI, fig. 11.

Boldt, Desm. Grønl., p. 20 (Kung Oskars hamn).
Børgesen, Ferskvandsalg. Østgrønland, p. 15 (Røde Ø).
Larsen, Freshw. Alg. East Greenl., p. 88 (Sabine Ø).

Specimens agreeing very well with Nordstedt's description and figure were found in two collections from Vester Elv.

Long. = 62—65 μ; lat. = 40—47 μ.

Loc. Danmarks Havn.

19. **C. spetsbergense** Nordst., Desm. Spetsb., p. 27, tab. 6, fig. 3.

Larsen, Freshw. Alg. East Greenl. p. 89 (Liverpool Kyst in Hurry Inlet).

This arctic species hitherto only known from Jan Mayen, Spitzbergen, Nova Zembla and the above mentioned locality in East Greenland has been found in two collections from Vester Elv.

Long. = 61 μ, lat. = 32 μ.

Loc. Danmarks Havn.

20. **C. subcrenatum** Hantzsch. in Rabenh. Alg. No. 1213; Nordstedt, Desm. arct., p. 21. tab. 6, fig. 10—11.

Boldt, Desm. Grønl. p. 18 (Kung Oskars hamn).

Børgesen, Ferskvandsalg. Østgrønland, p. 14 (Hekla Havn).

Larsen, Freshw. Alg. East Greenl., p. 89 (in several localities from Kordlortok 65° 40′ to Sabine Ø 74° 30′).

Long. = 32 μ; lat. = 29 μ.

Loc. Found in two collections from Vester Elv.

21. **C. subspeciosum** Nordst., Desm. arct. p. 22, tab. 6, fig. 13.

Børgesen, Ferskvandsalg. Østgrønland, p. 16.

A form agreeing very well with the description and figure of Nordstedt was found in a collection from Lille Snenæs.

Long. = 42 μ; lat. = 30 μ.

A zygospore was found of this species (Fig. 4). This was globose, furnished with rather long furcate-emarginate spines, each of which arises from a broadly conical base provided with teeth.

Lat. zygosp. cum. spin. = 54 μ.

Lat. zygosp. sine spin. = 40 μ.

Loc. Lille Snenæs.

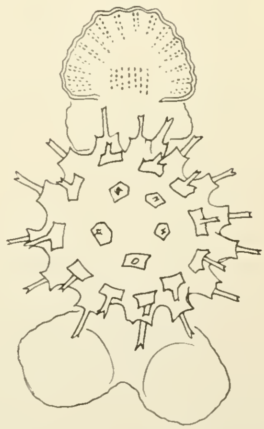

Fig. 4. *C. subspeciosum* Nordst. A Zygospore. (350/1.)

22. **C. Turpinii** Bréb., Liste Desm., p. 127, tab. 1, fig. 11.

Boldt, Desm. Grønl., p. 24 (Kung Oskars hamn).

Børgesen, Ferskvandsalg. Østgrønland, p. 13, tab. 1, fig. 7 (Hekla Havn).

Larsen, Freshw. Alg. East Greenl., p. 90 (in several localites from Kordlortok 65° 40′ to Sabine Ø 74° 30′).

The specimens found agreed very well with the form (forma *gallica* Lund.) mentioned in my earlier paper.

Long. = 62 μ; lat. = 54 μ.

Loc. Danmarks Havn; Vester Elv.

Euastrum Ehrenb., Ralfs.

1. **E. binale** (Turp.) Ehrenb., Berlin. Monatsber. 1840, p. 208. Ralfs, Brit. Desm., p. 90, tab. 14, fig. 8 (partim).

Boldt, Desm. Grønl., p. 8 (Kung Oskars hamn).

Børgesen, Ferskvandsalg. Østgrønland. p. 31 (Danmarks Ø, Gaasefjord, Hekla Havn).

Larsen, Freshw. Alg. East Greenl., p. 91 (in several localities from Kordlortok 65° 40 to Sabine Ø 74° 30').

Forms like Ralf's fig. 8 b and e were found in collections from Vester Elv.

Long. = 22 μ.

subspec. **dissimile** Nordst., Desm. arct. p. 31, tab. VIII, fig. 31.

Found in a gathering from the same locality.

Long. = 28 μ; lat. = 20 μ.

Loc. Danmarks Havn.

Fig. 5. *E. cuneatum* Jenner. Forma. (350/1).

2. **E. cuneatum** Jenner in Ralfs, Brit. Desm., p. 90, tab. 32, fig. 3 a.

Boldt, Desm. Grønl., p. 7 (Kung Oskars hamn).

Børgesen, Ferskvandsalg. Østgrønland, p. 31 (Hekla Havn).

The form found (Fig. 5) was somewhat smaller than the typical form and had somewhat narrower apices. It seems to come rather near the form mentioned by Raciborski in Nowe Desmidyje, p. 30, tab. VI, fig. 8. Cfr. also Boldt, l. c. p. 7, tab. 1, fig. 7.

Long. = 86 μ; lat. = 42 μ.

Only a few specimens were found in two collections from Vester Elv.

Loc. Danmarks Havn.

3. **E. elegans** (Bréb.) Kütz., Phycol. germ., p. 135; Ralfs, Brit. Desm., p. 89, tab. 14, fig. 7 a—d.

Boldt, Desm. Grønl. p. 9 (Kung Oskars hamn).

Børgesen, Ferskvandsalg. Østgrønland, p. 31 (Hekla Havn).

Larsen, Freshw. Alg. East Greenl. p. 91 (in several localities from Kordlortok 65° 40' to Sabine Ø 74° 31').

Forms like Ralfs fig. 7 a and b (l. c.) were found in Vester Elv and a small lake at Hvalrosodde.

Loc. Danmarks Havn, Hvalrosodde.

4. **E. tetralobum** Nordst., Desm. arct. p. 30, tab. VIII, fig. 30.

This characteristic and, it seems, true arctic species was not earlier known from East Greenland. Hitherto it was only known from Spitzbergen and Nova Zembla.

The form observed quite agreed with the figure and description of Nordstedt.

Long. = 89 μ; lat. = 64 μ.

It was found in several collections from Vester Elv.

Loc. Danmarks Havn.

Staurastrum Meyen.

1. **S. aculeatum** (Ehrenb.) Menegh., Desmidium aculeatum Ehrenb., Infus. p. 142, tab. 10, fig. 12. Ralfs, Brit. Desm., p. 142, tab. XXIII, fig. 2.

β **ornatum** Nordst., Desm. Spetsb. p. 40, tab. VII, fig. 27.

forma **spinossisima** Wille., Ferskvandsalg. Nov. Semlja, p. 54, tab. XIII, fig. 67—68.

Børgesen, Ferskvandsalg. Østgrønland, p. 28 (Hekla Havn).
Larsen, Freshw. Alg. East Greenl., p. 95 (Kap Dalton, Liverpool Kyst in Hurry Inlet).

Some few specimens of this variable species, coming near to the above-mentioned form of Wille, were found in several collections from Vester Elv.

Long. = 37 μ; lat. = 40 μ.

Loc. Danmarks Havn.

2. **S. avicula** Bréb. forma Boldt, Desm. Grønl. p. 37. Staur. denticulatum (Näg.) Archer forma Elfv. Anteckn. finska desm. p. 9, tab. 1, fig. 5.

A single specimen was found in a collection from Vester Elv.

Long. 29 μ; lat. sin. acul. = 35 μ.

It was not earlier found in East Greenland but the species is known from Godthaab (Larsen, l. c., p. 347) and Friedrichsthal (Boldt, l. c., p. 37) in West Greenland.

Loc. Danmarks Havn.

3. **S. Brebissonii** Archer in Pritch. Infus. p. 739.

forma **minor** Nordst., Desm. Grønl. p. 10.

Larsen, Freshw. Alg. East Greenl. p. 96 (Kordlortok, Amaka, Kap Dalton, Liverpool Kyst in Hurry Inlet, Jameson Land).

Found in several collections from Vester Elv.

Long. = 40—50 μ; lat. 35—40 μ.

Loc. Danmarks Havn.

4. **S. hexaceros** (Ehrenb.) Wittr., Gotl. Öl. sötv. Alg., p. 151.

forma **alternans** Wille, Ferskvandsalg. Nov. Semlja, p. 52, tab. XIII, fig. 63.

Børgesen, Ferskvandsalg. Østgrønland, p. 27 (Hekla Havn).
Larsen, Freshw. Alg. East Greenl., p. 97 (Jameson Land).

The form observed was a little larger than that mentioned by Wille (l. c.).

Long. = 31 μ.

Found in a collection from Vester Elv.

Loc. Danmarks Havn.

5. **S. lunatum** Ralfs, Brit. Desm., p. 124, tab. 34, fig. 12.

Forma **Groenlandica** Børgs. Ferskvandsalg. Østgrønland, p. 29, tab. 2, fig. 27.

Larsen, Freshw. Alg. East Greenl., p. 98 (Liverpool Kyst in Hurry Inlet).

Found in a collection from Vester Elv.

Lat. sin. spin. = 30 μ.

Loc. Danmarks Havn.

6. **S. meganolotum** Nordst., Desm. arctoæ, p. 35, tab. VIII, fig. 38.

Boldt, Desm. Grønl. p. 39 (Kung Oskars hamn).

Børgesen, Ferskvandsalg. Østgrønland, p. 28 (Hekla Havn).

Of this species I have found a form coming near to forma *Groenlandica* mentioned by me (l. c. p. 28, tab. 2, fig. 29). It was observed in a collection from Vester Elv.

Loc. Danmarks Havn.

7. **St. monticulosum** Bréb. in Chev. Micr. p. 272. Ralfs, Brit. Desm., p. 130, tab. 34, fig. 9.

β **bifarium** Nordst., Sydl. Norg. Desm. p. 31, fig. 14.

forma **Groenlandica** Børgs., Ferskvandsalg. Østgrønland, p. 29, tab. 2, fig. 25.

Larsen, Freshw. Alg. East Greenl., p. 98 (Jameson Land).

Found in collections from Vester Elv.

Long. = 40 μ; lat. = 38 μ.

Loc. Danmarks Havn.

8. **S. muticum** Bréb., Ralfs, Brit. Desm., p. 125, tab. 21, fig. 4; tab. 34, fig. 13.

Børgesen, Ferkvandsalg. Østgrønland, p. 24 (Hekla Havn).

Found in collections from Vester Elv.

Long. = 32—39 μ; lat. = 29—31 μ.

Loc. Danmarks Havn.

9. **S. orbiculare** (Ehrenb.) Menegh., Synops. Desm. p. 225. Ralfs, Brit. Desm. p. 125, tab. 21, fig. 5.

Børgesen, Ferskvandsalg. Østgrønland, p. 24 (Hekla Havn).

A form like Ralfs fig. 5 a was found once in a collection from Vester Elv.

Long. = 30 μ = lat.

Loc. Danmarks Havn.

10. **S. pachyrhynchum** Nordst., Desm. arctoæ, p. 30, tab. VIII, fig. 34.

Børgesen, Ferskvandsalg. Østgrønland, p. 24 (Hekla Havn, Røde Ø).

Larsen, Freshw. Alg. East Greenl. p. 99 (Amaka, Kap Dalton, Jameson Land, Sabine Ø).

forma *3-gona* Nordst. l. c.

forma *5-gona* Nordst. l. c.

This very variable species occurred rather commonly in several collections from Vester Elv.

Loc. Danmarks Havn.

11. **S. polymorphum** Bréb. in Ralfs, Brit. Desm. p. 135, tab. 22, fig. 9; tab. 34, fig. 6.

Boldt, Desm. Grønl., p. 38 (Kung Oskars hamn).
Børgesen, Ferskvandsalg. Østgrønland, p. 27 (Hekla Havn).
Larsen, Freshw. Alg. East Greenl., p. 99 (Kordlortok).

Found in collections from Vester Elv.

Long. = 42 μ = lat.

Loc. Danmarks Havn.

12. **S. punctulatum** Bréb. in Ralfs Brit. Desm., p. 133, tab. 22, fig. 1.

β **Kjellmani** Wille in Dijmphna Togt. vidensk. Udb. p. 86, St. Kjellmani Wille, Nov. Semlja, p. 50, tab. XIII, fig. 52.

Boldt, Desm. Grønl. p. 35 (Kung Oskars hamn).
Børgesen. Ferskvandsalg. Østgrønland. p. 26 (Hekla Havn).
Larsen, Freshw. Alg. East Greenl. p. 99 (Kap Dalton, Liverpool Kyst in Hurry Inlet, Sabine Ø).

A single specimen was found in Vester Elv.

Long. = 48 μ; lat. = 33 μ.

Loc. Danmarks Havn.

13. **S. pygmæum** Bréb. in Ralfs Brit. Desm., p. 213, tab. 35, fig. 26.

Boldt, Desm. Grønl., p. 34 (Kung Oskars hamn).
Børgesen, Ferskvandsalg. Østgrønl., p. 26 (Hekla Havn).
Larsen, Freshw. Alg. East Greenl. p. 99 (Amaka, Tunok, Kap Borlase Warren).

forma **major** Wille, Ferskvandsalg. Nov. Semlja, p. 51, tab. XIII. fig. 54.

Long. = 44 μ.

Found once in a collection from Vester Elv.

Loc. Danmarks Havn.

14. **S. Saxonicum** Bulnh. in Rab. Krypt. Fl. Sachs. p. 190.

Børgesen, Ferskvandsalg. Østgrønland, p. 27.

Found in a collection from Vester Elv.

Long. = 75 μ; lat. = 68 μ.

Loc. Danmarks Havn.

15. **S. teliferum** Ralfs, Brit. Desm. p. 128, tab. 22, fig. 4; tab. 34, fig. 14.

Børgesen, Ferskvandsalg. Østgrønland, p. 27 (Hekla Havn, Danmarks Ø).
Larsen, Freshw. Alg. East Greenl. p. 100 (Kordlortok, Amaka, Falkefjæld, Jameson Land).

var. **ordinata** Børgs. l. c. p. 27, tab. 2, fig. 23.

Lat. cell. sine spin. = 33 μ.

Found in collections from Vester Elv.

Loc. Danmarks Havn.

Hyalotheca Ehrenb.

1. **H. dissiliens** (Dillw.) Bréb. in Ralfs Brit. Desm. p. 51, tab. 1, fig. 1.

Boldt, Desm. Grønl. p. 43 (Kung Oskars hamn).

Børgesen, Ferskvandsalg. Østgrønland, p. 32 (Hekla Havn).

Larsen, Freshw. Alg. East Greenl. p. 93 (Falkefjeld, Jameson Land, Liverpool Kyst in Hurry Inlet, Sabine Ø).

This species seems to be rather common; var. *tridentula* Nordst. (Sydl. Norges Desm. p. 48, fig. 23) was found and most probably also other forms occurred.

Found in several collections from Vester Elv.

Loc. Danmarks Havn.

Desmidium Ag.

1. **D. Swartzii** Ag., Syst. Alg. p. 9. Ralfs, Brit. Desm., p. 61, tab. 4.

Børgesen, Ferskvandsalg. Østgrønland, p. 32 (Hekla Havn).

Larsen, Freshw. Alg. East Greenl., p. 90 (Kordlortok, Amaka).

Found in two collections from Vester Elv.

Loc. Danmarks Havn.

Zygnemaceæ.

Zygnema (Ag.) De Bary.

Z. spec.

Filaments of a sterile *Zygnema* were found rather richly in a collection from Vester Elv. A few of the filaments had rhizoids; perhaps we have to do with *Zygogonium ericetorum*.

Also in a collection from "Lille Snenæs" a sterile *Zygnema*.

Chlorophyceæ.

Pleurococcaceæ.

Pleurococcus Menegh.

1. **P. vulgaris** Menegh., Näg. Gatt. einz. Alg. p. 64, tab. IV E, fig. 2.

Børgesen, Ferskvandsalg. Østgrønland, p. 36 (Danmarks Ø, Røde Ø, Hekla Havn).

Very few cells were found on bones.

Loc. Stormbugt.

Oocystaceæ.

Oocystis Nägl.

O. spec.?

A few colonies were found of an *Oocystis*-like plant. The cells were roundish-oblong and occurred two together in the mother-cell.

Long. cell. = 32 μ: lat. = 24 μ.

Found in a collection from a small lake.

Loc. Hvalrosodde.

Hydrodictyaceæ.

Pediastrum Meyen.

P. spec.

A quite yonng colony was once found in a collection from Vester Elv.

Loc. Danmarks Havn.

Coelastraceæ.

Coelastrum Näg.

1. **C. microporum** Näg. in A. Braun, Alg. unic. p. 70.

Found in two collections from Vester Elv.

Loc. Danmarks Havn.

Ulothricaceæ.

Stichococcus Näg.

1. **S. bacillaris** Näg., Gatt. einz. Alg. p. 76, tab. IV G, fig. 1.

f. **confervoidea** Hazen., The Ulothricaceæ and Chaetophoraceæ of the U. S. p. 160, tab. 22, fig. 2, 3.

Was found in form of longer or shorter filaments between *Zygnema*.

Breadth of the cell 2,7 μ, the length 2—4 times as great.

Found in a collection from Vester Elv.

Loc. Danmarks Havn.

Microspora Thur.

1. **M. stagnorum** (Kütz.) Lagerh., Entwickelungsg. einiger Confervaceen (Ber. d. d. bot. Ges. 1887, p. 417). Hazen., Ulothricaceæ, p. 176, tab. 24, fig. 12, 13.

Larsen. Freshw. Alg. East Greenl. p. 108 (Falkefjeld, Jameson Land, Sabine Ø).

Lat. cell. = 8,5 μ.

Loc. Lille Snenæs (422).

Tribonema Derb. et Sol.

1. **T. bombycinum** (Ag.) Derb. et Sol., Mém. phys. Alg. p. 18, tab. IV; fig. 16—21. Hazen, Ulothricaceæ, p. 184, tab. 25, fig. 1—3.

Larsen, Freshw. Alg. East Greenl. p. 108 (Found in several localities from Kap Dan (65° 31′) to Sabine Ø (74° 30′).

Lat. cell. = 6—8 μ.

Loc. Lille Snenæs.

Prasiolaceæ.

Prasiola Ag.

1. **P. velutina** (Lyngb.) Wille, Færøernes Ferskvandsalger (Bot. Notiser, 1897, p. 32, tab. 1).

Only a few filaments were found, but these agreed quite well with the original specimen of Lyngbye. Only filaments with a single row of cells were present.

Lat. of the filament = 14—18 μ.

Loc. Lille Snenæs.

Oedogoniaceæ.

Oedogonium Link.

O. sp. Sterile.

Lat. fil. = 5,5 μ.

Loc. Found in a small lake at Hvalrosodde.

O. sp. Sterile.

Lat. fil. = 11 μ.

Loc. Found in the same locality as the above-mentioned.

Bulbochaete Ag.

B. sp. Sterile.

A form with short cells.

Lat. cell. = 24 μ; long. cell. = 27 μ.

Loc. Found in a collection from a small lake at Hvalrosodde.

B. sp. Sterile.

A form with longer cells (*Bulbochæte setigera*?).

Lat. cell. = 24 μ.

Loc. Found in the same collection as the above-mentioned.

6—4—1910.

Arbejder fra den Botaniske Have i København. Nr. 54.

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 4

SÆRTRYK AF »MEDDELELSER OM GRØNLAND« XLIII

ON THE MARINE ALGÆ

FROM

NORTH-EAST GREENLAND

(N. OF 76° N. LAT.)

COLLECTED BY THE "DANMARK-EXPEDITION"

BY

L. KOLDERUP ROSENVINGE

KØBENHAVN

BIANCO LUNOS BOGTRYKKERI

1910

INTRODUCTION.

The Marine Algæ procured during the Danmark Expedition have been collected by the botanist of the Expedition, Mr. Andr. Lundager. As will be seen from the list of stations, they were procured by dredgings partly at the wintering place of the Expedition, partly at various distances from it, outwards and southwards to the small Island Maroussia, inwards and northwards to Stormbugt. Only some few samples of algæ found frozen in the ice or lying on or floating among the ice originate from more distant localities; these however are of less interest, as it is uncertain whether they have grown in the neighbourhood of the place where they were found or far from it. Almost all the gatherings have been made in August and September 1907 and in July 1908. Only the accidental samples mentioned have been collected at other seasons. The collected algæ are partly dried partly preserved in alcohol; some of the larger Laminariaceæ were dried in the air and afterwards salted.

A list of the localities where the algæ were collected is given here. They are disposed from South to North. With exception of the first and the two last, they are all situated between ca. 76° 30′ and ca. 76° 47′ Lat. N. From notes kindly given me by Mr. Lundager I have added some communications about the vegetation and the natural conditions at some of the places.

List of collecting places.

Ca. 75° 50′ Lat. N., 11° 23′ Long. W., Aug. 4th 1906. Floating in the ice.

Along the East side of Store Koldewey Island, and in the bay between the two islands, Aug. 26th. (Calcareous algæ).

— Sept. 5th 1907. In the bay near the low tongue between the islands *Fucus inflatus* was found growing in shallow water. At a depth of 6 to 9 meters were found *Alaria* and *Laminaria* (*saccharina v. grandis*), in 15 meters depth Florideæ. In 19 to 22 meters depth was found *Delesseria* (*sinuosa*) on soft bottom without stones or shells.

At Cape Bismarck, Sept. 28th 1906.

Along Cape Bismarck Peninsula, around Renskæret, and to Maroussia. July 20th 1908. The two *Laminariæ* and *Alaria* were seen growing more or less gregariously in comparatively shallow water between Cape Bismarck and Renskæret. *Delesseria sinuosa*, *Turnerella Pennyi*, *Polysiphonia arctica* a. o. occurred at a some-

Danmarks Havn and surroundings. By Captain J. P. Koch.

what greater depth, probably ca. 20 meters. At a depth of more than 24 meters *Lithothamnia* were dredged, but they were lost by an accident.

Østre Havnenæs. Aug. 15th 1907.

Danmarks Havn. Aug. 1906 (*Laminariæ*).

— Aug. 15th and 28th, Sept. 10th 1907. *Fucus* (*inflatus*) grows in shallow, disturbed water on stony ground around Vestre Havnenæs at a depth of 2 to 4 meters. — 8 to 11 meters, soft bottom with Florideæ.

Entrance to the harbour (Danmarks Havn), Sept. 9—10th. Calcareous algæ (*Lithothamnia* and other incrusting algæ).

At Vestre Havnenæs, Sept. 4th and 10th 1907. On both sides of the reef projecting from the point of land, 28 meters. In 8 to 11 meters depth *Alaria* with large sporophylls; no calcareous algæ. — One sample from Vestre Havnenæs, Sept. 4th 1907 must have been collected in the littoral (tidal) region. (Nothing has been noted about the place where it grew.) It contains decidedly littoral alga, such as *Calothrix scopulorum*, *Enteromorpha prolifera*, *Pseudendoclonium submarinum*, *Ectocarpus maritimus* (*Pilinia maritima* (Kjellm.) Rosenv.) further *Rhodochorton* and others.

Along Vestre Havnenæs and off Baadskæret, Aug. 26th 1907. 38 meters and deeper, stony bottom with calcareous algæ and shells of bivalves and barnacles. — In lesser depth associations of *Delesseria* (*sinuosa*) or *Phyllophora* (*Brodiæi *interrupta*).

— Aug. 28th 1907, 19 to 47 meters, Florideæ.

Stormbugt. *Laminariæ* and *Alaria*.

Bay off Vesterdalen, Aug. 28th 1907, 4 to 11 meters.

Cap Amélie, 77° 32′ Lat. N., April 22th 1907, clumps of algæ frozen in the ice.

Hyde Fjord, 83° 15′ Lat. N., May 15th 1907. 4 stipes of a *Laminaria* (probably *L. saccharina* v. *grandis*), found lying on the ice in a dried state by Capt. Koch.

As will be seen from the above list, a well developed sublittoral vegetation seems to exist at several places in the explored area. Thus, *Fucus inflatus* forms a vegetation at a few meters depth under low-water mark. The Laminariaceæ (*Laminaria saccharina* v. *grandis*, *L. solidungula* and *Alaria Pylaii* v. *grandifolia*) also form true associations at a somewhat greater depth, while the Florideæ are predominant at other places, mostly in greater depths, in particular *Delesseria sinuosa*, *Turnerella Pennyi*, *Polysiphonia arctica* and *Phyllophora Brodiæi* interrupta*. The brown algæ, except the Laminariaceæ, seem to be less copious; one of the most abundant in the collection is *Desmarestia viridis*. The incrusting algæ seem to occur rather often abundantly at places where other algæ do not occur, in particular on stony bottom in great depths: the most common of these algæ is *Lithothamnion læve;* further may be named *Lithoderma fatiscens*, *Lithothamnion glaciale* and *fœcundum*, *Cruoria arctica* and *Rhododermis elegans*.

Further, it results from the facts related in the list and from the examination of the collection that associations of loose-lying algæ occur at several places on soft bottom. In this condition *Turnerella Pennyi* occurs in particular very abundantly and further *Phyllophora Brodiæi* *interrupta, Polysiphonia arctica, Delesseria sinuosa, Stictyosiphon tortilis, Ectocarpus littoralis, Chætomorpha Melagonium.* On the other hand, *Fucus inflatus,* which was so abundant among the loose algæ in Scoresby Sound (Comp. K. Rosenvinge 1898, I p. 47, II p. 219) seems to occur more rarely as loose-lying on the bottom in the explored area. Most of the species named continue probably vegetating for a long time in a loose condition. As formerly stated by me (1898 II p. 221), that *Polysiphonia arctica* is almost always sterile is certainly in connection with the fact that it is not attached to the bottom.

As to the littoral region, it will be seen from the list that one sample only has been collected above low-water mark; but Mr. Lundager has noted that *Fucus inflatus* occurs in clefts in the rocks in the lower part of the littoral region at Vestre Havnenæs and at Cape Bismarck.

Our knowledge of the Marine algæ of East Greenland is due for a great part to collections made during two Danish expeditions in the last decade of the nineteenth century, namely by N. Hartz in 1891—92 (K. Rosenvinge 1898, I) and by C. Kruuse in 1898—99 (H. Jónsson 1904). According to Jónsson 114 species were known from East Greenland in 1904. One of these species, however, *Lithothamnion varians* Foslie, must be omitted, as according to Foslie it must be regarded as a form of *Lithothamnion glaciale* Kjellm. The total number of species therefore becomes 113. The best investigated part of the coast is that situated between 65° 31′ and 70° 27′ Lat. N., while only very few species are known from more northern localities.

In the systematic part of this paper 60 species are recorded (besides two undetermined). 5 of these species are new to Greenland, 3 of them new to science (*Cruoriopsis hyperborea* sp. n., *Punctaria glacialis* sp. n., *Myrionema foecundum* (Strömf.) Sauv., *Arthrochæte phæophila* sp. n., *Pseudendoclonium submarinum* Wille). 11 are new to East Greenland (besides the last-named, further *Lithothamnion tophiforme, Chorda tomentosa, Phæostroma pustulosum, Ectocarpus maritimus* (= *Pilinia maritima* (Kjellm.) Rosenv.), *Epicladia Flustræ, Ulothrix scutata*). The total number of species known from East Greenland is thus 124 (besides an undescribed species of *Choreocolax* (?) and perhaps a species of *Acrosiphonia*)[1].

[1] The total number of species known from Greenland was in 1904, according to Jónsson, 176, of which 165 were recorded from the west coast. As *Lithotham-*

Of the 60 enumerated species not less than 9 (15 p. ct.) have only been found on the East coast (besides the five species new to Greenland, further *Chantransia efflorescens, Petrocelis polygyna, Laminaria saccharina* var. *grandis* and *Arthrochœte penetrans*). This rather high number seems to suggest a considerable difference between this area and that of the West coast. Some of these species are however very small and will probably be found also on the West coast on further investigation, like e. gr. *Pseudendoclonium submarinum,* but others are so large and conspicuous that they can scarcely be supposed to have been overlooked, as *Punctaria glacialis* and *Laminaria saccharina* var. *grandis.* It must however be remembered that only the southern part of the West coast can be said to be rather well investigated with regard to the marine algæ, while the part North of 73° Lat. N., with which a comparison would be particularly desirable, is very imperfectly known in that respect.

A comparison of the flora communicated below with a list of the species found in Scoresby sound, ca. 70° 27′ Lat. N. (comp. K. Rosenvinge 1898 I) shows nearly the same number of species. As the last-named locality, in particular Hekla Havn and surroundings, must be considered as comparatively well investigated through N. Hartz's careful collections, we may be permitted to conclude that the material brought home by Mr. Lundager also gives a rather exhaustive idea of the algal flora of that small part of the Arctic Sea where it was gathered. The comparison of the two floræ shows further that a great number of species are common, as was to be expected. Some of the not-common species are so inconspicuous that their absence from one of the areas ought not to be taken into consideration; in other cases their absence cannot be regarded as accidental. As species occurring in Scoresby Sound but wanting in the area here in question might be named: *Dilsea integra* (also found at Sabine Island, 74° 32′ Lat. N.), *Pessonellia Rosenvingii, Scaphospora arctica* (= *Haplospora globosa*?) *Chordaria flagelliformis, Dictyosiphon foeniculaceus, Punctaria plantaginea, Chætomorpha tortuosa.* Further may be named *Agarum Turneri,* the presence of which in Scoresby Sound, however, has not been proved with certainty, and *Ptilota pectinata,* which has been found at Cape Wynn (74° 32′ Nat. N.), though not in Scoresby Sound. Of the species only found North of 76° Lat. N. must especially be named the new species *Punctaria*

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nion varians must be omitted (see above, the number must be diminished with 1, but as *Chantransia microscopica* var. *collopoda* must be regarded as a distinct species (comp. K. Rosenvinge 1909 p. 81) the number remains the same. Thus, after the new additions to the flora, the total number for Greenland is 181, for West Greenland 165.

glacialis, which seems to be a strongly arctic species with an extremely northern extension, at least on this coast. The occurrence of *Chorda tomentosa*, though only in feebly developed specimens, appears rather surprising, as it has not hitherto been observed on the East coast. *Lithothamnion tophiforme* may also be named, though it was only represented by one specimen. Thus, a certain floristic difference seems to exist between Scoresby Sound and the area North of 76° Lat. N., depending principally on the absence in the latter of a number of species with a comparatively southern extension but also on the presence of at least one species with hyperborean occurrence.

When considering the number of species within the main groups of algæ the following numbers are found for the area here in question, when the two undetermined species are included:

	Number of species	p. ct.
Rhodophyceæ	23	37·1
Phæophyceæ	23	37·1
Chlorophyceæ	15	24·2
Cyanophyceæ	1	1·6

It is rather surprising that the red and the brown algæ are found to be equally numerous in this area, as it has proved elsewhere that the Phæophyceæ are the most numerous group of algæ in the arctic regions. When comparing these numbers with those found by me for the whole of Greenland (1898, II p. 173[1]), we find that the percentage of the Rhodophyceæ has greatly increased, that of the other groups more or less diminished. On the other hand, we find the same proportion between the red and brown algæ in Scoresby Sound, for in Hekla Havn were found 21 red, 22 brown and 9 green algæ (l. c. p. 232), and including the species found in the neigbourhood of Hekla Havn (l. c. p. 231) we find the following numbers: 26 red, 26 brown and 10 green algæ. The relative number of the Phæophyceæ seems thus to be increasing and becomes predominant on going from the Atlantic northwards to the Arctic Sea, but it diminishes on going further northwards in the strongly arctic parts of the sea, dividing the dominion with the Florideæ which greatly increase in number.

When the 60 species of North-East Greenland are divided into three groups, arctic, subarctic and North Atlantic in a similar man-

[1] I take here the numbers as I found them in 1898 without considering the later additions and corrections to the flora.

ner as that used in 1898 (II), a much smaller number of North Atlantic species results than in the flora of the whole of Greenland, as might be expected. When all the species are included the following numbers result: arctic 35 p. ct., subarctic 46·6 p. ct. and North Atlantic 18·3 p. ct., while the numbers for the whole of Greenland are: arctic 30 p. ct., subarctic 37·7 p. ct. and North Atlantic 32·3 p. ct.[1] When the Rhodophyceæ and Phæophyceæ are only taken in consideration, we obtain for North-East Greenland: **35·6** p. ct. arctic, **53·3** p. ct. subarctic and **11·1** p. ct. North Atlantic species, for the whole of Greenland: 33 p. ct. arctic, 46·1 p. ct. subarctic and 20·9 p. ct. North Atlantic. The last named numbers for North-East Greenland are almost identical with the corresponding numbers for the whole of East Greenland found in 1898 (i. e. for the East coast south of 74° 30′ Lat. N. or more correctly south of 70° 30′ Lat. N.): **36·5** p. ct. arctic, **54** p. ct. subarctic and **11** p. ct. North Atlantic species, (K. Rosenvinge 1898 II p. 180). This striking agreement in spite of the existing floristic differences between the different parts of the East coast seems to be the expression of the pronounced arctic character of the whole coast. Even if the numbers given might be somewhat altered by taking Jónsson's paper (1904) into consideration, and will probably be altered by further investigations, I do not doubt that the agreement mentioned really exists.

LIST OF THE SPECIES.

A. Rhodophyceæ.

Fam. *Corallinaceæ.*

Lithothamnion Phil.

1. **L. tophiforme** Unger.

Foslie (1895) p. 119, (1905) p. 51, K. Rosenvinge (1898 I) p. 13.

The collection contains one specimen only which can be referred to this species. It agrees with the specimens formerly found in West Greenland and has bipartite sporangia (144 μ long, 45 μ thick).

Locality. Entrance to the harbour.

2. **L. glaciale** Kjellm.

Kjellman (1883) p. 123; K. Rosenvinge (1893) p. 773, (1898 I) p. 9.

f. **typica** Foslie (1905) p. 26.

[1] See note page 98.

f. **botrytoides** Foslie (1905) p. 26.

L. *botrytoides* Fosl. in K. Rosenvinge (1898 I) p. 10.
L. *delapsum* f. *conglutinata* Fosl. (1895) p. 50 pl. 14 fig. 4.

f. **subsimplex** Foslie (1905) p. 27.

L. *varians* Fosl. in K. Rosenvinge (1898 I) p. 11.

There are some few specimens belonging to f. *typica*, some others agreeing with f. *subsimplex* and a single specimen belonging to f. *botrytoides*. The specimens referred to f. *subsimplex* are mostly large flat crusts with low rounded processes, with very few and feebly developed or even without such processes. In the latter case I should perhaps not have dared to refer the plant to this species, had not Foslie referred to L. *glaciale* a similar crust from East Greenland which he had formerly referred to L. *varians*. The great variability of the processes and the gradual transition from forms with well-developed branches to those with even crusts make me have no doubt as to the correctness of this determination. The species has been dredged at a depth between 19 and 47 meters and in another place at a depth of 38 meters or deeper.

Loc. Entrance to the harbour; along Vestre Havnenæs; off Baadskæret.

3. **L. foecundum** Kjellm.

Kjellman (1883) p. 131; K. Rosenvinge (1898 I) p. 12, Foslie (1905) p. 21.

The collection contains a number of specimens which in my opinion must be referred to this species. They agree in habit and as to the size and form of conceptacles of sporangia with the descriptions and the formerly collected Greenlandic specimens of this species. The conceptacles, however, were most often empty, and in a single case, when they still contained sporangia, these were two-parted, while the species, according to Kjellman and Foslie, has ordinarily four-parted sporangia. Foslie has also sometimes found the sporangia two-parted, but he supposes that they were not fully developed. The sporangia observed by me were at all events well developed as to the size, for they measured 175—200 μ in length and 77—120 μ in breath. The conceptacles of sporangia were 400—500 μ in diameter. A crust with antheridial conceptacles, ca. 400 μ in diameter, was also met with. — The plants were found growing partly and principally on barnacle-shells, partly on stones, most often in company with *Lithothamnion læve*. — Collected at a depth of 38 meters.

Loc. Along Koldewey Island; entrance to the harbour; along Vestre Havnenæs; off the Baadskær.

4. **L. læve** (Strömf.) Foslie.

Foslie (1898) p. 7: K. Rosenvinge (1898 I) p. 14; Jónsson (1904) p. 6; Foslie (1905) p. 16.

Lithophyllum læve Strömfelt (1886) p. 21 pl. I fig. 11—12.
Lithothamnion tenue K. Rosenvinge (1893) p. 778 ex parte.

This species has been collected in considerable quantities in various localities; it is the species of *Lithothamnion* most represented in the collection. It forms extended thin crusts over stones, and further over shells of bivalves and of barnacles. Usually it has conceptacles of sporangia the diameter of which most frequently attains or even exceeds 1 mm. The sporangia contained in all examined cases two spores only; they were 240—360 μ long, 93—167 μ broad. According to Foslie, (1905), p. 18 and 53, the sporangia are four-parted; he says however that he has "often seen two-parted ones, sometimes even only two-parted ones, particularly in the northern part of the arctic zone. But having found in other specimens, partly from the same places, both two-parted and four-parted ones,

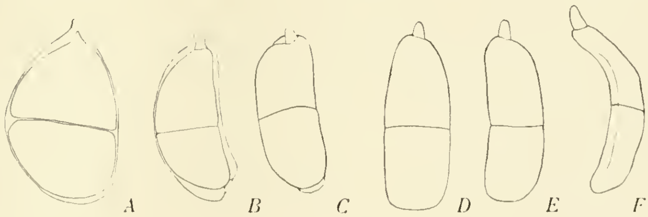

Fig. 1. *Lithothamnion læve,* sporangia. *A—C* from the same conceptacle, *D—F* from another conceptacle. 95 : 1.

sometimes even in one and the same conceptacle, I think it fair to presume that the two-parted ones have not been fully, or normally developed". The fact that I have found only two-parted sporangia in all, not few, examined cases, seems however to favour the belief that this species has only two-parted sporangia in this arctic region. The only argument which could be alleged against this is. that all the specimens in question are collected in August and September and that the sporangia possibly at a later period might be four-parted. After what is known about the fructification of these Algæ, that supposition is however little probable. As shown in fig. 1, the breadth of the sporangia is rather variable, partly according to their place in the conceptacle.

Specimens with sexual conceptacles were also found, though in lesser quantity. These conceptacles are easily recognizable from their conical form and smaller diameter; the conceptacles of cystocarps were 500—800 μ broad, those of antheridia 500—600 μ.

Loc. Along Cape Bismarck Peninsula; in and off the entrance to the harbour; at Vestre Havnenæs, 28 meters; off Baadskæret, 19—47 meters.

Fam. *Squamariaceæ.*

Cruoria Fries.

5. **Cruoria arctica** Schmitz.

K. Rosenvinge (1893) p. 784, (1898 I) p. 15.

It forms crusts up to 4 cm. in diameter on barnacle-shells and on *Lithothamnion læve;* it seems to be always attached to a calcareous substratum. The specimens of the collection fully agree with the original ones from West Greenland and are, like those, provided with glandular cells. In a thick crust ripe sporangia (56 μ long, 23 μ broad) were found in the upper part while abortive sporangia were visible at a lower level. This species is always infested by *Chlorochytrium Schmitzii.* — Found in various depths e. g. ca. 38 meters.

Loc. Along Koldewey Island; off Baadskæret and along Vestre Havnenæs.

Cruoria firma Kjellman (1906) p. 14. is hardly specifically distinct from *C. arctica.* According to Kjellman it differs from this species by having the basal layer consisting of at least two layers. This statement, which is put forward however by the Swedish author with some reservation, I suppose to be founded on imperfect preparation; sections of *C. arctica* which are not very thin or exactly vertical lead easily to the belief that there is more than one basal layer of cells. The sporangia appear to offer no difference; they were only comparatively narrow in Kjellman's specimens. And the erect filaments seem to have essentially the same structure as in *Cr. arctica.*

Petrocelis J. Ag.

6. **P. polygyna** (Kjellm.) Schmitz.

K. Rosenvinge (1898 I) p. 16.
Hæmescharia polygyna Kjellman (1883) p. 182.

Some few crusts of this species, partly sterile, partly with carpogonia have been found growing on stones.

Loc. Along Vestre Havnenæs, ca. 38 meters, and another locality.

Cruoriopsis Dufour.

7. **C. hyperborea** sp. n.

Crusta intense sangvinea, 80—100 μ crassa. Stratum basale unistratosum, e filis radiantibus compositum, cellulis 4·5—5·5 μ crassis, 8—10·5 μ altis, crassitudine vulgo 2—3-plo longioribus. Fila erecta 5—8-cellularia, cylindrica vel sursum paulo incrassata, 7·5—10 μ crassa, cellulis diametro aequilongis vel ad duplo longioribus, chromatophorum unicum continentibus. Sporangia in filis erectis terminalia vel in parte superiori eorum lateralia, sessilia vel rarius stipitata, obovata vel breviter oblonga, 15—23 μ longa, 11—13 μ lata.

One crust only of this new species has been found growing on a stone. It has a deep blood-red colour, by which it differs from the other crustiform Florideæ of the collection. The cells of the basal layer are about twice as high as they are broad. Fusions sometimes occur between cells belonging to neighbouring cell-rows of the basal layer. The erect filaments are not connected by any soft gelatinous matter; they are of the same thickness in their whole length or upwards somewhat thicker; their cells are usually $1^1/_2$ to 2 times as long as broad, more rarely of the same length. The cells contain a single chromatophore lying in the upper part of the cell, apparently cup-shaped. The filaments are sometimes a little branched at the upper end, bearing one or two (or perhaps

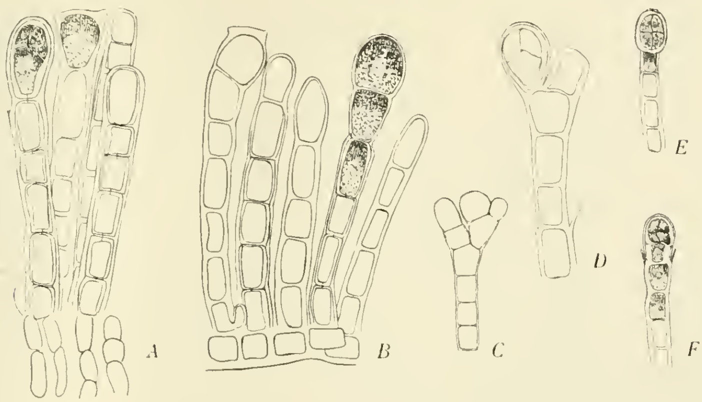

Fig. 2. *Cruoriopsis hyperborea. A,* portion of the basal layer seen from above and vertical filaments springing off from it, two of them ending in a sporangium. *B,* vertical section of a crust, the filaments somewhat disunited. *C,* vertical filament branched at the upper end. *D,* vertical filament bearing a lateral sporangium. *E* and *F,* vertical filaments with terminal sporangia. *A, B, D* 555 : 1; *C, E, F* 345 : 1.

more than two) short one- or two-celled branchlets. Possibly ramification only takes place by the formation of sporangia.

The sporangia are placed on the ordinary filaments and are usually terminal but never emerging over the surface of the frond. They may also be lateral on one of the upper joints of a filament and are then usually sessile (fig. 2 *D*); sometimes however two-celled branchlets occur, the upper cell of which will develop into a sporangium (fig. 2 *C*). The sporangia are obovate, more rarely shortly oblong; their division is always cruciate, the first dividing wall being horizontal. Sometimes the first division wall is oblique and the arrangement of the spores somewhat irregular.

Our plant having no sex-organs, its systematic position cannot be determined with certainty. I think however it could be referred to the genus *Cruoriopsis*, as a new species. At all events it cannot belong to the genus *Cruoriella*, the sporangia not occurring in nemathecia but scattered in the very crust. It reminds one somewhat of *Cruoriella armorica* Hauck (1885, p. 31, non Crouan) which is referred to the genus *Cruoriopsis* by Batters (1896, p. 387) under the name of *C. Hauckii*. De-Toni (1905, p. 1690), has certainly protested against its translation to this genus, as it has terminal sporangia; this however does not appear convincing to me, the diagnosis of the genus *Cruoriopsis* containing nothing very precise as to the position of the sporangia (comp. De-Toni l. c. and Schmitz und Hauptfleisch (1897, p. 535)). In *Cruoriopsis cruciata* Dufour the sporangia are certainly lateral on the filaments (comp. Zanardini (1876), Tav. 86), but in our species lateral sporangia also occur though more rarely than the terminal ones. I think it therefore most correct, at least provisionally, to refer it to the same genus.

I have been able to compare our plant with a microscopical preparation of *Cruoriopsis Hauckii* Batt. from Plymouth, kindly sent me by the late Mr. Batters, thus an original specimen. It differs by having thinner erect filaments, ca. 4 μ thick or a little thicker, consisting of more elongated and more thin-walled cells. The sporangia are more lengthened, narrower, 21—25 μ long, 7—8 μ broad, always terminal on the ordinary erect filaments, scattered in the crust; the divisions are cruciate but oblique. In the basal layer numerous transversal fusions occur.

Through the kindness of Mrs. Weber—van Bosse I have also been able to examine two microscopical preparations of *Cruoriella armorica* Hauck, from the collection of Hauck, originating from Naples. This plant is also different from the Greenland one. The basal layer consists of broad cells arranged in regular radiating filaments, the erect filaments are thinner, sometimes dichotomous above. The sporangia are always terminal, they are larger, 46—56 μ long, 26—28 μ broad, regularly cruciate.

Loc. Along the Koldewey Island, Aug. 26th 1907 (No 556).

Rhododermis Crouan.

8. R. elegans Crouan.

K. Rosenvinge (1898 I) p. 18.

Crusts of this species, recognizable by their dull rose-red or light purple colour have been found growing on stones from various localities. They are always polystromatical and may be up to 20 cells thick and even thicker. The vertical filaments are 7—9 μ thick; the height of the cells is variable, sometimes about the same as the breadth or a little greater, in other cases smaller; in the upper part of some crusts the cells were very low, several times broader than high. Transversal fusions between the cells, especially those of the basal layer, but also those of the vertical filaments (fig. 3 A) occur here and there.

Some crusts bear sori of sporangia, with unripe or fully developed sporangia; in other cases the sori had fully developed paraphyses but no sporangia, these having probably decayed. Ripe sporangia, found in August, were 30—32 μ long, 19—20 μ broad.

Some other crusts, collected in August and September, bear antheridia, which organs were hitherto unknown in this genus. They covered a great part of the surface of the frond as a continuous layer of much greater extent than the sporangial sori. The antheridia (spermatangia) are obovate, 10—11 μ long, 4 μ broad. In a vertical section the vertical cell-rows are seen bearing at their upper end one or usually two cells, which are smaller and richer in plasmatic contents than the vegetative cells and bear the antheridia. These cells (Svedelius's spermatangial mother-cells) bear at the top two antheridia, a terminal and a lateral one, or perhaps more. By the development of the antheridia the thick cuticula is lifted and finally thrown off by the developing antheridia. The spermatia are, like the antheridia, obovate and contain a very distinct nucleus, lying in the upper part or the middle of the cell.

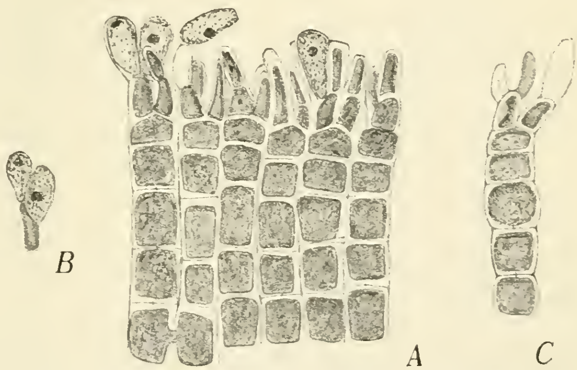

Fig. 3. *Rhododermis elegans*, sections of male plant. *A*, Vertical section of crust with antheridia. *B*, antheridia-bearing cell with two antheridia. *C*, Vertical cell-row with two antheridia-bearing cells. 830 : 1.

Carpogonia were not observed.

Loc. Along Koldewey Island; entrance to the harbour (♂ and spor.); off Baadskæret and along W. Havnenæs, ca. 38 meters (♂ and spor.)

Fam. *Ceramiaceæ*.

Antithamnion Næg.

9. **A. Plumula** (Ellis) Thur. β, **boreale** Gobi

K. Rosenvinge (1898 I) p. 21, Jónsson (1904) p. 8.

This species has been found growing on *Phyllophora Brodiæi* *interrupta*, *Delesseria sinuosa* and *Lithothamnion glaciale*. The specimens were 1 to 2 cm. long, all sterile.

Loc. Danmarks Havn and the entrance to it.

Rhodochorton Næg.

10. **R. Rothii** (Turt.) Næg.

K. Rosenvinge (1893) p. 791, (1898 I) p. 23, Jónsson (1904) p. 8.

This species has been found in two different sublittoral localities in up to ca. 40 meters depths; it was here mostly found in company with *Cruoria arctica*, forming scattered tufts on the surface of the latter. A closer examination showed however that, at all events in some cases, it had grown through the crust of *Cruoria*, the basal layer being situated under the crust. This has probably been occasioned by the *Cruoria* overwhelming the *Rhodochorton* growing previously on the stone. This supposition is supported by the fact that the same *Rhodochorton* was found growing on *Lithothamnion læve* covering the stone beside the *Cruoria*. These specimens were all sterile.

Fertile specimens with ripe and empty sporangia were found in September in company with *Calothrix scopulorum* a. o. in a gathering from the littoral region.

Loc. Along Koldewey Island; Vestre Havnenæs, in the tidal region; off Baadskæret and along Vestre Havnenæs, ca. 40 meters.

11. **R. penicilliforme** (Kjellm.) K. Rosenv.

K. Rosenvinge (1894) p. 66, (1898 I) p. 23, Jónsson (1904) p. 9.

R. *mesocarpum* (Carm.) Kjellm. var. *penicilliforme* Kjellm., K. Rosenvinge (1893) p. 792.

One specimen of this easily recognizable species was found on *Polysiphonia arctica;* the upright filaments were 10 μ thick and bore young sporangial branchlets but without sporangia.

Loc. Along Koldewey Island, ca. 8 fathoms.

Fam. *Rhodomelaceæ.*

Rhodomela C. Ag.

12. **R. lycopodioides** (L.) Ag. f. **tenuissima** (Rupr.) Kjellm.

K. Rosenvinge (1893) p. 797, (1898 I) p. 24, Jónsson (1904), p. 9.

This species is only feebly represented in the collection. At Koldewey Island, where it was collected by dredging in September, it occurred in small quantity among *Stictyosiphon tortilis;* the specimens had still hairs (trichoblasts), branched and unbranched, but were sterile. Specimens found frozen in the ice in April bore tetrasporangia in the shoots of the previous year.

Loc. Along Koldewey Island; in clumps frozen in the ice at Cap Amélie.

Polysiphonia Grev.

13. P. arctica J. Ag.

K. Rosenvinge (1893) p. 800, (1898 I) p. 25; Jónsson (1904), p. 10.

Non *Pterosiphonia arctica* Setchell and Gardner (1903) p. 329.

A considerable number of specimens of this strongly arctic species has been collected in two localities situated comparatively near the open sea; they fully agree with typical specimens, reaching a length of over 20 cm. and are as usual without basal part. They seem not to have been fixed to the bottom and are all sterile.

Pterosiphonia arctica Setchell and Gardner (l. c.) which these authors have thought identical with *Polysiphonia arctica*, after comparison with a specimen from Greenland determined by me, is fairly distinct from it, judging from the remarks and the figures of the authors. The Northwest American species has a complanated frond, is plainly distichous near the tips and has constantly 6 or 7 pericentral cells, while *Polysiphonia arctica* has a cylindrical frond with branches given off on all sides and 4—7 pericentral cells. As no figures of this species have ever been published, I give here some drawings, showing the ramification and transverse sections of the frond (fig. 4). The branches are spirally arranged with an angle of divergence approaching to 180°, however somewhat smaller. As shown before (1893, p. 800) no hairs (trichoblasts)

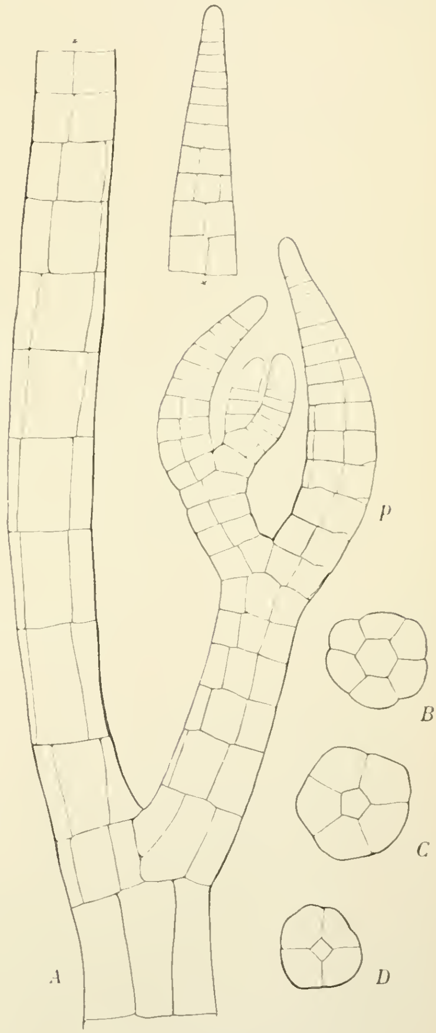

Fig. 4. *Polysiphonia arctica*. *A*, Upper end of a plant; at *p* formation of the secondary pores. *B*—*D*, transverse sections of fronds. 200 : 1.

occur. The specimen figured had 4—6 pericentral cells; the number was greatest in the main axes.

Loc. Along the East side of Koldewey Island, ca. 15 meters; off Cape Bismarck Peninsula.

Fam. *Delesseriaceæ.*

Delesseria Lamour.

14. **D. sinuosa** (Good. et Woodw.) Lamour.

K. Rosenvinge (1893) p. 808, (1898 I) p. 27; Jónsson (1904) p. 11.

The collection contains a considerable number of well-developed specimens of this species. They attain a length of 25—30 cm. or even more and are also broad, and they belong to the f. *typica.* Some of them bear at the base a considerable number of narrow shoots which had attached themselves on gravel or fragments of shells. One specimen was attached to a barnacle. A number of the specimens seem however to have been loose-lying on the bottom. Specimens collected in July and August showed ripe tetrasporangia, in small marginal leaflets, or cystocarps.

Loc. Along the East side of Koldewey Island, 19—23 meters; along Cape Bismarck Peninsula; off Cape Bismarck; Danmarks Havn; off Baadskæret; the bay off Vesterdalen.

Fam. *Rhodymeniaceæ.*

Halosaccion Kütz.

15. **H. ramentaceum** (L.) J. Ag.

K. Rosenvinge (1893) p. 825, (1898 I) p. 43; Jónsson (1904) p. 12.

Only 3 specimens have been met with in the collection. They have a single set of unbranched branches, are provided with hyaline hairs but are sterile.

Loc. The bay off Vesterdalen, in at most 4 meters depth.

Fam. *Rhodophyllidaceæ.*

Euthora J. Ag.

16. **E. cristata** (L.) J. Ag.

K. Rosenvinge (1893) p. 813, (1898 I) p. 28; Jónsson (1904) p. 13.

A number of specimens, all epiphytic, mostly on *Chætomorpha Melagonium* and *Delesseria sinuosa,* further on *Phyllophora Brodiæi* *interrupta* and *Turnerella Pennyi,* are contained in the collection. They all belong to f. *angustata.* The largest specimens are 5 cm. long. Ripe tetrasporangia and cystocarps occurred in specimens collected in August and September.

Loc. At Koldewey Island; Danmarks Havn.

Turnerella Schmitz.

17. **T. Pennyi** (Harv.) Schmitz emend.

F. Schmitz in K. Rosenvinge (1893) p. 815; K. Rosenvinge (1898 I) p. 29; Jónsson (1904) p. 13.

Inclus. *Kallymenia rosacea* J. Ag. (1876) p. 220, comp. Børgesen and Jónsson (1905) p. XII.

A great number of specimens of this arctic species have been collected at various localities, most abundantly in Danmarks Harbour. The form of the frond is somewhat variable, in some cases of nearly orbicular outline, usually however more or less lobed and often also undulated. Most of the specimens are devoid of basal disc and have probably been so at the moment of dredging. Some of the specimens, however, show well-developed basal discs mostly attached to barnacles. Some of the specimens provided with basal disc seem not to have been attached, when they were collected, as is to be concluded from the form of the basal disc, its under face not being plain but hollow, by strong development of the border, probably after its detachment from the substratum. The reason why almost all the specimens are without basal disc may be in some cases, that the plant has been torn away from its substratum, leaving its basal part; I imagine however that most of the specimens have been really loose-lying on the bottom. This is suggested by the form of the frond and by the fact that most of the numerous specimens from Danmarks Harbour have been dredged at a locality where the bottom is soft.

Some of the specimens agree fully with specimens referred by J. Agardh to *Kallymenia rosacea*, which however is not specifically distinct from *Turnerella Pennyi*, as stated by Børgesen and Jónsson (l. c.) and as suspected already by J. Agardh (l. c.)

The largest of the specimens contained in the collection measures 50 cm. in greatest diameter in a dried state. Some specimens contain numerous cystocarps, partly ripe, partly empty.

Loc. Along the East side of Koldewey Island, ca. 15 meters; off Cape Bismarck; along Cape Bismarck Peninsula; Danmarks Havn, 7—11 meters, soft bottom; off Baadskæret, 28 meters; the bay off Vesterdalen, 4—11 meters.

Fam. *Gigartinaceæ.*

Phyllophora Grev.

18. **Ph. Brodiæi** (Turn.) J. Ag. ***interrupta** (Grev.) K. Rosenv.

K. Rosenvinge (1893) p. 821, (1898 I) p. 32; Jónsson (1904) p. 14.

All the specimens of the collection belong to the subsp. *interrupta;* they are well-developed; partly very broad, and up to 18 cm. high. Nearly all the specimens have no basal portion and have certainly been lying loose on the bottom; in some of them the undermost part is in a state of disintegration. For most of the specimens from the harbour it has also been stated, that they have been dredged on soft bottom. Some smaller specimens are however provided with basal disc.

Loc. Along Koldewey Island, 15 meters and deeper; Danmarks Havn, 7—11 meters, soft bottom.

Actinococcus Kütz.

19. **A. subcutaneus** (Lyngb.) K. Rosenv.

K. Rosenvinge (1893) p. 822, (1898 I) p. 33; Jónsson (1904) p. 14.

A large specimen of *Phyllophora Brodiæi *interrupta* bears numerous specimens of this much disputed alga attached to the upper margin of some of the one-year old segments.

Loc. Along Koldewey Island, ca. 15 meters.

Ceratocolax K. Rosenv.

20. **C. Hartzii** K. Rosenv.

K. Rosenvinge (1898 I) p. 34.

Several specimens of *Phyllophora Brodiæi *interrupta* are infested with this parasite which is situated partly on the border partly on the flat side of the frond. The specimens of the parasite form small bushes up to 3 mm. in diameter, fully agreeing with the previously found Greenlandic specimens; several of them bore nemathecia, but the sporangia were still undivided in August. The specimens of *Phyllophora* on which they were parasitic were certainly all looselying when dredged.

Loc. Danmarks Havn, 7—11 meters, August.

Choreocolax sp.?

In a specimen of *Euthora cristata* from Koldewey Island were found some cushions of a small parasitic Floridea looking much like a *Choreocolax* or *Harveyella*. As there is not sufficient material for a detailed description, I shall not mention it closer but only state that it grows in the same manner as *Harveyella* and *Choreocolax*, sending out from the underside of the cushion-shaped or nearly globular frond filaments penetrating between the cells of the host. In a dried state the parasite has a pretty red colour.

Fam. *Helminthocladiaceæ.*

Chantransia (D. C.)

21. **Ch. efflorescens** (J. Ag.) Kjellm.

K. Rosenvinge (1898 I) p. 40, (1909) p. 134.

Found in small quantity on *Delesseria sinuosa* and *Cruoria arctica*. The thickness of the filaments is 5—6 μ. Antheridia, carpogonia and ripe cystocarpia occurred in August.

Loc. Along Koldewey Island; Danmarks Havn and the entrance to the harbour.

Fam. *Bangiaceæ*.

Conchocelis Batt.

22. **C. rosea** Batters.

Batters (1892) p. 25; K. Rosenvinge (1898 I) p. 44.
Non *Ostreobium Queketti* Born. et Flah. var. *rosea* Nadson (1900) p. 36.

This perforating alga is frequently met with in old shells in particular of *Mya* and *Saxicava*, which assume a rose-red colour when the alga occurs alone or is predominant. It agrees very well with Batters' description and figures. According to Nadson (l. c.) this alga should not be a *Rhodophycea* but a red variety of *Ostreobium Queketti*; this however does not agree with my observations of the material from North-East Greenland. *Conchocelis* and *Ostreobium* grow frequently intermingled in these shells, but they are very easy to distinguish and do not show any indication of mutual transition. *Conchocelis* is always rose-coloured, while *Ostreobium* is constantly green. *Conchocelis* consists always of articulated filaments, the cells of which are more or less inflated in the middle but narrow at the transverse walls, while the filaments of *Ostreobium* are continuous and show here and there large irregular inflations. As far as I know, Nadson has given no account of the manner in which the transition takes place between these two widely different algæ[1], and it seems therefore most probable, that the red alga which Nadson examined is not the true *Conchocelis rosea* but rather a red variety of *Ostreobium Queketti*.

As stated by Batters, the alga forms within the surface of the shell a horizontal layer of interlaced filaments of very various shapes and widths. The cells are often inflated in the middle and the filaments may then be more or less moniliform. I have not been able to detect any pore in the middle of the transverse walls. In the deeper parts of the shell some filaments are thicker, consisting of short cylindric cells separated by broader transverse walls and with rich plasmatic contents (comp. Batters l. c. pl. VIII figs. 2—6). In the thinner cells I have found a parietal chromatophore which seems to be much branched; in some cases I saw however several intensely red-coloured bodies in each cell, probably chromatophores. In some

[1] Mag. O. Paulsen has most kindly translated for me the part of Nadson's Russian text treating of *Conchocelis*.

cases I have found in the thicker filaments one intensely red-coloured body in some of the cells, similar to those taken for spores by Batters. I have not submitted this interesting alga to a more detailed study and therefore cannot express an opinion on the question of its systematic position; I refer it with doubt to the *Bangiaceæ*[1].

Loc. East side of Koldewey Island; entrance to the harbour; at Vestre Havnenæs; off Baadskæret.

B. Phæophyceæ.

Fam. *Fucaceæ.*

Fucus (L.) Dcne et Thur.

23. **F. inflatus** L.

K. Rosenvinge (1893) p. 834, (1898 I) p. 45; Jónsson (1904 p. 19.

This species seems to be common in the upper sublittoral region, in particular in the harbour where it grows gregariously at a depth of 2 to 4 meters, on stony ground, but it occurs also in the littoral region (comp. p. 96). It occurs in a form coming near to f. *evanescens*. The frond is up to 12 mm. broad, the midrib well developed, the border sometimes feebly undulato-serrate. The receptacles are short, seldom over 5 mm. long. The largest specimen is 30 cm. long. Inflations filled with air have not been observed. Some plants, which have perhaps been loose, approach to f. *membranacea*. The species for the rest only rarely occurs among other loose algæ. Found with ripe sex-organs in August and September.

Loc. East side of Koldewey Island; Cape Bismarck; Danmarks Havn; Baadskæret.

Fam. *Laminariaceæ.*

Alaria Grev.

24. **A. Pylaii** (Bory) J. Ag. emend. var. **grandifolia** (J. Ag.) Jónsson.

Jónsson (1904) p. 21.

The Alariæ contained in the collection belong undoubtedly all to the same species. They have all a long stipital part, the greater part of which belongs to the rachis. It agrees in this and in its large dimensions with *A. grandifolia* J. Ag. The base of the lamina, however, is often comparatively narrow, cuneate; it may also be rounded ovate, but I have never found it „eximie subcordato-ovata",

[1] In (1909) I have not mentioned this alga under the *Bangiaceæ*, as a provisional examination led me to believe, that Nadson's above-mentioned supposition was right.

as J. Agardh describes it (1872 p. 26). The lamina is thin as in *A. membranacea* J. Ag. (*A. Pylaii β, membranacea* K. Rosenv.). Jónsson

Fig. 5. *Alaria Pylaii* var. *grandifolia*. The lower part of the stipe is wanting in *B*. From dredging along Cape Bismarck Peninsula, July. *A* 1 : 11·5. *B* 1 : 13.

also found, in Kruuse's collection from East Greenland, specimens of *A. grandifolia*, but he thought that this species, at least provisionally, might be regarded as a variety of *A. Pylaii*, and he pointed out in particular its close relation to the var. *membranacea*. Considering the great variability of *A. Pylaii* which I have been acquainted with on the Western coast of Greenland, I am inclined to believe that this translation is legitimate, but it must be admitted, that it is very difficult to decide, whether the differences existing between the plants from North-East Greenland and those from the southern part of the West coast are due to the differences in the external conditions or are of specific value. When considering the great number of species of *Alaria* described, I cannot help thinking, that the variation of the species has often been taken too little into consideration. The specimens from North-East Greenland are distinguished from those from West Greenland — which I have determined formerly as *A. Pylaii α typica* and *β membranacea* — in my opinion only by their long and well-developed rachis.

The collection contains unfortunately only a few complete and well-developed specimens. In order to give an idea of the dimensions, I give here some measurements in centimeters:

Stipe, included rachis	Length of new lamina	Length of rest of old lamina	Greatest breadth of lamina	Greatest length of sporophylls
$26 + x$	80	17	17	30
64	82	13	13	18
$33 + x$	160	20	33	46
71	151	22	ca. 40	42
	70		32	over 100
$72 - x$				

The costa was in all cases convex on both sides, the cryptostomata were usually very distinct. As will be seen from the table, the sporophylls attain a very considerable length; their sterile upper part is sometimes bipartite.

According to Kjellman (1877, p. 11) the lamina of *Alaria grandifolia* is shed in winter at Spitzbergen, and that seems to be the case also at the shores of North-east Greenland. The lower part of the old lamina remains however and is to be found still in the following summer. The limit between the laminæ of the two years is marked as a strong narrowing (fig. 5), much as in *A. esculenta,* as shown by R. Rasmussen (1909).

Loc. Along Koldewey Island, ca. 5—15 meters; along Cape Bismarck Peninsula; Stormbugt.

Laminaria Lamx.

25. **L. saccharina** (L.) Lamx. var. **grandis** Kjellm.

Kjellman (1890) p. 25; Jónsson (1904) p. 27.

This species is common in the region explored. A considerable number of specimens have been collected in various localities; only a few large and well preserved plants have however been brought home. They seem to be referable to f. *grandis* Kjellm. and agree with the specimens from East Greenland determined to this form by Jónsson. The stipe is, in larger plants, now rather short, e. gr. 30 cm., now long (over 106 cm.). The lamina bears always, in July to September, a remnant of the lamina of the foregoing year at the top, sharply marked against the new lamina by means of a strong narrowing. The new lamina is up to 100 cm. long, up to 50 cm. broad, with very undulated border and with broadly cuneate to rounded base. In older plants the lamina may be provided with a network of lists, in the median part as well as the marginal ones. The lamina has always muciparous canals; in some cases they are rather small, in others they are larger and visible with the naked eye from the face, in particular after staining with methylene-blue. The sorus is distinctly limited, elliptical or oblong. In most of the fertile specimens only remains or traces of a sorus are visible in the old lamina, most often only a hole indicating the outline of the sorus, while a sorus is not yet visible on the new lamina, which seems to show that the sorus is not developed before winter. The hole reached in a larger plant to the very base of the old lamina.

The hapteræ are always feeble with long thin branches. Some specimens were attached to stipes of the same species.

Some narrow specimens approach to f. *glacialis* K. Rosenv. (1898 I).

Loc. Along Koldewey Island; along Cape Bismarck Peninsula; Danmarks Havn; Baadskæret; bay off Vesterdalen, 2—11 meters. From Hyde Fjord were brought home by Capt. Koch 4 stipes with hapteræ, probably belonging to this species, found on the ice on May 15th 1907.

26. **L. solidungula** J. Ag.

J. Agardh (1868) p. 3; K. Rosenvinge (1893) p. 850, (1898 I) p. 57; Jónsson (1904) p. 28.

This strongly arctic species is common within the explored area, where it seems to thrive well. The plants had only one constriction, at the limit between the new lamina and that of the foregoing year, but in most of the plants the latter is not complete, probably because it has been lost during collection or under the preservation. In a few cases only the lamina of the foregoing year was complete and bore further at the top a remnant of the two years old lamina (comp. J. Agardh l. c. plate I fig. 2). The largest specimen brought home has a total length of 133 cm.; thereof the stipe 39 cm. long, the new lamina 69 cm. long, 40 cm. broad, the lamina of the foregoing year (incomplete) 25 cm. long. The broadest specimen is 45 cm. broad. In some cases a well-developed sorus occurred at the base of the one year old lamina. The named greatest specimen, collected Aug. 15th, has a sorus at the base of the old lamina, and a new sorus is developing in the lower part of the new lamina, but in the other plants collected in July and August a new sorus was yet not visible[1].

The muciparous canals are particularly well-developed in this species; they form a network which is easily visible with the naked eye in dried specimens and in specimens preserved in alcohol; they become particularly conspicuous after staining with methylen-blue[2].

Loc. Renskæret, 2—4 meters; along Cape Bismarck Peninsula; east side of Koldewey Island; Danmarks Havn; Baadskæret.

Fam. *Chordaceæ.*

Chorda (Stackh.)

27. **Ch. tomentosa** Lyngb.

K. Rosenvinge (1893) p. 854.

In a gathering preserved in alcohol two small specimens of a *Chorda* were found, intermingled among other algæ. They were certainly sterile and feebly developed, but the hairs containing numerous chromatophores showed them to belong to *Ch. tomentosa*. They were about 5 cm. long and had not yet begun to develop the outer, fertile layer.

Loc. Bay off Vesterdalen in a depth of at most 4 meters, Aug. 28th.

Fam. *Desmarestiaceæ.*

Desmarestia Lamx.

28. **D. aculeata** (L.) Lamx.

K. Rosenvinge (1893) p. 857, (1898 1) p. 59; Jónsson (1904) p. 32.

Found at several localities, but only abundant at one. One specimen has the basal portion; in this the primary axis bears below two pairs of opposite branches, while the branches otherwise are always alternate. I have found the same in plants collected on the shores of Denmark. Plants collected in the middle of July

[1] Jónsson found many specimens in Kruuse's collections from East Greenland, the lamina of which was divided into four parts (in one plant into five) and he takes it for granted that these sections or laminæ have developed in four (five) consecutive years. The fact that some of these plants bear a sorus or mark after an emptied sorus on the uppermost section only, while the three younger segments do not yet show any trace of a sorus, (l. c. p. 28, fig. 2), suggests the question whether more than one section may not exceptionally be formed in the same year.

[2] While Areschoug (1883 p. 7) did not find muciparous canals in the lamina of this species, Guignard (1892 p. 37) found them in all examined specimens, though in some cases they were small and not easily visible.

were still in growth and had the new branches beset with long brown hairs. One specimen dredged in August was still beset with hairs while hairs were wanting in the other specimens gathered in August and September.

Loc. At the East side of Koldewey Island; along Cape Bismarck Peninsula (abundantly); Danmarks Havn; Baadskæret; bay off Vesterdalen.

29. **D. viridis** (O. F. Müll.) Lamx.

K. Rosenvinge (1893) p. 859, (1898) p. 60; Jónsson (1904) p. 32.

The plants collected are on the whole well-developed and attain a length of over 30 cm. The growth has ceased and the hairs are thrown off in August. — Found in depths from 4 to 11 meters, and perhaps deeper.

Loc. Along Koldewey Island; Danmarks Havn; bay off Vesterdalen.

Fam. *Punctariaceæ.*

Scytosiphon (Ag.)

30. **S. Lomentaria** (Lyngb.) J. Ag.

K. Rosenvinge (1893) p. 863, (1898 I) p. 62; Jónsson (1904) p. 33.

A very badly preserved, ca. 4 cm. long fragment of a tubular brown alga without base and upper part seems to belong to this species. As it has neither sporangia nor paraphyses, the determination is however uncertain. It differs from *Chorda* through lesser consistency and the structure of the frond.

Loc. East side of Koldewey Island, September.

Symphyocarpus K. Rosenv.

31. **S. strangulans** K. Rosenv.

K. Rosenvinge (1893) p. 896, (1898 I) p. 67.

Found in small quantities on older fronds of *Turnerella Pennyi* and on crusts of *Lithothamnion,* in the latter case forming ca. 2 mm. broad crusts. In all cases brown paraphyses were observed; young and empty plurilocular sporangia were also recorded. The plants were collected in September.

Loc. Danmarks Havn; along Vestre Havnenæs and off Baadskæret.

Phæostroma Kuckuck.

32. **Ph. pustulosum** Kuckuck.

Kuckuck (1895) p. 182; K. Rosenvinge (1898 I) p. 68, fig. 15.

This minute species was found on the upper end of a young *Alaria.* The plants agreed with those found on young fronds of *Laminaria nigripes* which I have formerly mentioned (l. c. p. 68 lowest). The plurilocular sporangia reach as a rule to the bottom of the plant, a sterile basal cell, as in Kuckuck's plants (l. c.), being not developed. Such a cell, however, is always met with under the hairs which have the structure described by me (l. c.). The undermost long cell of the hair is as a rule somewhat constricted at some distance from the base. In some cases I found the cell situated under the hair developed into a sporangium, the cell having protruded on one side and upwards along the base of the hair and formed an opening at the upper end of the prolongation. I am uncertain whether unripe unicellular sporangia also occur.

Loc. Along Cape Bismarck Peninsula.

Stictyosiphon Kütz.

33. **S. tortilis** (Rupr.) Reinke.

K. Rosenvinge (1893) p. 868, (1898 I) p. 70; Jónsson (1904) p. 34.

Occurs rather abundantly in gatherings from the harbour and some other localities, but almost always loose, together with other loose algæ, as *Pylaiella*, and sterile. One filament only, taken in the harbour in August, had well-developed, rather prominent plurilocular sporangia. In the old loose plants the articulation is often very prominent, much as in some *Sphacelaria*. Hairs occur only rarely. Found in 4 to 11 meters depth.

Loc. Danmarks Havn; Baadskæret; bay off Vesterdalen. In clumps in the ice at Cape Amélie, April.

Punctaria Grev.

34. **P. glacialis** n. sp.

Frons eximie stipitata, stipite 5 — c. 14 mm. longo, superne abrupte cuneatim dilatato. Lamina oblonga vel lingulata aut late elliptica, basi late cuneata, long. 17 — c. 45 cm., latit. 4—14·5 cm., plerumque 4—7·5 cm., crassit. ad 140 μ, colore in sicco olivaceo-fusco, substantia tenera, fragili, e stratis cellularibus 3—6 composita, cellulis interioribus quam exterioribus aliquantum majoribus. Pili omnino desunt. Sporangia unilocularia sparsa, ex exteriori visa eadem fere forma ac cellulæ vegetativæ exteriores, parte interne sæpe latiore, alt. 45—53 μ, latitudine supra 21—25 μ, infra 30—50 μ.

This good-sized species most resembles *Punctaria latifolia* Grev. as to the form and the consistency of the frond. It is distinguished from it through the darker colour and the want of plurilocular sporangia. In colour and structure it more resembles *P. plantaginea* (Roth) Grev. The want of hairs distinguishes it from both the named species as well as from all other species of the genus. Most of the specimens are oblong or lingulate of nearly equal breadth in the whole length of the frond, only at the base and usually also at

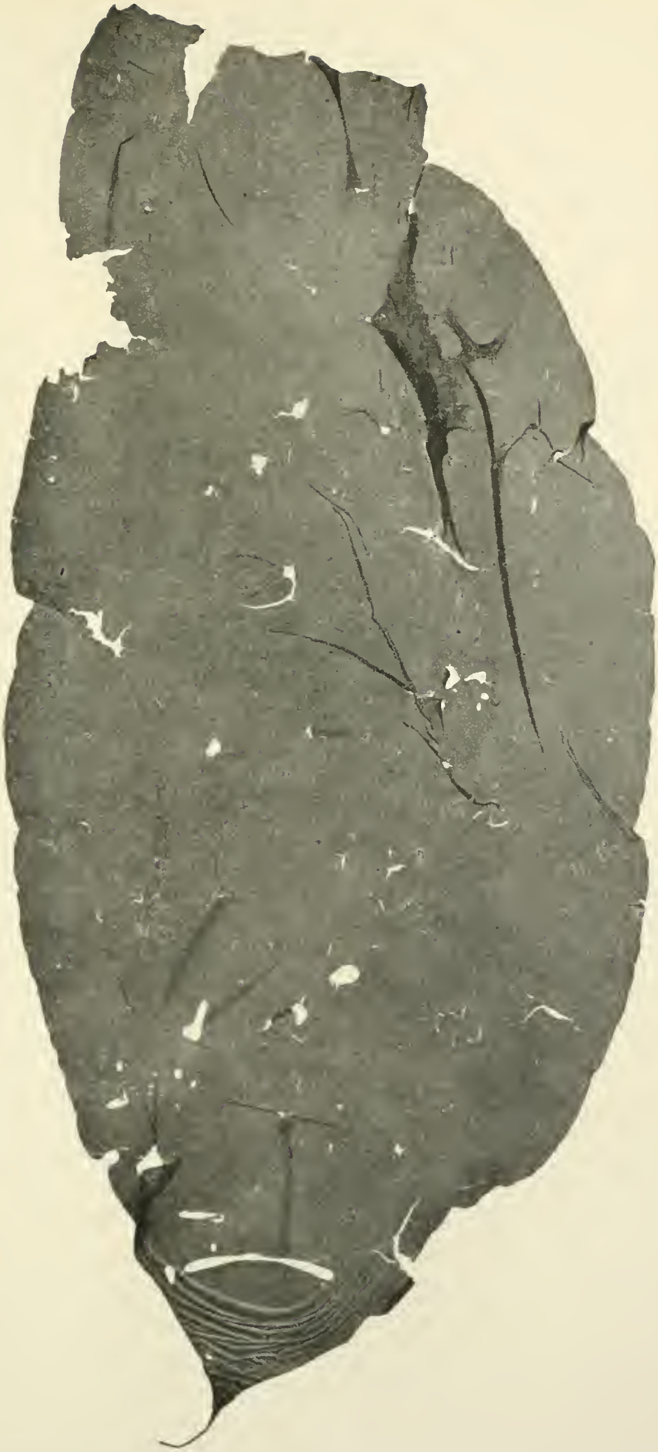

Fig. 6. *Punctaria glacialis.* From the east side of Koldewey Island. 2 : 3.

the upper end narrower. Most of the specimens were dried, but some fragments are preserved in alcohol; one of these, which was fructifying, had a thickness of 130—140 μ, another sterile was 77—95 μ thick.

The outer cells are as a rule somewhat smaller than the inner, and the structure thus most resembles that of the genus *Punctaria*

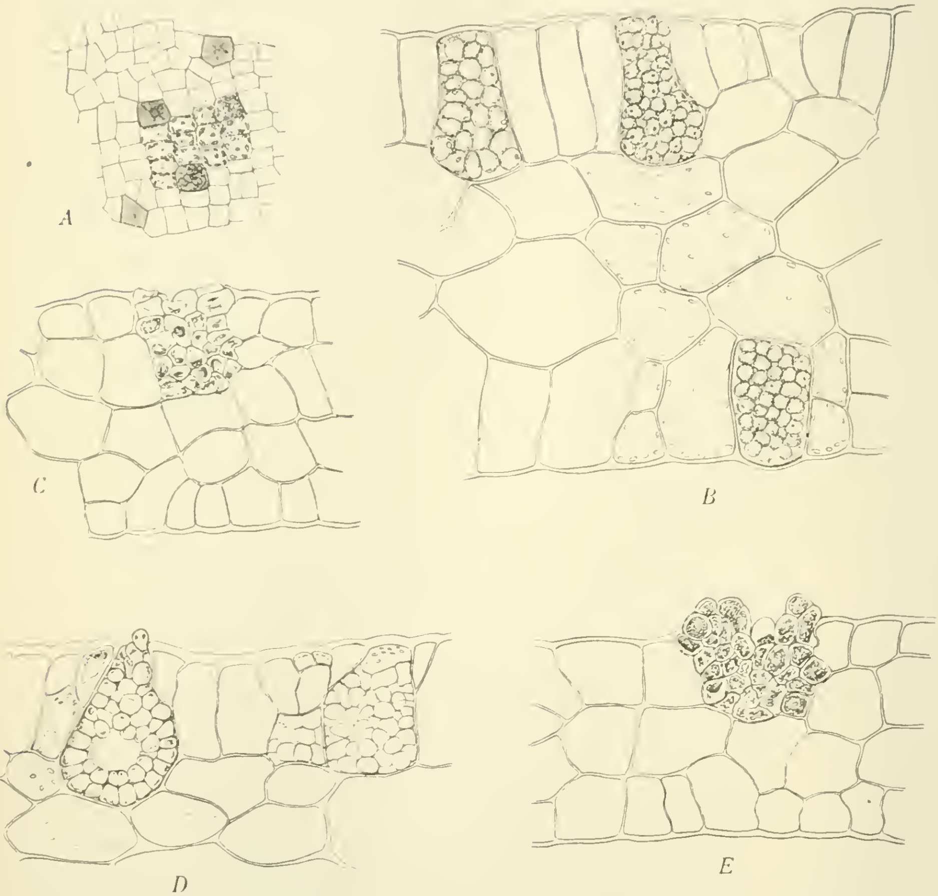

Fig. 7. *Punctaria glacialis.* *A,* part of frond seen from the surface; the shaded cells are sporangia. 200 : 1. *B—E,* transverse sections of fronds with unilocular sporangia. 340 : 1.

in the sense of J. Agardh (1896, p. 4). The frond is usually 4 to 5 cells thick. The cells contain numerous small disc-shaped chromatophores.

Some plants contain rather numerous sporangia which are all unilocular. Seen from the face they have nearly the same form and size as the vegetative cells, or they are a little more rounded. In transverse sections of the frond they appear often enlarged inwardly, a result of the growth of the sporangium and the surrounding cells after the formation of the former and often combined with cell-divisions of the latter (fig. 7 *B. D*). Strange to say, the zoospores had not developed normally but had formed a cell wall without having been set free, and the older sporangia thus became filled with closely packed polygonal cells, which gradually became rather poor in contents and might sometimes suggest the structure of plurilocular sporangia (fig. 6, *C*). Not seldom the older sporangia are open and the cells derived from the abortive zoospores are prominent above the surface of the frond (fig. 6, *D, E*), but normally developed and emptied sporangia have not been met with. Sometimes the zoospores do not fill the sporangium but leave an empty place in the middle of it (fig. 6, *D*). It may also happen that the upper part of the cell has not participated in the formation of zoospores.

Notwithstanding that this species differs from the other hitherto described species of the genus *Punctaria* by the want of hairs, I think it unnecessary to remove it from that genus. It is noteworthy that two other arctic members of the same family are also entirely devoid of hairs, namely *Omphalophyllum ulvaceum* and *Phæosaccion Collinsii*. Gathered in the end of August and the beginning of September.

Loc. Along Koldewey Island; Danmarks Havn; Baadskæret; bay off Vesterdalen, 4 to 11 meters depth.

Omphalophyllum K. Rosenv.

35. **O. ulvaceum** K. Rosenv.

K. Rosenvinge (1893) p. 873. (1898 I) p. 73; Jónsson (1904) p. 34.

The collection contains a large specimen of this arctic species, no doubt the largest hitherto found; it measures 28 cm. in greatest diameter, 16 cm. in greatest radius. It was sterile in the beginning of September. A small fragment without indication of locality was also sterile.

Loc. Along Koldewey Island.

Fam. *Elachistaceæ.*

Elachista Dub.

36. **E. fucicola** (Vell.) Aresch.

K. Rosenvinge (1893) p. 878. (1898 I) p. 74; Jónsson (1904) p. 35.

A few specimens occur attached to *Halosaccion ramentaceum* and *Punctaria glacialis*. They belong to the f. *typica* and had unilocular sporangia in August.

Loc. Bay off Vesterdalen.

Leptonema Reinke.

37. **L. fasciculatum** Reinke.

K. Rosenvinge (1893) p. 879; Jónsson (1904) p. 35.
Elachista fasciculata (Reinke) Gran, K. Rosenvinge (1898 I) p. 35.

Attached to *Lithothamnion glaciale*, mostly f. *subcylindrica* K. Rosenv., some filaments f. *uncinata* Reinke.

Loc. Entrance to the harbour.

Fam. *Ectocarpaceæ.*

Ectocarpus Lyngb.

38. **E. (Pylaiella) littoralis** (L.) Lyngb.

K. Rosenvinge (1893) p. 881, (1898 I) p. 75; Jónsson (1904) p. 35.

Found in various localities, mostly loose and in company with other loose algæ, in particular *Stictyosiphon tortilis.* Also found attached to stipes of *Alaria.* The latter specimens were very branched with secund branches, the others had often opposite branches. Unilocular sporangia were met with in plants collected in July and August.

Loc. East Side of Koldewey Island; along Cape Bismarck Peninsula; Danmarks Havn; bay off Vesterdalen, at most 4 meters; Cape Amélie, in clumps in the ice.

39. **E. ovatus** Kjellm. var. **tenuis** K. Rosenv.

K. Rosenvinge (1898 I) p. 77; Jónsson (1904) p. 37.

Small ca. 1 mm. high plants were found epiphytic on *Turnerella Pennyi* and *Lithothamnion glaciale.* They bear plurilocular sporangia which are mostly alternate or secund; opposite sporangia however also occur. The upright filaments are often unbranched (comp. Jónsson l. c.).

Loc. Danmarks Havn, and the entrance to the harbour.

40. **E. maritimus** (Kjellm.) K. Rosenv. comb. nov.

Chætophora maritima Kjellman (1877) p. 51, pl. V fig. 15—16.
Pilinia maritima (Kjellm.) K. Rosenv. (1893) p. 932.

In company with *Calothrix scopulorum* and other littoral algæ a small, branched filamentous alga was met with, occurring partly in a rather elongated partly in a shorter and denser form. The latter agrees pretty well with *Chætophora maritima* Kjellm., which has been referred by me to the genus *Pilinia.* On the other hand the more elongated plants remind one so much of *Ectocarpus lucifugus* Kuckuck, which has been so carefully described by its author (Kuckuck 1897, p. 35, pl. XI—XII), that the question arises whether it has been legitimate to refer this plant to the Chlorophyceæ. It is in reality very imperfectly known in regard to the cell-contents and to the reproduction. Thus, the zoospores seem never to have been observed. The colour was yellow-green in the dried specimens from West Greenland I have examined, and according to Kjellman the colour of the cell-contents is brownish-green (fusco-viride) (l. c. p. 51). An examination of specimens from West Greenland and from Spitzbergen (communicated by Kjellman) showed really that the cells contained no starch and that the cell-wall did not consist of cellulose, the walls of the empty sporangia only staining violet by chlor-iodide of zinc. There is thus reason to believe that the alga in question is not a Chlorophycea but a Phæophycea, and as the more elongated plants in the material from East Greenland much resemble *Ectocarpus lucifugus* Kuck. the plant must be in that case a species of *Ectocarpus* related to *E. lucifugus*. On account of the good state of preservation (alcohol) of the material from North-East Greenland it was easy to see that the cells contain a parietal chromatophore like that described by Kuckuck. The plants had unilocular sporangia agreeing with those described by me in *Pilinia maritima* (1893 fig. 43) and with those of *Ectocarpus lucifugus* (l. c.); they were only a little smaller than the latter, namely 20—24 μ long, 9—10 μ broad, while the sporangia in Kuckuck's plants were 30—35 μ long and 11—15 μ broad.

As the more elongated and the denser plants undoubtedly belong to the same species, and as the denser form fully agrees with *Chætophora maritima* Kjellm., the species must retain Kjellman's specific name but it must be referred to the genus *Ectocarpus*. It is beyond doubt that the species is nearly related to *E. lucifugus* Kuck., and the resemblance is so great that there is reason to ask if these two species might not be identical. There seems however to be at least one distinctive character, some of the branches in *E. maritimus* terminating in hairs or hair-like filaments consisting of narrower and longer cells with scarcer and less coloured contents, as in several species of *Ectocarpus*, while such hairs are wanting in *E. lucifugus* according to the express statement of Kuckuck (l. c. p. 35) and to what I found on examining original specimens sent by Prof. Kuckuck. In the plants from North-East Greenland, however, the hairs were only fully developed in the specimens with short and dense branches.

This species much resembles the fresh-water alga *Pleurocladia lacustris* A. Br. (comp. Wille (1895) and Klebahn (1895)) and seems to be related to it. In my opinion, the genus *Pleurocladia* cannot be maintained as distinct from *Ectocarpus*; the species named must therefore be called *Ectocarpus lacustris* (A. Br.) nob.

Loc. Vestre Havnenæs.

Fam. *Myrionemaceæ.*

Myrionema Grev.

41. **M. foecundum** (Strömf.) Sauv.

Sauvageau (1898) p. 10; Børgesen (1902) p. 426.
Phycocelis foecunda Strömfelt (1888) p. 7.

A small *Myrionema* which seems referable to this species was met with in the upper end of a young *Alaria* in close company with *Phæostroma pustulosum.* The hairs were provided with a sheath at the base, and were 4—5 μ thick. The sporangia which showed here and there a few longitudinal divisions were 7—9 μ broad.

Loc. Along Cape Bismarck Peninsula.

Sorapion Kuck.

42. **S. Kjellmani** (Wille) K. Rosenv.

K. Rosenvinge (1898 I) p. 95.

Some crusts of this species agreeing with the formerly collected specimens from Greenland were met with growing on *Lithothamnion*-crusts. They were up to 4 mm. in diameter and bore empty unilocular sporangia which were scattered over the surface of the frond. Sterile specimens undoubtedly of the same species were found on *Turnerella Pennyi.*

Loc. Danmarks Havn; off Baadskæret.

Lithoderma Aresch.

43. **L. fatiscens** (Aresch.) emend. Kuckuck.

Kuckuck (1894) p. 238; K. Rosenvinge (1893) p. 901, (1898 I) p. 97; Jónsson (1904) p. 39.

This species is common, forming more or less extended crusts on the stones, often confluent so that the stones are covered with a continuous brown crust which easily loosens from the stone on drying. The crust is often fairly thick, e. gr. 30 cells thick and more. Some of the specimens collected in the end of August (or perhaps also in the beginning of September) showed plurilocular sporangia, as described by Kuckuck (l. c. p. 238 fig. 11 A), partly young partly fairly well developed, however scarcely fully ripe. This agrees with what I have found in specimens from Scoresby Sound (1898 I p. 98).

Loc. Danmarks Havn; entrance to the Harbour; along Vestre Havnenæs, ca. 38 meters.

Fam. *Sphacelariaceæ.*

Chætopteris Kütz.

44. **Ch. plumosa** (Lyngb.) Kütz.

K. Rosenvinge (1893) p. 903, (1908 I) p. 99; Jónsson (1904) p. 40.

Only a few badly developed and sterile specimens were met with.

Loc. Danmarks Havn; bay off Vesterdalen; Cape Amélie, in clumps in the ice, April.

Sphacelaria Lyngb.

45. **S. racemosa** Grev. var. **arctica** (Harv.) Reinke.

K. Rosenvinge (1893) p. 904, (1898 I) p. 100; Jónsson (1904) p. 40.

A couple of well-developed but sterile specimens have been found at Cape Bismarck Peninsula. Specimens found in the harbour in August had young unilocular sporangia sitting solitary on short 1—3-celled stalks, which were as a rule monosiphonous, more rarely two in one stalk.

Loc. East Side of Koldewey Island; along Cape Bismarck Peninsula; Danmarks Havn, very scarce.

C. Chlorophyceæ.

Fam. *Phyllosiphonaceæ.*

Ostreobium Born. et Flah.

46. **O. Queketti** Born. et Flah.

K. Rosenvinge (1893) p. 906, (1898 I) p. 101.

Occurs frequently in old shells of various bivalves (*Mya, Saxicava*), but also met with in *Lithothamnion foecundum*. It is well-developed and has often the characteristic swellings described by Bornet and Flahault. These swellings often reach considerable dimensions and are then filled with a granular green matter, but I cannot state anything about their significance. The colour is always green. Transverse walls do not occur.

Loc. East Side of Koldewey Island; entrance to the harbour; along Vestre Havnenæs, 19—17 meters; off Baadskæret 38 meters.

Fam. *Cladophoraceæ.*

Acrosiphonia (J. Ag.) Kjellm.

47. **A. hystrix** (Strömf.) Jónss.

Jónsson (1904) p. 46.

Spongomorpha hystrix Strömfelt (1886) p. 54.

Cladophora arcta γ, *hystrix* K. Rosenv. (1893) p. 907.

A fragment of an *Acrosiphonia* which seems to belong to this species has been met with. The filaments are 154—175 μ thick and are partly composed of rather short cells, only twice as long as broad. They are much like *A. hystrix* f. *debilis* (K. Rosenv.), only a little thinner (comp. Jónsson l. c. p. 48).

Loc. Danmarks Havn.

A. sp.

Some of the samples contain fragments of another species of *Acrosiphonia* in small quantities. They occur together with several loose algæ and have undoubtedly also been loose. Owing to their small quantity and their incomplete and sterile condition they are scarcely determinable. The filaments are 50—90 μ thick; hooked branches do not occur. A complete specimen, possibly belonging to the same species, was met with on a stone dredged at Cape Bismarck Peninsula. Its filaments were up to 121 μ thick. The cells were in this specimen, as well as in the loose ones, several times as long as broad, and rhizoidal branches were abundant. The last-named specimen was also sterile.

Loc. East Side of Koldewey Island; along Cape Bismarck Peninsula; bay off Vesterdalen.

Chætomorpha Kütz.

48. **Ch. Melagonium** (Web. et Mohr) Kütz.

K. Rosenvinge (1893) p. 917, (1898 I) p. 104; Jónsson (1904) p. 51.

Most of the specimens in the collection seem to have been loose. Some of these specimens are very vigorous, about 1 mm. in diameter and consist of cells which are one to two diameters long, while others are much thinner, from 100 μ up to 300 μ in diameter, and composed of cells which are 3 to 4 diameters long. As there is so great a break between these two forms, one might be inclined to think that they represent two different species, but the specimens being on the whole rather scarce in the collection, and the species being very variable in breadth also in other arctic regions (comp. K. Rosenvinge 1898 p. 104), I judge it preferable to consider the thin filaments as an extremely thin form of the same species. It might be named f. *tenuis*. The thinnest specimens approach in breadth to the thickest filaments of *Chætomorpha tortuosa;* they differ however in having much more numerous nuclei, viz.

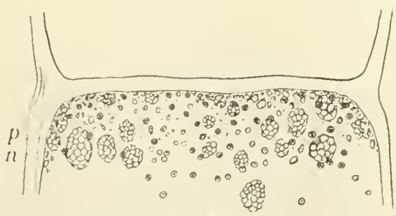

Fig. 8. *Chætomorpha Melagonium* f. *tenuis*. Upper end of a cell, showing nuclei, *n*, pyrenoids, *p*, and stroma starch. 200 : 1.

one to several hundreds (fig. 8), while *Ch. tortuosa* has ca. 20 nuclei in each cell (K. Rosenvinge 1893 p. 917).

The species seems to attain a greater thickness in high latitudes than farther south. According to Kjellman (1877 p. 56) it also reaches at Spitzbergen a diameter of ca. 1 mm., while its maximum diameter is otherwise stated to be 800 μ on the West coast of Sweden (Areschoug (1850) p. 202), 700 μ in the North Sea (Hauck 1885 p. 438) and 500 μ on the New England coast (Farlow 1881 p. 46).

In one gathering only it was found attached to a stone. These filaments had a diameter of at least 400 μ.

Loc. East Side of Koldewey Island; Danmarks Havn.

Fam. *Chætophoraceæ.*

Arthrochæte K. Rosenv.

49. **A. penetrans** K. Rosenv.

K. Rosenvinge (1898 I) p. 111.

This peculiar epi- and endophytic alga, which seems not to have been found by others since it was described in 1898, is rather frequently met with in older fronds of *Turnerella Pennyi,* in particular on discoloured spots. The plants fully agree with those from Scoresby Sound. The epiphytic crusts are in great measure polystromatic. Numerous sporangia, mostly empty, were found in plants collected in September.

Loc. East Side of Koldewey Island; Danmarks Havn.

50. **A. phæophila** sp. n.

Thallus endophyticus e filis irregulariter ramosis inter fila thalli *Symphyocarpi strangulantis* repentibus compositus. Fila primaria horizontalia ramosa, ramos breves verticales etiam emittentia; fila nonnunquam in massam pseudoparenchymaticam confluentia. Cellulæ subcylindricæ aut magis rotundatæ ad subglobosæ, longitudine diametro æquantes vel ad duplo longiores, lat. 9—15 μ, chromatophorum pyrenoide uno vel duobus instructum continentes. Pili articulati laterales vel terminales filis repentibus et erectis impositi, inferne 5·5—6·5 μ crassi. Sporangia obovata ad subglobosa in filis repentibus vel erectis lateralia aut terminalia, nonnunquam plura dense aggregata, apice dehiscentia, long. 14—25 μ, lat. 10—21 μ.

This new species has only been met with in small quantity in a few dried crusts of *Symphyocarpus strangulans* growing on a *Lithothamnion*-crust. The filaments creep irregularly between the cells of the host, in particular horizontally, in accordance with the small thickness of the host. They are often much branched, particularly in a horizontal direction, but short erect filaments are also given off. Sometimes, when the filaments are much branched, they are united to pseudoparenchymatous bodies. I am uncertain whether the plant may also be partly epiphytic. Here and there vigorous hairs, slowly tapering upwards, occur; they show one or two transverse walls, and their cells, in particular the upper, have not much contents. The vegetative cells almost certainly contain one parietal chromatophore, which however could not be distinguished in the dried plants; on the other hand one or two pyrenoids were often distinctly visible (fig. 9, *A*, *I*). Besides the pyrenoid-starch, the chromatophores contained abundant stroma-starch. The cell-wall gave intense cellulose-reaction with chlor-iodide of zinc. The position of the sporangia is different; they may be terminal on the erect filaments and lateral, sessile, on the same and on the creeping filaments. Once I have seen a terminal and a subterminal sporangium on the end of a filament, (fig. 9 *G*). The sporangia observed were all emptied through a split in the upper part of the cell-wall. They have undoubtedly contained swarm-cells, but whether asexual zoospores or gametes, it is impossible to say.

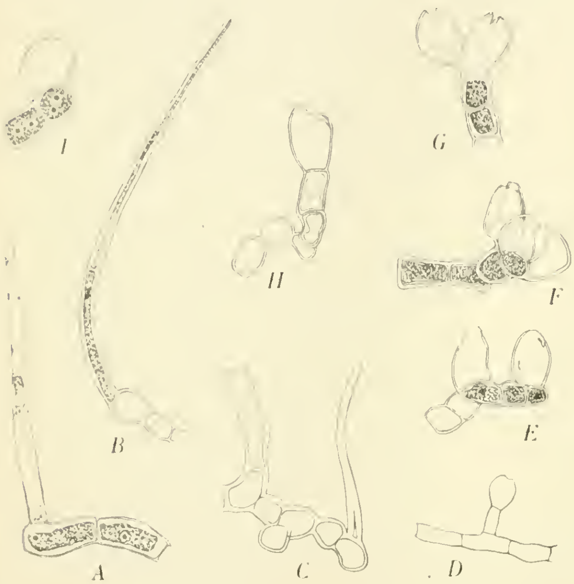

Fig. 9. *Arthrochæte phæophila*. *A*, creeping filament with lateral hair. *B*, terminal hair. *C*, branched filament with hair. *D*, creeping filament with erect filament bearing a sporangium. *E*, creeping filament with two sessile sporangia. *F*, erect filament, given off from a creeping one, bearing four sporangia, seen from above. *G*, filament with a terminal and a subterminal sporangium. *H*, erect filament with a terminal sporangium. *I*, lateral sporangium. 350 : 1.

I was at first inclined to refer this alga to the genus *Pilinia* which it somewhat resembles in its mode of growth. It is distinguished however from this genus by the presence of pyrenoids which, as far as known, are wanting in *Pilinia*. Moreover, it differs by the pluricellular hairs. Such hairs were certainly pointed out in *Pilinia maritima*, but as this plant has turned out to be a species of *Ectocarpus*, as shown above (p. 123), hairs are now not to be found in any species of *Pilinia*. By these hairs it resembles *Arthrochæte penetrans*, and as the sporangia and the structure of the vegetative cells are also similar, it might be referred to the same genus. It is distinguished from the species named by the arrangement of the filaments and the broader, often nearly globular sporangia. The differences in the structure of the vegetative frond are probably partly dependent on the differences in structure of the host plants. In this respect the new species is too little known, owing to the scarce material.

Loc. Off Baadskæret.

Epicladia Reinke.

51. **E. Flustræ** Reinke.

K. Rosenvinge (1898 I) p. 115.

The determination of the plants referred to this species is not quite sure, as they were not fructiferous. They agreed with Reinke's description and figures; the creeping filaments were partly confluent, forming a membrane, and the cells showed here and there foldings inward of the cell-wall. Found on *Delesseria sinuosa* and *Desmarestia aculeata*.

Loc. East Side of Koldewey Island; Danmarks Havn.

Gomontia Born. et Flah.

52. **G. polyrrhiza** (Lagerh.) Born. et Flah.

K. Rosenvinge (1893) p. 907, (1898 I) p. 101.

In old dead greenish crusts of *Lithothamnion læve* and in shells of *Mya* and *Saxicava*, in the latter case together with other perforating algæ (*Conchocelis, Ostreobium*) and as a rule in lesser quantity than these. Found in 19 meters depth, at least. With sporangia in the beginning of September.

Loc. Entrance to the harbour; along Vestre Havnenæs.

Pseudendoclonium Wille.

53. **P. submarinum** Wille.

Wille (1901) p. 29.

In company with *Calothrix scopulorum* and other littoral algæ a small alga was found which agreed well with Wille's description and figures, as to the mode of growth, dimensions and structure of the cells. The elongated cells were 5—6 μ broad; the cells contained a parietal chromatophore.

Loc. Vestre Havnenæs.

Fam. *Ulothricaceæ.*

Ulothrix Kütz.

54. **U. flacca** (Dillw.) Thur.

K. Rosenvinge (1893) p. 935; Wille (1901) p. 18; Jónsson (1904) p. 54.

At the upper end of a young *Alaria* some filaments of a *Ulothrix* were met with which must be referred to this species. The swarm-cell producing parts of the filaments were curved in the manner characteristic of the species and consisted of low cells undoubtedly producing gametes[1]. The filaments were comparatively thin, the fertile parts only reaching 33 μ in diameter. The cells often contained only one pyrenoid, probably in connexion with the small thickness of the filaments.

Loc. Along Cape Bismarck Peninsula.

55. **U. scutata** Jónsson.

Jónsson (1904) p. 57.

This species seems to be common within the region explored. However, I am only sure of the determination of the specimens from one locality, as I have seen only in these the basal part characteristic of the species. Most of the specimens from the other localities are dried. At the base the filaments were 5—7 μ thick, and the cells in the lower part of the filaments were frequently up to 4 times as long as broad.

Loc. East Side of Koldewey Island. Further, uncertain as to the determination from dredging along Cape Bismarck Peninsula, Danmarks Havn and Baadskæret.

56. **U. consociata** Wille.

Wille (1901) p. 25; Jónsson (1904) p. 60.

The North-East Greenland specimens agree with Wille's description; only they were rather thin. Young sterile plants were only 7—7·5 μ thick near the base, older filaments 10·5 μ, fertile filaments 12·5 μ thick. The filaments are often decumbent at the base and form rhizoids there. Sometimes two filaments were found coalesced near the base. The apical cell is rounded. — It was found growing on *Enteromorpha prolifera* in the tidal region.

Loc. Vestre Havnenæs, September.

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[1] In stating (1893 p. 935—36) that I have found this species with zoospores in West Greenland, I have not intended to say anything about the question whether the swarm-cells were asexual zoospores or gametes. Probably they were gametes (comp. Wille (1901) p. 21).

Fam. *Ulvaceæ.*

Enteromorpha (Link.)

57. **E. prolifera** (O. F. Müll.)

K. Rosenvinge (1893) p. 960; Jónsson (1904) p. 66.

It is with hesitation that I have referred to this species some specimens collected in the littoral region. They are rather much branched, thin, with still thinner branches. The arrangement of the cells in longitudinal series is sometimes tolerably distinct, the new cell-walls being mainly perpendicular to the axis of the frond, sometimes indistinct or wanting. The cells are angular with somewhat rounded edges, much as in the typical form of *E. intestinalis*, but only 7—9 μ in diameter. The membrane of the frond is 11—12 μ thick, the cell-wall is not thickened on the inner side. A great number of very young plants were met with. Some of the large plants looked as if they had wintered and later on produced new branches. No "trabeculæ" were observed in the cavity of the frond.

In view of the great difficulty of determining species of *Enteromorpha* much stress cannot be laid on the determination of the above-mentioned specimens; nor shall I enter into the question whether *E. prolifera* is specifically distinct from *E. intestinalis*.

Loc. Vestre Havnenæs, September.

Fam. *Protococcaceæ.*

Chlorochytrium Cohn.

58. **Ch. inclusum** Kjellm.

K. Rosenvinge (1893) p. 963, (1898 I) p. 119; Jónsson (1904) p. 69.

Very common in *Turnerella Pennyi*.

Loc. East Side of Koldewey Island; Danmarks Havn; off Baadskæret a. 28 meters.

59. **Ch. Schmitzii** K. Rosenv.

K. Rosenvinge (1893) p. 964, (1898 I) p. 119; Jónsson (1903) p. 338.

Very common in *Cruoria arctica* and in *Petrocelis polygyna*.

Loc. Off Baadskæret and along Vestre Havneaæs, ca. 28 meters.

D. Cyanophyceæ.

Fam. *Rivulariaceæ.*

Calothrix Ag.

60. **C. scopulorum** (Web. et Mohr) Ag.

K. Rosenvinge (1893) p. 966, (1898 I) p. 121; Jónsson (1904) p. 70.

Well developed filaments, in a great measure with hormogonia. In the littoral zone.

Loc. Vestre Havnenæs, September.

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9—5—1910.

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 5
SÆRTRYK AF »MEDDELELSER OM GRØNLAND« XLIII

FUNGI TERRESTRES

FROM

NORTH-EAST GREENLAND

(N. OF 76° N. LAT.)

COLLECTED BY THE "DANMARK-EXPEDITION"

DETERMINED

BY

C. FERDINANDSEN

WITH PL. IX

KØBENHAVN
BIANCO LUNOS BOGTRYKKERI
1910

INTRODUCTION.

The material of earth-fungi brought home by the "Danmark Expedition" was collected by A. Lundager between 76° and 77° N. L., partly on the mainland, partly on the southern Koldewey Island[1], and is very scanty, as was to be expected. In all 16 species are represented in the collection, of which however only 11 can be identified with any certainty. The greater number of these, 7 species namely, have been earlier noted from Greenland, and of the remainder *Calvatia arctica* n. sp. and *Calvatia cyathiformis* (Bosc.) Morg. have already, as will appear from the text, also been found by previous collectors. The same holds good in all probability for *Cortinarius collinitus* (Pers.) Fr. The fourth species hitherto not noted from Greenland, *Russula* cfr. *R. integram* (L.) Fr., belongs to the commonest North European fungi and is also known from Arctic regions.

Russula cfr. *R. nitidam* Fr. is new for the east coast; on the other hand, *Scleroderma vulgare* Fr. and *Lycoperdon favosum* (Rostk.) Bonord. are dropped from its flora (cfr. text).

As was to be expected beforehand, the species found are such as grow — or are able to grow — on barren and little sheltered places in temperate latitudes; there is much agreement especially between this small high-northern fungus-flora and that of our own heaths.

As mentioned above, it has not been possible to determine all the fungi with certainty to their species; many characters namely are wiped out on preserving the material — chiefly the colours, next also the whole appearance of the living fungus, which is an essential, sometimes indeed necessary condition for a correct determination of species. This is helped out somewhat for the species which have been drawn in colours by the artists of the Expedition; but we can naturally not expect to find just the mycologically important characters illustrated in such sketches. A completely satis-

[1] A single, indeterminable species was collected by Dr. Lindhard on Maroussia.

factory picture of the fungal flora of a region will on the whole only be obtained, when a specialist visits the country and himself collects his material.

For friendly assistance in the examination of the *Gasteromyceteae* collected I am much indebted to Dr. Ladilaus Hollós of Kecskemét in Hungary and my friend cand. Winge of Copenhagen.

Agaricineae.

Cortinarius Fr.

Cortinarius (Myxacium) collinitus (Pers.) Fr. — Epicr. p. 274.

No. 270 a (coloured drawing): bog north of Thermometerfjæld, 4—6—07; No. 355: near the large lake, 9—8—07; No. 1911: Danmarks Havn, 16—7—08; No. 1916: Basiskæret, 16—7—08.

On the largest and best preserved specimens (No. 355) the belted structure of the stalk is still to be seen; the other specimens are less typical, but undoubtedly belong within the range of this species, which is very variable. In microscopical regards they are quite the same.

This species, which seems comparatively common, has probably been brought home from Greenland on earlier occasions, without its being possible to determine the specimens; cfr. Rostrup: Fungi Groenlandiae orientalis etc., Medd. om Grønland XXX, p. 15: "In collectionibus .... Agaricaceae .... indeterminabiles e generibus *Russulae* .... et *Cortinarii* inventae sunt".

Cortinarius sp.

No. 380: Cape Bismarck, 14—8—07.

Galera Fr.

Galera Hypnorum (Batsch) Fr. — Syst. Myc. I, p. 267.

No. 33 a (coloured drawing): near the large lake, 1—8—07; No. 1766: in damp moss, 18—7—08.

Cystidia bottle-shaped, usually with a small knob or bud on the neck. In the material from Julianehaab I have found conical cystides, which however showed a tendency to swell out above into knobs; on the whole this species seems to contain several types in regard to the form of the cystidia.

"Seems to be one of the commonest Agaricaceae occurring in Greenland" (Rostrup: Tillæg til Grønlands Svampe, Medd. om Grønland III, p. 597).

Inocybe Fr.

Inocybe lacera Fr. — Syst. Myc. I, p. 257.

No. 48a: Koldewey Island, 13—8—06.

A covering of sand, containing protonema threads, small mosses, a very small *Juncus* plant and withered stumps of older, still surrounds the somewhat knob-shaped, swollen basal part of the stalk.

This fungus thrives well on sandy, naked ground; the author has found it on such a locality on heaths in Jutland. — Noted by Rostrup from Danmarks Ø (Øst-Grønlands Svampe, Medd. om Grønland XVIII, p. 7).

Lactarius Pers.

Lactarius rufus (Scop.) Fr. — Epicr. p. 247.

No. 48b: Koldewey Island, 13—8—06; No. 381b: Thermometerfjæld, 17—8—07.

The anatomical examination of the trama shows that the fungus is a *Lactarius* or a *Russula*. There is nothing stated regarding the milk contents; but most fortunately *Lactarius rufus* belongs to the fungi, which resist excellently the influence of the preserving fluid, so that it is easily recognised even in alcohol.

The fungus is noted by Rostrup from Danmarks Ø (Øst-Grønlands Svampe, Medd. om Grønland XVIII, p. 8); it is of rather common occurrence on Danish heaths.

Naucoria Fr.

Naucoria sp. sc. **N. lapponica** Fr. — Hym. Eur. p. 263.

No. 1935: Bog near Danmarks Havn, 16—7—08.

A small specimen (stalk ca. 2 cm. high, pileus 1½ cm. broad), with quartz grains firmly attached to the surface of the pileus. Spores ellipsoidal, 8—10 μ × 5—6 μ, light-yellow with oil-drops. — Colour of the pileus is now dark-brown, but on drying yellow spots come to view which have been very apparent in the fresh state; this is indicated by a note in the journal: "honey-fungus". The pileus has thus been covered by bright yellow scales, and the pellicle has been viscous; add to this, that the lamellae are toothed at the edge and with decurrent teeth, and it becomes very probable that we have *N. lapponica* Fr. before us. — Unfortunately, no microscopic characters have been included in the diagnosis of this species, which makes the identification very difficult. — Rostrup notes *N. lapponica* Fr. from Cape Stewart (Øst Grønland Svampe p. 7).

Omphalia Fr.

Omphalia umbellifera (L.) Fr. — Elench. I, p. 22.

No. 381 a (coloured drawing): Thermometerfjæld, 17—8—07; No. 1936: bog near Danmarks Havn, 16—7—08 (Honey-fungus).

As the drawing and the term "honey-fungus" indicate, the fungus has a beautiful yellow colour in the living condition (the form *Ag. chrysoleucus* Pers., which is common in high mountains and in the Arctic).

"Seems to be the most commonly occurring and most widespread of the Agaricineae in Greenland" (Rostrup: Fungi Groenlandiae, Medd. om Grønland III, p. 528). — Cf. also Rostrup: Øst-Grønlands Svampe, Medd. om Grønland XVIII, p. 7, Duc d'Orléans: Croisière océanographique etc. Botanique p. 12. — N. Hartz's note, that the fungus is common on damp spots in the heath in Scoresby Sound (Øst-Grønlands Svampe l. c.) agrees well with the fact, that on Danish heaths it is also chiefly bound to moist spots between the *Calluna*-tufts, where the author has even found it submerged.

Omphalia umbellifera (L.) Fr. var. ad O. rusticam Fr. vergens.

No. 360: fungi on fairly dry ground on S. E. side of the Varde-Ridge, 11—8—07; chocolate-brown, the small specimen with a light spot in the middle.

From the typical *O. umbellifera* this form differs by its dark colour and by somewhat narrower, more crowded lamellae; in these characters it approaches to *O. rustica* Fr., which species along with *O. umbellifera*-forms is united by Persoon to the species *Agaricus ericetorum*. Both species (*umbellifera* and *rustica*) are found on Danish heaths.

Omphalia sp.

No. 991: Basiskæret 20—6—08; in rough dried moss and as stiff as wood.

The badly preserved condition makes a certain determination impossible.

Russula Fr.

This is one of the genera in which the separation of the species is often very difficult, in fact almost impossible in alcohol material when the plants have not been collected and labelled by a specialist. A certain amount of knowledge of the shades of colour of the spores and of the taste (smell) of the flesh is in fact an indispensable condition for the determination of the species — and of these characters the first can be only with difficulty, the last impossibly recognised after treatment with alcohol. The determinations given must therefore merely be regarded as approximate.

Russula sp. cfr. R. integram (L.) Fr. — Epicr., p. 360.

No. 333b (coloured drawing): near the large lake, 1—8—07; No. 353 (coloured drawing): no locality noted.

Of these specimens No. 353 (deep-red, strongly tuberculated at the margin, stalk somewhat faintly yellowish) certainly comes nearest to the true *R. integra* Fr.; No. 333b seems more distant, to judge from the coloured drawing, especially in the yellow stalk — and is in any case not *R. integra* sensu Friesii. — "Plures occurrunt ambiguae formae, praecipue *R. integra* coloris varietatibus fallax". (Sacc. Syll. V, 469).

Russula integra is "in Europa boreali ex vulgatissimis" and is further noted from Siberia and the Bellot Islands (81° 41′ N. L.) (Sacc. Syll. V, p. 475).

Russula sp. cfr. R. nitidam (Pers.) Fr. — Epicr. p. 361.

No. 400 (coloured drawing): Basiskæret, 20—8—07.

The pileus has a characteristic, deep-blue colour with red-mauve spots. If the lamellae are yellowish — and they certainly seem to be so — the fungus belongs in the neighbourhood of the species named.

Rostrup (Fungi Groenlandiae, Medd. om Grønland III, p. 529) gives *R. nitida* from Upernivik.

Russula sp.

No. 270b (coloured drawing): In pool N. of Thermometerfjæld, 4—6—07.

The plant itself is not to be found in the collection, and the coloured drawing does not give sufficient information to make a determination of the species possible.

Tubaria Fr.

Tubaria furfuracea (Pers.) Fr. — Syst. Myc. I, p. 262.

No. 374: Near the shore E. of Thermometerfjæld, 12—8—07. On the slope in a dried-up water-course. Moorland.

Small, but typically developed specimens with several concentric circles of clay-coloured scales along the margin of the pileus.

Rostrup does not mention this fungus from East Greenland (only from Upernivik and Disco); but it has probably been found later at Cape Bismarck; cf. Duc d'Orléans: Croisière océanographique etc., Botanique, p. 12.

Agaricaceae indeterminatae.

The remainder of the Agaricaceae collected, in all three species, must be taken together under this designation, as not even a determination of the genus is possible in these cases; for this, so far as the species A (Nos. 1293 and 1294) is concerned, the too little developed condition stands in the way, and the material of the second species, B, (Nos. 70 and 454) was already damaged by larvae and frost on collecting. Lastly, the third species, C, (Nos. 382 and 383) belongs to such a difficult generic group, that a determination from the available, very sparse material would be quite indefensible. — For the sake of completeness the fungi in question are noted — with the collector's and a few other additions — as an appendix to the above-given list.

A. No. 1293: Maroussia 20—7—08; Dr. Lindhard found these fungi in an eskimo ruin, the kitchen-corner, deep under the surface. No. 1294: Like the foregoing, only seen here.

The specimens found are quite small, the largest 1 cm. high with pileus just formed. Brownish. Grows on a swampy soil, chiefly of moss.

B. No. 70: Fungi in wet moss under Thermometerfjæld. No. 454: Basiskæret, 25—8—07, taken in the frozen condition, later thawed and put in alcohol.

The spores are rough, hyaline; the flesh is almost entirely eaten away by larvae. *Russula?*

C. No. 382: Thermometerfjæld, 17—8—07, damp grass. No. 383: the same, lot of rain on preceding days.

These specimens have characteristic, edged spores; but as nothing is noted regarding the colour of the spores, a certain determination of the genus cannot be made. If the spores were red, the fungus has to be referred to *Entoloma* (or *Leptonia*); if they were brown, on the other hand, the species will belong to *Inocybe*. — There is absolutely no resemblance between the material of small, dark fungi preserved in alcohol and the coloured drawing of No. 382, which shows a very large, fine, grey-lilac, silky fungus and seems to have indications of brown spores. — *Inocybe?*

Gasteromyceteae.

Calvatia Fr.

Calvatia cyathiformis (Bosc) Morg. — North American Fungi, Journ. Cincinati Soc. Nat. Hist. XII, p. 168.

Synonyms:

Lycoperdon cyathiforme Bosc, Berlin Mag. 1811 V p. 87, t. VI fig. 11 A, B.

Bovista lilacina Berk. & Mont., Hook. Lond. Journ. Vol. IV 1845.

Lycoperdon lilacinum (Berk.) Mass., Massee: Monographia Lycop. nr. 10.

Lycoperdon lilacinum (Berk. & Mont.) Speg., Fungi Argent., p. 197, nr. 321.

Lycoperdon fragile Vitt., Monogr. Lyc. p. (36) 80, 1842.

Calvatia fragilis (Vitt.) Morg., North American Fungi in Journ. Cincinati Soc. Nat. Hist. XII, p. 168.

Lycoperdon Bovista Vitt., Fungi. Mang. p. 264, t. XXXIII, fig. II G et E.

Lycoperdon pseudolilacinum Speg., Fungi Guaran. p. 45, nr. 94.

No. 1906, Hvalrosodde Aug. 1906; No. 79, Hvalrosodde 16—6—07; No. 133, Hvalrosodde 13—6—07.

This fungus is very cosmopolitan in its distribution (Asia, Africa, America, Europe) and also occurs in this country, mostly on heath and downs. — Of the specimens brought home No. 1906 is about to shed its spores and it is distinctly seen, that the brown, chequered periderm is bursting irregularly, *Calvatia*-like; in the other specimens, which probably have wintered, only the bowl-shaped basal part remains; in No. 79 this has a diameter of ca. 7 cm. All the specimens are almost sessile, stalky-contracted below and with wrinkled-grooved basal part. The spore-mass is dark-brownish, with purple shade; under the microscope the spores are distinctly warted, sometimes with a small pedicel, yellowish brown, 5—6 μ diam.; threads of the capillitium have almost the same diameter as the spores and a slightly darker colour. The loose tissue in the quite weakly developed, sterile foot-part has a lilac sheen. There could scarcely be any doubt from these characters, that these fungi belonged to *Calvatia cyathiformis*, and the well-known specialist on the Gasteromyceteae, Dr. LADISLAUS HOLLÓS of Hungary, to whom I sent No. 1906, has also confirmed my determination of that specimen.

On going through the East Greenland collections in the Botanical Museum of Copenhagen I came across a specimen of the above-mentioned species, collected at Cape Dalton by C. KRUUSE and published in ROSTRUP's "Fungi Groenlandiae orientalis ...." in Medd. om Grønland XXX, p. 115, under the name of *Lycoperdon favosum* (Rostk.) Bonord[1]. The specimen in question consists only of the persistent basal part of the fungus, which in this case is but little typical, almost disc-shaped and with *Geaster*-like, retroverted lobes on the margin. Further, the colour is lighter than the type. A section through the (short and but little distinct) stalk of the fruit-body shows, however, the loose, lilac-coloured tissue which is so characteristic of *C. cya-*

[1] Bot. Zeit. 1857, p. 595; Sacc. Syll. VII p. 121. In Bot. Centralbl. 1902, Beil. p. 4 (extra) OUDEMANS has given the same specific name to a newly founded species; according to a generally applied rule this last species should be called *Lycoperdon Oudemansii.*

thiformis. Also in regard to gleba and microscopic characters there is full agreement with this species.

Calvatia arctica Ferdinandsen et Winge sp. n.

Peridio fere habitum *Sclerodermatis aurantii* aemulante, subreniformi-globoso, inferne stipitiformi-protracto indeque plicato, lat. ad 6 cm., alt. circ. 3 cm., ± radicato. Exoperidio tenui, superne verrucis eximie pyramidatis, lineolis horizontalibus parallelis ornatis, obsesso, nonnumquam magis irregulariter areolato-caelato, inferne, secundum limitem satis distinctum, granuloso — primo albo, ad maturitatem fungi ochraceo. Endoperidio crasso, irregulariter dehiscente, fragili. Gleba peridium fere totum explente, initio alba, matura griseobrunneola, levissime olivaceo-tincta, basi sterili pallida, parvo-cellulari, partem infimam stipitiformem peridii tantum occupante, instructa. Basidiis obovato-clavatis, 14—16 μ × 7—8 μ, sterigmatibus tenuibus, usque 18 μ long., suffultis. Sporis globosis, 4·5 μ — 5·5 μ diam, minute papillatis, uniguttulatis, tenuiter tunicatis, flavidulis, ad maturitatem verrucis hyalinis, perexiguis, deciduis exasperatis. — Floccis diametro fere sporarum (raro ad $7^1/_2$ μ lat.), iisdem subconcoloribus, nonnumquam dichotome ramosis.

Hab. ad terram in tractu litoreo Groenlandiae orientalis, Lat. bor. c. 77°.

No. 241, in a bog, 19—7—07; No. 1803, Lille Snenæs, 9—7—08, common in heath-bogs, damp *Carex*- and *Eriophorum*-pools.

As the above diagnosis shows (see also Plate IX), this fungus has a very characteristic external appearance, not unlike certain forms of *Scleroderma aurantium* (Vaill.) Pers.[1] The specimens collected were unripe, but on going through the collections of the Botanical Museum of Copenhagen in order if possible to find material for comparison, I was successful in obtaining a ripe specimen of the fungus, collected on the Liverpool Coast, Hurry Inlet (C. Kruuse). The latter is noted in Rostrup's Fungi Groenlandiae orientalis etc., Medd. om Grønland XXX, p. 115, under the name of *Lycoperdon favosum* (Rostk.) Bonord.. This last species seems from the description hardly distinct from *Calvatia caelata* (Bull.) Morg., and in his work "Die Gasteromyceten Ungarns" p. 163, Hollós also gives the two species as synonyms. — It is not possible now, however, to bring the above-described species in under the true *Calvatia caelata*; the gleba-mass,

[1] In "Tillæg til Grønlands Svampe", Medd. om Grønland III p. 601, Rostrup states, that *Scleroderma vulgare* Fr. is "common in heaths", citing a note of N. Hartz, written on a label to a specimen from Vajgattet. The specimen in question, however, is no *Scleroderma,* but belongs to the *Lycoperdaceae* and is most likely nothing but a young *Calvatia arctica.* After this *Scleroderma vulgare* Fr. (= *S. aurantium* (Vaill.) Pers.) is not recorded from the East coast.

namely, is greyish chocolate-brown, and the spores are slightly warted (4·5 – 5·5 μ diam., light-yellow); further, the threads of the capillitium have nearly the same diameter as the spores. These microscopic characters point towards *C. cyathiformis,* without however permitting identification with this species; for this also the sculpture of the periderm and the light colour stand in the way.

I then sent the specimen from the Liverpool Coast (A), as also a true *C. cyathiformis,* (No. 1906) to Dr. Hollós, who very kindly subjected these fungi to a closer investigation and returned them with the following remarks: „Exemplar A ist entschieden kein *Calvatia caelata* (Bull.) Morg. .... Auch nicht *Calvatia cyathiformis* (Bosc) Morg. — Ich kenne den Pilz nicht. In meiner reichen Sammlung befindet sich kein solches Exemplar, mit dem ich Exempl. A vergleichen könnte."

On an accompanying, analytical drawing Dr. Hollós has written: *Calvatia* sp.? — and in this genus the fungus should certainly be placed. It seems, from the information given, to be rather widely distributed in East Greenland.

EXPLANATION OF PLATE IX.

Calvatia arctica Ferd. & Wge sp. n.

Fig. 1. Habitus of a young fungus, nat. size (after a specimen in alcohol).
Fig. 2. Part of the peridium of a ripe fungus, from the outside, nat. size (after a dried specimen).
Fig. 3. The same, from the inner side.
Fig. 4. Spores. $\frac{1000}{1}$.
Fig. 5. Basidia. $\frac{1000}{1}$.
Fig. 6. Threads of the capillitum, $\frac{1000}{1}$.

CALVATIA ARCTICA sp. n. FERD. et WGE.

Arbejder fra den Botaniske Have i København. Nr. 56.

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 6

SÆRTRYK AF «MEDDELELSER OM GRØNLAND» XLIII

SYSTEMATIC LIST OF FUNGI (MICROMYCETES) FROM NORTH-EAST GREENLAND (N. OF 76° N. LAT.)

COLLECTED BY THE "DANMARK-EXPEDITION" 1906—1908

DETERMINED BY

J. LIND

WITH PL. X

KØBENHAVN

BIANCO LUNOS BOGTRYKKERI

1910

INTRODUCTION.

The following list of fungi is mainly the result of my examination of the vascular plants, collected by Mr. Lundager; only a few of them belong to Captain J. P. Koch and Mr. Freuchen's collections. Only very few specimens have been collected expressly for the sake of the fungi themselves, and accordingly the majority of the fungi found belong to the less conspicuous species.

Most of the species are already known from Greenland and have been mentioned in E. Rostrup's publications in earlier volumes of "Meddelelser fra Grønland"; 4 of the 65 species are new to science, and 18 of them have not formerly been found in Greenland.

For the rest my report comes close to C. H. Ostenfeld and Andr. Lundager's "List of vascular plants", so that I may refer to their list for the names of authors of the host-plants etc.

List of the collecting places, arranged from north to south.

Hyde Fjord 83° 15′ N. Lat.
Mallemukfjeld 80° 10′ —
Lambert Land 79° 8′ —
Ymers Nunatak 77° 24′ —
Cape Marie-Valdemar c. 77° 20′ —
Germania Land: Rypefjeld, Hvalrosodde, Dove Bugt, Lille Snenæs, Snenæs, Stormkap, Harefjeld, Danmarks Havn, Termometerfjeld, Basiskær, Cape Bismarck,
arranged from N. W. to S. E. 77° — 76° 43′ N. Lat. and 21° — 17° 30′ W. Long.
Maroussia Island 76° 39′ N. Lat. — 18° 43′ W. Long.
St. Koldewey Island ca. 76° 30′ — 18° 50′ —

List of papers dealing with Fungi of northern East Greenland.

Ferdinandsen et Winge: Champignons, in Duc d'Orléans, Croisiere oceanographique dans la mer du Grønland en 1905. Resultats scientifiques. Bruxelles. 1908.
Fuckel: Pilze, in Die 2te deutsche Nordpolarfahrt. Bremen 1872.

ROSTRUP: Fungi Groenlandiae. Meddelelser om Grønland III. Kjøbenhavn 1888.
— Tillæg til Grønlands Svampe. — — III. — 1891.
— Østgrønlands Svampe. — — XVIII. — 1894.
— Fungi Groenlandiae orientalis. — — XXX. — 1904.
SACCARDO: Sylloge fungorum. vol. I—XVIII. Patavii 1882—1906.

Myxomycetes.

1. **Licea brunnea** Preuss. Sacc. Syllog. VII, p. 405.

Sporidiis cinnamomeis, globosis, 4—5 μ diam.

Loc. On Owls disgorging, Lille Snenæs 2/9 07.

Phycomycetes.

2. **Physoderma Hippuridis** Rostrup. Sacc. Syllog. XI, p. 250.

Loc. On living stems of *Hippuris vulgaris*, Danmarks Havn 15/7 08.

Note. Has hitherto only been noticed in Greenland and in the Isle of Funen. (cf. ROSTRUP: Mykologiske Meddelelser VIII. Botanisk Tidsskrift Bd. 22, p. 254).

Ustilagineae.

3. **Cintractia Caricis** (Pers.) Magn. Syn: *Ustilago Caricis* (Pers.) Fuck. Sacc. Syll. VII, p. 464.

Loc. On *Cobresia* (*Elyna*) *Bellardi*, Termometerfjeld. 15/8 07.

Uredineae.

4. **Melampsora arctica** Rostrup. Sacc. Syll. VII, p. 594 & IX, p. 926.

Loc. Both on the upper and lower sides of leaves of *Salix artica*. Harefjeld 10/7 07, Danmarks Havn 18/7 08, Lille Snenæs 12/7 08.

5. **Puccinia Cardamines-bellidifoliae** Dietel. Sacc. Syll. XVI, p. 275. Sydow: Monographia Uredinearum. Vol. I, p. 510.

Sporidiis 33—36 μ × 17 μ.

Loc. On living leaves of *Cardamine bellidifolia*, Lille Snenæs 2/9 07.

Gymnoasceae.

6. **Gymnoascus Reessii** Baranetzky. Sacc. Syll. VIII, p. 823.

Loc. On *Lemming* excrement, Termometerfjeld, Sept. 07.

Note. New for Greenland.

Pezizeae.

7. **Mollisia advena** Karst. Sacc. Syll. VIII, p. 352.

Loc. On *Eriophorum polystachyum* f. *elegans*, Danmarks Havn 14/7 08.
Note. New for Greenland.

8. **Mollisia atrata** (Pers.) Karst. Syn: *Pyrenopeziza atrata* (Pers.) Fuck. Sacc. Syll. VIII, p. 354.

Loc. On stems of *Potentilla emarginata*, Renskæret 20/7 08.

9. **Pyrenopeziza Karstenii** Sacc. Syll. VIII, p. 367. Syn: *Mollisia graminis* Karsten *non Peziza graminis* Desm.

Loc. On dead leaves of *Aira caespitosa*, Danmarks Havn 16/7 08; and of *Poa* (?), Lille Snenæs 22/6 08.

10. **Geopyxis Ciborium** (Vahl) Sacc. Syllog. VIII, p. 64.

Ascis clavatis 200 μ (p. sp. 100 μ) $\times$ 12 μ; paraphysibus hyalinis, ramosis, septatis ascos superantibus, apice sensim ad 5 μ incrassatis; sporidiis hyalinis, continuis, eguttulatis, 15—17 μ $\times$ 6 μ.

I have compared the specimens found with Flora danica tab. 1078 fig. 1, they have not so long and slender a stalk as shown in the picture, but they are similar as regards size and shape (see tab. X fig. 5).

Loc. Termometerfjeld 4/6 07 among mosses.

Sticteae.

11. **Naevia diminuens** (Karst.) Rehm. Syn: *Phacidium diminuens* Karst. Sacc. Syll. VIII, p. 721.

Loc. On dead leaves of *Hierochloa alpina*, Cape Marie-Valdemar. 15/8 06.

12. **Naevia pusilla** (Lib.) Rehm. Sacc. Syll. VIII, p. 662. Syn: *Trochila juncicola* Rostrup. Sacc. Syll. VIII, p. 732.

Loc. On dead leaves of *Luzula arcuata* var. *confusa*. Lamberts Land 14/6 07. (Koch.)

Phacidieae.

13. **Rhytisma salicinum** (Pers.) Fries. Sacc. Syll. VIII, p. 753.

Loc. Living leaves of Salix arctica, Danmarks Havn 20/5 08.

Hysterineae.

14. **Lophodermium arundinaceum** (Schrad.) Chev. Sacc. Syll. II, p. 975.

Loc. On leaves of *Festuca ovina*, Termometerfjeld 28/7 07; *Festuca ovina* var. *brevifolia* Danmarks Havn 15/7 08.

15. **Lophodermium arundinaceum** (Schrad.) Chev. var. **alpinum** Rehm. Sacc. Syll. II, p. 795.

Ascis 80 μ × 12 μ; paraphysibus filiformibus; sporidiis 40—48 μ × 4 μ.

This var. differs distinctly and noticably from the principal species by its shorter and more open perithecia and by its spores, which are up to 4 μ broad.

Loc. On leaves of *Poa glauca*, Danmarks Havn, 16/7 08.

Erysiphaceae.

16. **Erysiphe graminis** deC. Sacc. Syllog. I, p. 19.

No perithecies, only conidies (*Oidium monilioides* Link. Sacc. Syllog. IV, p. 46) are to be found.

Loc. On living leaves of *Poa cenisia*. Snenæs 12/7 08.

17. **Sphaerotheca Humuli** (deC.) Burr. var. **fuliginea** (Schlecht.) Salmon (A monograph of the Erysiphaceae. New York 1900).

This fungus is the same as described by Juel under the name of *Sphaerotheca Drabae* (Några mycologiska notiser. Botaniska Notiser 1890. Sacc. Syllog. IX, p. 365).

Rostrup (Ascomyceter fra Dovre. Kria. Vid. Selsk. Forh. 1891 No. 9, p. 6) and Salmon (A monograph of the Erysiphaceae p. 51 & p. 57) however agree in classifying it under *Sphaerotheca Humuli* in spite of its different appearance.

Loc. On *Braya purpurascens* (hosp. nov.). Lille Snenæs 24/6 08 and Trekroner 27/6 08.

Melanommaceae.

18. **Melanomma Dryadis** Johans. Sacc. Syllog. IX, p. 804.

Sporidiis fuscidulis, 3-septatis, 21—22 μ × 8—10 μ.

Loc. On dead leaves of *Dryas octopetala*, Hyde Fjord, 14/5 07 (Koch).
Note. New for Greenland.

Sphaerellaceae.

19. **Ascospora graminis** spec. nov.

Mycelio repente, effuso, subpersistente, hypophyllo, fusco e hyphis torulosis, ramosis, septatis composito; Peritheciis superficialibus, applanato convexis, sparsis 80—100 μ diam., medio perforatis; ascis fasciculatis, globoso-ovatis, sessilibus, apice crasse tunicatis, aparaphysatis, octosporis, 24—40 μ × 13—17 μ; sporidiis ellipticis, inaequi lateralibus, granulosis, hyalinis, conglobatis, 15—16 μ × 4 μ. (Look tab. X fig. 1 & 2).

Loc. On dead leaves of *Poa glauca* and *Poa abbreviata*, Lille Snenæs, Sept. 08.

20. **Carlia rhytismoides** (Babingt.) Kuntze. Syn: *Laestadia rhytismoides* (Berk.) Sacc. Syllog. I, p. 424.

Loc. On leaves of *Dryas octopetala*, Hydefjord 18/5 07 (Koch) and Danmarks Havn 6/7 08.

21. **Mycosphaerella pachyasca** (Rostrup) Vgr. Syn: *Sphaerella pachyasca* Rostr. Sacc. Syll. IX, p. 613.

Loc. On dead leaves and stems of *Campanula uniflora*, Danmarks Havn 8/7 08; *Cardamine bellidifolia*, Bugten 8/7 and Danmarks Havn 16/7 08; *Cerastium alpinum*, Hvalrosodde 24/8 06. *Draba arctica*, Hvalrosodde 16/7 07; *Epilobium latifolium*, Rypefjeld 27/6 08 (Freuchen) and Lille Snenæs 11/7 08; *Oxyria digyna*, Danmarks Havn 8/7 08; *Papaver radicatum*, Rypefjeld 6/7 08, Danmarks Havn 17/7 08, Elven 6/7 07; *Ranunculus pygmaeus*, Danmarks Havn 8/7 08.

22. **Mycosphaerella Tassiana** (de Not.) Johans. Syn: *Sphaerella Tassiana* de Not. Sacc. Syllog. I, p. 530.

Loc. On dead leaves of *Aira caespitosa* and var. *arctica*, Danmarks Havn 28/7 07; *Arctagrostis latifolia*, Danmarks Havn 14/7 08; *Carex incurva*, Rypefjeld 6/7 08 (Freuchen); *Carex misandra*, Hvalrosodde August 06; *Carex pulla*, Termometerfjeld 28/7 07; *Carex rigida*, Rypefjeld Juny 08; *Eriophorum Scheuchzeri*, Danmarks Havn 14/7 08 and Vester Elv 17/7 07; *Festuca ovina*, Termometerfjeld 28/7 07 and St. Koldewey 13/8 06; *Festuca ovina* var. *brevifolia*, Danmarks Havn 10/8 07; *Glyceria angustata*, Hyde Fjord 18/5 07 (Koch) and Mallemukfjeld 11/6 07 (Koch), Danmarks Havn 20/7 08 & 10/8 07 and Maroussia 21/7 08; *Glyceria maritima* f. *vilfoidea*, Danmarks Havn 4/9 07; *Luzula nivalis*, Stormkap 19/8 06; *Phippsia algida* (hosp. nov.) Danmarks Havn 28/7 08; *Poa abbreviata*, Hvalrosodde 24/8 06; *Poa cenisia*, Cape Marie-Valdemar 15/8 06 and Danmarks Havn 14/7 08; *Poa pratensis* Hvalrosodde Aug. 1906.

23. **Mycosphaerella Wichuriana** (Schroet.) Johans. Syn: *Sphaerella Wichuriana* Schroet. Sacc. Syllog. I, p. 530.

Loc. On withering leaves of *Festuca ovina*, Termometerfjeld 28/7 07; *Glyceria angustata*, Danmarks Havn 9/8 07; *Poa cenisia*, Cape Marie-Valdemar 15/8 06; *Carex nardina*, Cape Marie-Valdemar 15/8 06.

Pleosporeae.

24. **Didymosphaeria Dryadis** (Fuck.) Berl. & Vogl. Sacc. Syllog. IX, p. 733, non *Didymosphaeria Dryadis* (Speg.) Wt.

Ascis 160 μ × 32 μ; sporidiis 35–36 μ × 16—17 μ.

Loc. *Dryas octopetala*, Danmarks Havn 6/7 08.

25. **Venturia chlorospora** (Ces.) Karst. Sacc. Syllog. I, p. 586.

Loc. *Salix arctica*, Danmarks Havn 10/8 07.

26. **Leptosphaeria Andromedae** (Awd.) Sacc. Syllog. II, p. 49. Syn: *Leptosphaeria hyperborea* (Fuck.) Berl. & Vogl.

Loc. On dead leaves of *Cassiope tetragona*, Hvalrosodde 25/8 06.

27. **Leptosphaeria caricinella** Karst. Sacc. Syllog. II, p. 65.

Peritheciis 260 μ diam.; ascis 110—152 μ × 24–28 μ; sporidiis 44—52 μ × 12—13 μ, 3-septatis, ad septa constrictis, strato mucoso obvolutis; paraphysibus numerosis, hyalinis.

Does not seem to have been found again since the Swedish Polar Expedition first obtained it in Spitzbergen August 10th 1868 (Karsten: Fungi in insulis Spitsbergen et Beeren Eiland collecti. Öfv. of Kgl. Vetensk. Akadem. Förh. 1872 No. 2, p. 91—108) on the same host-plant. Saccardo (l. c.) wants to classify it under *Leptosphaeria vagans* Karsten, yet I cannot but consider it a good species. My measurements are in complete accordance with those stated by Karsten (Perith 150—200 μ diam.; asci 125—140 μ × 28—34 μ; spor. 38—52 μ × 10—15 μ), on the other hand Berlese (Icon. fungorum tab. LVI fig. 1) found them much smaller (asc. 70—90 μ × 16—20 μ; spor. 35—38 μ × 6—7 μ).

Loc. On dead leaves of *Carex pulla*, Termometerfjeld 28/7 07. (Look tab. X fig. 3).

28. **Leptosphaeria epicarecta** (Cook) Sacc. Syllog. II, p. 65.

Loc. On *Carex misandra*, Danmarks Havn 17/7 08.

29. **Leptosphaeria gigaspora** Nssl. Sacc. Syllog. II, p. 65.

Peritheciis c. 400 μ diam.; ascis 140 μ × 24—28 μ; paraphysibus hyalinis; sporidiis ellipsoideis, curvulis, flavis, 5-septatis, ad septa non constrictis, 56—63 μ × 16 μ.

Loc. On dead leaves of Carex nardina, Termometerfjeld 22/7 07.

Note. New for Greenland.

30. **Leptosphaeria Hierochloae** Ouds. Sacc. Syllog. IX, p. 793.

Ascis 100—115 μ × 14—16 μ; sporidiis 28—31 μ × 8—10 μ, 3—5-septatis.

Loc. On dead leaves of *Hierochloa alpina*, Danmarks Havn 12/7 08.

Note. New for Greenland.

31. **Leptosphaeria microscopica** Karst. Sacc. Syllog. II, p. 59.

Peritheciis c. 120 μ diam.; ascis 72—88 μ × 14—17 μ; sporidiis 28—32 μ × 6—8 μ, flavis, curvulis, 3-septatis.

Loc. *Alopecurus alpinus*, Danmarks Havn 16/7 08; *Poa abbreviata*, Termometerfjeld 28/7 07; *Glyceria maritima*, Danmarks Havn 4/9 07.

32. **Leptosphaeria vagans** Karsten. Sacc. Syllog. II, p. 59.

Peritheciis depressis, subastomis, c. 240 μ diam.; ascis subcylindricis, apice rotundatis, deorsum breve truncato-stipitatis 92—115 μ × 25—32 μ; paraphysibus filiformibus, hyalinis, guttulatis; sporidiis oblongato-ellipticis, 3-septatis, loculo secundo et tertio leviter tumidis, ad septa constrictis, curvulis, flavis, circulo gelatinoso, hyalino circumdatis, 34—36 μ × 10—13 μ.

Loc. On *Glyceria angustata*, Danmarks Havn 10/8 07; *Phippsia* (*Catabrosa*) *algida* (hosp. nov.)

Note. New for Greenland.

33. **Pleospora Arctagrostidis** Ouds. Sacc. Syllog. IX, p. 879.

Ascis 120 μ × 32 μ; sporidiis 36—38 μ × 12—13 μ, 5—7-septatis.

Loc. On leaves of *Arctagrostis latifolia*, Danmarks Havn 14/7 08.

Note. New for Greenland.

34. **Pleospora arctica** Fuck. Sacc. Syllog. IX, p. 882. *Non Pleospora arctica* Karsten = *Pleospora Karstenii* Berl. & Vogl.

Peritheciis 350 μ × 240 μ; ascis oblongis, curvatis, 100—128 μ × 23—28 μ; paraphysibus numerosis, hyalinis, multiguttulatis; sporidiis initio flavis, dein saturate brunneis, 34—36 μ × 14—16 μ, 6-septatis, medio constrictis, parte superna parum tumidiore, longitudinaliter 1—2-septatis.

This is very probably the same fungus, as classified by Rostrup (Fungi groenlandiae 1888) under *Pleospora herbarum* (Pers.) Rabenh. with the remark, that there is no difference between *Pl. arctica* and *Pl. herbarum*. In my opinion there are, however, several differences between these two fungi: the sporidia of *Pl. arctica* are smaller and with age they grow darker than those of *Pl. herbarum*.

Loc. On *Epilobium latifolium*, Termometerfjeld July 1907 and Lille Snenæs 11/7 08.

35. **Pleospora Cerastii** Oudemans (Contributions à la Flore mycologique de Nowaja Semlja, Verslag. en Meded. d. Kon. Akad. v. Wetensch. Afd. Natuurk. 3. Del, II, Amsterdam 1885 p. 146). Ascis 100 μ × 20 μ, crasse tunicatis; sporidiis flavis, 28—32 μ × 12—14 μ, 4—6-septatis, septisque 1—3 longitudinaliter divisis.

Saccardo (Syllog. II, p. 285) considers it to be a variety of *Pyrenophora chrysospora*, with which opinion I cannot agree as f. inst. *Pyr. chrysosp.* is quite constant in having 7 dissepiments in every spore, this fungus always having less.

Loc. On dead stems of *Stellaria longipes*, Cape Marie-Valdemar 16/8 06.

Note. New for Greenland.

36. **Pleospora deflectens** Karst. Sacc. Syllog. II, p. 266.

Sporidiis 26—29 μ × 12 μ, 7-septatis.

Loc. On *Alopecurus alpinus*, Stormkap 18/6 06; *Poa abbreviata*, St. Koldewey 13/8 06.

37. **Pleospora discors** (Mont.) Ces. & de Not. Sacc. Syllog. II, p. 270.

Peritheciis sparsis, epiphyllis, globosis, vertice erumpentibus, ostiolo papillaeformi; ascis 8-sporis, 140 μ × 28—32 μ, crasse tunicatis; sporidiis oblongatis, utrinque obtuse rotundatis, inaequilateralibus, transverse 5—6-septatis, in longitudine 1 divisis, initio flavis dein atris opacis, 35—42 μ × 12—15 μ, interdum strato gelatinoso, 10—12 μ crasso cinctis.

Loc. *Alopecurus alpinus*, Lamberts Land $^{11}/_{6}$ 07 (Koch); *Poa cenisia*, St. Koldewey $^{13}/_{8}$ 06.

38. **Pleospora Drabae** Schroeter. Sacc. Syllog. II, p. 253.

Ascis 82—132 μ × 20—28 μ; sporidiis flavo-olivaceis, dein fuligineis, 25—33 μ × 12—17 μ, 5—7-septatis, ad septum medium constrictis, longitudinaliter 1-septatis.

Loc. On dead leaves and stems of *Braya purpurascens*, Lille Snenæs $^{29}/_{6}$ 08; *Draba alpina*, Rypefjeld $^{2}/_{7}$ 08, Vestre Havnenæs $^{7}/_{7}$ 07, Danmarks Havn $^{10}/_{8}$ 07; *Draba hirta* var. *arctica*, Harefjeld $^{24}/_{7}$ 07, Termometerfjeld $^{27}/_{6}$ 07, Lille Snenæs $^{29}/_{6}$ 08; *Draba fladnizensis*, Trekroner $^{27}/_{6}$ 08, Lille Snenæs $^{22}/_{6}$ 08; *Draba alpina* var. *glacialis*, Danmarks Havn $^{8}/_{7}$ 08.

39. **Pleospora papaveracea** (de Not.) Sacc. Syllog. II, p. 243.

Ascis 110—124 μ × 24 μ; paraphysibus hyalinis filiformibus; sporidiis 33—36 μ × 12—17 μ, transversim 4-septatis, septisque 3 longitudinaliter divisis.

Loc. On *Papaver radicatum*, Lamberts Land $^{11}/_{6}$ 09. (Koch).

40. **Pleospora Karstenii** Berl. & Vogl. Syn: *Pleospora arctica* Karsten. Sacc. Syllog. II, p. 271 non *Pleospora arctica* Fuck.

Peritheciis c. 240 μ diam.; ascis 108 μ × 30 μ; sporidiis 36 μ × 16 μ, 7-septatis.

Loc. On *Poa abbreviata*, Termometerfjeld $^{28}/_{7}$ 07.

41. **Clathrospora Elynae** Rbh. Syn: *Pleospora Elynae* (Rbh.) Ces. & de Not. Sacc. Syllog. II, p. 273.

Loc. On *Luzula confusa*, Cape Marie-Valdemar $^{15}/_{8}$ 06.

42. **Clathrospora pentamera** (Karst.) Berlese. Syn: *Pleospora pentamera* Karst. Sacc. Syllog. II, p. 266.

This fine species, which is easily recognized, and which seems to be common in this neighbourhood, was first described by P. A. Karsten (Fungi in insulis Spitsbergen et Beeren Eiland. Öfv. of Kgl. sv. Vet. Ak. Förh. 1872 No. 2) as a *Pleospora;* the spores have, however, as described and figured by Berlese (Icones Fungorum vol. II, p. 31 & tab. XLVI), all their cells in the same plane, and accordingly it is a *Clathrospora*. When seen from the front, the sporidia are oblong pear-shaped with four cross-walls and one longitudinal wall in the three middle compartments without any narrowing, when seen from the side the crosswalls only are visible, not the longitudinal wall, and then they have distinct narrowings. Their colour is most frequently yellow like honey, but may grow almost black with age. I most frequently found the sporidia somewhat larger than stated by Karsten, viz. 29—36 μ long, 15—17 μ broad and 9—12 μ thick.

Loc. *Alopecurus alpinus*, Dove Bugt 2/5 07; *Carex nardina*, Termometerfjeld 28/7 07 and Hvalrosodde 24/8 06; *Glyceria angustata*, Hyde Fjord 18/5 07 (Koch); *Hierochloa alpina*, Stormkap 19/8 06; *Poa abbreviata*, Termometerfjeld 28/7 07, Ymers Nunatak 17/5 08 (Freuchen); *Poa cenisia*, Danmarks Havn 14/7 08; *Poa glauca*, Lille Snenæs July 08 and Danmarks Havn 14/7 08.

43. **Pyrenophora chrysospora** (Nssl.) Sacc. Syllog. II, p. 285 & IX, p. 896.

Loc. *Campanula uniflora*, Snenæs 7/7; *Cardamine bellidifolia*, Danmarks Havn 16/7 08; *Erigeron compositus*, Danmarks Havn 12/7 07 and 28/7 07; *Lesquerella arctica*, Lille Snenæs 29/6 08 and Snenæs Feltplads 26/8 08; *Potentilla pulchella*, Hyde Fjord 14/5 07 (Koch); *Ranunculus sulphureus* (hosp. nov.) Lille Snenæs 29/6 08.

44. **Pyrenophora comata** (Nssl.) Sacc. Syll. II, p. 286.

Loc. On dead leaves and stems of *Armeria sibirica*, Hvalrosodde 2/7 08 and Danmarks Havn 9/7 08; *Oxyria digyna*, Danmarks Havn 8/7 08; *Papaver radicatum*, Cape Marie-Valdemar 15/8 06 and Stormkap 19/8 06; *Pedicularis hirsuta* and *Potentilla nivea*, Danmarks Havn July 1908; *Potentilla pulchella*, Maroussia 21/7 08 and Lille Snenæs 26/6 08; *Stellaria longipes*, Lamberts Land 14/6 07 (Koch) and Danmarks Havn July 1908.

45. **Pyrenophora filicina** nov. spec.

Peritheciis sparsis, erumpenti-superficialibus, globosis, majusculis, 300 μ diam., atris, coriaceis, superne setigeris, ostiolo breve conico; ascis oblongo-clavatis, stipite brevi, apice rotundatis et crasse tunicatis, 8-sporis, 88—110 $\mu \times 25 \mu$; ascis paraphysibusque mox fluxilibus; sporidiis subdistichis oblongo-ovatis, rectis, transverse 5—6-septatis, medio constrictis, in longitudine 1—2-septatis, primo flavis demum fuscis et totis opacis, 28—34 $\mu \times$ 15—17 μ. (See tab. X fig. 4).

Loc. On dead petioles of *Cystopteris fragilis*, Danmarks Havn 8/7 08.

46. **Pyrenophora paucitricha** (Fuck.) Berl. & Vogl. Sacc. Syllog. IX, p. 898.

The sporidia, measured and described by Fuckel (Die 2te deutsche Nordpolfahrt. I. Botanik, p. 23. Bremen 1872. (Tab. I fig. 3) have apparently not been quite ripe; besides olive-coloured sporidia of 26—30 μ in length and 10—12 μ in breadth and in every way corresponding to Fuckel's description, I have found other sporidia of significantly larger size, viz. 43—45 $\mu \times 22 \mu$ and of a black-brown colour. The capillaries of the perithecia are black-brown and septated.

Loc. On dead leaves of *Salix arctica*, Stormkap 19/8 06 and Lille Snenæs 24/6 08.

Gnomonieae.

47. **Gnomonia salicella** (Fries) Schroet. Syn: *Diaporthe salicella* (Fries) Sacc. Syllog. I, p. 622.

Loc. On dead twigs of *Salix arctica*, Danmarks Havn 16/7 08.

Sphaerioideae.

48. **Mycogala parietinum** (Schrad.) Sacc. Syll. III, p. 185.

Loc. On wood in the berth of Jarner, Danmarks Havn October 1907.

Note. New for Greenland.

49. **Ascochyta Dianthi** (A. & S.) Libert. Sacc. Syllog. III, p. 398 & X, p. 301.

Sporidiis utrinque obtusis, curvulis, 1-septatis, hyalinis, guttulatis, 15—21 μ × 4 μ.

Loc. On *Cerastium alpinum*, Harefjeld $^{24}/_{7}$ 07.

50. **Rhabdospora Drabae** (Fuck.) Berl. & Vogl. Sacc. Syllog. X, p. 391. Syn: *Phoma Drabae* Fuck., *Septoria Drabae* Rostrup, *Septoria semilunaris* Johans. Sacc. Syllog. X, p. 363.

It was first described by Fuckel as *Phoma Drabae* (Fuckel: Die 2. deutsche Nordpolfahrt in den Jahren 1869 und 1870. II. Abth. Botanik, p. 94. Bremen 1872) and figured in the same paper tab. I fig. 9. Both description and figures are again found in Oudeman's work (contributions à la flore mycologique de Nowaja Semlja p. 150, Amsterdam 1885). Rostrup classifies it as belonging to *Septoria* (Fungi groenlandiae, 1888 p. 572) and Berlese & Voglino calls it *Rhabdospora Drabae*.

Johanson's *Septoria semilunaris* (Svampar från Island. Öfv. of Kgl. Vet. Akad. Förh. 1884 No. 9 p. 173) ought to be classified in the same genus (formgenus) as it appears on dead stalks and leaves only. It is, however, impossible to find a constant difference between Johanson's and Fuckel's two fungi. According to the description the only difference should be, that the sporidia of *Rhab. Drabae* measure 22 μ × 2 μ and the sporidia of *Rhab. semilunaris* 10—15 μ × 3—5 μ; but Allescher (Allescher und Hennings: Pilze aus dem Umanakdistrict. Bibliotheca Botanica Heft 42, 1897 pag. 51), who has found *Rhab. semilunaris* on the same substratum as Johanson, viz. on dry stalks of the flowers of *Dryas*, gives the sizes of the sporidia as being 14—20 μ × 1·5—2·5 μ, and he has also found traces of a dissepiment in them. And if we examine a sufficient number of specimens, we find all possible transitions among them. So I consider it right to unite the two species (form-species) into one.

Septoria Vanhøffenii P. Henn (Allescher und Hennings l. c. p. 52), *Septoria nivalis* Rostrup (Fungi groenlandiae 1888) and *Septoria cerasticola* Rostrup (Islands Svampe. Botanisk Tidsskrift 1903) also seem to come very close to *Rhabdospora Drabae*.

In the size and shape of the sporidia (stylospores) they seem to be very much like *Rhabdospora groenlandica* (conf. Tab. X fig. 8—9—10) which will be mentioned later on, but *Rhab. Drabae* has larger, collapsed perithecies and is only to be found on dicotyledonous plants, f. inst.: *Braya, Campanula, Cerastium, Draba, Dryas, Erigeron, Geranium, Parnassia, Plantago, Potentilla, Rumex* and *Veronica.*

Loc. *Braya purpurascens.* Lille Snenæs 26/4 08 and 29/6 08; *Campanula uniflora.* Snenæs 7/7 08; *Cerastium alpinum.* Hvalrosodde 24/8 06; *Draba alpina,* Rypefjeld 2/7 08; *Draba arctica.* Lille Snenæs 29/6 08; *Draba hirta.* Lille Snenæs 24/6 08; *Draba subcapitata.* Lille Snenæs 22/6 08.

51. **Rhabdospora groenlandica** nom. nov. Syn: *Septoria nebulosa* Rostrup. Sacc. Syllog. X, p. 385.

By Rostrup it is called *Septoria nebulosa* (Rostrup: Fungi groenlandiae 1888 p. 575); as it is, however, always found on dead leaves and stalks and never forms spots on living leaves, it ought to be called *Rhabdospora* according to the common method of nomenclature. The name *Rhabdospora nebulosa* is, however, preoccupied for another fungus, *Rhabdospora nebulosa* (Desm.) Sacc. Syllog. III, p. 589, so that I am obliged to find a new name for the above mentioned fungus.

It is very common on dead leaves of the *Monocotyledones.* There is no small difference in size between the separate sporidia, the longest I measured were 28 μ, the shortest 13 μ; still the greater number are 20—22 μ long and 2—3 μ broad; their shape is always that of a small crescent, spindle-shaped with both ends evenly and sharply pointed; its contents are most frequently slightly granulated and there are sometimes slight traces of a dissepiment in the middle. The perithecies are small, their diameter 80—120 μ, they are numerous and grouped in darkish oblong spots (see Pl. X fig. 9 & 10).

Loc. On *Carex nardina.* Termometerfjeld 22/7 07; *Carex pulla.* Basiskæret 15/8 07; *Carex rupestris.* Lille Snenæs 25/6 08 and 7/7 08; *Cobresia Bellardi.* Lille Snenæs 25/6 08 and Danmarks Havn 15/7 08; *Eutrema Edwardsii.* Øster Elv 5/8 07; *Iuncus biglumis.* Termometerfjeld 17/8 07; *Poa abbreviata.* Stormkap 14/7 08 and Danmarks Havn July 08; *Poa cenisia.* Danmarks Havn 14/7 08; *Poa glauca.* Lille Snenæs July 08 and Danmarks Havn 20/7 08.

52. **Kellermannia cercosperma** (Rostrup) Syn: *Septoria cercosperma* Rostrup, *Rhabdospora cercosperma* (Rostrup) Sacc. Syllog. X, p. 391, *Septoria caudata.* Karsten, *Rhabdospora caudata* (Karst.) Sacc. Syllog. III, p. 593.

Allescher mentions *Rhabdospora caudata* and *Rhabdospora cercosperma* as two different species, saying:

> "Saccardo sagt bei *Rhabd. cercosperma:* "Videtur vix differe a *Rhabd. caudata,* sporulis 2—3 septatis". Dem kann ich vorläufig nicht beistimmen, da die Perithecien der vielen untersuchten Exemplare nie "superficialia" sondern von der geschwärzten Oberhaut bedeckt, die Sporen auch viel kürzer

sind und stets des borstenförmigen Anhanges entbehren; allerdings habe ich die 2—3 Scheidewände, welche Rostrup angiebt, auch nicht beobachten können".

(Allescher & Hennings: Pilze aus dem Umanakdistrikt, Bibliotheca Botanica Heft 42, p. 52).

In reference to this I would say that Karsten has probably only described his *Septoria caudata* in Hedwigia 1884 as a new species because he did not know Rostrup's description of *Septoria cercosperma* in Sv. Vetensk. Akad. Förh. from the preceding year. Saccardo, Rostrup, Johanson and Vestergren also quite agree as to the identity of these two species. I consider it much more likely, that Allescher, having noticed neither the septa in the sporidia nor the cauda and having found them shorter than stated in the report and with different perithecia, was dealing with quite another fungus, which he wrongly called *Rhabd. cercosperma*, and I am most inclined to believe this to be *Rhabd. Drabae* (Fuck) = *Septoria semilunaris* Johans. of which he says:

"Mir scheint der Pilz mit *Rhabd. cercosperma* identisch zu sein". (l. c. p. 52).

The spores (stylospores) of this species (form-species) are complelly different from those of all other *Rhabdospora* and *Septoria*-species. At the base they are rounded, outwardly pointed and finally they end in a long capillary tail. When unripe they are furnished with oil-drops, when older with up to three dissepiments. The perithecia are of varying size yet larger than is common in the Sphaerioideae and collapsed, with protruding ostiolum (see especially Vestergren's excellent description and figures in: Eine arktisch-alpine *Rhabdospora*, Bih. till. Kgl. Vet. Akad. Handl. Bd. 26. Afd. III No. 12, 1900).

It does not, however, differ essentially from the form-genus *Kellermannia* Ell. & Ev. in Journ. of Mycology 1885 p. 153. Sacc. Syllog. X, p. 337, so that I must move it from *Rhabdospora* to *Kellermannia*. In this connection I may mention, that a fungus, which I found in *Jutland* on dead stalks of Rumex acetosa and which E. Rostrup classified for me as his *Rhabdospora cercosperma* (distributed in Kabat & Bubak Exsiccat: Fungi imperfecti exsiccati as No. 426), is identical with one found by Ove Rostrup, also on *Rumex acetosa*, near Copenhagen and published by E. Rostrup in: Mykologiske Meddelelser IX. Botanisk Tidsskrift vol. 26, p. 312 as *Kellermannia Rumicis* Fautr. & Lamb.

Still I do not venture to say — until I have had an opportunity of seing more material of this fungus, the sporidia, and perithecia of which according to Vestergren vary very much in size — if the five species of *Kellermannia* (*K. yuccogena* Ell. & E., *K. Polygoni* Ell. & Ev., *K. Sisyrinchii* Ell. & Ev., *K. Rumicis* Fautr. & Lamb. and *K. cercosperma* (Rostr.) are identical, or if many different species can be distinguished.

Loc. On dead stems of *Polygonum viviparum*, Danmarks Havn 14/7 08.

53. **Stagonospora arenaria** Sacc. Syllog. III, p. 453.

Peritheciis 160 μ diam.; sporidiis 36—40 μ × 4 μ 3-septatis, hyalinis.

Loc. On dead leaves of *Poa abbreviata*, Termometerfjeld 28/7 07.

Note. New for Greenland.

54. **Coniothyrium Lesquerellae** spec. nov.

Peritheciis sparsis, e globoso-lenticularibus, subcutaneis, vix erumpentibus, tenuibus membranaceis, atris, majusculis c. 350 μ diam., ostiolo vix prominente pertusis; sporulis ut plurimum perfecte globosis, atro-fuscis, eguttulatis, 7—10 μ diam.

Loc. On dead stems of Lesquerella (Vesicaria) arctica, Harefjeld 10/7 07.

55. **Coniothyrium olivaceum** Bon. Sacc. Syllog. III, p. 305.

Sporidiis olivaceis, oblongatis, 5 μ × 1·5 μ.

Loc. *Campanula uniflora*, Snenæs 7/7 08.

56. **Diplodia Simmonsii** Rostrup (Report of the 2nd Norwegian Arctic Expedition in the Fram 1898—1902, No. 9, 1906).

Dead leaves may assume a black tinge from the attack of this fungus (Look tab. X fig. 6).

Loc. *Carex nardina*, *Hierochloa alpina* and *Luzula confusa*, Cape Marie-Valdemar 15/8 06.

Note. New for Greenland.

57. **Hendersonia arundinacea** (Desm.) Sacc. Syllog. III, p. 436.

Sporidiis flavo-olivaceis, guttulatis, 20—36 μ × 3—5 μ, 3-septatis.

Loc. *Arctagrostis latifolia*, and *Poa abbreviata*, Danmarks Havn 14/7 08; on the leaves of an undetermined sp. of grass, Maroussia 21/7 08.

Note. New for Greenland.

58. **Hendersonia Luzulae** West. Sacc. Syllog. III, p. 451 & X, p. 328.

Sporidiis olivaceis, 20—24 μ × 3 μ, 3-septatis.

Loc. On *Luzula arcuata* f. *confusa*, Danmarks Havn 12/7 08.

59. **Hendersonia gigantea** nov. spec.

Peritheciis immersis, saepe seriatim digestis, tectis, subglobosis, papillatis, brunneis, 225 μ diam., contextu parenchymatico; sporidiis cylindrico-fusoideis, flexuosis, laete flavo-brunneis, utrinque rotundatis, 92—108 (—188) μ × 5—6 μ, 7-septatis, ad septa non constrictis, guttulatis (Look tab. X fig. 7).

Loc. On dead leaves of *Carex pulla*, Termometerfjeld 28/7 07.

Hyphomycetes.

60. **Trichothecium roseum** (Pers.) Link. Sacc. Syll. IV, p. 178.

Loc. On material vomited by owls, Termometerfjeld 22/8 07.

61. **Mastigosporium album** Riess. Sacc. Syll. IV, p. 220.

Loc. On living leaves of *Alopecurus alpinus*, Vester Elv 17/7 07.
Note. New for Greenland.

62. **Cladosporium graminum** Cda. Sacc. Syllog. IV, p. 365.

Loc. *Festuca ovina*, Termometerfjeld 28/7 07; *Hierochloa alpina*, Stormkap 19/8 06 and Hvalrosodde 16/6 07; *Glyceria angustata; Phippsia algida; Poa abbreviata*, Dove Bugt 3/9 07; *Poa glauca*, Danmarks Havn 14/7 08; *Trisetum spicatum*, Termometerfjeld 22/8 07.

63. **Cladosporium herbarum** (Pers.) Link. Sacc. Syllog. IV, p. 350.

Loc. On dead stems and fruits of *Cardamine bellidifolia*, Vester Elv 17/7 07; *Draba fladnizensis*, Termometerfjeld 27/6 07; *Draba hirta*, Danmarks Havn 26/9 07.

64. **Torula Rhododendri** Kze. Sacc. Syllog. IV, p. 254.

Loc. On twigs of *Rhododendron lapponicum*, Hvalrosodde 23/8 06.

Addendum.

65. **Rhizophidium Olla** Henn. Petersen Contrib. à la connaiss. des Phycomycètes marins. Oversigt over d. k. Danske Vidensk. Selsk. Forh. 1905 p. 485.

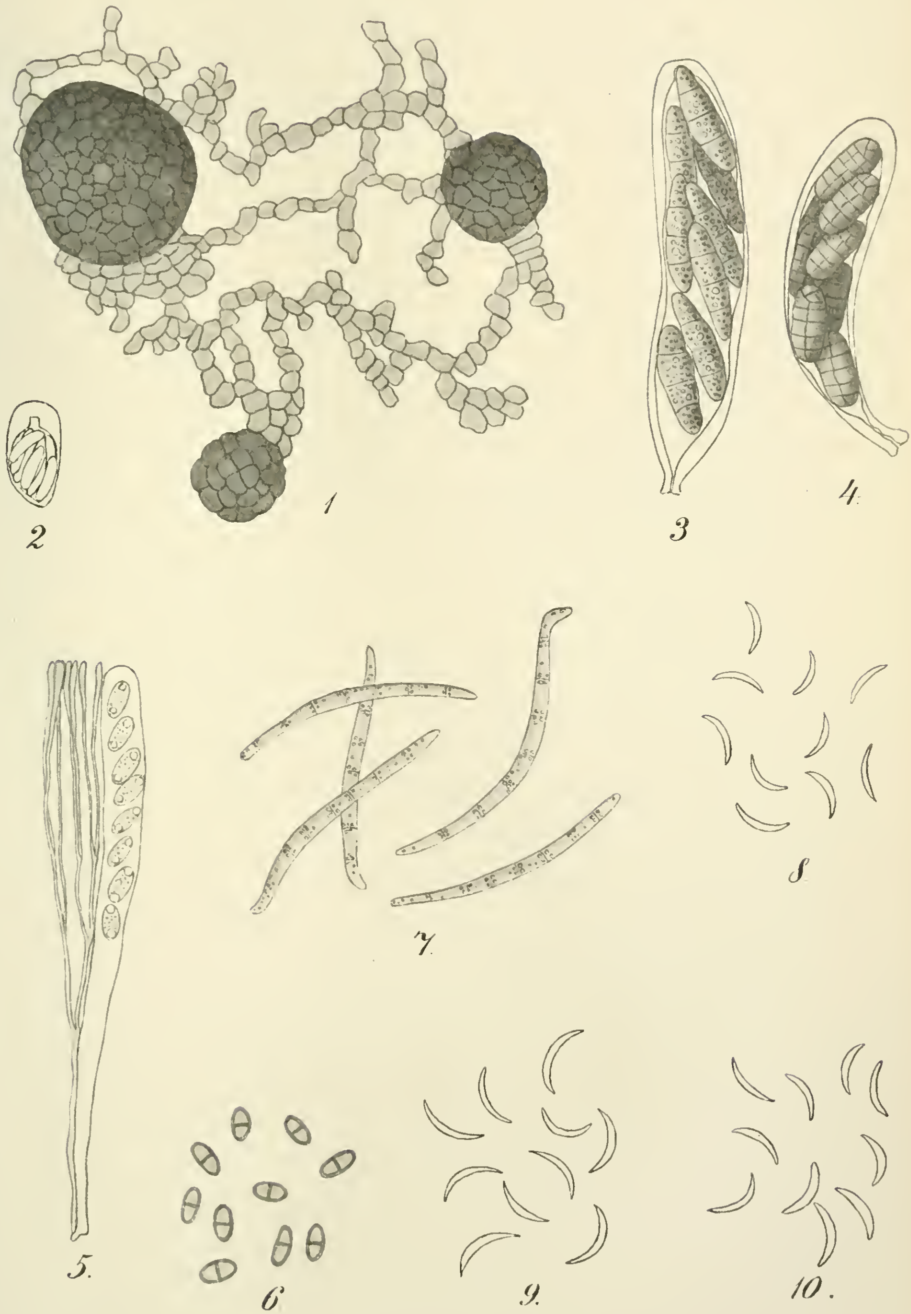
Loc. Parasitic on Ectocarpus littoralis and Ulothrix scutata, East side of Koldewey Island (determ. Henn. E. Petersen).
Note. New for Greenland.

EXPLANATION OF THE FIGURES.

Fig. 1. Perithecia of Ascospora graminis spec. nov. on Poa glauca.
— 2. Ascus of — —
— 3. Ascus of Leptosphaeria caricinella Karst. on Carex pulla.
— 4. — of Pyrenophora filicina spec. nov. on Cystopteris fragilis.
— 5. — of Geopyxis ciborium (Vahl) Sacc.
— 6. Sporidia of Diplodia Simmonsii Rostrup on Luzula confusa.
— 7. — of Hendersonia gigantea spec. nov. on Carex pulla.
— 8. — of Rhabdospora Drabae (Fuck.) Berl. & Vogl. on Draba hirta var. arctica.
— 9. — of Rhabdospora groenlandica nom. nov. on Eutrema Edwardsii.
— 10. — of — — on Poa abbreviata.

All the figures have been drawn by Mr. Ove Rostrup. Fig. 1 is magnified 330 : 1, all the other are magnified 400 : 1.

1—6—1910.



O. Rostrup del.

Arbejder fra den Botaniske Have i København. Nr. 57.

The Structure and Biology of Arctic Flowering Plants.

I.

Reprinted from „MEDDELELSER OM GRÖNLAND“ Vol. XXXVI.

Copenhagen.
Printed by Bianco Luno.
1910

Hitherto, the following papers have been published:

4.

Saxifragaceæ.

2. The Biological Leaf-anatomy of the Arctic species of Saxifraga.

By

Olaf Galløe.

1910.

INTRODUCTION.

A biological-anatomical description of the Arctic species of *Saxifraga* must essentially have reference to the foliage-leaves, as they are the organs which most distinctly bear the impression of external factors in nature. The roots were less suitable for anatomical investigation in the material which has been within my reach. All the material which I have had for examination has been placed at my disposal by the director of the Botanical Museum in Copenhagen.

The literature of the subject does not contain much regarding the leaf-anatomy of the genus *Saxifraga*. Engler was the first to give a more exhaustive account of it in his monographic treatment of the whole genus (Breslau, 1872. See list of literature). He does not treat the individual species anatomically, but confines himself to a kind of comprehensive characterization, without entering more fully into the peculiarities of the different species. The genus is treated in very much the same way by Thouvenin (1890) and Leist (1890). (I have unfortunately been unable to have access to a paper by Waldner (Graz, 1885) on the "lime-druses" of the *Saxifragas*).

The first three works mentioned above give, therefore, only very scattered data regarding the species we are here considering, and treat them according to systematic principles, without discussing the connection between structure and biological conditions.

More exhaustive descriptions are given by Leist (1889), Bonnier (1894), Borgesen (1895), Lazniewski (1896). These works aim particularly at elucidating the relation between habitat and anatomical structure, — Leist and Lazniewski with regard to the Alpine, Borgesen with regard to the Arctic plants. Bonnier compares Alpine with Arctic specimens of the same species; among the many examples he gives, he mentions only one *Saxifraga (S. Aizoon)*. Freidenfelt (1904) occupies himself with the root-anatomy of a few species, considering them to a certain extent from a biological point of view. Holm (1885) mentions the anatomy of several Arctic species, and I shall have occasion to refer to his work in the following pages. LINDMARK (1902), also, has made a few anatomical observations on the subject.

It is beyond the scope of this paper to discuss more fully the contradictory conclusions which previous authors have considered might be drawn from their studies of Alpine plants; here it will suffice for me to give the names of the contending parties (BONNIER, LEIST, WAGNER and LAZNIEWSKI) in the list of literature, and also STENSTROM who has, in a very comprehensive manner, studied and discussed the questions here under consideration. Quite recently SCHROETER (1904—08) has published some valuable observations upon Alpine *Saxifragas*. The investigations of these authors have been taken into consideration only in so far as they have touched upon Arctic species.

Here we are only concerned with those Arctic species which have been partially investigated by TH. HOLM and F. BORGESEN. I shall not enter more closely into the general and comprehensive results which BORGESEN gives in his paper.

The specimens investigated by me are the following: —

These belong to six different sections. Common to all the species is a leaf-venation which is either palmate or appears to have been derived from the palmate type even in such divergent forms as S. *aizoides* and *oppositifolia*, the relatively serrate and entire leaves of which, with regard to venation and form, are connected by gradually transitional forms (especially *S. tricuspidata*) with the palmate leaf of, for instance, *S. cernua*. Moreover, hydathodes are present in all the species. Consequently, the principal form (the type) had probably palmately-veined leaves with hydathodes. Nearest to this type-form are the mesophytic species with large leaf-blades, distinct leaf-stalks and marked differentiation between palisade-tissue and spongy parenchyma (the sections *Boraphila*, *Nephrophyllum*, and *Dactyloides* in part); less close to the type are the more decided xerophytes, with leaf-rosettes, narrow leaf-blades, etc. (the sections *Trachyphyllum*, *Euaizonia*, *Porphyrion*).

The following is a list of the chief literature upon the subject: —

Bonnier: Recherches expérimentales sur l'adaptations des plantes au climat alpin (Ann. des sc. nat., VII sér., T. XX) 1895.

— Les plantes arctiques comparées aux mêmes espèces des Alpes etc. (Révue gén. d. bot., T. VI) 1894.

Børgesen, F.: Bidrag til Kundskaben om arktiske Planters Bladbygning (Bot. Tidsskrift, Bd. 19) 1895.

Engler, A.: Monographie d. Gattung Saxifraga. Breslau, 1872.

Freidenfelt: Der anatomische Bau der Wurzel etc. (Bibliotheca botanica, Heft 61) 1904.

Holm, Th.: Novaja-Zemlia's Vegetation, særligt dens Phanerogamer. (Dijmphna-Togtets zool.-bot. Udbytte, Kobenhavn, 1885).

Lindmark: Bidrag til kännedomen om de svenska Saxifraga-artens yttre byggnad. (Bihang till k. svenska Vet.-Akad. handl., Bd. 28, Afd. III, Nr. 2) 1902.

Lazniewski, W. v.: Beitr. z. Biol. d. Alpenpflanzen (Flora) 1896.

Leist: Ueber den Einfluss des alpin. Standortes auf die Ausbildung d. Laubblätter (Separat-Abdruck aus Mittheil. d. Naturf. Gesellsch. von Bern) Bern, 1889.

— Beitr. z. vergleich. Anat. d. Saxifragen (Bot. Centralblatt XLIII) 1890.

Norman, J. M.: Norges arktiske Flora, II, 1895.

Rosenvinge, L. Kolderup: Andet Tillæg til Grønlands Fanerogam- og Karsporeplanter. (Meddelelser om Grønland, III) (separate copy) 1892.

Schroeter: Das Pflanzenleben d. Alpen. Zürich, 1904—08.

Stenstrøm: Ueber das Verhalten derselben Arten in verschiedenen Klimaten etc. (Flora) 1895.

Thouvenin: Recherches sur la structure des Saxifragacées (Ann. d. sc. nat., sér. VII, T. II) 1890.

Wagner, A.: Zur Kenntniss des Blattbaues d. Alpenpflanzen etc. (Sitzungsber. d. Wiener-Akad., Bd. CI, Abth. I) 1892.

Warming, E.: Grønlands Vegetation. (Meddelelser om Grønland, Hefte XII) 1888.

1. *Nephrophyllum.*

The two species of this group which have been investigated agree in the following points: — (1) The leaves are stalked and palmately lobed, (2) the epidermis has undulating radial walls, (3) glandular hairs are present, (4) the cells of the spongy parenchyma are decidedly stellate (without a compact layer of tissue under the epidermis), (5) the hydathodes are exactly marginal, without a cavity and without secretion of lime.

The species differ most in regard to the thickness of the outer walls of the epidermis, and the more or less decidedly stellate form of the cells of the spongy parenchyma. The two species can easily be distinguished from each other by these features, while, however, their mutual relationship is very distinctly expressed in their anatomy. A key to their determination by their leaf-anatomy would be as follows: —

Outer walls of the epidermis: —

(a) thin (2—3 μ): *S. cernua.*

(b) irregularly thickened (as much as 8—10 μ): *S. rivularis.*

Glandular hairs: —

(a) long-stalked upon the upper, and short-stalked upon the lower surface: *S. cernua.*

(b) similar upon the upper and lower surface: *S. rivularis.*

Saxifraga cernua L. (Figs. 1 and 2).

This species according to Norman (l. c., pp. 303—04) is a decidedly Arctic plant which extends beyond the tree-limit 697 metres and upwards. Grows both upon flat and sloping ground, as commonly on the northern as on the southern side, more rarely on the eastern and western sides. It prefers cold and damp localities, among moss, along the banks of rivers, upon stones in rivers, etc., and must be characterized as decidedly hygrophilous.

The leaves are long-stalked, reniformly-palmately lobed with 5—7 lobes. Each lobe terminates in a hydathode (Fig. 1 *A*). Along the margin and upon both surfaces glandular hairs occur, long upon the upper surface and short upon the lower (Fig. 2 *E.*)

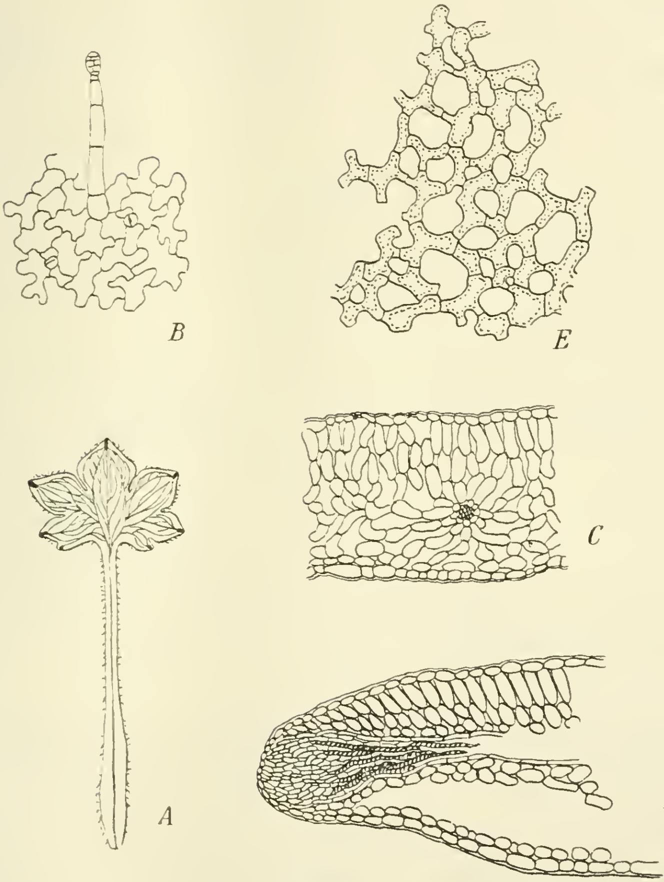


Fig. 1. *Saxifraga cernua.*
A (3/2), Leaf-form. *B*, Upper epidermis with a glandular hair. *C*, Transverse section of leaf. *D*. Longitudinal section of leaf-apex with hydathode. *E*, Spongy parenchyma. (*B*, *C*, *D* and *E* 50/1).

The epidermis of the upper surface consists of cells with undulating walls (Fig. 1 *B*), the lateral and outer walls of which are thin (2—3 μ). Cuticle is very slightly developed. The epidermis of the upper surface is provided with stomata which project above the leaf-surface and also with scattered, long-stalked glandular hairs. Borgesen (l. c., pp. 225—26) states that the stomata are most numerous upon the upper surface, where there are 10 per unit of surface, while on the lower surface only 8.

The epidermis of the lower surface has even more strongly undulating walls; it is otherwise very slightly developed (as upon

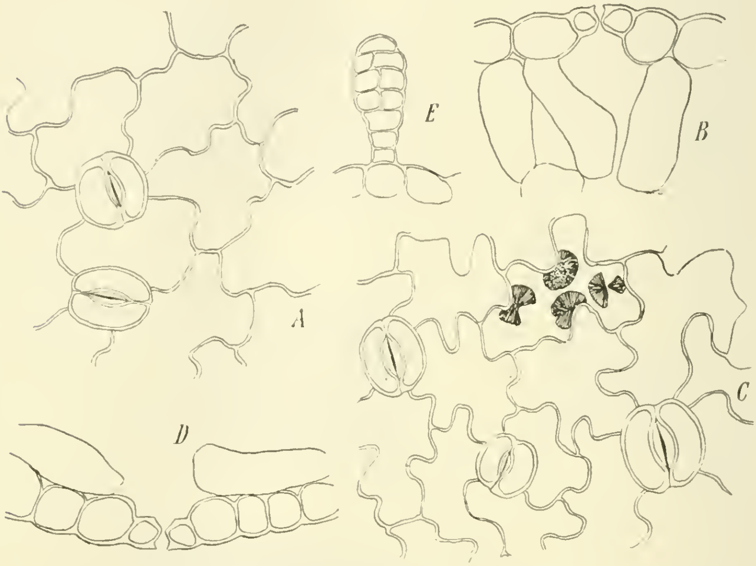


Fig. 2. *Saxifraga cernua.*
A, Epidermis of the upper surface of the leaf. *B*, The same in vertical section. *C*, Epidermis of the lower surface of the leaf (in a solitary cell several crystal-aggregates are seen). *D*, Lower epidermis in vertical section. *E*, Hair from the lower surface of the leaf ($^{282}/_{1}$).

the upper surface) and is provided with stomata, placed slightly above the level of the leaf-surface, and short-stalked glandular hairs exactly similar in appearance to those upon the margin of the leaves (Fig. 2 *E*).

The mesophyll is very loosely arranged, with large and numerous intercellular spaces (Fig. 1 *C*). The palisade-cells form indistinct rows and, in the greater part of the leaf, are placed almost vertically within the epidermis while towards the apex of the veins they are placed somewhat obliquely — a circumstance which has been exhaustively discussed by LAZNIEWSKI (l. c.) in regard to rosette-plants and which we shall find again in the very decidedly rosette-forming species (*S. Cotyledon*, *Aizoon*, etc.). The 2—3 palisade-layers are differenced, but not very distinctly, from the cells of the spongy parenchyma, which are decidedly stellate (i. e. branched), long, and loosely arranged (Fig. 1, *E*.)

The veins are not accompanied by mechanical tissue, but are surrounded by a (usually one-layered) bundle-sheath of elongated cells devoid of chlorophyll (Fig. 1 *C*).

All the veins at the apices of the leaves terminate in a hydathode. The epithema is interwoven, and enveloped by the spirally thickened tracheids of afferent veins and is covered with a small-celled epidermis with water-pores. Lime-secretions were totally absent from the Arctic specimens examined by me. The surface of the epithema is convex and situated directly at the edge of the leaf-margin; a hydathode-cavity is absent (compare, *S. oppositifolia*, *S. Aizoon*, etc., the hydathodes of which open upon the upper side of the leaf-margin and have a cavity). Fig. 1 *D*.

The leaves of the bulbils are morphologically somewhat different; a gradual transition may be traced from entirely bladeless scale-leaves to bulb-scales with rudimentary leaf-blades which have entire margins, and ultimately to bulb-scales with a small three-lobed blade (the cells of which are devoid of starch-grains although the latter occur in quantities in the leaf-base).

The bulb-scales are without hydathodes. The cell-walls of the lower epidermis are almost straight; no stomata were found by me although they were found by TH. HOLM (l. c., p. 47). The hairs are similar to those upon the lower surface of the foliage-leaves.

The cell-walls of the upper epidermis are straight, and there are no stomata. The hairs are similar to those upon the upper surface of the foliage-leaves.

All the cells of the mesophyll are alike, isodiametric and closely filled with starch-grains.

There is a solitary vein with a one-layered bundle-sheath devoid of starch.

The structure of the foliage-leaf and bulb-scale here described I found to be identical with that of the specimens from Mödruvellir in Iceland, and Egedesminde in Greenland.

As already mentioned, this species is hygrophytic in its choice of localities. Its anatomical structure is in distinct conformity therewith: Stomata (projecting above the level of the leaf-surface) on both sides; thin epidermis, — in short, no means of protection against excessive transpiration.

Saxifraga rivularis L. (Figs. 3 and 4).

Saxifraga rivularis L. is a decided mountain-plant which occurs most frequently on sloping ground, more numerously upon the shady than upon the sunny side. Probably grows usually in damp localities, and in the choice of its localities is almost exactly like *S. cernua* (Norman, l. c.).

The leaf is reniform and palmately-lobed, with usually 5 lobes, each provided with a hydathode at its apex (Fig. 3 *A*). Glandular hairs occur sparsely upon both surfaces.

The epidermis of the upper surface consists of large cells, which have slightly undulating walls and thin lateral and inner walls and irregularly thickened outer walls (Fig. 4). Cuticle thin. Stomata numerous and prominent. Glandular hairs are scattered over the whole surface, but are not abundant. Børgesen (l. c., p. 225) states that the stomata are most numerous upon the upper side, but yet he mentions (l. c., p. 226) having found 9 per unit of surface upon both the upper and lower surface.

The epidermis of the lower surface is almost exactly like that of the upper, but the cells are somewhat larger, and the walls more undulating (along the veins, however, to a less degree than outside them). (Fig. 4 *A, C.*)

The stomata here also are placed very slightly above the level of the leaf-surface; they are most numerous outside the veins (in the angles between the lobes), but are not entirely absent from along their length.

The mesophyll is exactly like that of *S. cernua.* What has been said above of the palisade-cells, spongy parenchyma and veins of the latter species will apply without any alteration to the

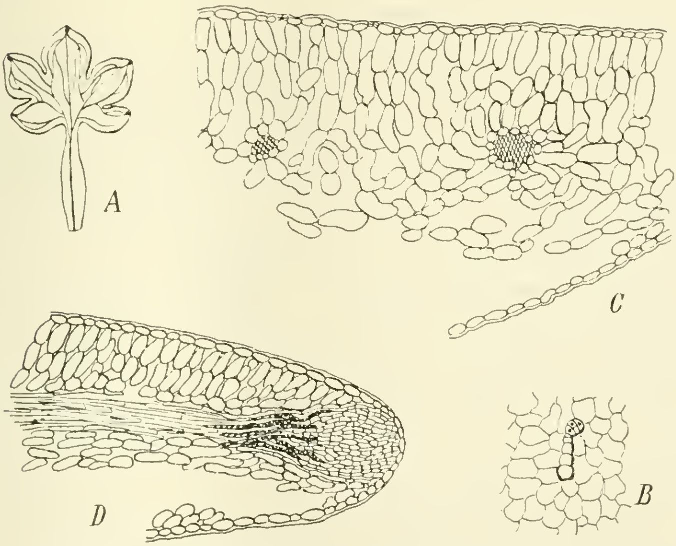


Fig. 3. *Saxifraga rivularis.*
A, ($^{2}/_{1}$) Leaf-form. *B*, Upper epidermis. *C*, Transverse section of leaf. *D*, Longitudinal section of tip of same with hydathode. (*B*, *C*, and *D* $^{50}/_{1}$).

present species also. The palisade-cells in this plant also are oblique; Børgesen evidently did not observe this feature, neither does he describe the hydathodes; the latter are exactly like those of *S. cernua.* It is extremely interesting to note how the modes of life of these two closely-allied species are reflected, with such close correspondence, in the anatomical structure of their leaves.

The material upon which the description here given is based, comes from the following localities: — Jan Mayen (July 22, 1896), Mödruvellir (Iceland, May 19, 1889), Upernivik (July 18, 1886), Danmarks Ø (Aug. 1; 1892), Frederikshaab (June 8, 1888), Malersomiarfik (July 6), Nova Zembla and Tromso (June 26,

Fig. 4. *Saxifraga rivularis.*
A, Epidermis of the upper surface of the leaf. *B*, The same (transverse section). *C*, Epidermis of the lower surface of the leaf. *D*, The same. *E*, Spongy parenchyma. (*A*, *B*, *C*, *D*, and *E* $\frac{282}{1}$).

1885); therefore from Norway, Iceland, Nova Zembla, Greenland and Jan Mayen. In spite of the widely separated localities of the individuals they were all absolutely identical in regard to leaf-anatomy. The specimens which have been investigated give no insight into possible seasonal differences; they were all collected between the end of June and the beginning of August.

Lastly, I may add, that I have examined numerous roots of this plant, without finding any kind of mycorhiza; but this also, no doubt, could scarcely be expected to be found.

2. *Boraphila.*

The three species of this group agree closely in the following features: — (1) Epidermis with undulating walls, (2) glandular hairs, (3) marked difference between the palisade-tissue and the spongy parenchyma (the spongy parenchyma varying from cells which are slightly branched, but arranged in irregular meshes and rows, with larger intercellular spaces (*S. stellaris*) — to much branched ("stellate") cells in the species *S. nivalis* and *S. hieraciifolia*; compact spongy parenchyma immediately beneath the epidermis does not occur), (4) hydathodes exactly like those in the section *Nephrophyllum.* The differences are as follows: —

Hairs: —

Two kinds (i. e. both glandular hairs and marginal non-glandular hairs): *S. nivalis* and *S. stellaris.*

Glandular hairs only: *S. hieraciifolia.*

Spongy parenchyma: —

(1) very loosely arranged, consisting of unbranched and branched cells, in rows of irregular length, the main direction of which is parallel to the longitudinal axis of the leaf: *S. stellaris.*

(2) all the cells of the spongy parenchyma branched: *S. hieraciifolia* and *nivalis.*

It can therefore be seen that the leaf-anatomy of this section corresponds closely with that of the section *Nephrophyllum.* It is in reality impossible, on the basis of our knowledge of the species of which the investigation is here recorded, to point out any anatomical difference which characterizes the whole of the one section in contradistinction to the whole of the other.

Saxifraga nivalis L. (Figs. 5 and 6).

Saxifraga nivalis L. occurs far above the tree-limit in Arctic regions, where (according to Norman) it usually grows on

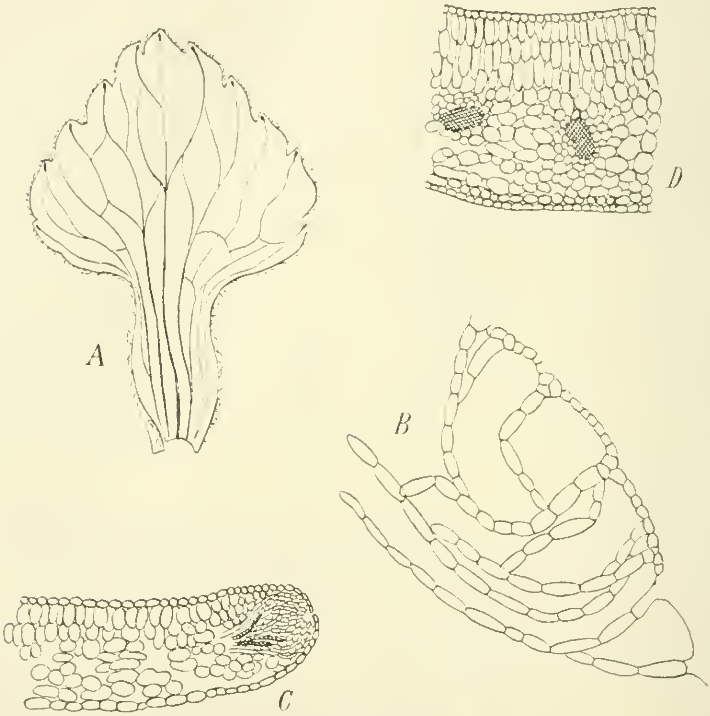


Fig. 5. *Saxifraga nivalis.*
A (2/1), Leaf-form. *B*, Hairs from leaf-margin. *C*, Longitudinal section of leaf with hydathode. *D*, Transverse section of leaf. (*B*, *C*, and *D* 50/1).

sloping ground, three times more commonly on the sunny side than on the shady side; it usually grows in dry localities, more rarely in damp. M. Porsild informs me verbally that in Greenland it is found among damp moss and upon cliffs wetted by spray. The plant according to my judgement is fairly distinctly mesophytic in its anatomical structure. The leaves are cordate, with a hydathode at the apex of each tooth. (Fig. 5 *A*.)

The epidermis of the upper surface consists of cells which have undulating walls and thin (about 2μ) lateral, inner and

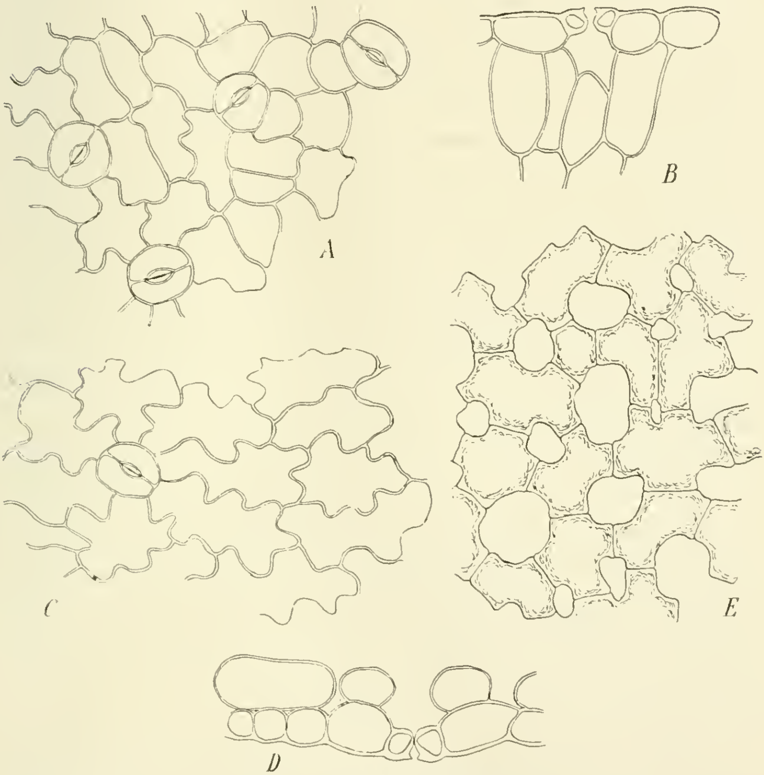


Fig. 6. *Saxifraga nivalis.*
A, Epidermis of the upper surface of the leaf. *B*, The same (transverse section). *C*, Epidermis of the lower surface of the leaf. *D*, The same. *E*, Spongy parenchyma. (*A*, *B*, *C*, *D* and *E*, $^{282}/_{1}$).

outer walls. Cuticle very slightly developed. Stomata numerous, and prominent (Fig. 6, *A*, *B*).

The epidermis of the lower surface is almost similar to that of the upper; but the cells are a little larger, and the lateral walls are somewhat more undulating. The stomata are precisely similar to those of the upper surface (Fig. 6, *C*, *D*).

Dr. Borgesen states that the stomata are equally abundant on both sides (l. c., p. 225); he has however counted 17 upon the upper surface, and 20 upon the lower per unit of surface (l. c., p. 226).

The mesophyll is fairly distinctly differentiated into a palisade-layer and spongy parenchyma; in the specimens examined by me there are three distinct palisade-layers (Borgesen found 2—3). The presence of these three layers, which implies that the specimens examined had been growing in comparatively ligh localities, harmonizes excellently with Norman's above-mentioned statement that the species occurs three times more commonly on the sunny side than on the shady side (I have not seen "shade-specimens," but Borgesen has evidently found them).

The spongy parenchyma is loosely arranged and consists of stellate cells (Fig. 6). The veins are accompanied by colourless, long-celled, usually one-layered bundle-sheaths.

The hydathodes have convex epithema and are quite similar in structure to those of *S. cernua*; they do not secrete lime.

Borgesen found scattered glandular hairs; these consist of a single row of cells, terminating in an undivided, obovate, one-celled head. Holm (l. c. Pl. X, Fig. 9) has figured a glandular hair with a two-celled head, — a feature which I have not met with. The hairs are more abundant upon the lower, and few in number upon the upper, surface.

The structure of the leaves is essentially the same in specimens from all the localities from which material has been examined; thus, I have more closely investigated specimens from Upernivik (July 10, 1887), Hold with Hope (July 10, 1891), Julianehaab (June 14, 1887), Dyrefjord (June 10, 1895), and Tromsø (June 28). The only deviation from the description given above was observed in the specimens from Hold with Hope and Dyrefjord, all of which contained a considerable quantity of oxalate of lime as crystal-aggregates in the cells of the spongy parenchyma near to the bundle-sheaths of the veins at the base of the leaf.

As may thus be seen, the structure of the leaf is distinctly mesophytic or perhaps even hygrophytic; the prominent stomata upon both leaf-surfaces, the thin-walled epidermis, and the loose structure of the spongy parenchyma show this. The agreement between the structure of the leaf and the character of the habitat, as it has been described to me by M. Porsild, is unmistakable.

Saxifraga hieraciifolia W. K. (Figs. 7 and 8).

Saxifraga hieraciifolia W. K. occurs in precisely the same localities as *S. nivalis* (according to verbal information from M. Porsild), and it should be expected to have a structure similar to that of the latter; that it has it will be more clearly proved by what follows.

The leaf is long-stalked, oval, with distant teeth and a hydathode at the apex of each tooth (Fig. 7). The thickness is slight, less than in *S. nivalis*.

The cells of the epidermis of the upper surface (Fig. 8 *A* and *C*) have undulating walls, and rounded, wavy contours; all the walls are thin, with cuticle very slightly developed. The stomata are numerous, and prominent. Scattered glandular hairs occur which consist of a single row of cells with a one-celled head.

The epidermis of the lower surface (Fig. 8 *B* and *D*) is essentially like that of the upper; but the undulating outline of the lateral walls is more acutely angled. Stomata are numerous, and prominent. Borgesen writes that there are as many upon the upper as upon the lower surface, but yet, at the same time, records seven upon the upper and twelve upon the lower surface per unit of surface.

The mesophyll (Fig. 7 *B*, *C* and *D*) is distinctly differentiated into palisade-tissue and spongy parenchyma. Borgesen found 2—3 layers; my specimens showed two; nowhere in the leaf are they placed obliquely. The cells of the spongy parenchyma are stellate, the whole of the tissue is highly lacunose. The veins are without mechanical tissue, but are accompanied by colourless, long-celled bundle-sheaths. The hydathodes are precisely similar in structure to those of *S. nivalis*, exactly marginal, with convex epithema; they secrete no lime (Fig. 7 *C*).

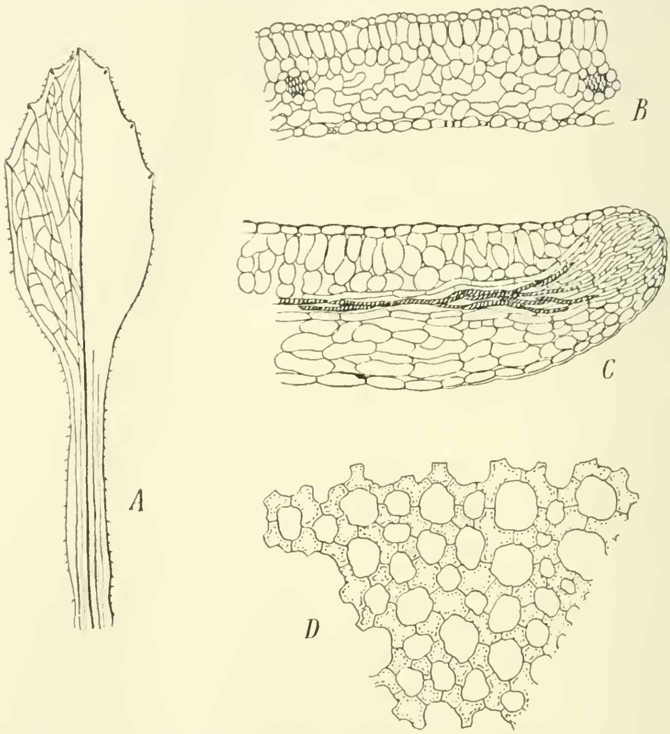


Fig. 7. *Saxifraga hieraciifolia.*
A (3/2), Leaf-form. *B*, Transverse section of leaf. *C*, The same in longitudinal section (with hydathode). *D*, Spongy parenchyma. (*B*, *C*, and *D* 50/1).

In its choice of localities this species probably nearly agrees with *S. nivalis.* In its structure (as may be seen from the above) it is more typically mesophytic than that species, the whole of its mesophyll being even more loosely arranged. Its means of protection against excessive transpiration are as slightly developed as those in *S. nivalis*; it can be distinctly seen that the palisade-tissue is less developed than in *S. nivalis*, —

from which it may perhaps be concluded that this species does not grow in quite as light localities as does *S. nivalis.*

Only specimens from Nova Zembla and Cape Tscheljuskin have been at my disposal; they were precisely similar in structure.

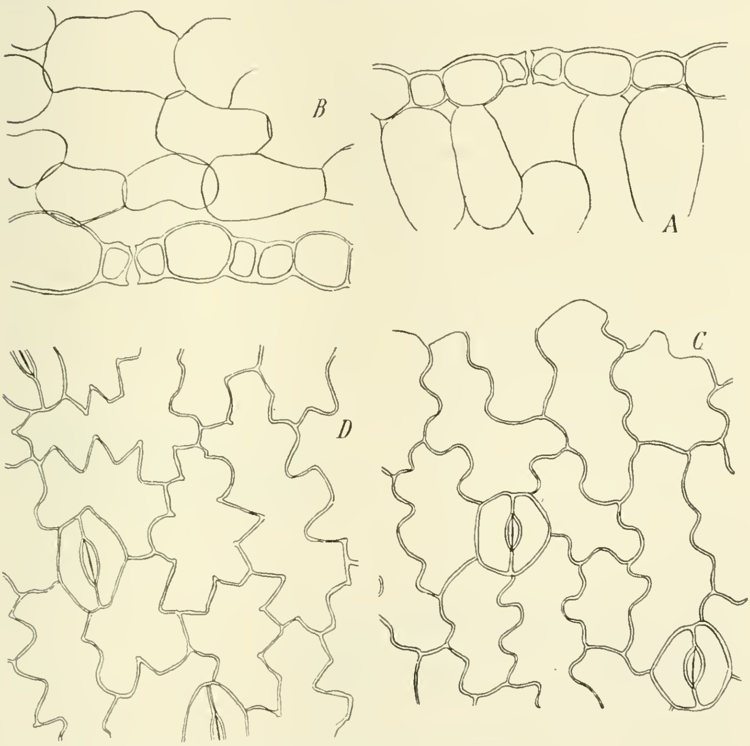


Fig. 8. *Saxifraga hieraciifolia.*
A, Upper epidermis. *B*, Lower epidermis. *C*, Upper surface. *D*, Lower surface ($^{282}/_1$).

Saxifraga stellaris L.

Saxifraga stellaris L. (Figs. 9 and 10) grows generally at very considerable heights on damp and cold ground, among moss, in clefts of rocks, along streams, in short it is a moisture-loving plant, as is also distinctly indicated by the anatomy of the leaf.

The leaf has slight and distant teeth and a hydathode at the apex of each tooth (Fig. 9). The epidermis of the upper surface

Fig. 10 *A* and *B*) has undulating walls which are thin everywhere. The outer walls are also thin, and have a distinct cuticle. Stomata are numerous, uniformly distributed, and prominent.

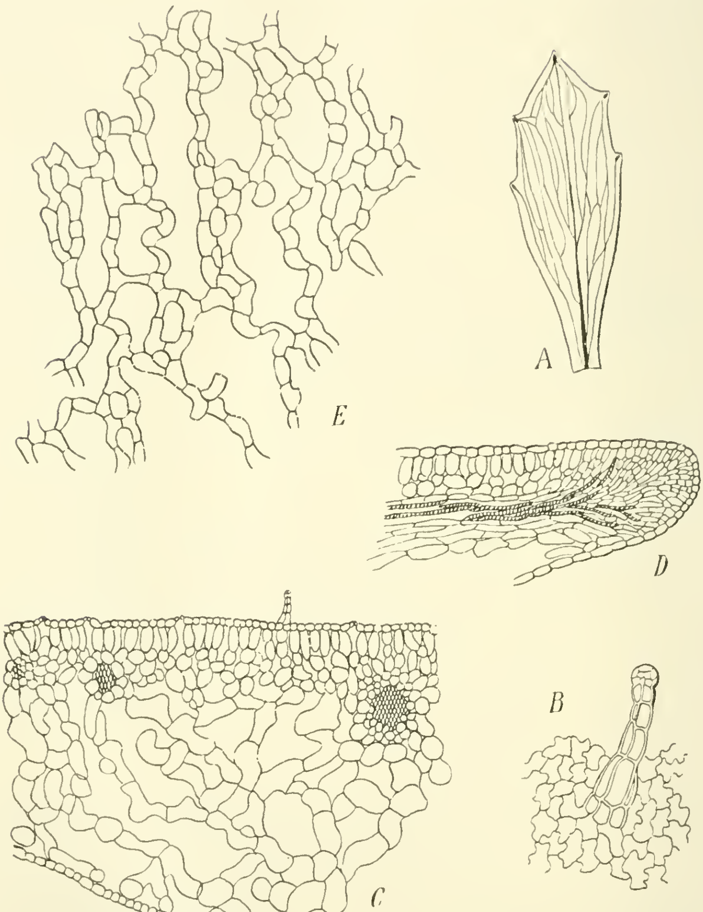


Fig. 9. *Saxifraga stellaris.*
A (2/1), Leaf-form. *B*, Epidermis of the upper surface of the leaf. *C*, Transverse section of leaf. *D*, Longitudinal section of leaf. *E*, Spongy parenchyma. (*B*, *C*, *D* and *E* 50/1).

Glandular hairs occur scattered over the whole leaf-blade; a definite head is wanting to some of the marginal hairs (Fig. 9).

The epidermis of the lower surface (Fig. 10 *C* and *D*) closely resembles that of the upper, but the cells are greatly elongated just above the veins and at that place stomata are wanting. The stomata are placed both upon the upper and lower surface, with their apertures principally in the direction of the length of the leaf. Glandular hairs are absent.

The mesophyll (Fig. 9) is very loosely arranged. All the cells above the veins are cylindrical — either shorter or longer — with

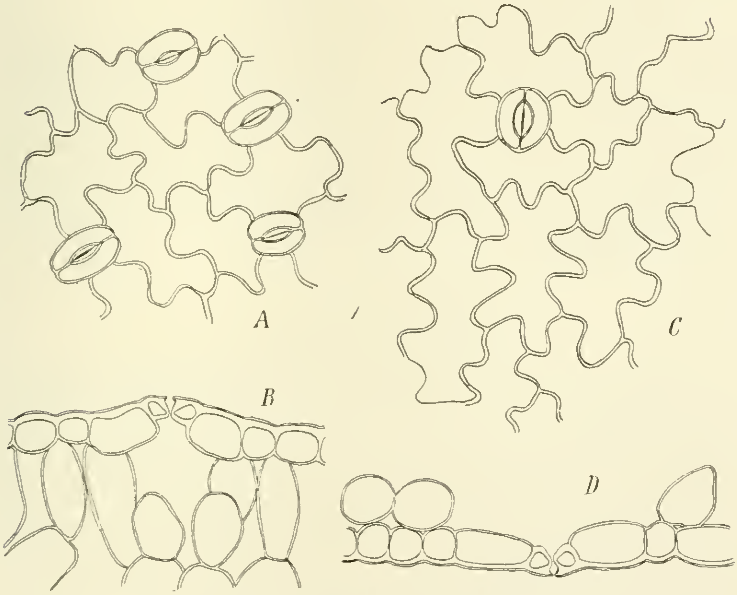


Fig. 10. *Saxifraga stellaris.*
A, Epidermis of the upper surface of the leaf. *B*, The same (transverse section). *C*, Epidermis of tbe lower surface of the leaf. *D*, The same (transverse section). (*A*, *B*, *C* and *D* $^{282}/_{1}$).

their axes at right angles to the epidermis. They can be readily distinguished from the stellate cells of the spongy parenchyma which form a very large-celled lacunose tissue. How many of the 3—4 layers of cylindrical cells are to be called palisade-cells ("collecting-cells" of Haberlandt) is quite arbitrary.

The veins are accompanied by colourless, one-layered (rarely many-layered) bundle-sheaths. Mechanical tissue is entirely absent. The structure of the hydathode is exactly similar to that, for instance, of *S. nivalis*; it does not secrete lime.

The leaf is consequently very distinctly mesophytic (more particularly hygrophytic), and is presumably the most hygrophilous of the three species of the section *Boraphila* here dealt with, a fact which agrees excellently with its usually very damp habitat; Lazniewski also states that it is: "nicht selten im Wasser wurzelnd angetroffen" (l. c., p. 246).

Of this species I have examined specimens from Upernivik (July 18, 1886), Frederikshaab (Aug. 17, 1886), East Greenland (Sept. 4, 1885), Nova Zembla, the Færöe (July 1895), Härjedalen (Aug. 1884), Tromsø (July 21, 1885), — therefore, from widely separated localities; but they all agreed in regard to their structure.

With regard to the fleshy leaves of the bulbils, see Holm, l. c. Pl. X, Fig. 6.

3. *Dactyloides.*

The two species of this group which have been investigated agree precisely in (1) the form of the leaves (stalked and palmately lobed to palmately cleft), (2) the undulating walls of the epidermis, (3) the distinct differentiation of palisade-tissue and spongy parenchyma, and (4) hydathode with convex epithema, opening upon the upper surface of the leaf slightly within the margin. — The layers of the spongy parenchyma, from the epidermis of the lower surface to beneath the palisade-cells, differ in compactness; immediately within the epidermis the cells are polygonal, without intercellular spaces; higher up, intercellular spaces occur in considerable numbers. The difference between the two species is most apparent in the extent to which they are hairy.

Saxifraga hypnoides L. (Figs. 11 and 12).

Saxifraga hypnoides L. greatly resembles *S. groenlandica* (see below) in its anatomy.

The epidermis of the upper surface (Fig. 11 *B* and *C*) consists of two kinds of cells, (1) large, somewhat straight-walled and elongated cells, (2) irregularly-shaped cells with undulating walls. The inner, lateral and outer walls are thin (the last about 2μ in thickness). In the leaf-stalk the cells are greatly elongated, narrow

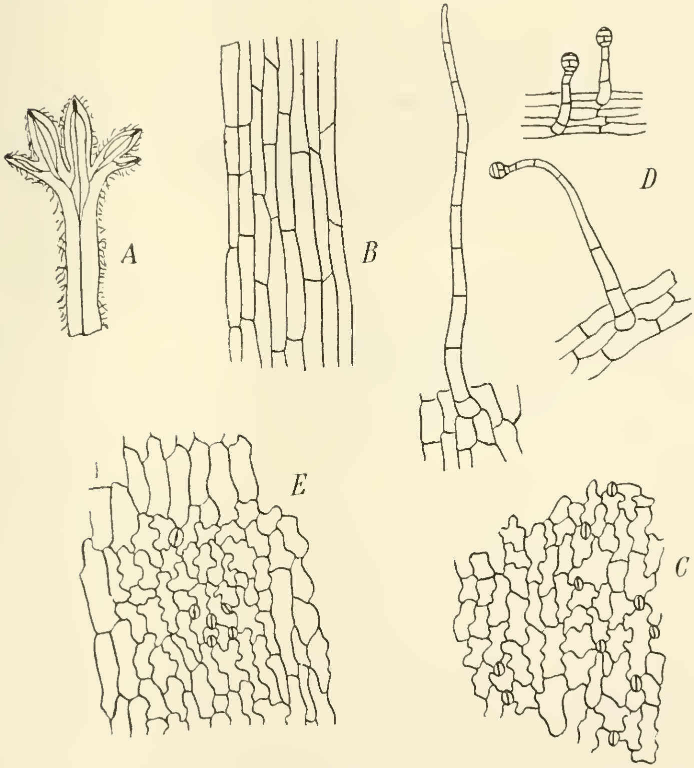


Fig. 11. *Saxifraga hypnoides.*
A (2/1), Leaf-form. B, Epidermis of the upper side of the leaf-stalk. *C*, Epidermis of the upper surface of the leaf. D, Hairs (see text). *E*, Epidermis of the lower surface of the leaf. (*B*, *C*, *D* and *E* 50/1).

and straight-walled. The stomata are placed on a level with the leaf-surface and are distributed in groups of very variable size; their apertures principally lie parallel with the longitudinal axis of the leaf. All the epidermal cells between and in immediate proximity to a group of stomata are smaller than the ordinary epidermal cells, and their walls are far more undulating. The groups of stomata are continued as a long and very narrow stripe along — and slightly within — both the margins of the leaf-stalk, and are here also accompanied by the highly charac-

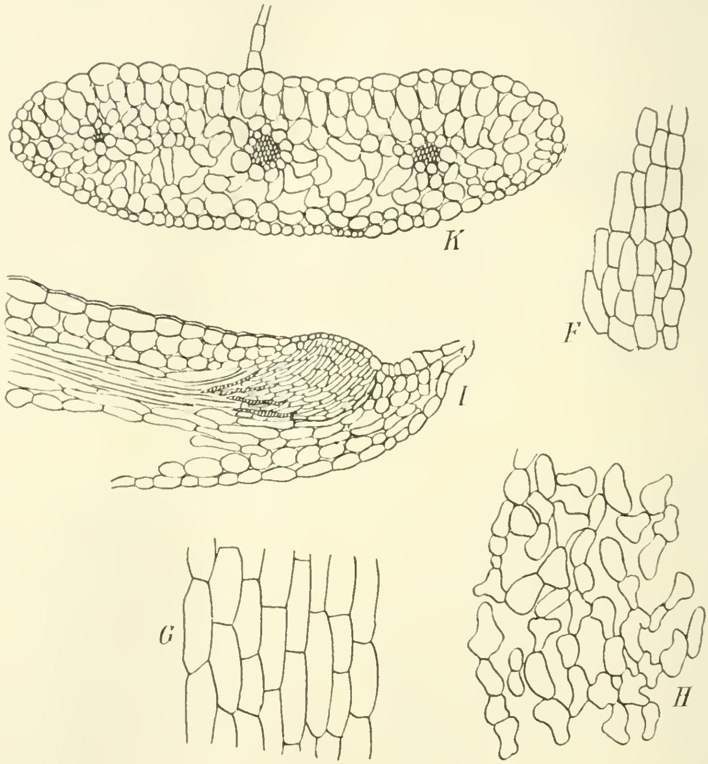


Fig. 12. *Saxifraga hypnoides.*

F, Spongy parenchyma from just below the epidermis of the leaf-blade. *G*, The same from just below the epidermis of the leaf-stalk. *H*, The same from midway between the epidermis and veins. *I*, Longitudinal section of leaf. *K*, Transverse section of leaf. (*F*, *G*, *H*, *I* and *K* $^{50}/_{1}$).

teristic small epidermal cells with undulating walls. Almost all the hairs are without apical glands; they occur invariably in the spaces between the groups of stomata and arise from the straight-walled cells — never from those with undulating walls.

The structure of the epidermis of the lower surface (Fig. 11 *E*) is like that of the upper, only the hairs of the former are glandular (upon the leaf-stalk, however, non-glandular hairs occur).

Along the margin of the leaf-stalk there are numerous hairs similar to those upon the upper surface of the leaf.

The mesophyll (Fig. 12) is differentiated to about the same degree as in *S. groenlandica*: the palisade-cells are short (in the specimens investigated very indistinctly, or not at all, obliquely placed) and the layer passes fairly gradually into the spongy parenchyma. The latter is loose and lacunose in the middle of the leaf, but immediately within the lower epidermis it becomes very compact and polygonal, and is almost without intercellular spaces.

The veins are without mechanical tissue, and are accompanied by a bundle-sheath of elongated cells one-layered on the whole.

The hydathode is well-developed, with convex epithema, and it opens upon the upper side of the leaf-margin and does not secrete lime (Fig. 12 *I*).

The description here given is based upon the investigation of specimens gathered by F. Borgesen at Velbestad (the Færoes), July 5, 1895; that is the only material I have had at my disposal.

Saxifraga groenlandica L. (Figs. 13, 14 and 15).

Saxifraga groenlandica L. is common everywhere on the heather moors and upon the rocky flats of Greenland, and ascends to the mountain heights there and also in Norway (Warming, Norman). Grows almost as commonly on the sunny side as on the shady side upon the mountains; and usually in dry localities.

The leaves are deeply palmately cleft, the leaf-stalk is broad and flat. A hydathode occurs at the apex of each segment. Glandular hairs occur fairly numerously upon both surfaces.

The epidermis of the upper surface (Figs. 13 *B* and 15 *A* and *B*) has everywhere thin-walled cells; the latter, upon the leaf-segments, are short and have undulating walls (straight-walled, however, above the veins and at the base of each hair). Upon the rest of the leaf-blade the epidermal cells are large and straight-walled; this also applies to the leaf-stalk, only its

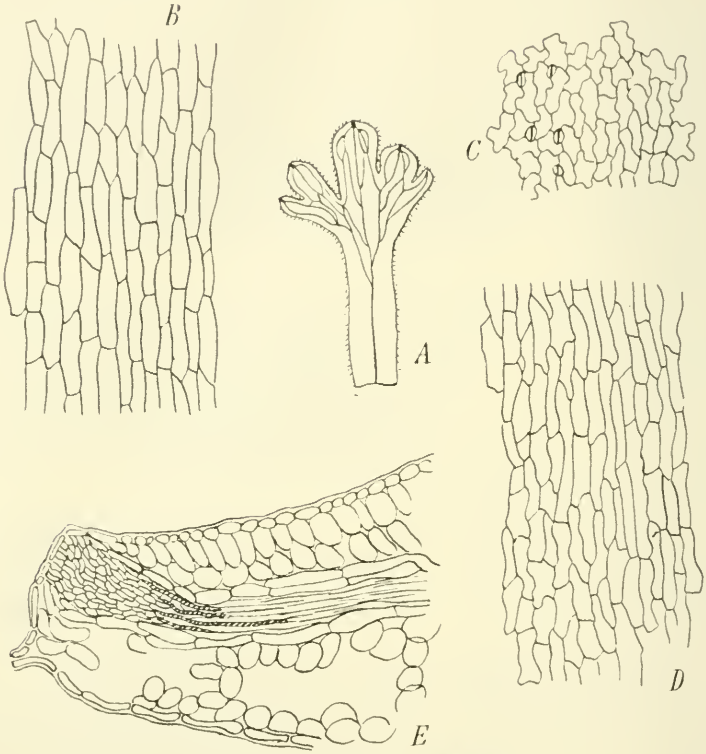
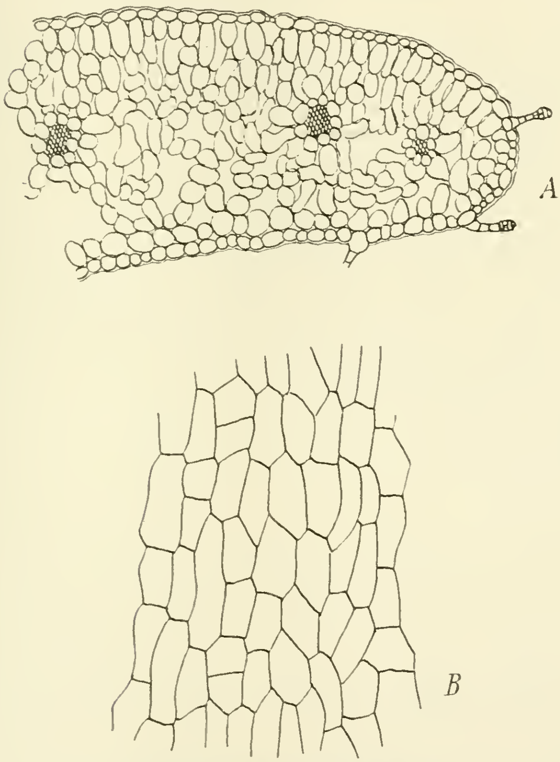


Fig. 13. *Saxifraga groenlandica.*
A (2/1), Leaf-form. *B*, Epidermis of the upper side of the leaf-stalk. *C*, Epidermis of the lower surface of the leaf, near the midrib. *D*, Epidermis of the lower surface, just above the midrib. *E*, Longitudinal section of leaf. (*A*, *B*, *C*, *D* and *E* 50/1).

epidermal cells, above the veins, are somewhat narrower than those upon the leaf-blade. Glandular hairs are found in numbers upon the leaf-segments, and are fewer in number upon the rest of the leaf-blade and along the margin of the leaf-stalk. The upper side of the leaf-stalk is very slightly hairy. The stomata are numerous and evenly distributed upon the leaf-segments;

upon the rest of the leaf-blade they are arranged in groups or rows and are always accompanied by short cells with undulating walls. Stomata are also found (very sparsely) along the margins of the leaf-stalk, accompanied by cells with undulating walls.



A

B

Fig. 14. *Saxifraga groenlandica.*
A, Transverse section of leaf. *B*, Spongy parenchyma from just below the epidermis ($^{50}/_{1}$).

All the stomata have their apertures parallel with the longitudinal axis of the leaf.

The epidermis of the lower surface (Fig. 13 *C* and *D*; Fig. 15 *C*) closely resembles that of the upper, only that the stomata, and the cells with undulating walls connected with them, are less numerous; the large-celled groups of hair-producing cells are more numerous than upon the upper side. Only glandular hairs occur.

The mesophyll is distinctly, but not markedly differentiated. The palisade-cells are oblique and short. The spongy parenchyma is fairly compact; (the section figured had been partly torn during preparation and has therefore been drawn as more lacunose than it was in reality). The cells of the spongy parenchyma are roundly-polygonal, unbranched or very shortly branched. The lowest layer of cells immediately within the epidermis is very compact, without intercellular spaces; the other layers (e. g. midway between the veins and the epidermis of the lower surface) are much looser in texture (Fig. 14).

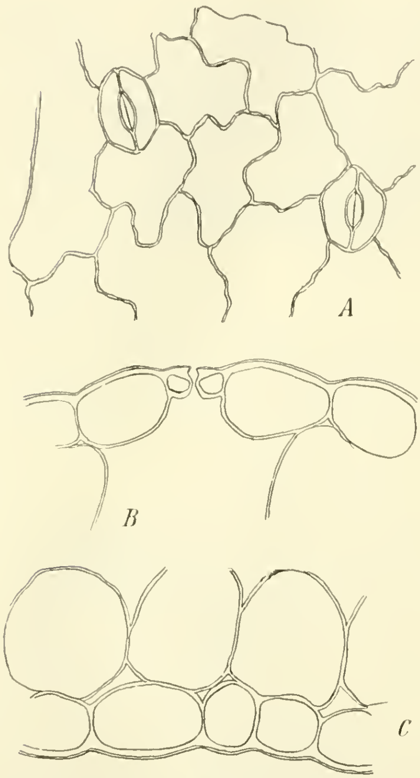


Fig. 15. *Saxifraga cæspitosa.* Epidermis of the leaf. *A*, Upper surface. *B*, The same (transverse section). *C*, Lower surface. (*A*, *B*, *C* 282/1).

The veins — like those in all the previous species — are without mechanical tissue and are surrounded by bundle-sheaths containing tannin. The hydathodes almost exactly resemble in structure those of *S. hypnoides*; they do not secrete lime.

The description here given refers to the specimens from Jan Mayen (July 22, 1896). Somewhat different from these (but otherwise resembling each other) were the specimens from Danmarks Ø (Aug. 6, 1892) and Disco (July 20, 1884), these latter having fewer stomata upon the upper surface and none at all upon the lower surface.[1]

4. *Trachyphyllum.*

The three species which have been examined, agree in (1) the structure of the hydathode (it opens upon the upper surface of the leaf, with flattened or highly convex epithema; hydathode-cavity absent), (2) the structure of the hairs (they are everywhere irregularly-multicellular and retain this feature, either they have, or are without, an apical gland, — in contradistinction to the sections *Boraphila, Nephrophyllum, Dactyloides*). and (3) the cells of the spongy parenchyma are very little or not at all branched. — The three species differ most in the form of their leaves, but are separated also by other, smaller differences.

The chief structural features useful in diagnosis are the following: —

Leaves: —

toothed at the apex, with three acute teeth: *S. tricuspidata.*

entire: —

margin hairy along the lower half of the leaf: *S. aizoides,*

margin hairy along its whole extent: *S. flagellaris.*

Hairs: —

irregularly-multicellular marginal hairs: *S. aizoides,*

glandular hairs with irregularly-multicellular stalks: *S. flagellaris,*

(1) with globular head: *S. flagellaris,*

(2) with club-shaped head: *S. tricuspidata.*

[1] Besides the principal form I also examined specimens of the variety *palmata* from Thingvellir in Iceland (June 13, 1895). The latter is very remarkable by reason of its agreeing in almost all points with *S. hypnoides* in regard to leaf-anatomy; the only difference being that a few of the marginal hairs of the leaf are glandular.

The other differences are not characteristic enough to be given as a key; they are best seen in the figures.

Saxifraga aizoides L. (Figs. 16, 17 and 18).

Saxifraga aizoides L. according to Norman is a decided mountain-plant which grows both upon very wet and very dry ground, and occurs most commonly on the sunny side.

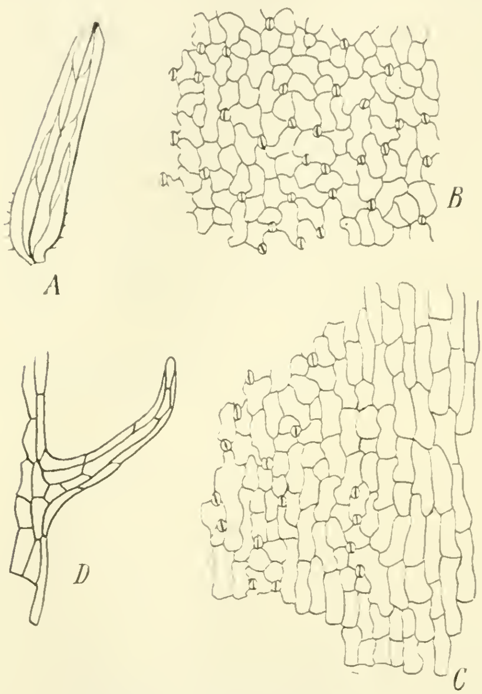


Fig. 16. *Saxifraga aizoides.*
The leaf: *A* (2/1), Leaf-form. *B*, Upper epidermis. *C*, Lower epidermis: the middle line of the leaf is to the right. *D*, Marginal hair. (*B*, *C*, *D* 50/1).

The leaf is linear, thick and succulent and terminates in a point at the base of which is found the only hydathode of the leaf. A few hairs occur along the margin towards the base; the leaf is otherwise glabrous.

The epidermis of the upper surface (Figs. 16 *B*; 18 *A* and *C*) consists of cells with slightly undulating, lateral walls and well-developed outer walls with distinct cuticle. At the base of the leaf, the lateral walls of the cells are straight and the cells are long and narrow. Stomata are absent at the base of the leaf upon its middle part, but in other places are evenly distributed. The stomata are parallel with the longitudinal axis of the leaf; they are placed on a level with the leaf-surface.

The epidermis of the lower surface (Fig. 16 *C*; Fig. 18 *B* and *D*), along the margin of the leaf, is almost exactly like that of the upper; the stomata are absent from a broad band along the middle, where the cells are elongated and narrow.

The differentiation of the mesophyll is fairly distinct. The palisade-cells, towards the apex of the leaf, are obliquely placed.

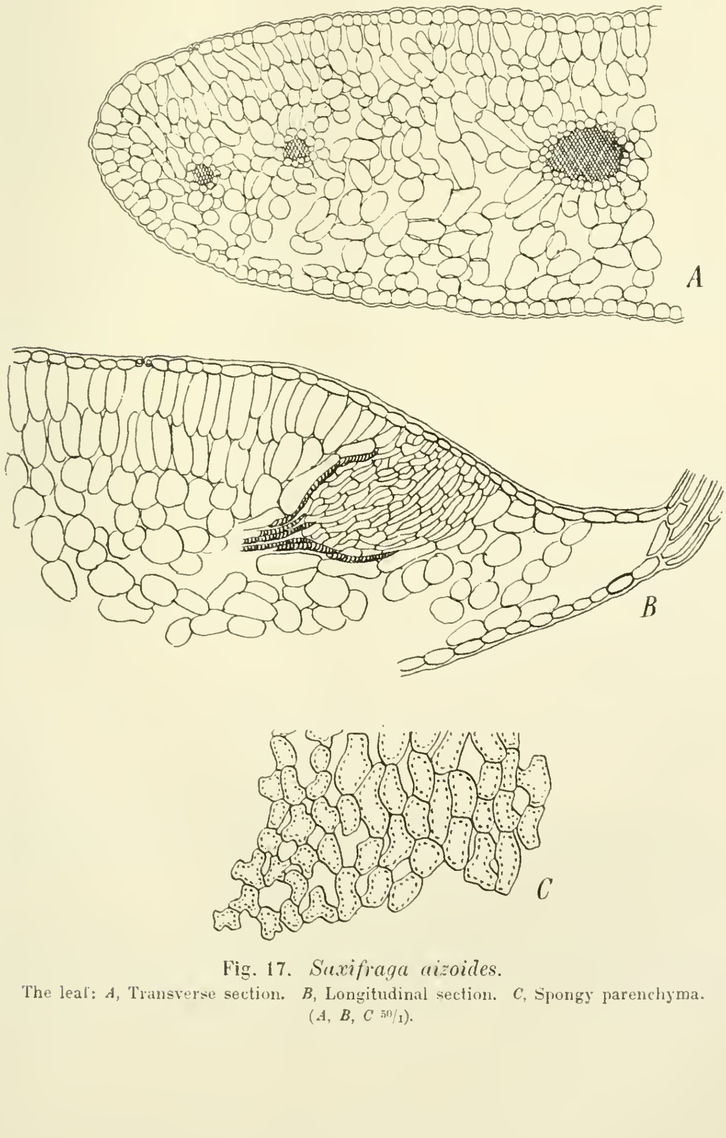


Fig. 17. *Saxifraga aizoides.*
The leaf: *A*, Transverse section. *B*, Longitudinal section. *C*, Spongy parenchyma. (*A*, *B*, *C* $^{50}/_{1}$).

The spongy parenchyma consists of roundish, shortly branched cells, which are placed more closely together, are elongated and are even more shortly branched in the middle band which is devoid of stomata.

The hydathode is situated at the apex of the leaf upon the upper surface; it does not secrete lime. The nerves are without stereom and are surrounded by a hyaline bundle-sheath.

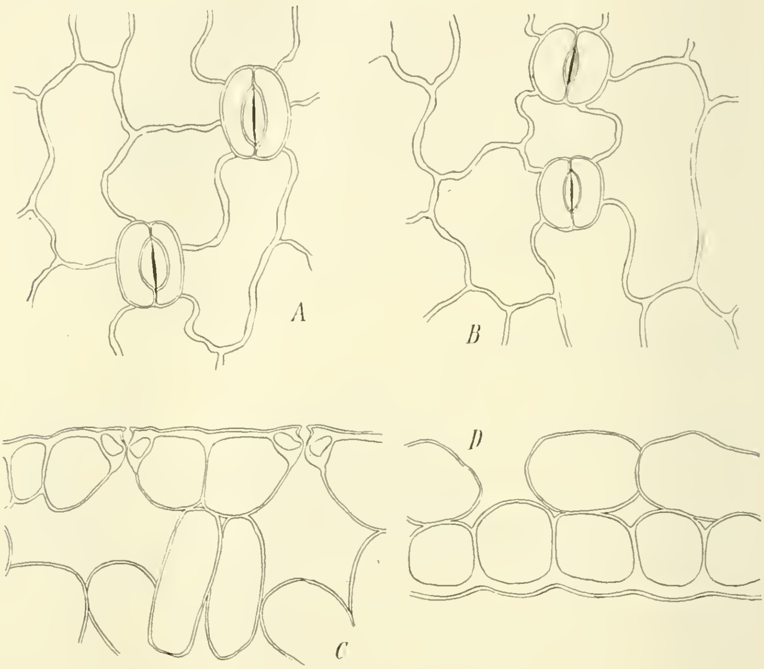


Fig. 18. *Saxifraga aizoides.*
The leaf: *A*, Upper epidermis. *B*, Lower epidermis. *C*, Upper surface. *D*, Lower surface. (*A*, *B*, *C*, *D* 282/1).

I have investigated specimens from Greenland (Ilua; Ivigtut, Aug. 20, 1883) and Tromsø (1885); from all three localities the specimens were similar in all respects.

As already mentioned the plant lives both in very wet and very dry localities. The specimens examined by me were not accompanied by notes containing further information regarding their habitats. The fact of their occurring more commonly upon the sunny side appears to suggest a predominant xerophytic tendency. At any rate, the anatomy shows, although not very decidedly, several xerophytic features (succulency, fairly well-developed epidermis, narrow leaves, etc.). Bonnier (Ann. des sciences nat., VII ser., T. XX) has grown the species in Alpine regions (1600 metres) and found the specimens grown there to contain several palisade-layers more than are found in the individuals from the lowlands, — probably a natural result of the more intense light upon mountains. The Arctic specimens, in that respect, resemble rather the lowland than the mountain specimens.

Saxifraga flagellaris Willd. (Figs. 19 and 20.)

Saxifraga flagellaris Willd. There are too few data regarding the habitats of this species to enable me to form an opinion concerning the extent of its adaptation.

The lamina is almost oval and passes gradually into the leaf-stalk. Large glandular hairs occur — along the margin, one upon the leaf-apex itself, and a few scattered over the upper surface (Fig. 19).

The epidermis of the upper surface (Fig. 20) consists of cells which have undulating walls; above the veins the cells are larger and more straight-walled than outside them. The outer walls of the cells are only fairly strongly developed, with distinct cuticle. The stomata are placed slightly above the level of the leaf-surface, are evenly distributed, and have their apertures parallel with the longitudinal axis of the leaf.

The epidermis of the lower surface (Fig. 19 *B*), along a very broad longitudinal band down the middle, has less undulating walls than upon the upper surface, and consists of longer cells. The outer walls are somewhat thickened (Fig. 20 *D*). Along the margin the epidermis, like that of the upper surface, has undulating walls, with only few stomata.

The cells of the mesophyll (Fig. 19) are not markedly differentiated; the palisade-cells are obliquely placed. The cells of the spongy parenchyma are roundish. The whole leaf is somewhat suc-

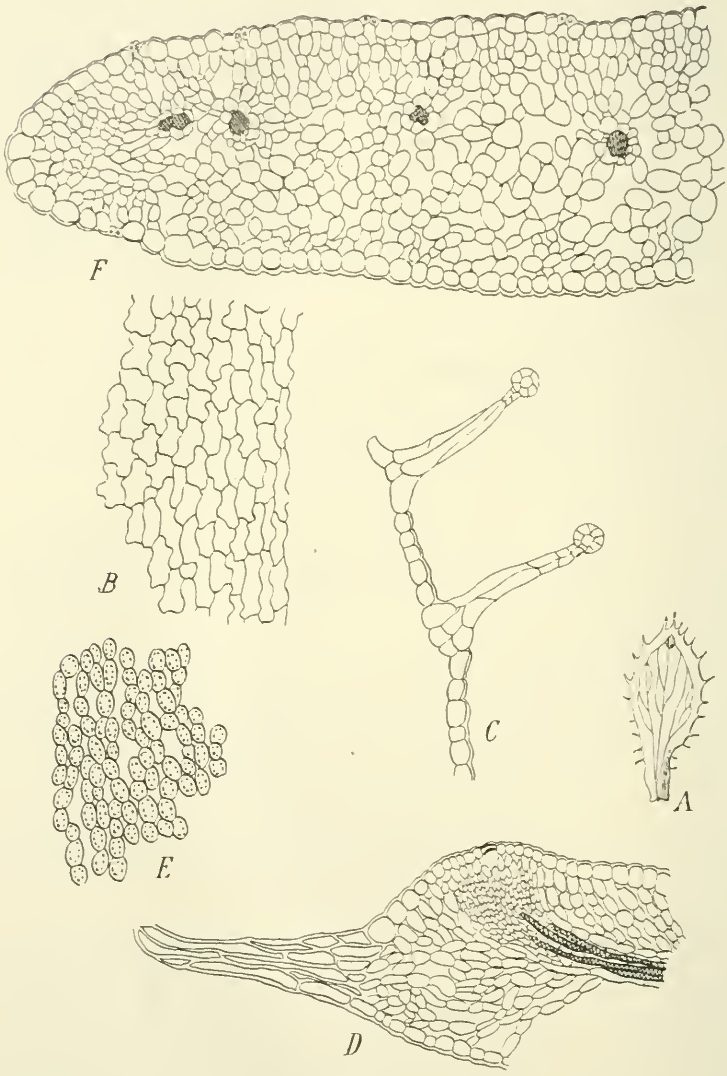


Fig. 19. *Saxifraga flagellaris.*
The leaf: *A* (2/1), Leaf-form. *B*, Lower epidermis. *C*, Marginal hairs. *D*, Longitudinal section. *E*, Spongy parenchyma. *F*, Transverse section. (*B*, *C*, *F* 56/1), (*D*, *E* 50/1).

culent, and appears, although not very decidedly so (e. g. on account of the numerous stomata upon the *upper* surface) to be somewhat xerophytic. The hydathode occurs at the apex of the leaf, upon the upper surface (Fig. 19); the epithema is

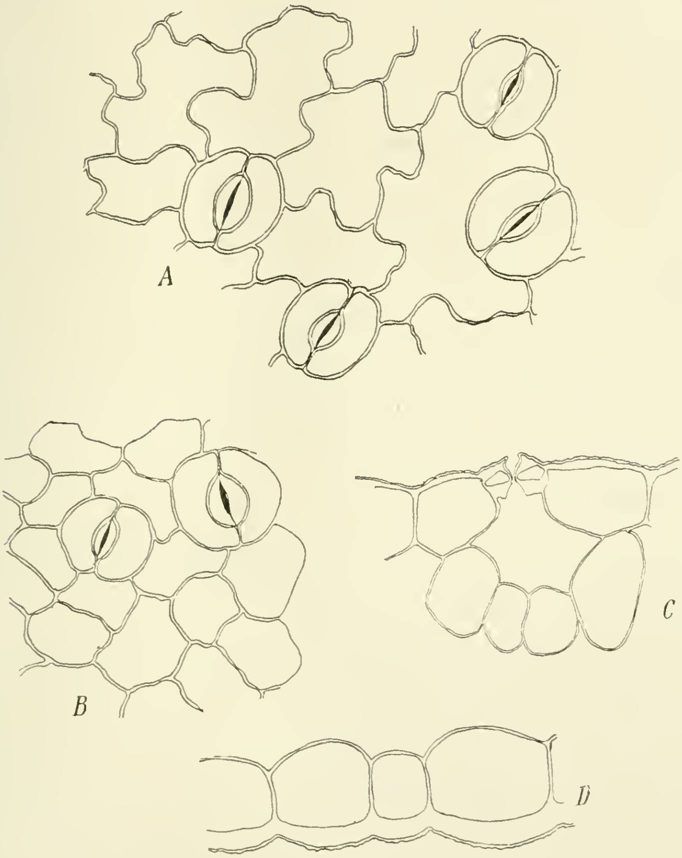


Fig. 20. *Saxifraga flagellaris.*
The epidermis of the leaf: *A*, Upper surface. *B*, The epidermis of the hydathode. *C*, Upper surface. *D*, Lower surface. ($^{282}/_1$).

convex. There is no secretion of lime. The veins are without stereom, and surrounded by a colourless sheath (Fig. 19).

The f l e s h y l e a v e s of the bulbils contain much starch. The form of their blade is nearly like that of the foliage-leaves, but the leaf is more short-stalked than that of the latter. The epidermis of the upper surface consists in part of very distinctly transversely elongated cells with slightly undulating lateral walls. The outer walls are 6—8 μ thick, with distinct cuticle. The stomata occur in fair numbers (not so abundantly, however, as upon the foliage-leaves), and scattered evenly over the whole surface from the apex to the base. At the apex of the leaf there is a hydathode with convex epithema. So far I could see, the stomata, both upon the leaf-blade itself and upon the epithema (the water-pores), Fig. 20, are functionless, the middle lamella in the wall common to both guard-cells not appearing to part, so that even upon the oldest leaves the stomata are permanently closed.

The epidermis of the lower surface consists of elongated cells, longer than those upon the upper surface. Outer walls 6—8 μ in thickness; cuticle present and stomata absent. Along the margin are glandular hairs, precisely similar in structure to those of the foliage-leaves.

The veins and the hydathode are exactly similar to those of the foliage-leaves, but — as already mentioned — upon the epithema the water-pores are closed.

The cells of the mesophyll are all more rounded than are those in the foliage-leaves; the cells of the layer answering to the palisade are set obliquely to the epidermis as in the foliage-leaves, although they are filled with starch-grains and are without chlorophyll; so this oblique position has absolutely no connection with any light-orientation which may have reference to assimilation. The cells of the spongy parenchyma are rounded and filled with starch.

Consequently, in these fleshy leaves are found three structural features which, for the existing functions of the leaves, appear to be useless rudiments inherited from parent-plants with foliage-leaves similar in structure to those of the present-day *S. flagellaris*.

These structural features are: —

(1) Functionless (permanently closed) stomata.

(2) Functionless hydathodes (the water-pores being closed).

(3) Light-orientated (obliquely placed) palisade-cells.

I have investigated specimens of this species from two localities, viz. Siberia (July 24, 1878, Kjellman) and Nova Zembla (Th. Holm). They were all alike.

Saxifraga tricuspidata Retz. (Figs. 21 and 22.)

Saxifraga tricuspidata Retz. a is usually found upon heaths and is xerophytic in the choice of its habitat, and this xerophytism is distinctly impressed upon the structure.

The leaf is narrow (Fig. 21 *A*), fairly thick, and, at the apex, is trifid and bears three hydathodes. The epidermis of the upper surface (Fig. 22) consists of fairly straight-walled cells, which at the base of the leaf are nearly isodiametric, but become more and more transversely elongated towards the apex of the leaf. The cells are not elongated along the midrib. Pits are present in the lateral walls. The outer walls are thick, with distinct cuticle (Fig. 22 *B*). Stomata are evenly distributed over the greater part of the leaf-blade, they are most numerous on the more exposed parts of the leaf, but are few in number at the base. They are somewhat prominent. Along the margin of the leaf are numerous irregularly-multicellular hairs. Glandular hairs occur, with long, club-shaped apical glands (Fig. 21 *B*).

The epidermis of the lower surface (Fig. 22) along the margin is, in structure, precisely similar to that of the upper surface — also in regard to its stomata. Along the middle of the leaf the cells are more ;elongated and the stomata few in number (more abundant, however, towards the apex of the leaf); Borgesen states that there are two per unit of surface, while the upper side has twelve per unit. At the base of the leaf they are almost completely absent.

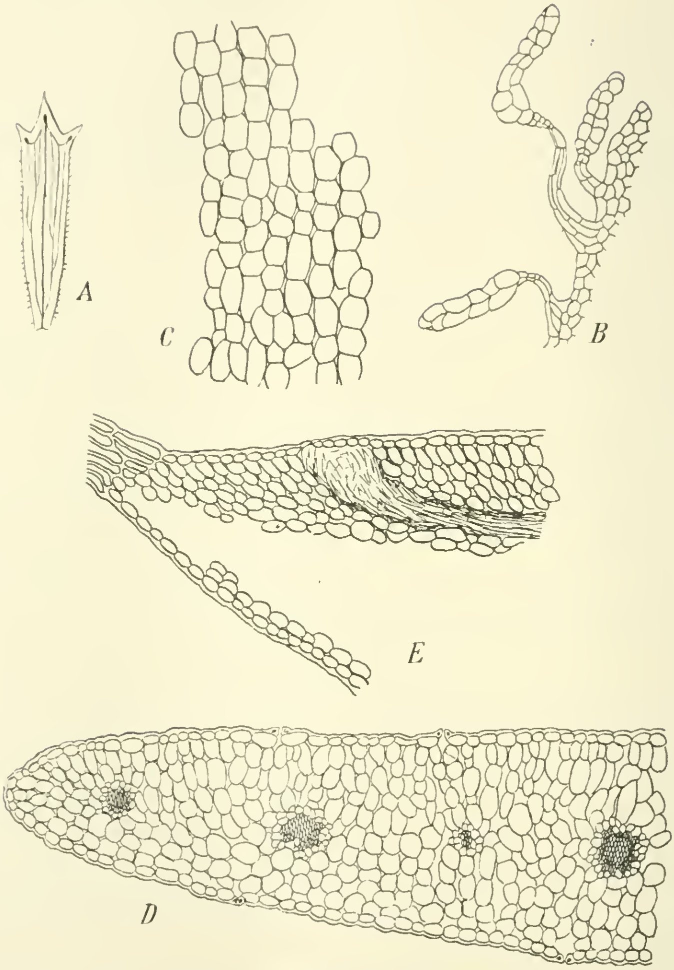


Fig. 21. *Saxifraga tricuspidata.*
The leaf: *A* ($^2/_1$), Leaf-form. *B*, Marginal hairs. *C*, Spongy parenchyma. *D*, Transverse section. *E*, Longitudinal section. (*B*, *D*, *E* $^{56}/_1$), (*C* $^{50}/_1$).

The mesophyll is slightly and indistinctly differentiated, and strongly recalls the condition in the section *Euaizonia* (see below). The palisade-cells are short and rounded, and some are placed in rows which are decidedly oblique to the long axis of the leaf (Fig. 21 *D*, *E*).

The cells of the spongy parenchyma are rounded, unbranched, and most compact immediately beneath the lower epidermis (Fig. 21, *C*).

The veins are without stereom and have hyaline bundle-sheaths (Fig. 21 *D*).

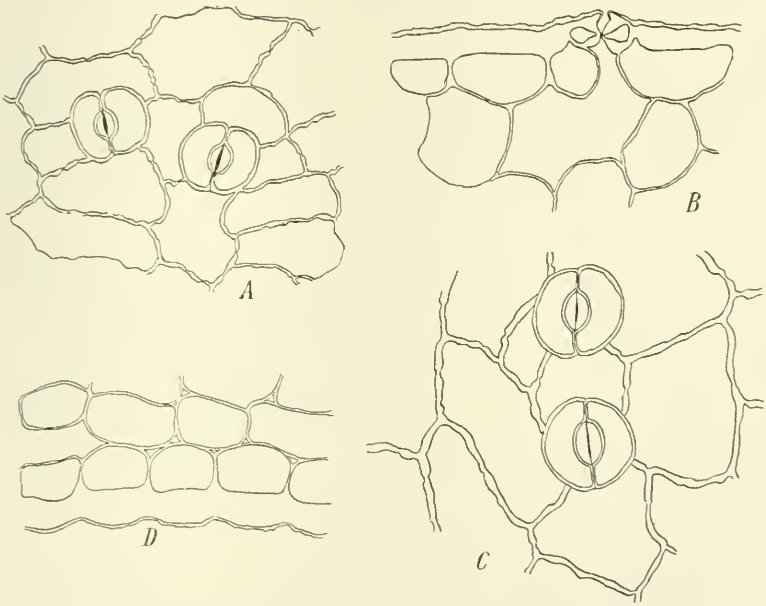


Fig. 22. *Saxifraga tricuspidata.*
The epidermis of the leaf: *A* and *B*, Upper surface. *C* and *D*, Lower surface.
(*A*, *B*, *C*, *D* $^{282}/_{1}$).

The hydathode opens upon the upper side of the leaf-margin (Fig. 21); it does not secrete lime. In one solitary specimen the water-pores were gathered very closely together, six being directly in contact with each other.

I have investigated specimens of this species from Disco (July 20, 1884), Amerdlok (July 11, 1884), Upernivik (May 10, 1887). They were all alike.

5. *Euaizonia.*

The two species of this group which have been investigated show their close relationship in (1) the form of the leaves (both are spathulate, and serrate, with a hydathode at each tooth), (2) the distribution and structure of the hairs, (3) the transverse elongation of the epidermal cells of the upper surface and the longitudinal elongation of those of the lower, (4) the pits in the radial walls of the epidermal cells, (5) the structure of the palisade-tissue and of the spongy parenchyma, (6) the structure of the veins, (7) the hydathodes with a cavity, and with secretion of lime, (8) and the stomata, surrounded by 4—6 smaller cells. The differences between the two species are so slight, that on the basis of the anonymous section at hand it would be difficult, if not impossible, to separate them from each other with any certainty; presumably they differ more particularly as regards the epidermis of the upper surface of the leaf, which in *S. Aizoon* has more decidedly transversely elongated cells than in *S. Cotyledon.* As far as is known, wax is absent from the epidermis of the latter species, while it is found in *S. Aizoon.* A key to their determination would therefore be as follows: —

Epidermal cells of the upper surface
- very distinctly transversely elongated: *S. Aizoon*,
- somewhat indistinctly, or more rarely not at all transversely elongated: *S. Cotyledon.*

Saxifraga Cotyledon L. (Figs. 23 and 24.)

Saxifraga Cotyledon L. This species is a Sub-alpine lowland plant which here and there extends almost down to the sea-level and scarcely ever extends higher into the mountains than about 500 feet; found most commonly at elevations of 200—300 feet above the sea. It grows partly upon level, partly (and most commonly) upon sloping ground, where it is

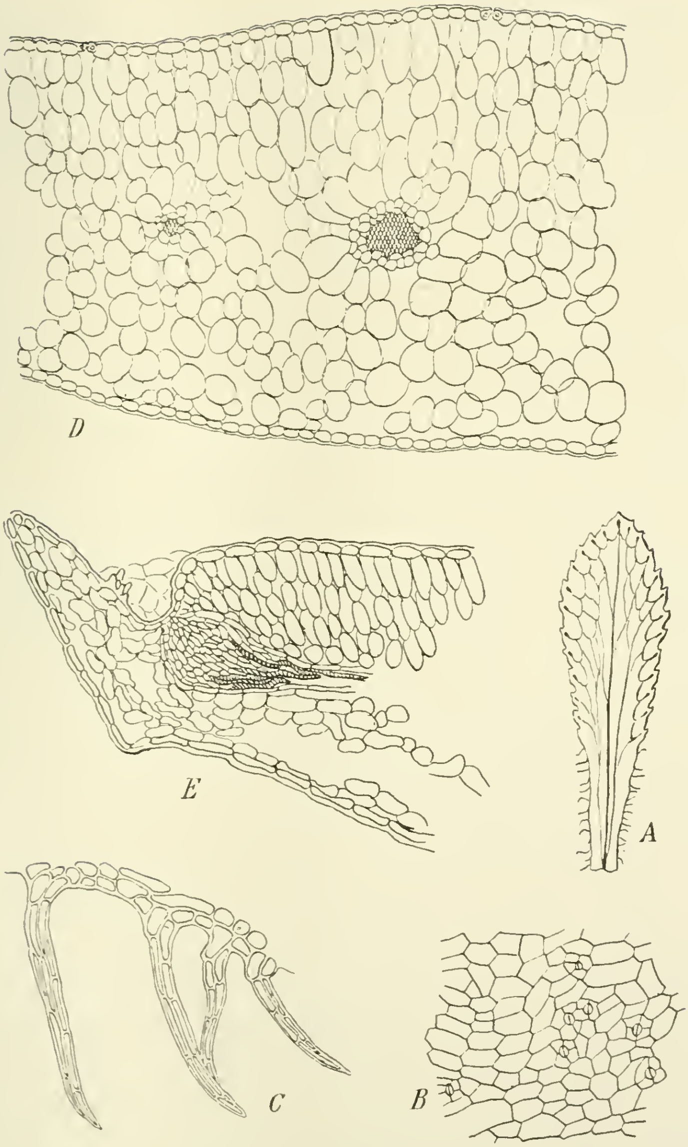


Fig. 23. *Saxifraga Cotyledon.*
The leaf: *A* (2/1), Leaf-form. *B*, Epidermis of the middle of the upper surface. *C*, Marginal hairs. *D*, Transverse section. *E*, Longitudinal section. (*B*, *C*, *D*, *E* 50/1).

about five times as common upon the southern side as upon the northern, while it scarcely ever occurs on the eastern and western sides (Norman, l. c., pp. 294—95).

The leaves are in a dense rosette, which somewhat recalls *Sempervivum*. Each of the teeth upon the leaves is provided with a hydathode (Fig. 23 *A*). The leaves are fairly thick.

The epidermis of the upper surface (Fig. 23 *B* and Fig. 24) consists of polygonal, straight-walled, usually transversely elongated cells; the lateral walls are rather thick (3—4 μ), with numerous thin-walled parts (pits). The outer wall is thick (8—10 μ), with a strong cuticle; stomata occur abundantly, but are absent towards the base, are more numerous upon the exposed parts of the leaves, and are all surrounded by 4—6 small cells; they project above the leaf-surface (Fig. 23 *B*).

The epidermis of the lower surface (Fig. 24) consists of elongated cells which are similar in structure to those upon the upper surface. The stomata are absent from along the whole of the middle band and from the base of the leaf, exactly as in *S. Aizoon* (a specimen from Kobbefjord — which see); but they are numerous along the margin, where the epidermal cells are less elongated, and are decidedly most abundant upon the lower side. Along the margin of the leaf-base there are some thick, irregularly-multicellular hairs (Fig. 23 *C*).

The mesophyll consists of remarkably homogeneous cells; the palisade-cells are somewhat longer than the cells of the spongy parenchyma, and approximately barrel-shaped (Fig. 23). They are placed, especially towards the apex, obliquely to the epidermis, and there are numerous, rather large intercellular spaces between them. Below, the palisade merges imperceptibly into the more isodiametric, unbranched cells of the spongy parenchyma, between which the intercellular spaces are still larger. The vascular bundles are without stereom, but are surrounded by a (usually one-layered) bundle-sheath which contains tannin. Sphaerocrystals, the nature of which has not been more closely investigated, are found (in spirit-material) precipitated in some of the cells of the mesophyll which differ in no other respect from the rest of the mesophyll.

All the veins terminate in a hydathode (Fig. 23). The latter opens into a cavity upon the surface of the leaf and secretes

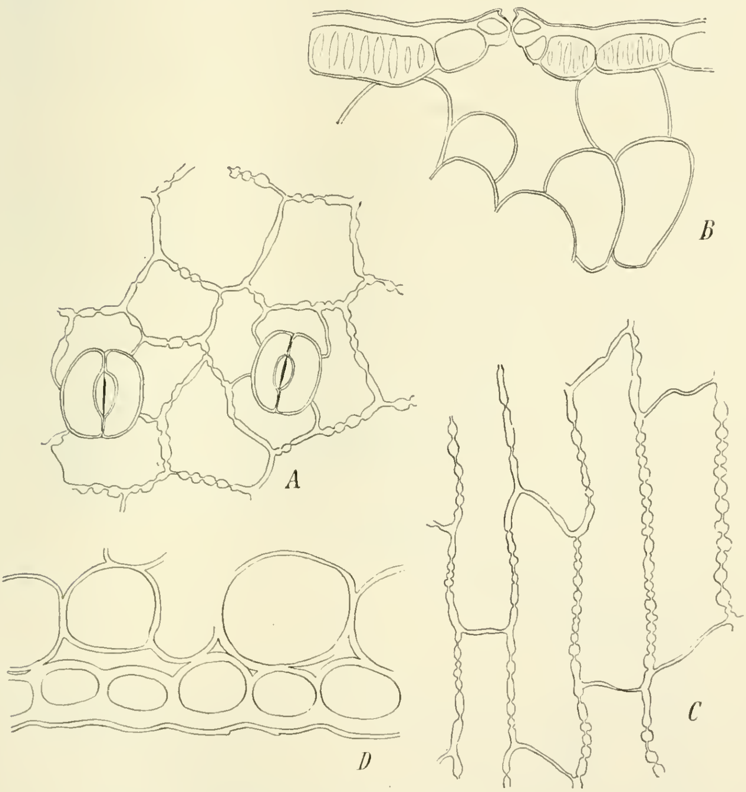


Fig. 24. *Saxifraga Cotyledon.*
The epidermis of the leaf: *A* and *B*, Upper surface. *C* and *D*, Lower surface.
(*A*, *B*, *C*, *D* $^{282}/_{1}$).

lime abundantly which in many cases entirely fills the cavity and spreads outside it (this is omitted in the figure).

Bonnier has proved that different specimens of this species, collected partly in the Arctic and partly in the Alpine regions of Central Europe, can be distinguished from each other by the former having less markedly differentiated palisade-tissue than the latter. This somewhat indistinct differentiation also found by me in the Arctic specimens of *S. Cotyledon* at my disposal agrees closely with characters found by Bonnier in Arctic specimens; the same investigator (Rev. gén. d. bot., Tome VI, p. 514) has demonstrated this feature very distinctly in *S. oppositifolia* (see below). His figure of the Arctic leaf of this latter species is good and agrees closely with the results of my investigations.

Saxifraga Aizoon Jacq. (Figs. 25, 26 and 27).

Saxifraga Aizoon Jacq. occurs upon sunny cliffs, and sometimes upon rather wet moraine, and is xerophytic. Its whole

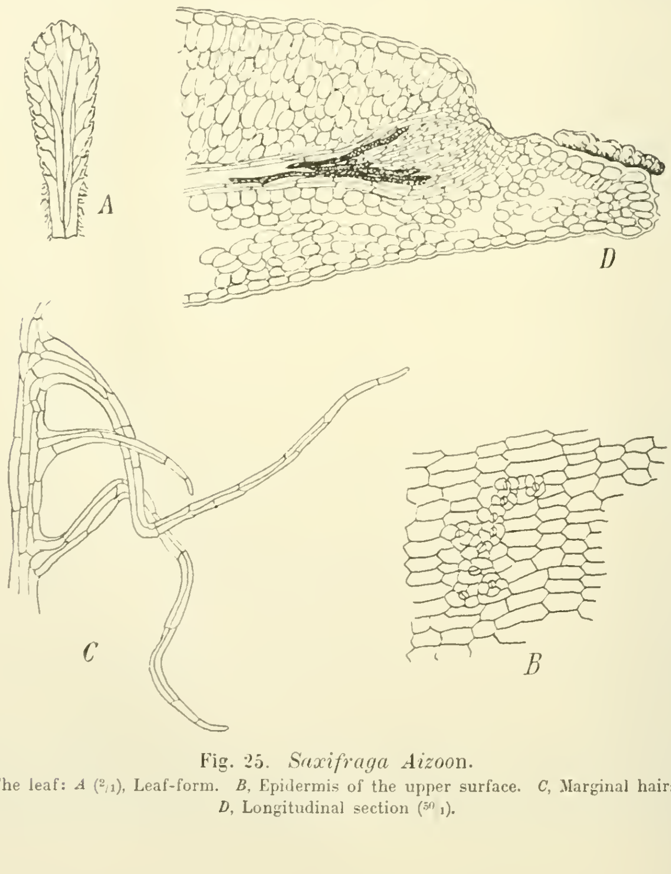


Fig. 25. *Saxifraga Aizoon*.
The leaf: *A* ($^2/_1$), Leaf-form. *B*, Epidermis of the upper surface. *C*, Marginal hairs. *D*, Longitudinal section ($^{50}/_1$).

morphological and anatomical structure has a great many points in common with that of *S. Cotyledon* (e. g. the succulent leaf-rosettes, the external form of the leaf, etc.).

The epidermal cells of the upper surface (Figs. 25 *B* and 27) of the leaf are elongated longitudinally at the base, but higher up in the leaf they become transversely elongated. The outer walls are thick, with distinct cuticle. The stomata are absent from the leaf-bases, they do not appear until above the

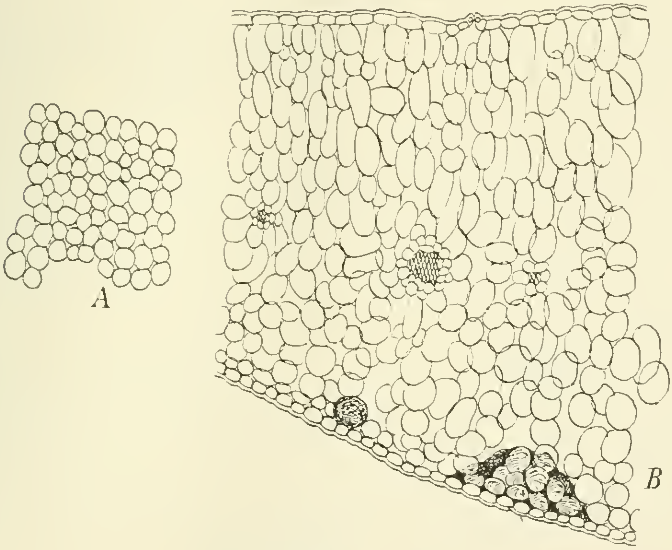


Fig. 26. *Saxifraga Aizoon.*
The leaf: *A*. Spongy parenchyma. *B*, Transverse section (below to the left, a tannin-cell, to the right a sphaerocrystal). (*A*, *B*, $^{50}/_{1}$).

marginal hairs. They are surrounded by, usually, four smaller cells (cf. Thouvenin l. c.) and are not definitely orientated (e. g. not parallel with the midrib).

The lower epidermis (Fig. 27) is of elongated cells at the base of the leaf and is continued as a median band of similar elongated cells without stomata, which gradually narrows towards the apex of the leaf. To the right and left of this band occur areas which are of smaller cells, and there all the stomata are placed in groups. These two marginal bands commence above the marginal hairs of the leaf and widen continuously towards the apex to the sacrifice of the middle band. Therefore stomata are quite absent from the leaf-blade below the point at which the marginal hairs begin, they all occur towards the apex of the leaf.

Borgesen states (l. c., p. 225) that the stomata are more abundant upon the upper surface, but yet, at the same time, records that it has eight, while the lower surface has twelve, per unit of surface. The latter statement unquestionably corresponds better with my observations. Lazniewski's statement that the stomata are entirely absent from the exposed leaf-apices of many rosette-plants does not at all agree with the conditions found by me in this species, which has all its stomata especially placed in the most exposed parts of the leaf.

A wax-covering is present in the form of small grains of irregular form upon the apical, exposed parts of the upper side of the leaf.

The description given above of the mesophyll of *S. Cotyledon* exactly suits that of the present species. The palisade-cells are very slightly differentiated, are barrel-shaped, and the tissue merges below imperceptibly into the spongy parenchyma with its more isodiametric, unbranched cells (Fig. 26).

The palisade-cells are more or less obliquely placed towards the apex of the leaves. Lazniewski (l. c.) has found this to be the case in many rosette-plants, and connects it with the peculiar way in which light falls upon such a rosette with its obliquely erect leaves (this feature was first pointed out by Pick).

At the base of the leaf the difference between the palisade-tissue and the spongy parenchyma is even further obliterated, nor does any obliquity occur there; the whole mesophyll is homogeneous, exactly like that found by Lazniewski in many Alpine rosette-plants.

In many of the cells of the mesophyll there are quantities of tannin, which gives the usual reaction with iron. Besides these scattered tannin-idioblasts there are found, precipitated

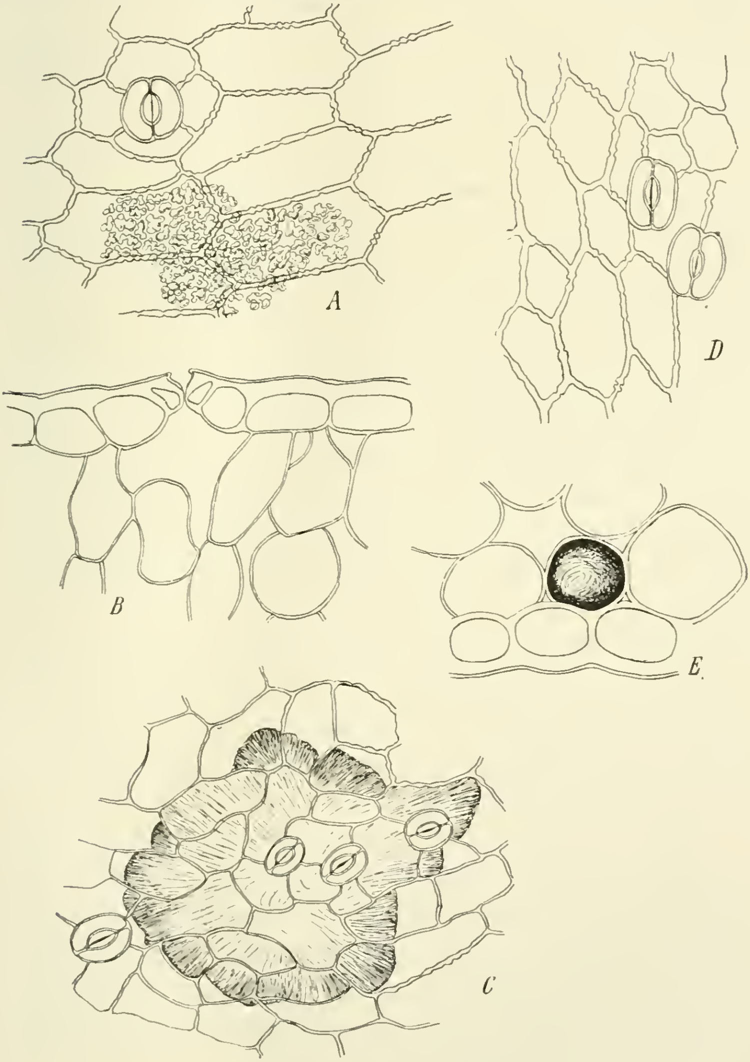


Fig. 27. *Saxifraga Aizoon.*
The epidermis of the leaf: *A* and *B*. Upper surface. *C*, Lower surface (a large sphaero-crystal is seen immediately beneath the epidermis, probably precipitated by alcohol. *D* and *E*, Lower surface (*C* $^{175}/_1$), (*A*, *B*, *D*, *E* $^{282}/_1$).

in many places (in spirit-material), large sphaerocrystals (the composition of which has not been more closely investigated) among the cells immediately beneath the epidermis (Fig. 27). Sphaerocrystals also occur here and there in the epidermal cells. In none of these places — as far as I could judge from living material — do these crystals occur in connection with living cells; they are probably an alcoholic precipitate.

The veins are accompanied by bundle-sheaths containing tannin (Fig. 26). Each tooth of the leaves is provided with a vein which terminates in a hydathode with a large cavity (Fig. 25). The epidermis of the hydathode has 1—2 water-pores and some of the cells are elongated as papillæ. Lime is abundantly secreted—much more abundantly than in *S. Cotyledon.*

I have investigated specimens from Kobbefjord (June 29, 1884), Holstensborg (July 17, 1884), Sarfanguak (July 15, 1884) in West Greenland, from Ryder's expedition to Scoresby Sound (July 28, 1887), and from Vatnsdal (Aug. 6) in Iceland. They were all almost identical; only the specimen from Sarfanguak had more ample lime-incrustations upon the hydathode than had the rest.

The plant grows usually in dry localities (part of my material came from sunny southern slopes); its whole character is rather decidedly xerophytic; but here also reference should be made to the occurrence of stomata upon the exposed parts of the leaf, as in *S. Cotyledon.*

Leist (1889) maintains that in Alpine districts this and the former species have a leaf-structure which more closely resembles that of shade-leaves. Lazniewski (l. c.) disputes this, and maintains that the Alpine *Saxifraga* are xerophytes. — It must be owned that Leist's assertion carries no conviction, as the necessary figures are wanting, and the descriptions are, by themselves, unsatisfactory.

6. *Porphyrion.*

Saxifraga oppositifolia L. (Figs. 28 and 29).

Saxifraga oppositifolia L. extends to the highest summits of the mountains into the snow-flora (Norman, Warming). Grows on dry, stony ground, upon the rock itself or among large boulders. Consequently it is a xerophyte, and shows this very distinctly in its internal structure. The leaf has only one hydathode at the apex. The marginal hairs are irregularly multicellular.

The upper epidermis (Fig. 29) has fairly straight lateral walls, with numerous pits. The outer walls differ in thickness in the different parts of the leaf; towards the apex they are very thick, and from thence become gradually thinner towards the leaf-base. The cuticle is distinct and very finely wrinkled. The stomata, with fair regularity, are placed parallel to the length of the leaf, only a few depart somewhat from this position. Their distribution upon the leaf-blade is very remarkable. They are entirely absent from the extreme tip of the apex, upon which is the hydathode. Immediately behind the apex they occur in a broad band across the leaf and are partially continued along the under-side of the leaf-margin.

The epidermis of the lower surface (Fig. 29) closely resembles that of the upper; its cells, however, are somewhat more elongated longitudinally. The distribution of the stomata is like that upon the upper side.

The palisade-cells of the leaves (Fig. 28), at the exposed apex, are very distinct and occur both upon the upper and lower surface, the leaf being directed sharply upwards. Further down towards the base the differentiation between palisade-tissue and spongy parenchyma disappears entirely. The spongy parenchyma consists of rounded, unbranched cells, fairly compact; within the epidermis towards the leaf-base there is a single layer of cells which is quite without intercellular spaces. As already mentioned, the parts of the leaf which are exposed to the light possess a spongy parenchyma developed in the form of palisade.

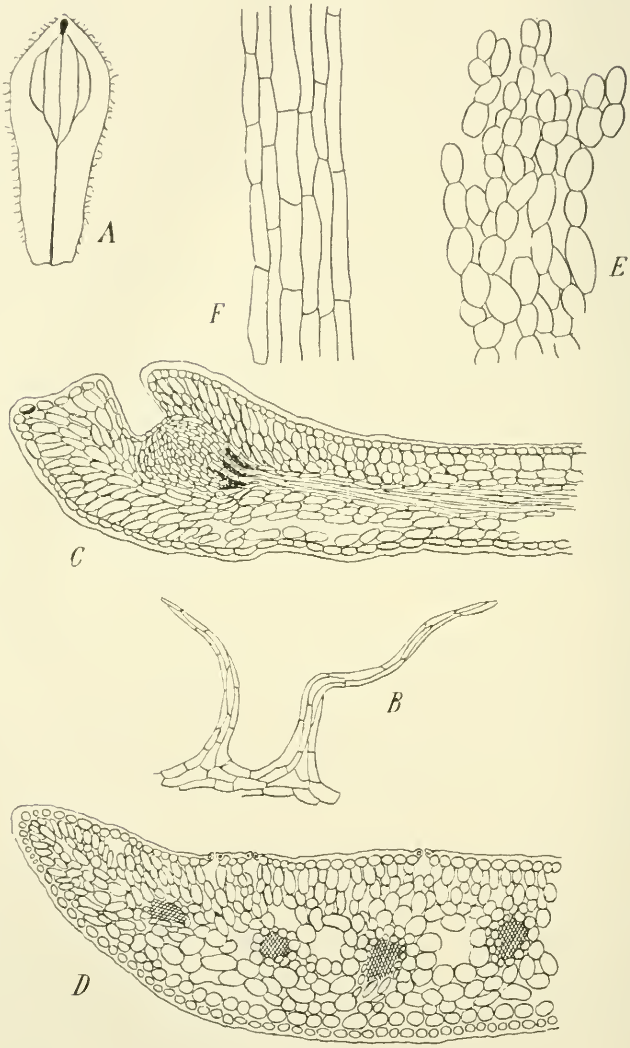


Fig. 28. *Saxifraga oppositifolia.*

The leaf: *A* ($^7/_1$), Leaf-form. *B*, Marginal hairs. *C*, Longitudinal section. *D*, Transverse section. *E*, Spongy parenchyma. *F*, Spongy parenchyma from the leaf-stalk. (*B, C, D, E, F* $^{50}/_1$).

Lazniewski (Flora, 1896) has described the leaf-anatomy of this species very accurately and has given figures of it. He points out that the leaves are seated so closely together that, for the greater part, they overlap each other, and he then emphazises the fact that only that part of the leaf which is covered by neighbouring leaves bears stomata abundantly, while

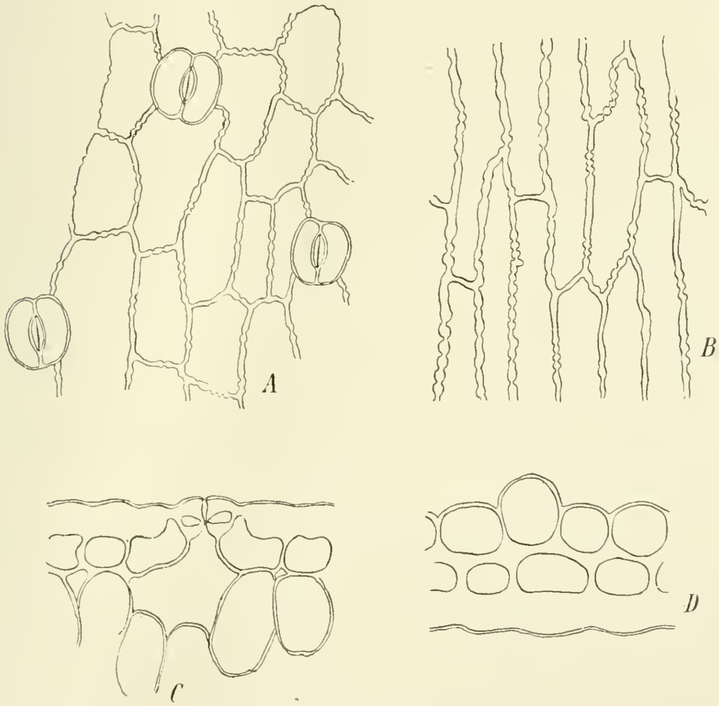


Fig. 29. *Saxifraga oppositifolia.*
The epidermis of the leaf: *A* and *C*, of the upper surface; *B* and *D*, of the lower surface. (*A*, *B*, *C*, *D* $^{282}/_{1}$).

the light-exposed leaf-apex is almost without them, and has a very thick outer epidermal-wall and true palisade-cells (which, on the other hand, are absent from the shaded part). Lazniewski maintains that this distribution of the stomata is also found in rosette-plants and regards it as a protection against excessive transpiration.

In all the specimens examined by me I found the distribution of the stomata to differ somewhat from that mentioned by Lazniewski. His Fig. 11 (l. c., p. 239) shows the stomata to be below the line *A—B*. But in all the Arctic specimens the stomata-bearing band begins still higher up and only the oblique surface upon which the hydathode is situated is devoid of them. In the fully expanded specimens that part of the leaf which bears the stomata, is not at all shielded from exposure to light, in fact, the stomata occur especially upon the strongly exposed parts of the leaf which possess palisade-cells, with the exception only of the oblique surface bearing the hydathode. Hence we must resort to quite a different explanation of the distribution of the stomata: — They are absent from the oblique surface bearing the hydathode, which is the only part of the leaf that in the bud-condition of the shoot is exposed to light and air; we have here an instance of a primitive bud-protection which comprises only the very young leaves, while already the oldest leaves of the bud, which are exposed to the elements, are somewhat expanded before winter sets in.

Besides, the stomata are absent from the base of the leaf, — where I think they might be expected to occur in large numbers if Lazniewski's hypothesis should also apply to the Arctic species. The absence of stomata from the base of the leaf is to be connected with the fact that the "leaf-base" is in reality the morphological leaf-stalk (below the common starting point of the veins), where neither palisade-cells nor stomata occur (compare *S. groenlandica* and *S. hypnoides*); consequently the other *Saxifraga*-species have no stomata upon their leaf-stalks. Lazniewski's assertion that the stomata are hidden in "interfoliar spaces free from air-currents" does not apply at all to the Arctic specimens, as (1) the stomata are situated chiefly in the parts of the leaf possessing palisade-cells and (2) they are entirely absent from the "inter-foliar-spaces" (i. e. the morphological leaf-stalks).

As regards the seasonal biology of the leaves it may be observed that at the base of the buds which live over the winter partially expanded leaves usually occur, which probably assimilate for some length of time before beginning their winter-rest; but of course this has not been proved. The buds, moreover, are sharply limited below by dead leaves, which persist upon the stems for several years. Bud-scales are absent, and the only protection the younger leaves have is due to the circumstance already mentioned, that they are without stomata exactly upon the small space containing the hydathode which, in the bud-condition, is the most visible and most exposed part of the leaf.

A specimen from East Greenland (Danmarks Ø), collected February 28, 1892, was remarkable with regard to the arrangement of its chlorophyll-grains, the latter (in the two upper palisade-layers) having sunk down to the bottom of the cells, of which the upper part was occupied by a large vacuole. The other cells of the mesophyll showed no such feature. Whether this circumstance (which was not observed in any leaf gathered during the period of growth) is really a common winter-phenomenon in *S. oppositifolia* in Arctic regions, or is due to the imperfect way in which ordinary spirit-material on the whole is fixed when collected, I am not prepared to state with any certainty.

I investigated plants of *S. oppositifolia* from the following places: — Upernivik (May 17, 1887), Danmarks Ø (Febr. 18, 1892) and Julianehaab (May 22, 1887) in Greenland, Jan Mayen (July 22, 1896), Nova Zembla, Vallanæs (Iceland: Dec. 21, 1893) and from the Botanic Garden in Copenhagen (April 18, 1907). The leaves of all these species agreed very closely in all anatomical details. Any difference which could be attributed to the influence of the different geographical conditions could not be demonstrated in spite of much investigation; the leaves all agreed with the description given.

The cultivated specimen from the Botanic Garden alone had very long internodes, but the structure of the leaf was exactly like that of, for example, the specimens from either Upernivik or Jan Mayen.

We have now seen what is the leaf-anatomy of the different species. It appears that the species belonging to any systematic section show greater anatomical relationship mutually, than they show with species of other sections. The structural features which vary least are here also of the most value as a supplement to the microscopical section-diagnosis. The structure of the hydathode and the appearance of the radial walls of the epidermis appear to be generally the characters which are least influenced by external conditions and which with a certain degree of constancy, remain uniform within the same section.

There are three different types of hydathodes: —

(1) Hydathode marginal, situated actually at the edge of the leaf; no secretion of lime: *Boraphila*, *Nephrophyllum.*

(2) Hydathode upon the upper surface of the leaf-margin; no cavity; no lime: *Dactyloides*, *Trachyphyllum.*

(3) Hydathode upon the upper surface of the leaf-margin; cavity present; lime secreted: *Euaizonia, Porphyrion.*

The other structural features, such as the thickness of the epidermis and the structure of the mesophyll, which are more easily influenced by external conditions, also are similar within each section, as may be seen from what has been written above. To this must be added, that Bonnier's investigations are greatly in favour of the idea that the structure of the mesophyll in the species here investigated would be different if they were cultivated in Alpine regions. When nevertheless they agree within each section in Arctic regions, this proves that although the structure of the mesophyll varies according to climate, yet it varies correspondingly in the species belonging to the same section. LEIST found that *S. Aizoon* and *S. Cotyledon* (from the Alps) had exactly the same structural features; I, also, in my Arctic specimens, found that these two species, belonging to the same section, had quite similar leaf-structure, — but it must be admitted it was a structure which was entirely different from that found by LEIST in his Alpine specimens — a good example, therefore, of corresponding variation in closely related species.

If we wish to define how the Arctic species of *Saxifraga* are adapted in their leaf-anatomy to their natural surroundings, emphasis must be laid upon the fact that the same characteristic tests cannot be applied to all the species investigated, taken as a whole. They cannot as a matter of fact be termed either xerophytic or hygrophytic, these words having on the whole only a relative value, as they do not state anything about the plant's absolute relation to water-absorption and transpiration. If, on the other hand, we can show that the Arctic *Saxifragas* are either more, or else less, xerophytic than their Alpine colleagues, that would be a positive result of great significance, as it would bring about a comparison from which, to a certain extent, we might be justified in deciding how Alpine plants must adapt themselves in order to be able to live under the external conditions of Arctic regions, and vice versa. My endeavour has been to give as accurate a description of Arctic species as possible; future investigations must prove wherein such species differ from Alpine species. BONNIER has already attempted something of this kind, but more exhaustive investigations are highly desirable. The variations occasioned by external conditions are, in the greater number of cases, so small that mere descriptions cannot indicate them, or can do so only with great difficulty and with little precision; detailed figures elucidate the variations better. It is my opinion, that much of the constant dispute as to how far Alpine plants are xerophytic or non-xerophytic in character is a merely verbal difference which might have been avoided if the several authors had given sufficient figures (for instance, as many as BONNIER or even more, by preference), — instead of the many verbal renderings, of very little characteristic importance or significance, of shades of difference.

Between the two extremes — submerged aquatic plants and leafless, xerophytic stem-succulents with abundant water-tissue — there is a long graduated series of life-types. It may be stated at once that no *Saxifraga* approaches these two extremes. The habitats of the species differ however fairly widely and therefore the degrees of adaptation are also somewhat variable. The subject may be best viewed by arranging the sections under investigation in a graduated series according to their greater or less xerophytism. Here we may note the very interesting circumstance that species belonging to the same section are fairly uniform in their degree of protection against excessive transpiration: the purely systematic divisions may be extended to include also anatomical and physiological characters. A careful study of the figures shows this fact more completely. The section *Porphyrion* (in casu *S. oppositifolia*) is the most xerophytic, then come the others in the following order: — *Trachyphyllum*, *Euaizonia*, *Dactyloides*, *Nephrophyllum* and *Boraphila*, the two last being almost similar in regard to this feature.

Lastly, if we wish to formulate the results thus obtained (the fact should, however, be particularly emphasized that they are of less importance than the information which may be gathered from the figures), it may be done as follows: —

(1) Each section has its own complex of structural

features in its leaf-anatomy which characterizes the whole group of species; this complex differs in the different sections (as regards its more minute details, see above).

(2) The species cannot, without a certain amount of arbitrariness, all be characterized in common. They show differing degrees of protection against excessive transpiration, from the highly protected species (*S. oppositifolia*, *Aizoon*, *Cotyledon*, *tricuspidata*) to the very slightly protected (e. g. the sections *Nephrophyllum* and *Boraphila*), in exact correspondence with the external conditions of their habitats.

(3) In the few cases in which we know the same species, as regards its leaf-anatomy, both from the Alpine regions of Central Europe and from Arctic regions, the specimens from the Arctic regions show less protection against excessive transpiration than the Alpine (for instance they have not their stomata hidden in "calm" interfoliar spaces, free from air-currents, as LAZNIEWSKI found to be the case in Alpine rosette-plants.

(4) Whether there are any differences between the Arctic and the Alpine specimens (besides those pertaining to transpiration) is as yet not known with any certainty, in this paper Arctic specimens, only, having been investigated; Alpine specimens have, it is true, also been investigated, but generally they have been described (and figured) so unsatisfactorily that a comparison would not be entirely reliable. — From the little we know (best from BONNIER and LAZNIEWSKI) it appears, however, that in the Arctic leaf there is generally a less decided difference between the spongy parenchyma and the palisade-tissue than in the Alpine, and that the former is

more abundantly provided with intercellular spaces than the latter.

(5) Individuals of the same species appear to vary very slightly in regard to leaf-anatomy, although they may have come from widely separated districts within the Arctic regions.

9.—6.—1910.

Arbejder fra den Botaniske Have i København. Nr. 58.

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 7

SÆRTRYK AF »MEDDELELSER OM GRØNLAND« XLIII

HEPATICAE AND SPHAGNACEAE

FROM

NORTH-EAST GREENLAND

(N. OF 76° N. LAT.)

COLLECTED BY THE "DANMARK-EXPEDITION" 1906—08

DETERMINED

BY

C. JENSEN

KØBENHAVN

BIANCO LUNOS BOGTRYKKERI

1910

The mosses mentioned in this list have been collected by Mr. ANDREAS LUNDAGER during the "Danmark Expedition" in the years 1907—1908. The collection is small and most of the specimens are only to be found sparsely mixed in tufts of other mosses. They have nearly all been taken from the neighbourhood in which the ship was ankered, on the north coast of Dove Bugt, about 76° 40′ N. Lat.

Hepaticae.

1. **Chomocarpon quadratus** (Scop.) Lindb.

Coast of Dove Bugt, on damp ground near a stream, ster. in a tuft of *Bryum ventricosum*.

2. **Odontoschisma Macounii** (Aust.) Underw.

"Stormkap" on the coast of Dove Bugt, ster. amongst *Sphaerocephalus turgidus, Dicranum congestum, Isopterygium nitidum,* and *Swartzia montana*.

3. **Cephalozia bicuspidata** (L.) Dum.

Coast of Dove Bugt, ster. amongst other mosses on damp ground near a stream.

4. **C. pleniceps** (Aust.) Lindb.

Coast of Dove Bugt, ster. in tufts of *Sphagnum fimbriatum* and *Dicranum neglectum* on damp ground near a stream.

5. **Cephaloziella divaricata** (Franc.) Schiffn.

Coast of Dove Bugt, ster. upon the ground or amongst and upon other mosses, such as *Dicranum neglectum, Conostomum boreale, Pohlia nutans, Swartzia montana, Ditrichum flexicaule, Blindia acuta* and several bog-mosses. The coast at 79° 8′, ster. in tufts of *Amphidium lapponicum*.

6. **C. striatula** (C. Jens.)

Coast of Dove Bugt, ster. on moist ground, amongst *Sphaerocephalus turgidus, S. palustris,* and *Calliergon sarmentosum*.

7. **Ptilidium ciliare** (L.) Hamp.

Coast of Dove Bugt, ster. amongst other mosses on damp ground near a stream.

8. **Anthelia julacea** (L.) Dum.)

Coast of Dove Bugt, ster. amongst bog-mosses on wet ground near a stream.

9. **A. nivalis** (Sw.) Lindb.

Coast of Dove Bugt, fr. on the ground near a stream.

10. **Blepharostoma trichophyllum** (L.) Dum.

Coast of Dove Bugt, ster. amongst other mosses on damp ground near a stream.

11. **Martinellia Bartlingii** (Nees.)

The coast at 79° 8′, ster. and gemmipar. amongst *Tortula ruralis, Swartzia montana* and a ster. *Bryum.*

12. **M. hyperborea** (Joerg.) Arn. et Jens.

Coast of Dove Bugt, ster. on wet ground near a stream.

13. **Jungermania quinquedentata** Huds.

Coast of Dove Bugt, ster. amongst *Dicranum neglectum* on moist ground.

Var. *turgida* Lindb.

From the same place, ster. amongst bog-mosses.

14. **J. alpestris** Schleich.

Coast of Dove Bugt, ster. amongst *Sphagnum fimbriatum* on damp ground near a stream.

15. **J. ventricosa** Dicks.

Coast of Dove Bugt, ster. in tufts of *Dicranum neglectum.*

16. **J. quadriloba** Lindb.

Coast of Dove Bugt, ster. amongst *Stereodon Bambergeri, Ditrichum flexicaule,* and *Myurella julacea* on damp ground.

17. **J. minuta** Cranz.

Coast of Dove Bugt, ster. in a tuft of *Dicranum elongatum.*

18. **Marsupella groenlandica** C. Jens.

Coast of Dove Bugt, ster. amongst other mosses such as *Calliergon sarmentosum, Sphaerocephalus turgidus, Oligotrichum glabratum* f. *gracilis, Ditrichum flexicaule, Swartzia montana, Cesia revoluta,* and *Anthelia julacea.*

19. **Cesia revoluta** (Nees.) Lindb.

Coast of Dove Bugt, ster. on damp ground near a stream, together with *Blindia acuta* and the preceding species.

20. **Riccardia pinguis** (L.) Gr.
Coast of Dove Bugt, ster. amongst bog-mosses near a stream.

Sphagnaceae.

21. **Sphagnum teres** Angstr.
Coast of Dove Bugt, ster. on moist ground near a stream.

22. **S. fimbriatum** Wils.
Coast of Dove Bugt, ster. from the same place as *S. teres*.

13—6—1910.

Arbejder fra den Botaniske Have i København. Nr. 59.

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 8
SÆRTRYK AF »MEDDELELSER OM GRØNLAND« XLIII

MOSSES

FROM

NORTH-EAST GREENLAND

(N. OF 76° N. LAT.)

COLLECTED BY THE "DANMARK-EXPEDITION" 1906—08

DETERMINED

BY

AUG. HESSELBO

WITH PLATES XI—XII

KØBENHAVN
BIANCO LUNOS BOGTRYKKERI
1910

The Mosses brought home by the "Danmark Expedition" were for the most part collected by the botanist of the Expedition, Mr. ANDREAS LUNDAGER, in the neighbourhood of Danmarks Havn, on the east coast of Greenland, about 76° 46′ N. lat. A smaller number of collections has been made by Captain KOCH on his sledge-journeys northwards.

The species found in the following localities were collected by Captain KOCH; all the others have been collected by LUNDAGER.

Mallemukfjeld (June 11, 1907)	80° 10′ N. lat.
Lamberts Land (June 14, 1907)	79° 8′ —
Dove Bugt (June 28, 1907)	77° 30′ —
Bjørne Skærene (June 19, 1907)	77° —
North side of Hyde Fjord (May 15, 1907)	83° 10′ —

1. **Polytrichum juniperinum** Willd.

Vester Elv[1], sterile; sparingly intermingled in a tuft of *Dicranum elongatum*.

2. **Polytrichum strictum** Banks.

Vester Elv, several collections, one fruiting, mixed with other mosses (*Gymnocybe, Sphagnum* and *Meesea triquetra*).

3. **Polytrichum pilosum** Neck.

Vester Elv, a few plants in a tuft of *Schistidium apocarpum*, sterile. Termometer Fjeld, in a tuft of *Dicranoweissia compacta*, sterile.

4. **Polytrichum hyperboreum.**

Vester Elv, a few plants in a tuft of *Sphagnum, Gymnocybe palustris* and *Meesea triquetra.*

5. **Polytrichum fragile** Bryhn.

Cape Bismarck, a small sterile tuft mixed with sterile *Bryum.*

[1] The following is a translation of some of the suffixes used in the place-names which occur in this paper: Elv = stream; Fjeld = rock; Odde = head (tongue of land); Kær = pool; Skær = rock; Havn = harbour; Næs = ness (headland).

6. **Polytrichum alpinum** L.

Common; usually sterile and mixed with other mosses. Stormkap, fruiting.

var. **arcticum** (Sw.) Brid.

Vester Elv, fruiting.

var. **brevifolium** (R. Br.) Brid.

Lille Snenæs, fruiting.

7. **Polytrichum gracile** Dicks.

var. **anomalum** (Milde) Hagen.

This peculiar form which, according to HAGEN (Musci Norvegiae borealis, p. 265) and to verbal information from C. JENSEN, is commonly distributed in northern Scandinavia, was found by Vester Elv intermingled in tufts of swamp-mosses such as *Amblystegium revolvens, A. sarmentosum, Bryum neodamense,* var. *ovatum,* etc.

The plants are as much as 8 cm. high, flaccid, with nearly entire leaves (forma *subintegrifolia*), but otherwise exactly resembling Norwegian specimens.

Polytrichum gracile has not previously been found in Greenland, and its northern limit as hitherto known is at about 70° N. lat. in Finmark.

8. **Oligotrichum laevigatum** Wahlb.

Vester Elv, sparingly intermingled in a tuft of *Hepaticae, Ditrichum flexicaule,* and other mosses (forma *tenuis brevifolia*).

9. **Cinclidium arcticum** (Br. eur.) C. M.

Vester Elv, sterile; a few plants in a tuft of *Gymnocybe turgida, Meesea triquetra* and *Sphagnum.*

10. **Cinclidium polare** Bryhn.

North side of Hyde Fjord among other mosses; sterile (KOCH).

11. **Astrophyllum curvatulum** Lindb.

Vester Elv, sparingly among *Gymnocybe turgida, Meesea triquetra,* and other mosses. Maroussia Island, a few plants in a tuft of *Bryum pendulum;* in both places forma *integrifolia.*

12. **Astrophyllum orthorhynchum** (Brid.) Lindb.

Vester Elv, a few sterile plants in a tuft of *Stereodon Bambergeri* and *Ditrichum flexicaule.* Lamberts Land, sterile (Koch).

13. **Timmia austriaca** Hedw.

Lamberts Land, sterile (forma *brevifolia*).

var. **papillosa** v. n.

The sheath-like part of the leaf papillose at the point of transition to the lamina. The leaf-margin coarsely denticulate at the apex and indistinctly denticulate downwards.

Stormkap, mixed with *Gymnocybe turgida, Pohlia cruda* and *Stereodon revolutus.*

14. **Timmia bavarica** Hessl.

Vester Elv, sterile, among *Amblystegium revolvens, A. latifolium* and *Meesea triquetra.*

15. **Timmia norvegica** Zett.

var. **crassiretis** v. n.

The cells of the leaf incrassated especially upon the lower side where the outer walls are also mamillosely convex. The cells of the leaf-base papillose almost to the base.

North side of Hyde Fjord; sparingly among *Hypna, Brya, Cinclidium polare,* etc.

16. **Gymnocybe palustris** (L.) Friis.

Vester Elv, sterile. Hare Fjeld, sterile. Dove Bugt, sterile.

17. **Gymnocybe turgidus** (Wahlb.) Lindb.

One of the most common mosses; occurs as a component of most of the tufts which were collected, rarely unmixed, always sterile.

18. **Meesea triquetra** (L.) Aongst.

Found as a component of a large number of the tufts collected from all the localities, generally mixed with *Amblystegium sarmentosum, A. revolvens, A. intermedium* and *A. latifolium.* It occurs sometimes with entire, and sometimes with serrulate leaves.

19. **Meesea longiseta** Hedw.

Vester Elv, sterile, a few plants in a tuft of *Meesea triquetra, Timmia bavarica* and *Hypna.*

20. **Philonotis alpicola** Jur.

Common as a component of mixed tufts, but always scanty and sterile.

21. **Philonotis fontana** (L.) Brid.

var. **adpressa** (Fergusson).

Cape Bismarck, sterile. Vester Elv, sterile.

22. **Bartramin ityphylla** Brid.

Hare Fjeld, fruiting. Danmarks Havn, fruiting. Vester Elv, several sterile specimens among other mosses.

23. **Conostomum tetragonum** (Will.) Sw.

Vester Elv, sterile, several collections, partly unmixed and partly mixed with other mosses.

24. **Bryum elegans** Nees.

Basis Kær, intermingled in a tuft of *Tetraplodon Wormskjoldii.*

25. **Bryum ventricosum** Dicks.

Vester Elv ♀. Hvalros Odde ♀. North side of Hyde Fjord, sterile (forma *tenuis brevifolia*).

26. **Bryum neodamense** Itzigs.

var. **ovatum** Jur.

Vester Elv, sterile, many specimens, but usually sparingly among other mosses.

27. **Bryum teres** Lindb.

Vester Elv, sterile. Havne Næs, sterile.

28. **Bryum cirratum** Hornsch.?

Stormkap, with ♀, ♂ and ☿ inflorescence, but without fruit.

29. **Bryum obtusifolium** Lindb.

Hare Fjeld, sterile. Termometer Fjeld, sterile. Sometimes unmixed, sometimes mixed with *Amblystegium sarmentosum, Pohlia commutata* and other species.

30. **Bryum cyclophyllum** (Schwgr.). Br. eur. Termometer Fjeld, sterile.

31. **Bryum tomentosum** Limpr.

Hare Fjeld, fruiting.

32. **Bryum foveolatum** Hagen.

Hvalros Odde; fruiting.

33. **Bryum pendulum** (Hornsch.) Schimp.

Vester Elv, fruiting. Maroussia Island, fruiting.

34. **Bryum calophyllum** R. Br.

At Danmarks Havn on damp sandy soil, sterile.

35. **Bryum argenteum** L.

Lille Snenæs, sterile. Renskæret, sterile. Maroussia Island, sterile. Danmarks Havn, sterile (forma *compacta brevifolia*).

36. **Bryum Myliusii** n. sp.

About three cm. high, loose tufts among other mosses. Stem red, 0·30 mm. thick, slightly radiculose, with slender, papillose rhizoids, and bearing one or two young shoots below the inflorescence. Leaves firm, narrowly-decurrent, entire, hollow, bordered by 2—4 rows of narrow, brownish cells. Stem-leaves broadly-ovato, 1·2—1·5 mm. long and about 1 mm. broad and bluntly, or shortly and broadly pointed, revolute at the base; upper leaves broadly lanceolate, 2—2·2 mm. long and 1—1·2 mm. broad, shortly and broadly pointed, revolute at the margins until towards the apex. Veins strong, brown, 0·10 mm. broad at the base and disappearing close under the apex. Leaf-cells brownish, incrassate, porose, rectangular at the base, 0·020—0·028 mm. broad and 2—3 times as long, in the rest of the leaf hexagonal and rhombic, 0·018—0·20 broad, and about twice as long.

Synoicous. Perichaetial-leaves broadly-lanceolate, pointed, indistinctly marginate. Antheridia and archegonia numerous.

Seta red, about 2 cm. high and 0·18 mm. thick. Capsule pendulous, in dry condition leather-brown and slightly wrinkled, not constricted below the mouth, about 1·5 mm. thick and 2·5—3 mm. long, of which the neck constitutes one half. The cells of the capsule-walls irregular, slightly incrassate; 2—4 rows of small, roundish or polygonal cells around the mouth.

Peristome teeth, 0·36 mm. long, and 0·10 mm. broad at the base, yellow, darker at the base, hyaline and indistinctly marginate at the apex. Lamellæ 15 in number, occasionally connected by a transverse trabecula. The median line slightly sinuous. Dorsal plates narrowly rectangular at the base, 2—3 times as broad as high, extremely delicately striped with papillæ, smooth towards the apex. Inner peristome probably not attached, pale, finely papillose. Cilia rudimentary. Spores 0·028—0·036 mm., brownish-yellow, finely papillose.

Vester Elv, associated with *Amblystegium revolvens*, *A. latifolium*, *A. sarmentosum* and *Meesea triqvetra*.

37. **Pohlia commutata** (Schimp.) Lindb.

Vester Elv; Hare Fjeld; Stormkap. It usually occurs sparingly intermingled with other mosses. Found sterile only.

var. **filum** (Schimp.) Husnot.

Termometer Fjeld; partly in large, unmixed tufts, and partly mixed with *Bryum obtusifolium*.

38. **Pohlia cruda** (L.) Lindb.

Vester Elv, several specimens, one fruiting, in part var. *minus* Sch. Havne Næs, sterile. Termometer Fjeld, sterile. Lamberts Land, fruiting.

39. **Pohlia nutans** (Schreb.) Lindb.

Vester Elv, numerous specimens, of which several fruiting, often mixed with other mosses. Hvalros Odde; sterile. Lille Snenæs, sterile. Dove Bugt, sterile.

40. **Leptobryum pyriforme** (L.) Wills.

Lille Snenæs, fruiting. Maroussia Island, fruiting.

41. **Tetraplodon Wormskjoldii** (Hornem.) Lindb.

Hare Fjeld, fruiting, large cushions about 10 cm. high upon the skull of a musk-ox.

42. **Tetraplodon pallidus** Hagen.

Stormkap, mixed with *Gymnocybe turgidus* and other mosses, fruiting.

43. **Leersia rhabdocarpa** (Schwägr.) Lindb.

Havne Næs, sterile, in a dry ravine. Vester Elv, fruiting, in both places mixed with *Tortula latifolia* and *Bryum argenteum*. Hvalros Odde, sterile.

44. **Tortula ruralis** (L.) Ehrt.

Vester Elv; Basis Kær; Termometer Fjeld; Lamberts Land; sparingly in all the localities and sterile, among other mosses.

45. **Tortula norvegica** (Wlb. f.) Wahlenb.

Clayey field between Laxe Sø and Øster Sø, sterile.

46. **Tortula mucronifolia** Schwägr.

Havne Næs, in a dry ravine, fruiting.

47. **Tortula systylia** (Br. eur.) Lindb.

Havne Næs, in a dry ravine, fruiting.

48. **Tortula latifolia** (Hedw.) Lindb.

Vester Elv, fruiting. Havne Næs, in a dry ravine, fruiting.

49. **Mollia fragilis** (Drumm.) Lindb.

Bjørne Skærene, sterile, in a compact tuft of *Carex*. (Koch).

50. **Barbula rubella** (Hoffm.) Mitten.

var. **brevifolia** Arnell et Lindb.

Vester Elv, sterile.

51. **Barbula alpigenia** (v. Venturi.)

Vester Elv, sterile, a few plants intermingled in a tuft of *Ditrichum flexicaule*, *Gymnocybe turgidus* and other mosses.

52. **Barbula curvirostris** (Ehrh.) Lindb.

North side of Hyde Fjord, sterile, sparingly among *Hypna*, *Cinclidium polare* and other mosses (forma *brevifolia*).

53. **Dicranum congestum** Brid.

Basis Kær, sterile, partly unmixed, partly mixed with other mosses.

54. **Dicranum neglectum** Jur.

Vester Elv, sterile. Stormkap, sterile.

55. **Dicranum elongatum** Schleich.

Vester Elv, sterile.

56. **Blindia acuta** (Huds.) Br. eur.

Vester Elv, sterile, both unmixed and mixed with other mosses. Basis Kær, sterile.

57. **Dicranoweissia crispula** (Hedw.) Lindb.

Termometer Fjeld, sterile.

58. **Dicranoweissia compacta** (Schleich.) Sch.

Termometer Fjeld, sterile.

59. **Swartzia montana** (Lam.) Lindb.

Vester Elv, sterile. Lille Snenæs, sterile. Stormkap, sterile. Hvalros Odde, sterile. Termometer Fjeld, fruiting. Bjorne Skærene, sterile. Everywhere forma *brevifolia*.

60. **Ditrichum flexicaule** (Schleich.) Hampe.

Common, but usually in small quantities in the collections from all the localities. Usually forma *brevifolia*.

61. **Ceratodon purpureus** (L.) Brid.

Cape Bismark, sterile. Vester Elv, sterile. Termometer Fjeld, sterile. Mallemukfjeld, sterile.

62. **Dorcadion Kiliassii** (C. M.) Lindb.

On stones at Danmarks Havn, fruiting. Basis Kær, sterile.

63. **Anoectongium lapponicum** Hedw.

Lamberts Land.

64. **Grimmia ericoides** (Schrad.) Lindb.

Vester Elv, sterile (partly var. *strictum* Schliep.). Lamberts Land (var. *prolixum* Br. eur.)

65. **Grimmia hypnoides** (L.) Lindb.

Termometer Fjeld, sterile, Lamberts Land, sterile.

66. **Grimmia Donniana** Smith.

Termometer Fjeld, sterile, associated with *Dicranoweissia compacta*.

67. **Grimmia apocarpa** (L.) Hedw.

One of the mosses of most common occurrence. Numerous specimens have been collected from all the localities which have been investigated: on stones, rocks and earth. Usually fruiting. It varies considerably both in habit, colour, leaf-form and length of hair-tip. The most peculiar forms are: —

var. **filiformis** Lind. Syn. Grimmia tenera Zett.; Termometer Fjeld, fruiting. Vester Elv, sterile.

var. **ovatum** Bryhn.

Frequent. Usually fruiting.

68. **Grimmia linearis** (Chalubinsky).

Syn. Schistidium angustum Hagen.

Vester Elv, fruiting, mixed with *Grimmia apocarpa* var. *ovatum*.

69. **Amblystegium radicale** (P. B.) Mitten.

var. **pulcherrimum** n. v.

Tufts compact, 1—2 cm. high, rusty brown below, green at the top. Stem short and irregularly branching, 0·10 mm. thick, with a few rhizoids. Leaves 0·5—0·8 mm. long, 0·14—0·18 mm. broad, finely serrate along the whole margin; sterile.

Mallemukfjeld (Koch).

Amblystegium radicale has not previously been found in Greenland.

70. **Amblystegium protensum** (Brid.) Lindb.

Maroussia Island. Sparingly in a tuft of *Bryum pendulum*; sterile.

71. **Amblystegium stellatum** (Schreb.) Lindb.

Hare Fjeld, sterile, among other mosses.

72. **Amblystegium latifolium** Lindb.

Very common and collected partly as unmixed cushions and partly among other mosses from all the localities which were investigated.

73. **Amblystegium brevifolium** Lindb.

Vester Elv, sterile. North side of Hyde Fjord, sterile. In both places sparingly among other mosses.

74. **Amblystegium intermedium** Lindb.

Vester Elv, sterile. Stormkap, sterile. North side of Hyde Fjord, sterile.

75. **Amblystegium revolvens.**

Vester Elv, sterile. Stormkap, sterile.

76. **Amblystegium aduncun** (L.) Lindb.

Vester Elv, sterile. Termometer Fjeld, sterile. In both places sparingly among other mosses.

var. **gracillimum** Bergg.

Termometer Fjeld, sterile.

77. **Amblystegium exannulatum** (Gumb.) de Not.

Vester Elv, sterile.

78. **Amblystegium fluitans** (L.) de Not.

Edge of Laxe Sø, sterile.

79. **Amblystegium purpurascens** (Schimp.)

Vester Elv, sterile.

80. **Amblystegium polare** (Lindb.) Lindb.

Vester. Elv, ♀, partly in unmixed cushions, partly mixed with other *Hypnaceae*.

var. **pseudostramineum** Lindb.

Typical specimens of this peculiar form were collected at Termometer Fjeld in rather compact tufts about 6 cm. high, with erect, almost branchless, round stems, and shortly-pointed very concave leaves which only towards the apex of the stem are indistinctly secundly bent. At the same place, at the edge of the inland ice, a form was found which, both in regard to habit and leaf-form, stands between the type and the variety. The variety was previously known only from Spitzbergen.

81. **Amblystegium turgescens** (Th. Jurs.) Lindb.

Vester Elv, sterile. Lille Snenæs, sterile. In both places sparingly among other mosses.

82. **Amblystegium sarmentosum** (Wahlenb.)

Is the most commonly occurring species. Was collected abundantly in unmixed tufts, and also occurred as a component of most of the moss-collections which were made.

83. **Amblystegium Richardsonii** (Mitten) Lindb.

North side of Hyde Fjord, sterile, a few plants among other swamp-mosses.

84. **Hypnum plumosum** Huds.

Dove Bugt, sterile. Maroussia Island, sterile. Bjørne Skærene, sterile.

85. **Myurella tenerrima** (Brid.) Lindb.

Vester Elv, in a tuft of *Polytrichum pilosom*. Stormkap, sterile. Lamberts Land, sterile, among *Swartzia*, *Ditrichum flexicaule* and *Gymnocybe*.

86. **Myurella julacea** (Vill.) Br. eur.

Stormkap, sterile. Lille Snenæs, sterile. Vester Elv, sterile. Bjørne Skærene, sterile. Everywhere mixed with other mosses in tufts.

87. **Hylocomium proliferum** (L.) Lindb.

var. **Alaskanum** (Lesq. et James).

Vester Elv, a single plant in a tuft of *Sphaerocephalus palustris* and *Sphagnum*.

88. **Stereodon revolutus** Mitten.

Vester Elv, sterile. Stormkap, sterile. Lille Snenæs, sterile. Basis Kær, sterile. North side of Hyde Fjord, sterile. Everywhere mixed with other mosses.

89. **Stereodon Bambergeri** (Sch.) Lindb.)

Vester Elv, sterile. North side of Hyde Fjord, sterile. In both places among other mosses.

90. **Stereodon chryseus** (Schwgr.) Mitten.

Vester Elv, sterile, several collections, in part among other mosses. Hvalros Odde, sterile. North side of Hyde Fjord, sterile, sparingly among other mosses.

91. **Isopterygium nitidum** (Wahlb.) Lindb.

Vester Elv, sterile. Maroussia Island, sterile. Stormkap, fruiting. Bjørne Skærene, sterile. Everywhere sparingly among other mosses.

PLATE XI.

Fig. 1. Polytrichum gracile var. anomalum. Habit $^1/_1$.
— 2—3. — — — Leaves $^{12}/_1$.
— 4. — — From the middle portion of a leaf $^{115}/_1$.
— 5. Bryum Myliusii. 2 capsules $^4/_1$.
— 6. — — Habit $^2/_3$.
— 7—8. — — Leaves $^{25}/_1$.

PLATE XII.

Fig. 9. Amblystegium polare var. pseudostramineum. Habit $^1/_1$.
— 10. — — — Leaf $^{40}/_1$.
— 11. — — — Leaf-base $^{100}/_1$.
— 12. Amblystegium radicale var. pulcherrimum. Habit $^3/_1$.
— 13. — — — Leaf $^{125}/_1$.

14—7—1910.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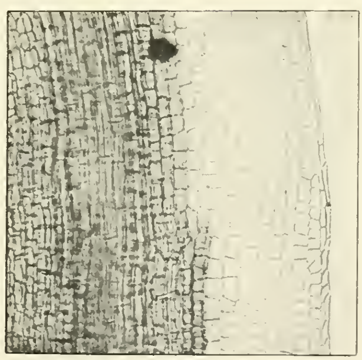
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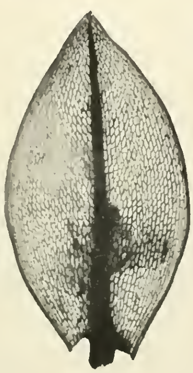
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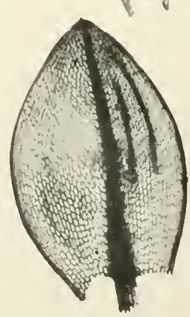
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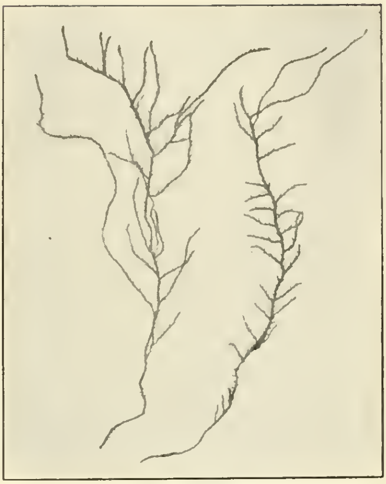

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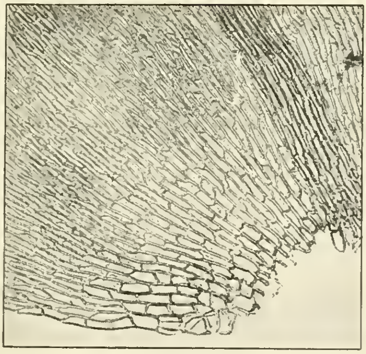

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Arbejder fra den Botaniske Have i København. Nr. 60.

The Structure and Biology of Arctic Flowering Plants.

I.

Reprinted from „MEDDELELSER OM GRÖNLAND“ Vol. XXXVI.

Copenhagen.
Printed by Bianco Luno.
1910.

Hitherto. the following papers have been published:

5.

Hippuridaceæ, Halorrhagidaceæ and Callitrichaceæ.

By

Agnete Seidelin.

1910.

This investigation is based on the Arctic collections, made by several observers, which are preserved in the Botanical Museum of the Copenhagen University.

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Hippuridaceae.

Hippuris vulgaris L.

Herbarium material from East and West Greenland and Iceland, as also in small quantity from Finmark, Lapland, Nova Zembla and Waigatsch, further, alcohol material from Greenland and Iceland.

In Greenland *Hippuris* is the commonest, phanerogamic water-plant, and it is on the whole the most wide-spread in Arctic regions, according to the reports of botanists. The most northerly place where it has been found is Danmarks Havn, 76°77′ N. L., where it was in the flowering condition when taken by the Danmark Expedition in the month of July (OSTENFELD 1910 p. 29). Mr. LUNDAGER's photograph of the vegetation here which he has kindly allowed me to see, shows it in very shallow water, which is said to have sunk a great deal since the early summer; otherwise it would seem remarkable that the broad, short leaves, which in Denmark are found as a rule under water, are here seen on a large piece of the emerged part of the stalk. The picture also shows with great clearness the slight development of the Arctic plants in comparison with the Danish. KRUUSE (1905 p. 151) found it most frequently in water of less than 30 cm depth, "liable to drying up", Porsild (1902 p. 206), however also in deeper water, 30—70 cm. In "Norges arctiske flora" it is stated, that "it grows most often in localities, where in the earlier part of the summer it lives in water and towards autumn in the air" (Norman 1895 p. 278).

With regard to its growth at Disko, West Greenland ca. 70° N. L., Mr. Porsild has given me the following information.

"*Hippuris* grows preferably in small pools, small depressions in gneiss, often for example no larger than a large bath, so long as they contain water through the whole summer. I have only seen it quite dry once, in the very dry summer of 1909, in a small lake on sandy bottom. It lay there in a curious tangle, but living, with flowers and fruit, and covered the whole bottom.

In larger lakes it forms the outermost belt of the vegetation, outside the *Carex-Equisetum* belt. As there is a predominant wind-direction at each single place, and as this determines the mode of growth, we always find the marsh plants and *Hippuris* on the sheltered side, whilst as a rule there are no plants on the windward side. The seed namely is carried over to the lee side, loose parts of the plants are washed over here, and here there is a "gytje" of dead material of *Nostoc*, of submerged, growing *Hypnum* species and the like, and in this grow *Hippuris*, *Batrachium*, *Callitriche* and *Potamogeton*. The fairly dark material and the dark mosses (e. g. *H. scorpioides*) absorb considerable quantities of heat, and the water is here always much warmer (up to 12°—15° C.) than on the windy side over naked bottom.

In lakes and lagoons with a little brackish water I have never seen *Hippuris*".

According to Lange (1880 p. 13 and 1887 p. 237) and several later authors, the true *H. vulgaris* occurs very seldom in Greenland and most Greenland specimens are referred to v. *maritima* Hartm. (= *H. maritima* Hellen.), though, it is added at several places, with transitions to the main species. They all seem to me, both the more and less divergent, best regarded as f. *litoralis* Lindberg (1906 p. 109), which only differs from the main form by somewhat shorter and broader leaves (12—17 mm long and 2—3 mm broad), usually 6—8 in a whorl (fig. 1); in the Greenland specimens 9 may occur, according to Kruuse (1906 p. 224) even 11. The few plants which agree with the description of *H. maritima* Hellen. (1786), or as Lindberg explains, more correctly *H. tetraphylla* L. fil. (1781 p. 81), without however having the characteristic habitus of this, might possibly have developed into f. *litoralis*, the lower parts of the stalk of which may sometimes have short, broad leaves at a height of several dm.

The few specimens I have seen from Finmark, Lapland, Nova Zembla and Waigatsch somewhat resemble the Greenland ones, whereas most of those from Iceland approach more to or are even the typical *H. vulgaris,* thus 10—11-leaved plants from Vallanes, taken in two successive years by Mr. H. Jónsson.

The rhizome forms a sympodium, the structure of which, so far as the material was able to show, agrees with the descriptions in Irmisch (1854 p. 281) and Warming (1884 p. 69). Porsild (1902 p. 206), who gives an account of the occurrence of *Hippuris* on Disko Island in West Greenland, 69°—70° N. L., found the rhizomes about 15 cm down in the mud, in as mentioned 30—70 cm of water, the depth preferred by the plant here, especially in clefts between the rock boulders or between loose stones.

Some plants, among them one found by Jens Vahl "in stagnis sinus Tessarmiut, (= Tasermiut), South Greenland", are richly provided with adventitious roots in the lower leaf-whorls of the upright shoots, like individuals according to Irmisch (1854 p. 287) which grow in damp soil, not in water; yet even in shallow water, which *Hippuris* is said to like in the polar regions, extensive production of roots may occur.

In a basin with shallow water in the Botanical Gardens of

Fig. 1. *Hippuris vulgaris* L. (1/2 nat. size)
(reprinted from Medd. om Grønland. Bind XLIII. Nr. 1.)

Copenhagen the vertical shoots had an even denser whorl of roots, which however were not very long, but greatly branched; the lowest internode of all was here quite covered by mud. In deeper water in the pond of the Gardens the corresponding shoots had but few roots.

As a rule the roots are unbranched; they are triarch or diarch (fig. 2). The vessels, which are naturally fewer than in the land-form (Schenck 1886 b, Taf. X, fig. 69), gave no wood-reaction in those examined, neither with phloroglucin-hydrochloric-acid nor with potassium permanganate-hydrochloric-ammonia. On Danish specimens examined the red colouration with phloroglucin was extremely faint, not more than observable. It will very probably be more apparent in some specimens. Root-hairs are wanting (Schenck 1886 b p. 58), as in many water and amphibious plants.

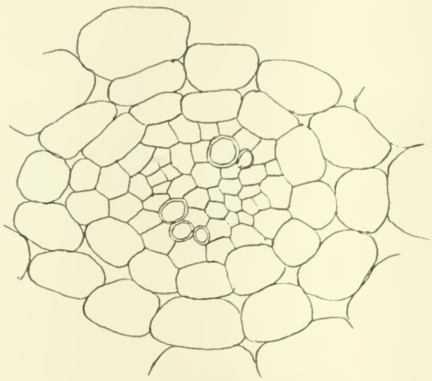


Fig. 2. *Hippuris vulgaris* L.
Root, transverse section.

Transverse sections of the stalk differ from the structure described by Sanio (1865 p. 184) and from that of most of the Danish plants examined, by having fewer — 3 or 2 — circles of large air-canals in contrast to the 5 of Sanio, but they are wider here (fig. 3); the condition is the same whether the section is made across the lower part of the stalk, which would be submerged, or 2—3 cm from the tip, in the flowering, probably emerged part (a very strong specimen from Igaliko 60°—61° N. L.). The most divergent are some small, sterile plants, which I had the opportunity to collect, on an excursion of the Swedish Botanical Society late in July 1909, in a lagoon at Torne Träsk 68°23′ N. L., 342·1 m above the sea, not within the arctic region strictly speaking, but still in the birch region. In these stalks there are only 2 circles; the fact that *Hippuris* was here growing in the shade of some small bushes, was perhaps not without influence on the structure of the stems. Transverse sections of a herbarium specimen

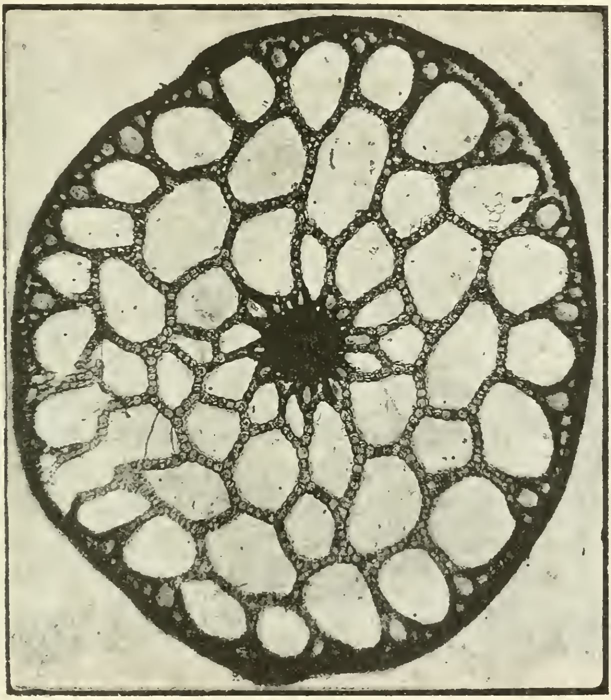


Fig. 3 a. *Hippuris vulgaris* L.
Transverse section of stem. From Greenland.

of *H. tetraphylla* from the Åbo district, Finland, resemble the arctic. Such a structure can also be found in Danish specimens in the submerged portion, whilst the emerged part after an even transition is like that of other Danish plants, and these two stalk-forms can be taken side by side in the same pool. The following seems common in *H. vulgaris*: in the rhizome and lowermost part of the vertical shoot many and small canals, higher up larger and fewer, then in the upper submerged part and in the aerial part again many and small, though not so marked as in the rhizome.

The outer wall of the epidermis may be rather greatly thickened. The cuticle, coloured red with Sudan III, has fine, longitudinal folds (fig. 4), as can be seen both in arctic and

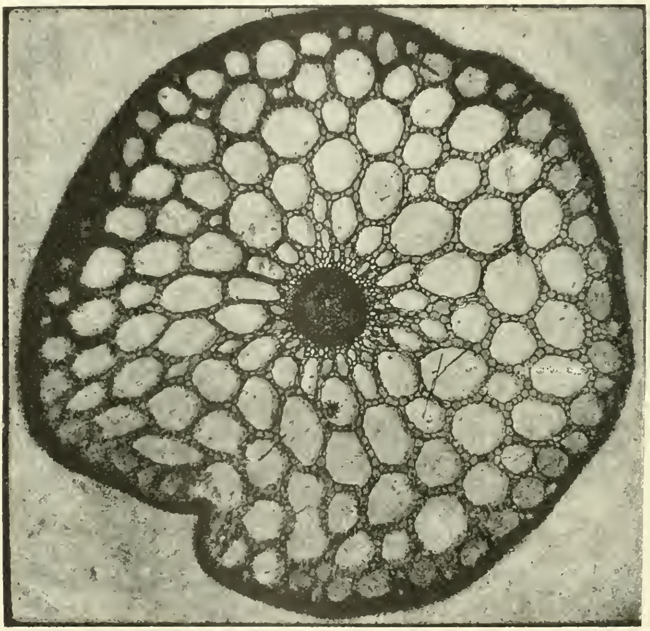


Fig. 3 b. *Hippuris vulgaris* L.
Transverse section of stem. From Denmark.

in fresh, Danish material, where the folds of the submerged part however are indistinct in some cases.

Costantin (1884 p. 317), who has investigated the proportion between the central cylinder and bark in the air stem and water stem in some amphibious plants, gives it for *H. vulgaris* as 0.5 and 0,46: Sernander (1901 p. 170) gives for the bark of the rhizome at least 5/6ths of the diameter. What the condition in this regard is in the arctic *Hippuris* has not been investigated, as the boundary between the submerged and emerged parts can only be exactly determined at the place of growth. But both in arctic and Danish plants the bark has been relatively greater than given by Costantin.

In longitudinal sections thin sieve tubes can be seen.

Scattered stomata are present on the stalk, as also the characteristic, shield-shaped hairs closely investigated by Rauter (1871). These hairs occur in large quantities on the leaves, especially on the upper side, and in greater numbers on the higher than on the lower leaves.

The leaves appear in three forms with transition-forms.

In the lower, 4—6 leaved whorls they are broad and short without lateral veins and with the mid-vein stopping at the tip without hydathodes (fig. 5 *a*, *b*, *c*): they greatly resemble the leaves on some *H. tetraphylla* specimens, on which however I have not made anatomical investigations.

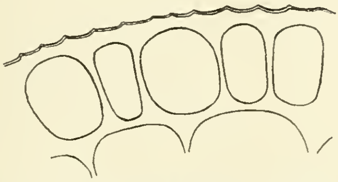
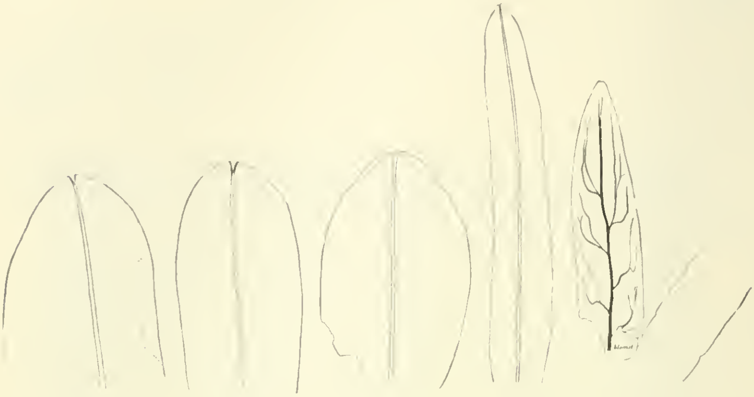


Fig. 4. *Hippuris vulgaris* (× ca. 200). Epidermis of the stem.

The upper leaves, to judge from the Danish specimens air-leaves, and the uppermost water-leaves are longer and narrower (fig. 5 *e*): they have branched lateral veins and prolonged midvein, whose tip which falls off later is provided with hydathodes (fig. 6 *a*) and epithema, in which the spiral tracheids sometimes, but not usually, reach right out to the tip (cf. Borodin 1870). These leaves are dorsiventral, the upper part of the green tissue palissade-like, the lower part with more numerous and larger lacunae, sponge-like (fig. 7) (cf. Clements 1905 fig. 36).

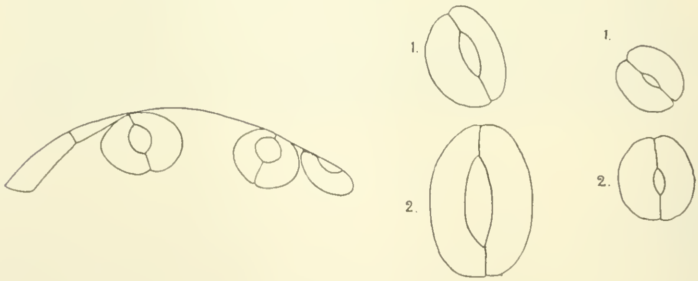
Shoots are present both from Greenland and Iceland, which have the long, narrow, flaccid, submerged leaves but not in the most extreme form from deep water (*B. fluitans* Liljebl. v. *fluviatilis* Hartm.). Porsild (1902 p. 206) observed the usual difference between "submerged" and "emerged" leaves, between which however as above mentioned, the boundary should not be drawn definitely at the surface, in any case not in Denmark. These ribbon-



a *b* *c* *d* *e*

Fig. 5. *Hippuris vulgaris* L (× ca. 4).
a, *b*, *c* lower leaves. *d* submerged ribbon-leaf. *e* upper leaf.

leaves have no lateral veins, but have hydathodes or they are emarginated after the tip is thrown off (fig. 5 *d*). On transverse sections of them which were examined, only one row was seen



a. b c.

Fig. 6. *Hippuris vulgaris* L. (× ca. 200).
a apex of leaf with hydathodes. *b*, *c* stomata. *b* from upper leaf, *c* from ribbon-leaf.

of large chlorophyll cells between the epidermis of the upper and under sides, which is said to be common by Schindler (1904 p. 75). Some Danish ribbon-leaves had three (cf. Clements

l. c.). The structure of the assimilating tissue varies probably according to the outer conditions of the leaves, especially according to the light directly or indirectly influencing it. The influence of these on the form of the leaf has been studied by Noll (1902 p. 59). In a dark room, which was damp but not steamy, the *Hippuris* leaves, apart from their yellow colour, assumed the appearance of water-leaves without reaching the size of these however, but they did not develop into this form, neither in a dry, dark room nor in a light, almost steamy room.

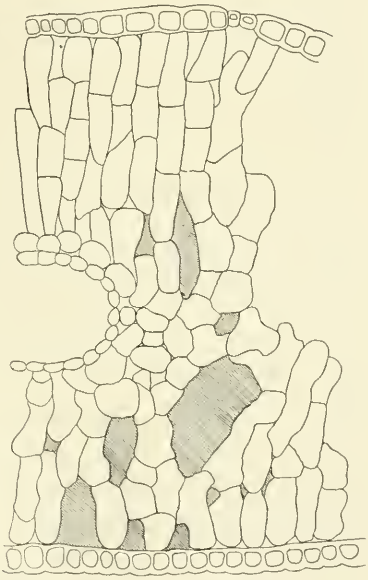


Fig. 7. *Hippuris vulgaris* L. (× ca. 70). Upper leaf, transverse section.

On the ordinary form of leaf there are numerous stomata; as is common among water-plants (Costantin 1884, Schindler 1904) they seem to be present in greater numbers on the upper side than on the under side, both in Arctic and in Danish plants. On the ribbon-leaves they are found only rarely and then but few, and on the short, broad, lower leaves there are only for example 2—4 on a leaf; here they are smaller and with smaller slits than those of the "air-leaves" (cf. figs. 6 *b* and *c*). Porsch (1905 p. 84) found that the stomata in *H. vulgaris* L., just as in *Callitriche verna* L., were the reverse of what is usual, as the central slit closed, even on contact with water and under favourable conditions of light.

Flowering, which occurs in July—August in Greenland, in June in some cases in subarctic South Greenland, seems general and occurs even at 76° 77′ N. L., N.-East Greenland; in the plants from here the flowers occur on a considerable part of the stalk in the axils of flaccid, presumably submerged leaves as well as on the upper leaves.

According to Knuth (1898 p. 411) fertilisation takes place by means of the wind. In the pond of the Botanical Gardens, Copenhagen, however, some fruits were formed on the submerged shoots, which had flowered though less richly than the "air-shoot", down to 10 cm below the surface of the water. Whether these fruit-bearing, submerged shoots have been less submerged during the period of fertilisation, or whether the conditions of fertilisation are different from what is known, must remain an open question.

As the flowers are protogynous (Knuth l. c.), it is difficult to determine from the material, which is for the most part dried, whether in some cases, where only pistils can be seen, the stamens are not at all formed, or whether they are not yet developed. Gynodioecy has several times been observed (Knuth l. c.). Schacht (1850 p. 165) found. that the anthers failed in dry and warm summers; in May he found ⚥ flowers, in July ♀ flowers. In the pond of the Botanical Gardens, in the but little sunny summer of 1907, the upper or lower whorls in the flowering part of the stalk of a number of specimens consisted wholly or partly of female flowers. It is possible that they occur in greater quantities in sunny summers. Hellenius (1786) says, that *H. maritima* seems to be always hermaphrodite; neither Linné nor Lindberg mention the flowers in the synonymous *H. tetraphylla*.

Some of the plants were taken with fruit, though the collections do not embrace the whole summer. The fruits are however in general empty. Developed fruits were found in plants from Røde Ö on Scoresby Sound, East Greenland ca. 70° N. L. Hartz (1895 p. 148) describes the region here as having the most copious vegetation he had seen in Scoresby Sound. The bottom of the small lake, which lies ca. 185 m above the sea, where there are good biological conditions above the fog from the sea and the cold from the icebergs[1], was covered by *Hippuris* and water-mosses. Kruuse (1906 p. 224) states "sets ripe fruit", Angmagsalik ca. 66° N. L., East Greenland.

Vegetative propagation seems predominant here even to a greater degree than in temperate regions. Whether it can proceed here, in addition to by running shoots in the bottom, as Sernander (1901 p. 175) describes, also by means of loose plagiotropic shoots on which are placed orthotropic ones with a kind of hibernaculum, and by means of others with short internodes furnished with compressed leaves, which are formed in the axils of the leaves, or how the spreading from water to water proceeds, is not shown by the material, and just as little the mode of passing the winter. Jonsson (1895 p. 290) on January 10th found the large and small pieces of ice lying on the bank of a large channel at Vallanes, Iceland, densely covered on the downward side with *Hippuris* and *Equisetum limosum*, which were still living and which had earlier been carried away by the ice. At Angmasalik 65°—66° N. L. "the air shoots begin to appear early in June" (Kruuse 1906 p. 224).

Hippuris belongs just as little as *Myriophyllum* and *Callitriche* to the water-plants, whose resistance to the cold has been investigated by Lidforss (1907 p. 47).

It is unknown, how far the rather variable arctic form — or more correctly speaking Greenland form, to judge from the composition of the material — called for practical reasons f. *litoralis* Lindberg, is constant or if it is which is most probable only a reduced *H. vulgaris*, which certainly flowers — even a specimen of only 7—8 cm in height from Angisek, Kitsigsut Islands 59°58′ N. L. Kolderup Rosenvinge (1896 p. 65) — but remains for a long time at an early stage of development in vegetative regards. Often the short, broad leaf-form is retained very long, and on the whole the plant does not attain all the developmental stages, the

[1] According to verbal communication from Dr. N. Hartz.

full number of the leaves nor the usual proportions of size, and with regard to the air-passages remains in the whole length of the stalk like the middle part of some Danish plants. All these questions can only be settled by cultivation of living material, which unfortunately I have not yet had at my disposal.

Nor can we learn without experiment, whether this possible reduction has to be ascribed exclusively to the account of the arctic conditions, or further to the littoral condition which is often added here, and whether both contain factors with the same influence. At any rate there can be no question of the influence of brackish water where Mr. Porsild has seen *Hippuris* on Disco Island (cfr. p. 301).

Halorrhagidaceae.

Myriophyllum alterniflorum DC. and **M. spicatum** L.

Herbarium material from West and East Greenland, Iceland and, for *M. alterniflorum*, the Faeröes; *M. alterniflorum* also in alcohol.

The lower, branched, in the end leafless stems creep rhizome-like in the bottom of still or running water (cf. Irmisch 1859, Warming 1884, Sylvén 1906).

The plagiotropic shoots are chlorophyllous with usually long internodes. *M. alterniflorum* from Kvalböejde, Syderö, the Faeröes, differs from the same species from other localities by having short internodes and being tuft-like; it grew here in shallow water on the sandy west side of the lake, where with other water-plants it came almost right in to the margin, *M. alterniflorum* also in great quantities a little further out (Ostenfeld 1908). Some specimens on the sandy beach of Gurresø, Denmark, have a similar appearance, others not.

From the bases of the leaves descend branched or unbranched roots, as a rule only from the creeping internodes or those just above these, but they may also arise in the upper part of the shoot, above a long, rootless part of the stalk, in specimens both from Greenland and Iceland. Regarding *M. alterniflorum* from one of the localities Kingua Neriak, Greenland, N. Hartz who found it reports on the label, that it grew "on the bottom of a lake." In Denmark I have observed root-formation in the upper stalk part even when the shoot occurs on the surface of the water, in *M. spicatum* and *M. verticillatum*, at a depth of 2—3 m in Furesø and on a moor, in a trench of slight depth, in August; in the last case roots even sprang from the bracts of the flowers[1]. In running water at Fiskebaek on Furesø both *Myriophyllum* and *Batrachium* had a similar root-formaton, here perhaps deeper in the water. As known, the broken-off shoots of a number of water-plants have the power to develop roots both in the lower and upper parts. Sernander (1901 p. 100) has remarked specially regarding *M. spicatum* that it is found in the autumn "with long roots high up on the shoot".

The branching is generally as Irmisch (1859 p. 354) notes for *M. verticillatum*, shoot-formation from only one of the leaves in a whorl; in *M. alterniflorum* from Friedrichsthal, Greenland, and from a lake at Kobbermine Island at Julianehaab as also from Breidalur, Iceland, 2—4 shoots spring from one leaf-whorl.

The material does not show how the winter is passed; it contains no winter-buds. But at the base of the air-shoot in a number of *M. spicatum* there are leaves which differ from the ordinary by having larger lobes and a somewhat similar appearance to the leaves in hibernacula of Danish *M. verticillatum*. The lateral shoots from the axils of such leaves bear ordinary, finely divided leaves.

As the three *Myriophyllum* species are so difficult to distinguish from one another in the vegetative condition, there might be a possibility in statements regarding the winter-buds in *M. a.* and *M. spic.* of confusion with *M. verticillatum*.

[1] The formation of roots from the nodi of the upper, horizontal part of M. spicatum in running, ca. 1 m deep water is mentioned by O. Rosenberg: Om växternas utbildning i rinnande vatten. Svensk bot. tidsskrift. Band I. 1907. Stockholm.

We find such statements in several authors, for example in Koch (1892 p. 865), in Schenck (1886a p. 92), who says that *M. spic.* forms winter-buds, *M. a.* also probably. Birger (1908 p. 57) relies on Schenck's statements when he gives *M. spic.* among the water-plants which form winter-buds further south, but not in Härjedal. Sernander (1901 pp. 184—185) describes hibernacula in both species; in Schindler's diagnosis of *M. spic.* (1905 p. 90) it is said "hibernacula adsunt", whereas they are not named here for *M. a.* In Ferdinandsen and Winge's cultures of *M. a.* at a little below 18° C. (1909 p. 309) no winter-buds were formed. Nor have I found them in this species, when I investigated it in shallow water on the beach of Gurresø in the middle of October 1909, and specimens from here, since cultivated in a room not warmed, have not formed them either, whereas they have been in slow growth through the whole winter and obtained new, weak shoots. Glück (1906 p. 95) concludes from his excursion observations and culture experiments, that these two species are not at all able to form hibernacula.

That the formation of hibernacula might occur in nature by combinations of conditions, which were perhaps not present in experiments even of many different kinds, does not seem impossible, just as that they sometimes appear, sometimes not, dependent on the outer conditions probably, in these species as in *M. verticillatum*, where the time for their formation varies at different places in Denmark at least from August to October. Goebel (1893 p. 361) even found that the formation of winter-buds did not occur "owing to the assimilating activity being too much reduced" at places which were much shaded, but, it must be admitted, that the majority of the plants died here "owing to the cold."

It does not seem excluded that the above mentioned basal leaves belonged to hibernacula, although on the other hand it might well be thought, that the short, polar summer did not offer conditions for their formation, even if we allow that they at all exist.

A strikingly large number of plants are delicate and the lobes of the leaves are fine as hairs, as Schenck (1886 a p. 23) mentions in *Myriophyllums* from very still and small pools.

Abromeit (1899 p. 12) describes specimens from Ikerasak (Umanak region, 70°30′ N. L., West Greenland), taken by Vanhöffen 1899; the leaves have a broad central part and few, but broad lateral lobes or these are absent. A plant of the same material in our possession bears such leaves with lateral lobes on a part of a shoot, whilst the rest of the plant looks like the ordinary *M. spicatum* (fig. 8). The vein of the main part has lateral veins, its tip is bent like a cap but has no marks from the usually occurring and deciduous, trichome-like appendages, which however the lateral lobes show. The leaves examined have no stomata. Abromeit mentions some shield-shaped hairs, and he considers this form to be near to *M. spicatum β heterophyllum* Petermann, whose original description has not been accessible to me[1]. Such hairs I have not seen, possibly because the available material was very scarce. Whether these leaves are formed in the air or under other special outer conditions is not known.

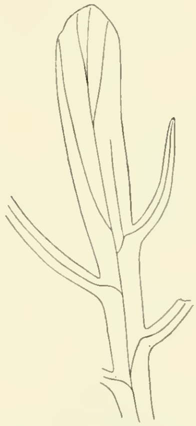


Fig. 8. *Myriophyllum spicatum* L. (× ca. 5).
Leaf of a lateral shoot. (Ikerasak, Umanak, West Greenland). Lateral lobes not finished.

The adventitious roots have a distinct ectodermis. Their woody parts is extremely feebly developed, often only one or 2 vessels in each of the rays, the number of which varies from 2 to 4 within the same order of root, the first one on the same plant. On Schenck's figures (1886 b) a root of *M. spic.* is given as pentarch, whilst its root-branch only has two vessels on the whole; the root of the land-form of *M. a.* is tetrarch. Here as in most of the cases referring

[1] According to Koch (1892 p. 865) *β) heterophyllum* has "die obersten Blätter aufgetaucht (schwimmend) lanzettlinealisch, ganz".

to the anatomy, I have only examined *M. a.*, as only this form was at my disposal in alcohol material.

The structure of the stalk resembles that of *M. spicatum* (Vöchting 1872, Taf. IV); the central cylinder is surrounded by a broad bark with large air-spaces in a circle. In July a large quantity of starch was found in the rhizomic and orthotropic shoots as also in the roots and leaves in slightly brackish water (Melrakke Heath, North Iceland).

Both species may have land forms; the leaves of the latter (Schenck 1884 a p. 22) have dorsiventral lobes in contrast to the radial lobes of the water form; the epidermis of the leaves has no chlorophyll but has stomata, both conditions being the reverse of the submerged form. The stomata in a land form (*M. a*) from a muddy lake-beach, Graenavatn in Iceland (*M. a.*), lie in the longitudinal direction of the leaf section.

Leaves examined of the above-mentioned form, which resemble those of winter-buds, have no stomata.

The section of the submerged leaves has a radial structure and resembles that of the stalk; in principal lobes the air-passages are rather well-developed and arranged in circles, but they are much reduced in very thin leaves; in the lateral lobes they are but few and small and situated irregularly.

Schilling (1894 p. 326) found mucilage formation in the characteristic leaf-hairs of *M. spic.*, in large quantities especially on the winter-buds, the presence of which he thus also recognizes. Other points of the shoot are also enveloped in mucilage from the surrounding leaves. On older leaves only the brown scars from the deciduous trichomes are seen.

According to Parmentier (1897 p. 138) and Schindler (1904 p. 53) *M. spicatum* is distinguished from most other species by having calcium oxalate crystals only in the stalk, not in the leaves. They also occur in the leaves however of specimens both from Greenland and Iceland, and from Denmark (determined by Dr. A. K. Schindler), though in smaller quantity than in *M.*

alterniflorum and *M. verticillatum.* The plants examined were taken in July and August.

Both species flower in July—September, *M. spicatum* taken by Vanhöffen at 70°30′ N. L. on July 18 (Abromeit 1899 p. 12).

Myriophyllum is monoecious. Warming (1886 p. 116) gives *M. a.* and *M. spic.* among the anemophilous plants of Greenland (cf. Knuth 1898 p. 309). So far as I know, water-pollination has not been noted for these two species as for *M. verticillatum* (Ludwig 1881 p. 10). Abromeit (l. c.) observed distinct protogyny in *M. spicatum*, in the Umanak Fjord district, but further, that the pollen is emptied already in half-opened ♂ flowers. Schindler (1905 p. 14) remarks, that the lowermost, first opened flowers of several Myriophyllum species are wholly female.

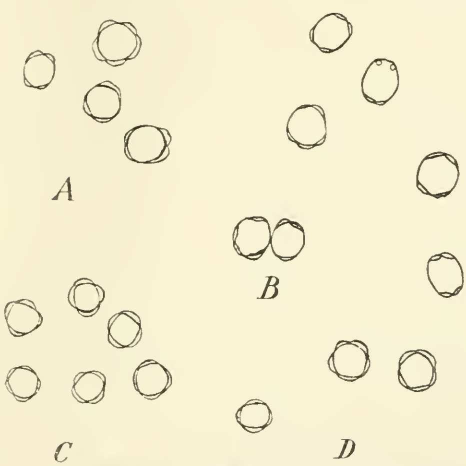


Fig. 9. *Myriophyllum.* Pollen (× ca. 100). *A* and *B* M. alterniflorum DC. *A* Danish, *B* Arctic. *C* M. verticillatum L. *D* M. spicatum L.

The pollen grains of *M. alterniflorum* (fig. 9), both in arctic and Danish specimens, differ from those of *M. spicatum* and *M. verticillatum* as described and figured by Mohl (1834 p. 331). The pores of the pollen, usually 4, are placed 2 near one another at the one pole, 2 at the other, and not with the same distance between all 4 as in the other species. 2, 3 and 5 may also occur; 5 may also be found in *M. spicatum*, just as we sometimes see transitional forms with regard to the distance between the pores.

The outgrowths mentioned in Schindler's description (1905 p. 94) as occurring on the ovary of *M. a.*, give with vanillin and hydrochloric acid (Raciborski 1893) the reaction for myriophyllin, which was found by the latter in the leaf-appendages; on the ovarial outgrowths it is however less purely red in colour than from the leaf-appendages, more brownish red.

M. a. has formed fruits at several places, in Greenland (Septbr.) at Tunugdliarfik, 60°50′ N. L., in Iceland (Aug.) among other places at Breidalur; fruits from here have developed embryos. The small quantity of fruit in the material is possibly due, for *Myriophyllum* as for *Hippuris*, to the fact, that the collections were in general not made in the autumn.

Sylvén (l. c.) has only described and figured seedlings of *M. a.*

Vegetative propagation probably occurs readily, even if the winter-buds are not found, on detached parts of shoots as in other regions (Sernander 1901; Glück 1906 etc.).

M. alterniflorum is on the whole a more northerly species than *M. spicatum*, and a greater number of specimens have been collected than of the latter. Both species have generally a more slender appearance than is common in Denmark, possibly connected with the less favourable conditions of life; this refers less to *M. a.* which is a slender species in any case. The Greenland specimens of this species are not so strong as those from Iceland, but there are only 3 individuals from the latter country.

Callitrichaceae.

Material from East and West Greenland, Iceland and the Færöes together with a very few samples from Finmark.

The following species have been found: *C. autumnalis* L., *C. hamulata* Ktz., *C. stagnalis* Scop. and *C. verna* L.

C. stagnalis which is a species belonging to the temperate and warm regions e. g. found at Ceylon (Hegelm. 1864, p. 59, Schenck 1886 a p. 151) has not been gathered in Greenland and in Iceland only in the surroundings of hot springs, thus at Laugarne near Reykjavik in water of a temperature of ca. 25° (Grønlund 1890 p. 140, Ostenfeld 1899 p. 238, Stefansson 1901 p. 117); the ubiquitous *C. verna* not with certainty on the Færöes. In Greenland *C. verna* was found as far up the mountains as ca. 166 m. above the sea, in Scoresby Sund ca. 70°15′ N. L., East Greenland (Hartz 1895 p. 323). Hegelmaier notes it from the Morteratsch glacier, Engadin (l. c.).

C. polymorpha Lönnr. is mentioned from Greenland, but as far as I am able to judge, this species consists of forms of other species, viz. of *C. verna* and *C. hamulata.*

C. autumnalis, gathered only a few times, has a low growth, especially the species from Disco, West Greenland, ca. 70° N. L., found by M. P. Porsild in a depth of 0,16—0,33 m, but those from Iceland too; from the Færöes there is but little material of this species. It is only available in herbarium-specimens, and for that reason not examined anatomically.

Some peculiar plants gathered by Professor Warming July 6, 1885, in the river Alten, Finmark, appear to be *C. longistyla* Norman (1895 p. 281), who has noted it only from one locality, near to the same river at Raipas about 69°57 N. L.

Callitriche is found in still as well as in running water, *C. verna* also in dried-up places (e. g. Norman l. c. p. 280), which seems to be comparatively often the case in Greenland.

C. autumnalis in lakes at Disco, ca. 70° N. L. (Porsild 1902 p. 206), was growing in patches together with *Batrachium paucistamineum* and aquatic mosses, in shallow water as mentioned above. On the Færöes *C. hamulata* occurs mostly as landform, but also grows in the *Litorella*-association in lakes, and in streams (Ostenfeld 1901 p. 57, 1908 p. 140—142).

The bottom in which seedlings of *C. verna* were observed in a lake on Danmarks Island (70°27′ N. L., East Greenland, Hartz 1895 p. 278) consisted of gytje. It was sandy and muddy in a pond with about 35 cm water, in which *C. hamulata* Ktz.

var. *trichophylla* Ktz. was growing, 3—10 cm high, with fruit, Septbr. 30. 1901, Angmagsalik, 65°37′ N. L. (Kruuse 1906 p. 224).

The habitus of the different species, if living in water, is very similar, small plants with slender branching stems and opposite leaves, the uppermost of these, except in *C. autumnalis*, forming a rosette on the emerged part of the stem. When living in dry places *C. verna* is short and branches abundantly, looking tuftlike, often it is prostrate (cfr. *f. minima* Hoppe and *f. caespitosa* Schultz). The forms, however, vary very much and do not always correspond to the description.

Most likely the species of *Callitriche* in arctic as well as in temperate regions are as a rule perennial without making special winter-buds (Irmisch 1859 p. 354; Schenck 1886a p. 84; Warming 1884 p. 90; Sylvén 1906 p. 187; Birger 1908 p. 57). H. Jonsson (1895 p. 290) observed lots of *C. hamulata* in a slowly streaming channel, Vallanes, Iceland, Jan. 10; the water had been frozen from the beginning of Novbr. until Decbr. 28. That *Callitriche* is able to live below the ice during the winter is often seen, e. g. *C. verna* in the Botanical Gardens of Copenhagen and in ditches near Furesø, but how it hibernates if the water is frozen to the bottom, seems not to have been investigated; perhaps at least parts of the stem will survive even then (cf. p. 332).

The observation that species of *Callitriche* are annual (e. g. Hartmann 1879 p. 383; Neumann 1901 p. 307—308) probably applies only to the terrestrial forms. Such is the case according to Irmisch (l. c.) and Sylvén (l. c.). Ostenfeld (1908 p. 938) writes that occasionally *C. hamulata* is annual on the Færöes; i. e. when the plant grows on land, according to verbal information of the author.

The primary root is succeeded by adventitious roots.

The ability of the nodes to form roots is very great. They are short and rather stout in many of the land-plants, long and slender in aquatic ones. They may be found, just as sometimes in *Myriophyllum*, even at the nodes bearing flowers.

The roots are furnished with root-hairs, but rather sparingly; the latter condition seems quite natural with aquatic plants, which are often quite devoid of them, but it is also the case in the terrestrial specimens (*C. verna* and *C. stagnalis* examined).

Generally the roots are not branching. In a few cases one to four branches have been noticed e. g. in *C. verna* from a dried-up pool at the settlement Ingnukertok (in Angmagsalik-fjord, Greenland 65°45′ N. Lat.) and in *C. hamulata* from a river at Miavevatn, the Færöes, gathered by C. H. Ostenfeld. The slender roots of the latter indicate, that the plant has been submerged; it cannot with certainty be seen whether parts of them have grown on the bottom. According to Lebel (1863 p. 4) it was only in the latter case that the roots were branching; Hegelmaier (1864 p. 29) looked in vain for branching roots though, as is added, not to any great extent. Schenck (1886 b p. 60) describes the root as not ramiferous.

The central cylinder is the most simply built of the Dicotyledons, being diarch (*C. stagnalis*, aquatic form) or triarch (*C. stagnalis*, terrestrial form and *C. verna*) (Schenck l. c.) as in *Hippuris vulgaris*, but with less numerous vessels than this plant. The arctic roots examined agree in all essentials with the description of Schenck.

The stem, if submerged is thin and the internodes long, if growing on damp places thicker with shorter internodes, partly prostrate and sending out roots.

The anatomy is that characteristic of several aquatic plants. Below a thin epidermis without chlorophyll is a thick bark, with large air-channels. The parenchyma contains chlorophyll, in older plants it is partly resorbed. The endodermis as in a root is sharply marked off towards the central cylinder.

Hadrom and leptom are only slightly developed. As pointed out by Hegelmaier (1864 p. 20) the number of the vessels vary within the species being dependent on the nutritious conditions. The following numbers will give an idea of the variability.

C. verna, a land specimen from a dried-up pool, Røde Ö East Greenland c. 71° N. L., had 4—6 vessels in the upper internodes; in a basin in the Botanical Garden of Copenhagen 5, in a part of the stem 6—7 internodes below the top. *C. hamulata* from Miavevatn, the Færöes, has 7, while in the figure of Hegelmaier (l. c.), only two are seen. In *C. stagnalis* from Laugarne, Reykjavik, Iceland, 16 are found, in a part of the stem furnished with stomata and pith, indicating emerged situation; Hegelmaier and Schenck mention, that 12 may be found, which number was seen in a robust specimen from Kunø, the Færöes; the figures of Schenck and of Hegelmaier show 7 and 11 in the land form, 4 and 7 in the aquatic form (1886 b and l. c.).

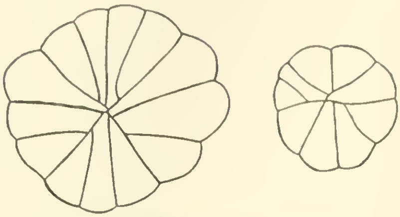


Fig. 10. *Callitriche hamulata* Ktz. (× ca. 150). Hairs from leaf and stem.

Either very little pith is present or in its place in the centre of the stem, only a canal, the young pith-cells, when only very few, having burst with the stretching of the surrounding tissue (Hegelm l. c. p. 20). On an average the pith is less resorbed in terrestrial forms than in aquatic ones.

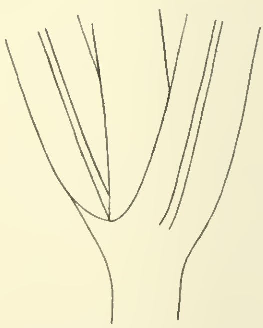


Fig. 11. *Callitriche hamulata* Ktz. (× ca. 10). Base of the leaves.

The stem and both sides of the leaves, in the species belonging to *Eucallitriche*, bear shield-shaped hairs (fig. 10), resembling those of *Hippuris*, abundantly on the air shoots or upper part of the submerged ones, very few on the lower part.

The opposite leaves connate at the base (fig. 11).

With exception of *C. autumnalis*, belonging to *Pseudocallitriche*, the species have polymorphous leaves with transitional forms.

Fig. 12. *Callitriche hamulata* Ktz. (× ca. 5). *A* upper leaf, *B*, *C* lower leaves.

The short and brod obovate form in the rosette of *C. verna* is strikingly different from the linear one, which is deeply submerged.

In *C. hamulata* some of the emerged leaves and the upper submerged are shortly spatulate, below these longer spatulate and sublinear ones are found, the narrowly linear leaf closing the series (fig. 15 and 12).

Most specimens of *C. stagnalis* have typically broad leaves, yet diminishing in breadth downwards, e. g. in plants from a ditch at Vaags Ejde lake, the Færöes, July 23, 1897 (C. H. Ostenfeld). The form *platycarpa* Ktz. from deeper water has not been found in the arctic material.

The leaves of *C. autumnalis* as well as those of other *Pseudocallitriche* are uniform and linear.

Most of the submerged leaves may be classed in the elodioid type of Warming (1909 p. 182) or are somewhat longer.

Fig. 13. *Callitriche verna* L. (× ca. 15). Terrestrial form.

The apex of the leaf is in varying degree emarginate; the two points are straight if short, but converging if longer. More rarely the leaf is almost evenly truncate (fig. 14 *c*, *d*). In the small leaves of the terrestrial form of *C. verna* the apex is rounded (fig. 13).

Very deeply emarginate are the exceedingly long and narrow leaves of *C. hamulata f. trichophylla* Ktz. (fig. 14 *e*, *f*), e. g. gathered at Sukkertoppen 65°25′ N. L. Greenland, and at Bjørnedal near Ivigtut 61°13′ N. L. Greenland, moreover those of the robust, relatively broader leaves of the already mentioned specimens from Vallanes, Iceland.

The venation is very simple. In the broader leaves three or five veins, in most of the narrow leaves only a single one, while in others and in transition-forms three or one with lateral veins only in the upper part of the leaf, generally making a sharp curve towards the median vein at the beginning and ending. Sometimes parts of them do not meet, either the middle part or those next to the midvein being absent (fig. 12 *C*).

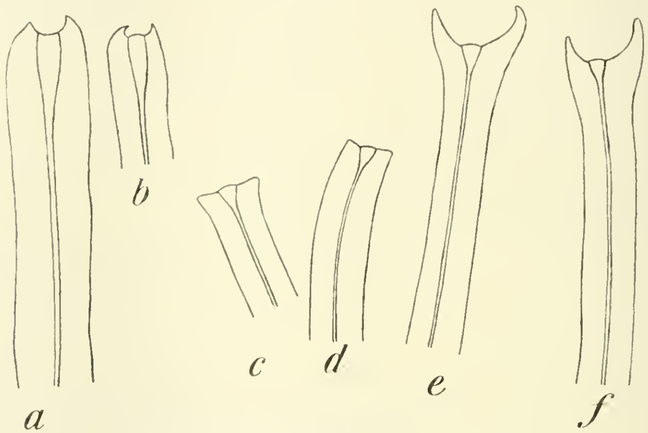


Fig. 14. *Apex of the leaf.* (× ca. 5).
a, b Callitriche verna L. *c—d* Callitriche hamulata Ktz., *d* upper leaves. *e, f* lower leaves.

According to Hegelmaier (1864 p. 32) the former are generally formed first, but sometimes the formation of the lateral vein begins in the middle part quite without connection with the mid-vein.

A few communicating small veins may be found.

It is remarkable, that the small leaves of *C. verna* terrestrial form, have only one vein, perhaps with a few indistinct branches, the venation of amphibious plants generally obtaining the richest development in emerged leaves. Possibly this is, in one way or another, connected with the form of the leaf.

Beneath the broad apical part of the median vein, opening on the under side of the leaf is a big hydathode (Borodin 1870 p. 841 and fig. 1—5), developed both in air-leaves and in water-leaves.

The dorsiventral condition is distinct in the upper leaves, but gradually grows very indistinct downwards, the lowest leaves of submerged stems are almost isolateral.

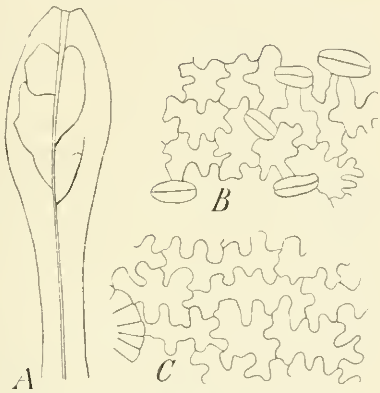


Fig. 15 *Callitriche hamulata* Ktz. *A* one of the uppermost leaves (× ca. 5). *B* upper, *C* lower epidermis of a leaf like *A* (× ca. 70).

It need hardly be said, that the outer wall of the epidermis is thicker in air-leaves than in water-leaves. The epidermis does not contain any chlorophyll as does that of many other aquatic and amphibious plants. The cells have undulating walls and are nearly isodiametrical in the short and broad leaves; the undulation gradually grows less marked and at last wholly disappears, the cells becoming more and more oblong, as the leaves gradually decrease in breadth downwards (cf. fig. 15 and 16). The drawings represent cells from the middle part of the leaves, placed between the mid-vein and the border. Near the apex the cells are in the main shorter and the walls more undulated than in the middle of the leaf, and near the base they are longer and narrower and often straight-walled. The cells above and below the mid-vein and near the border also differ, namely, in being rather long and not or only slightly undulated.

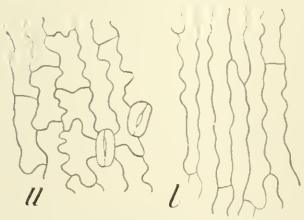


Fig. 16. *Callitriche hamulata*. Ktz. (× ca. 70). *u* upper, *l* lower epidermis of the leaf fig. 12 *C*.

The lower epidermis generally appears less well developed than the upper one, the cells being longer and the walls less distinctly undulating. The lower surface of an upper leaf may often have the same appearance as the upper surface of one placed lower down.

In *Callitriche* as in many other aquatic plants only the upper epidermis is furnished with stomata, except in some cases in emerged leaves, in which they also may be found on the lower (fig. 15 and 16).

They are numerous, as is to be expected in air-leaves and perhaps also in upper water-leaves, few or none in deeper submerged ones. Sometimes they are deformed. As mentioned above (cf. p. 309) Porsch (1905 p. 84) observed, that the stomata of *C. verna* behave differently to other stomata, closing if in contact with water and under favourable conditions of light.

The structure of the chlorenchyma agrees in the main with the drawings and the descriptions of Hegelmaier (1864 p. 31) and Schenck (1886 b p. 19). The leaves in some cases are more highly differentiated than those represented by these authors. The palissade-tissue of a plant of *C. verna*, which is apparently the terrestrial form (Mudderbugten, Greenland ca. 70°15′ N. lat., N. Hartz Aug. 30.), as well as that of an upper leaf of *C. stagnalis* (Laugarne, Reykjavik, Iceland, C. H. Ostenfeld Aug. 7, 1895), is more developed than in the "land-leaf" of *C. verna* (Scenck l. c.), while the structure of another leaf, about 6 cm lower down on the stem of the same specimen of *C. stagnalis*, is almost like the drawing.

Some linear leaves, deeply emarginate at apex, of *C. hamulata* (Sukkertoppen, Greenland 65°25′ N. L., 16. August 1884) are a little more reduced than in any mentioned by these authors. The upper one of the three or only two layers of chlorenchyma cells are more rounded, of an almost isodiametrical. i. e. more primary shape, only incompletely developed (Fig. 17), the intercellular spaces are larger, while the vascular bundle and its starch-sheath are less developed.

As the anatomy of aquatic-plants varies exceedingly within the species, influenced as they are by the very variable conditions to which they are exposed, no great importance should be attached to these smaller differences, the value of which can not be measured without intimate knowledge of local conditions.

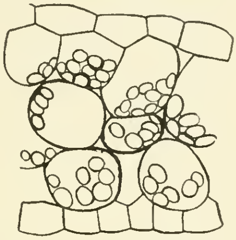


Fig. 17. *Callitriche hamulata* (× ca. 165). Transverse section, middle of leaf. Starch is seen.

As is quite natural, because of the more intense assimilation, in some cases much more starch is found in the short and broad leaves than in the narrow leaves, often quite filling up the chlorenchyma cells of the former.

Callitriche develops flowers and fruits in abundance in arctic countries; only a few specimens of the material are devoid of flowers. Both are found at the same time generally, except of course in the beginning of the summer, when only the very first flowers are present.

	Greenland		Iceland	
	only flowers	fruiting	only flowers	fruiting
C. autumnalis.		Aug.		July
C: hamulata.	June—July	Aug.—Septbr.	June—January	July—Aug.
C. stagnalis.				July—Aug.
C. verna.		July—Septbr.		July—Aug.

	The Færöes		Danmark
	only flowers	fruiting	flowering (Raunkiær, 1906)
C. autumnalis.			July—Septb.
C. hamulata.		July—Aug.	May—Septb.
C. stagnalis.		July—Aug.—Novb. 4.	May—Septb.
C. verna.			May—Septb.

The flowering period is thus in the main as was to be expected, somewhat later than in temperate regions. Very likely fruits and perhaps flowers might be found later in the year than Aug.—Septb., but as mentioned before, most travellers have finished collecting at that time. The material of *C. stagnalis* from Kvannasund (the Færöes) Novb. 4. still contains fruits *in situ* and even that of *C. hamulata* from Vallanes, Iceland, January 10 (cf. p. 320), bears both pistillate and staminate flowers; both have been gathered by H. Jonsson.

The monoecious flowers are placed in the axil, ordinarily one flower in each of them; in some cases a staminate and a pistillate flower are found in the same axil.

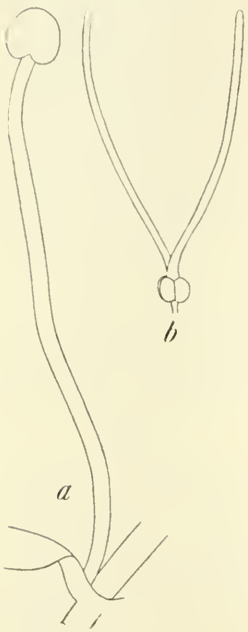


Fig. 18. *Callitriche longistyla* Norman? (Alten, Finmark) (× ca. 8). *a* staminate flower. *b* pistillate flower.

The arrangement is often the following (cf. Hegelmajer 1864 p. 36); low on the stem, i. e. early developed, pistillate flowers, higher on the stem, i. e. later developed, staminate ones and in the middle part a pistillate flower in one corner and a staminate flower in the other corner of the same pair of leaves, e. g. in *C. hamulata* from a river, Bjørnedal at Ivigtut, South Greenland.

The pollen from the only stamen of the male-flower is transported to the two long and thin stigmas, covered in most part of the length with oblong papillæ, by the wind according to Knuth and other authors, while some authors suppose hydrophily and entomophily to take place.

The stigmas of the above-mentioned form from Alten, Finmark — possibly *C. longistyla*, Norman — are exceedingly long (Fig. 18).

The stigmas of the flowers of *C. stagnalis* (gathered by C. H. Ostenfeld at Laugarne near Reykjavik, Iceland, Aug. 7. 1895, are longer than the fruit, while those of other flowers were shorter or of the same length as the fruit, as is common in this species. Warnstorff (1896 p. 27) observed flowers with such long stigmas on lateral shoots and supposed them to be fecundated below water, though he had not then found submerged male flowers.

Knuth (1899 p. 380) and Warnstorff (1896 p. 27) describe *C. verna* and *C. stagnalis* as anemophilous and protogynous, speaking of the sprout; in the small inflorescence of the axil, found in strong and well nourished specimens of these two species, the male flower is earlier developed than the female one, Hegelmaier (1864 p. 35); according to Ludwig (1881 p. 9) they are hydro-entomophilous.

In contradiction to this Hegelmaier (1864 p. 59) found *C. stagnalis* sterile, if quite submerged, and he supposes that such is also the case with *C. hamulata* (l. c. p. 56). According to Kerner[1] "the stamen of these flowers did not open at all". In Botany of the Færöes Ostenfeld (1908 p. 938) writes of *C. hamulata*, that it is pollinated by the wind but capable of self pollination, when the water is high and the flowers submerged, this accounting for the regularity of fruiting. Some plants of this species from Mödrúvellir and from Vallanes, Iceland, bear fruits; only linear leaves being present, the plants have probably been submerged. In a fruit from Vallanes, placed in the axil of a deeply emarginate leaf, 8·5 cm. from the top of the shoot, the embryos were developed, which shows, as far as might be concluded from a herbarium specimen, that Hegelmaier is not right in supposing that submerged fruiting does not take place.

The fecundation of the more simply built flowers of *C. autumnalis* as well as those of other *Pseudocallitriche* is effected below the water. It has been studied by Jönsson (1884 p. 21); the pollen, the specific gravity of which is less than that of the water, is filled with oil.

As in temperate regions the abundance of fruits is largest

[1] quoted from Knuth's Blüthenbiologie.

in terrestrial plants, but even in shoots which appear to have been submerged, e. g. from Iceland (Aug. 24. 1894, Ol. Davidsson), three fruits to one pair of leaves, i. e. two in one of the axils, may be found.

Some of the plants of *C. hamulata* (from Godthaab, West-Greenland 64° 11′ N. L. Septb. 31. 1907, dr. Søren Hansen) are only 2 cm. long and yet fruiting; also in the small specimens of *C. autumnalis*, 1·3—3·2 cm. long, from shallow water, only c. 0·33 m. deep, from a lake in West-Greenland (Hammersdal, Disco 70° 9′ N. L., M. P. Porsild) fruits are present. Irmisch (1859 p. 354) observed flowers in the first pair of leaves of *C. verna*, both on the primary stem and on the shoot from the cotyledonary axil.

Fig. 19. *Callitriche verna L.* (× ca. *16*) Embryo.

As a rule all parts of the quadrisulcate separating fruit have been developed, all of them containing an embryo (fig. 19). Sometimes only two or three parts have been developed, e. g. in *C. stagnalis* from Laugarne (at Reykjavik, Iceland, C. H. Ostenfeld Aug. 7. 1895) this is rather common.

The material of *C. autumnalis* being very small and only herbarium specimens, only a few fruits have been examined; some of these contain three embryos; thus they do not correspond to v. *lunulifera* Norm. from the farthest North (Hartman p. 383) with only two separating fruits developing. Judging from the abundance of well-developed embryos, seedlings should be expected to be very common; Hartz (1895 p. 278) found *C. verna β minima* only as seedlings in the middle of July in an early ice-free lake on Danmarks Ø 70° 27′ N. L., East Greenland. Some of the specimens of the material are seedlings.

But vegetative propagation is probably frequent in the far North as well as in the temperate zone, where (Sernander 1901 p. 157 etc.) many shoots are set free all the year round in water free of ice.

If cultivated they grow and roots are developed even on very small pieces. "In *C. autumnalis* the vegetative propagation might be less important than in the other species. The vegetative shoots, however, with their air-channels act as an excellent floating apparatus for the heavy fruits, which, if isolated, immediately sink to the bottom. Within the other species too the fruits are generally carried with the mother-plant" (Sernander). Kolpin Ravn had also observed (1894 p. 178), that the fruits of *C. autumnalis* were unable of themselves to float.

Thus their wings are in that respect of no use.

Isolated seedlings of *C. stagnalis* were found among the flotsam in the course of the summer in Sweden (Sernander l. c. p. 157 and 82).

Summary.

As was to be expected the plants examined, being aquatic plants, show no morphological or other peculiarities except in size, which could with certainty be referred to arctic conditions. Aquatic plants as is well known are subject to great variations, such variations being very dependent on external conditions, probably mainly of a nutritious nature, as has especially been pointed out by Goebel (1893, 1908 etc.) and Küster (1903). This being granted, it seems natural, that these variations largely depend on light conditions, — seen for instance in the differences between specimens from deep and from shallow water —, because of the assimilation which does not preclude the light from also in other ways having effect on the variations.

Thus, the numerous small differences met with may be due only to local circumstances.

But in size the specimens from Greenland are on the whole smaller, both those of *Hippuris*, *Myriophyllum* and *Callitriche*

— and the specimens of *M. spicatum* and *Callitriche* are also less robust than those from Iceland and the Færöes, which show no obvious differences from plants from other temperate regions. The shorter period of vegetation might suffice to explain the smaller size, but in the case of the robustness, e. g. of the leaves, other circumstances must also be active, very likely amongst others temperature of the water. But investigations relative to this must be carried out on the spot and combined with experiments.

Whether the quantitative peculiarities of *Hippuris* from Greenland — the smaller number and the relatively greater breadth of the leaves together with the fewer circles of air-channels of the stem — which features might possibly all be regarded as reduction — are constant characters, the arctic *Hippuris* thus being a special systematic form, or whether they would alter if exposed to other circumstances, can be decided only by investigations on living and cultivated plants.

My best thanks are due to Professor Warming for the kind interest taken in this work, to Dr. C. H. Ostenfeld for various, especially phytogeographical items of information and for having controlled the determination of some species, further to the Director of the Danish arctic station at Disco, mag. sc. M. P. Porsild for the above-quoted notes on the biology of *Hippuris* in Greenland and for several other communications.

Additional Note. About *C. autumnalis* mag. sc. Porsild has given me the following information. "It was growing on gytje on the lee-side of a shallow pond, the windward side being without vegetation. It must be supposed to remain frozen in the ice from the beginning of Octbr. until late in May, when the ice melts at the border, while in the middle it remains until late in June, at least".

20.—6.—1910.

Arbejder fra den Botaniske Have i København. Nr. 61.

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 9

SÆRTRYK AF «MEDDELELSER OM GRØNLAND» XLIII

LICHENS

FROM

NORTH-EAST GREENLAND

(N. OF 76° N. LAT.)

COLLECTED BY THE "DANMARK-EXPEDITION" 1906—08

DETERMINED

BY

OLAF GALLØE

KØBENHAVN

BIANCO LUNOS BOGTRYKKERI

1910

The work of the "Danmark-Expedition" has brought to a preliminary close the purely floristic side of lichen collecting in Greenland, as practically the whole coast of the land has now been investigated. Later collections will assuredly be able to find one thing or another new, but we already have a view over the floristic character of the lichen vegetation, thanks to the persevering scientists who in the course of time have added to the collections in the Botanical Museum of Copenhagen.

What has been known hitherto of the Greenland lichens is to be found mainly in the papers by Deichmann Branth and Grønlund in the "Meddelelser om Grønland", Hefte III (1888) and the Appendix (ibidem 1892), as also in later papers by Branth and by Wainio (ibidem Hefte XVIII and XXX).

Our floristic knowledge now extends so far, that it will undoubtedly be of greatest interest to begin a biological and ecological investigation of these plants, not only for the arctic species but also for the species of the whole world. Far too little attention has hitherto been paid to the part played by the lichens in the existing plant-associations and to the mutual relations between the lichens and the widely different natural conditions offered them at their varied and different places of growth.

The species mentioned here have almost all been found in Greenland before. A single species is however remarkable, as it has hitherto not been found in that country, or at least is not present in the collections of our Museum, namely *Dufourea muricata*, which was found for the first time in arctic regions by Th. Fries in Spitzbergen.

A discussion of the correctness of the more difficult species has been omitted, as it would lead as too far here — even though the subject might in itself be tempting for several Parmelia species and a few others.

Under each species reference is made to a main work, where further information on the literature can be obtained.

The following is the principal literature:

1. J. S. DEICHMANN BRANTH og CHR. GRØNLUND: Grønlands Lichen-Flora. Meddelelser om Grønland. Hefte III. Kjøbenhavn 1888.
2. J. S. DEICHMANN BRANTH: Tillæg til Grønlands Lichen-Flora (ibid. 1892).
3. J. S. DEICHMANN BRANTH: Lichener fra Scoresby Sund og Hold with Hope. (ibid. XVIII 1896).
4. DUC d' ORLÉANS: Croisière océanographique . . . . dans la mer du Groenland. Botanique. Bruxelles 1908. (Here in: Lichens, déterminés par J. S. Deichmann Branth).
5. FRIES, TH.: Lichenes Arctoi etc. Upsaliæ 1860.
6. FRIES, TH.: Lichenes Scandinavici vol. I. Upsaliæ 1871—74.
7. FRIES, TH.: Lichenes Spitsbergenses Kongl. Svenska Vet.-Akad. Handl. Bd. VII Nr. 2. Stockholm 1867).
8. C. H. OSTENFELD og ANDR. LUNDAGER: List of vascular plants from north-east Greenland etc. (Meddelelser om Grønland XLIII. Kjøbenhavn 1910).
9. EDW. WAINIO: Lichenes expeditionis G. AMDRUP (Medd. om Grønl. XXX. 1905).

The material for the present list was collected by Mr. ANDREAS LUNDAGER.

With regard to the position of the places where the various species were taken I may refer to the above-cited work of OSTENFELD and LUNDAGER.. They lie mainly about Danmarks Havn, 76° 46′ n. L.

SYSTEMATIC LIST OF THE LICHENS.

Usnea Dill.

1. **Usnea melaxantha** Ach. Th. Fries, Lich. arct. p. 24. — Branth og Grønl.: Grønl.s Lichen-Flora, p. 464.

Loc.: Cape Bismarck, Danmarks Havn.

Common among stones, where it grows abundantly; found also on hilly ground, on stones.

Bryopogon Link.

2. **Bryopogon jubatus** L. *β. nitidulum* Th. Fr. Th. Fries: Lich. arct. p. 25. — Branth og Grønlund: Grønlands Lichen-Flora p. 464.

Loc.: Termometerfjeld (among moss, on the ground); Danmarks Havn (on the ground).

Alectoria Ach.

3. **Alectoria Thulensis** Th. Fr. Th. Fr. Lich. arct. p. 28. — Branth og Grønlund: Grønlands Lichen-Flora p. 465.

Loc.: Termometerfjeld (on the ground, among moss); at the Danmarks Havn (on ground about the moss); common.

Cornicularia Ach.

4. **Cornicularia aculeata** (Ehrh.). Th. Fries: Lich. arct. p. 30. — Branth og Grønlund p. 465.

Loc.: Termometerfjeld (on sandy ground).

Cetraria Ach.

5. **Cetraria islandica** L. Th. Fries: Lich. arct. p. 35. — Branth og Grønlund p. 466. — All the specimens found belong to var. *Delisei* Bory.

Loc.: Termometerfjeld (on the ground, among moss).

6. **Cetraria odontella** Ach. Th. Fries: Lich. arct. p. 36. — Branth og Grønlund p. 466.

Loc.: Termometerfjeld (on the ground), Danmarks Havn (on the ground), the Bay (on the ground, among moss), Snenæs (on the ground), Storm Kap (among moss).

7. **Cetraria nivalis** L. Th. Fries: Lich. arct. p. 37. — Branth og Grønlund p. 466.

Loc.: Termometerfjeld (very common on sandy ground), Danmarks Havn (among moss on the ground), the Bay (on the ground), Snenæs (on the ground).

8. **Cetraria Fahlunensis** (L.) Schær. Th. Fries: Lich. scandinavici p. 108. — Branth og Grønlund p. 471.

Loc.: Danmarks Havn (among moss).

Nephroma Ach.

9. **Nephroma papyraceum** Hoffm. Lich. arct. p. 42. — Branth og Grønlund p. 467.

Loc.: Termometerfjeld (on mosscovered ground).

Peltigera Hoffm.

10. **Peltigera rufescens** Fr. Lich. arct. p. 45. — Branth og Grønlund p. 468.

Loc.: Hvalrosodde (on a withered tuft), Basiskær (on mossy ground), Danmarks Havn (damp soil above moss).

Peltidea (Ach.) Nyl.

11. **Peltidea aphtosa** L. Lich. arct. p. 43. — Branth og Grønlund p. 468.

The locality is not exactly indicated in the material collected. — On a dead Empetrum tuft.

Solorina Ach.

12. **Solorina crocea** L. Lich. arct. p. 48. — Branth og Grønlund p. 469.

Loc.: Termometerfjeld (on the ground), Danmarks Havn (on clay ground).

Parmelia Ach.

13. **Parmelia saxatilis** L. Lich. arct. p. 52. — Branth og Grønlund p. 469.

Loc.: Termometerfjeld (on stones); only the variety *omphalodes* L. was found.

14. **Parmelia encausta** Sm. Lich. arct. p. 54. — Branth og Grønlund p. 470.

Loc.: Occurs very frequently with the variety *intestiniformis* Vill., for example at Termometerfjeld, at Danmarks Havn and at Basiskær, everywhere on stones.

15. **Parmelia stygia** L. Lich. arct. p. 57. — Branth og Grønlund p. 470.

Loc.: Varde Ridge (on stones).

16. **Parmelia alpicola** Th. Fr. Lich. arct. 57. — Branth og Grønlund p. 470.

Loc.: Danmarks Havn (on stones).

17. **Parmelia lanata** L. Lich. arct. p. 58. — Branth og Grønlund p. 470.

Loc.: North Koldewey Island (on stones), Termometerfjeld (on stones), Danmarks Havn (on stones), Basiskær (common on stones).

Physcia Fr.

18. **Physcia pulverulenta** Schreb. Lich. arct. p. 63. — Branth og Grønlund p. 472.

Loc.: Termometerfjeld, Basiskær, Danmarks Havn, the Bay, Snenæs, at all places above moss on the ground. All the specimens belonged to the variety *muscigena* Ach.

19. **Physcia stellaris** L. Lich. arct. 63. — Branth og Grønlund p. 472.

Loc.: Danmarks Havn (on ground among moss), Termometerfjeld (on stones), a single specimen on a decayed reindeer horn.

Xanthoria Fr.

20. **Xanthoria elegans** Link. Lich. arct. p. 69. — Branth og Grønlund p. 473.

Loc.: very common, e. g. Hvalrosodde (on stones), Termometerfjeld (on stones), Danmarks Havn (ground and small stones), the Bay (on ground), Lille Snenæs (on bone).

21. **Xanthoria lychnea** (Ach.) Th. Fr. Th. Fries: Lich. scandinav. p. 146.

Loc.: Termometerfjeld (on ground), the Bay (on ground), (some specimens on a decayed reindeer horn).

Placodium Hill.

22. **Placodium fulgens** (Sw.) Lich. arct. p. 81. — Branth og Grønlund p. 475.

Loc.: Danmarks Havn (on ground), Lille Snenæs (on ground). All the specimens belong to the variety *alpinum* Th. Fr.

Acarospora Mass.

23. **Acarospora smaragdula** Wnbg. Lich. arct. p. 92. — Branth og Grønlund p. 477.

Loc.: Termometerfjeld (on stones).

Lecanora Ach.

24. **Lecanora tartarea** L. Lich. arct. p. 99. — Branth og Grønlund 478.

Loc.: Termometerfjeld (moss-covered ground), Danmarks Havn (above moss on the ground).

25. **Lecanora Hageni** Ach. Lich. arct. p. 106. — Branth og Grønlund p. 479.

Loc.: Basiskær (on dead moss on the ground), Danmarks Havn (on dead Dryas), the Bay (on ground), Hvalrosodde (on decayed whale-bones), Snenæs (on decayed whale-bones), further some specimens on an old reindeer horn.

26. **Lecanora polytropa** Ehr. Lich. arct. p. 110. — Branth og Grønlund p. 481.

Loc.: Danmarks Havn (on stones); all the specimens belonged to the variety *conglobata* (Smrft).

27. **Lecanora cenisea** Ach. Lich. arct. p. 115. — Branth og Grønlund p. 480.

Loc.: Lille Snenæs (on the hill, most abundant on the north side), Danmarks Havn (on stones).

28. **Lecanora bryontha** Ach. Lich. arct. p. 117. — Branth og Grønlund p. 481.

Loc.: Termometerfjeld (on the ground).

Caloplaca Th. Fr.

29. **Caloplaca cerina** (Ehrh.) Th. Fr. Th. Fr. Lich. scand. p. 173. — Branth og Grønlund p. 482.

Some few specimens on a decayed reindeer horn.

30. **Caloplaca pyracea** (Ach.) Th. Fr. Lich. scand. p. 178. — Branth og Grønlund p. 482.

Loc.: Lille Snenæs (on decayed bone), as also several places on reindeer horn and on raw humus ground among moss.

31. **Caloplaca Jungermanniæ** (Vahl) Th. Fr. Lich. scand. p. 180. — Branth og Grønlund p. 482.

Loc.: Basiskær (on ground over dead moss), Danmarks Havn (on ground), the Bay (on dead moss), as also at one place on reindeer horn. — All the specimens belonged to the variety *subolivacea* Th. Fr.

32. **Caloplaca ferruginea** (Huds.) Th. Fr. Lich. scand. p. 184. — Branth og Grønlund p. 482.

Loc.: Several places not exactly indicated, on stones (and moss). All the specimens belonged to the variety *nigricans* Tuckerm.

33. **Caloplaca vitellina** (Ehrh.) Th. Fr. Lich. scand. p. 188.

On decayed reindeer horn (well-developed, with apothecia), also several places as a rule sterile (and thus easily mistaken).

34. **Caloplaca subsimilis** Th. Fr. Lich. scand. p. 189.

Loc.: Termometerfjeld (among moss on the ground), Lille Snenæs (on whale bone), as also sterile at several places.

Rinodina Mass.

35. **Rinodina turfacea** Wnbg. Lich. arct. p. 126. — Branth og Grønlund p. 483.

Loc.: Termometerfjeld (on moss).

36. **Rinodina mniaroea** Ach. Lich. arct. p. 127. — Branth og Grønlund p. 483.

Loc.: Termometerfjeld (on ground), Danmarks Havn (clay soil) — All the specimens belonged to the variety *cinnamomea* Th. Fr.

37. **Rinodina exigua** Ach. Lich. arct. p. 129. — Branth og Grønlund p. 483.

At several places (on wood) not exactly indicated.

Aspicilia Mass.

38. **Aspicilia calcarea** L. Lich. arct. p. 130. — Branth og Grønlund p. 484.

Loc.: not exactly given; on sand-stone. The specimen belongs to the variety *contorta* Hoffm.

Stereocaulon Schreb.

39. **Stereocaulon coralloides** Fr. Lich. arct. p. 142. — Branth og Grønlund p. 486.

Loc.: Varde Ridge (on ground), the Bay (on ground). All the specimens belonged to the variety *conglomeratum* Fr.

40. **Stereocaulon evolutum** Græwe. Lich. scand. p. 45.

Loc.: Varde Ridge (on ground), Danmarks Havn (on ground).

41. **Stereocaulon paschale** L. Lich. arct. p. 143. — Branth og Grønlund p. 485.

Loc.: Seems to be very common, e. g. Dove Bugt (on loose sand), Danmarks Havn (among moss), Cape Bismarck (on ground among moss), Varde Ridge (both on dry and damp ground, among moss), the Bay (among moss), Basiskær (on damp ground).

Cladonia Hoffm.

42. **Cladonia coccifera** (L.) Willd. Wainio: Monographia Clad. I p. 149. — Branth og Grønlund p. 488, Cl. carnucopioides.

Loc.: Renskæret (on mossy ground).

43. **Cladonia decorticata** (Floerke) Spreng. Wainio, Monogr. Clad. II p. 67.

Loc. Renskæret (on ground).

44. **Cladonia degenerans** (Floerke) Spreng. Wainio, Monogr. Clad. II p. 135. — Branth og Grønlund p. 487.

Loc.: Not exactly given; on ground.

45. **Cladonia pyxidata** (L) Fr. Wainio: Monogr. Clad. II p. 209. — Branth og Grønlund p. 487.

Loc.: Basiskær (on dry ground), Termometerfjeld (on sandy ground), Varde Ridge (on ground, in part over moss).

46. **Cladonia fimbriata** (L) Fr. Wainio: Monogr. Clad. II p. 246. — Branth og Grønlund p. 487.

Loc.: Danmarks Havn (on dry ground).

47. **Cladonia foliacea** (Huds.) Schaer. v. *alcicornis* (Lightf.) Schær. Wainio: Monogr. Clad. II p. 384. — Branth og Grønlund p. 484, Clad. *alcicornis*.

Loc.: Danmarks Havn (on dry ground, in part over moss; fairly common).
Note. In addition to the species mentioned here, there are also several very little developed specimens mong the other lichen samples; they cannot be determined in their present state.

Thamnolia Ach,

48. **Thamnolia vermicularis** Sw. Lich. arct. p. 161 — Branth og Grønlund p. 465.

Loc.: Hvalrosodde (among moss on the ground), Termometerfjeld (among moss on the ground), Danmarks Havn (on the ground).

Dufourea Ach.

49. **Dufourea muricata** Laur. Th. Fries: Lich. Spitsbergenses p. 10, in Kongl. Svenska Vetenskaps-Akad. handl. Bd. 7, Nr. 2. Stockholm 1867.

Loc.: Snenæs (on the ground).

Gyrophora Ach.

50. **Gyrophora hyperborea** Ach. Lich. arct. p. 164. — Branth og Grønlund p. 490.

Loc.: Termometerfjeld (on stones).

51. **Gyrophora erosa** Web. Lich. arct. p. 164. — Branth og Grønlund p. 490.

Loc.: Danmarks Havn (on stones), Renskæret (on stones).

52. **Gyrophora proboscidea** L. Lich. arct. p. 166. — Branth og Grønlund p. 490.

Loc.: Termometerfjeld (on stones), Danmarks Havn (on stones), Varde Ridge (on stones); seems to be common in North-East Greenland.

53. **Gyrophora cylindrica** L. Lich. arct. p. 166. — Branth og Grønlund p. 491.

Loc.: Termometerfjeld (on stones), Pustervig (on stones), Basiskær (on stones), Danmarks Havn (on stones), Varde Ridge (on stones, 200 m. above the sea).

Lopadium Koerb.

54. **Lopadium pezizoideum** Ach. Lich. arct. p. 201. — Branth og Grønlund p. 497.

Loc.: Termometerfjeld (on the ground).

Arthrorhaphis Mass.

55. **Arthrorhaphis flavo-virescens** Dicks. Lich. arct. p. 203. — Branth og Grønlund p. 493, *Bacidia citrinella*.

Loc.: Danmarks Havn (on the ground), Varde Ridge (on raw humus).

Lecidea Ach.

56. **Lecidea fuscoatra** L. Lich. arct. p. 210. — Branth og Grønlund p. 502.

Loc.: Renskæret (on stones).

57. **Lecidea lapicida** (Ach.) Fr. Lich. arct. p. 211. — Branth og Grønlund p. 499.

Loc.: Danmarks Havn (on stones).

58. **Lecidea auriculata** Th. Fr. Lich. arct. p. 213. — Branth og Grønlund p. 499.

Loc.: Danmarks Havn (on stones), Orléans Island (on stones).

59. **Lecidea sabuletorum** (Schreb.) Ach. Lich. arct. p. 214. — Branth og Grønlund p. 500.

Loc.: Danmarks Havn (on dry ground above dead moss). The material belonged to the variety *muscorum* (Wulf.).

60. **Lecidea enteroleuca** Ach. Lich. arct. p. 216. — Branth og Grønlund p. 500.

Loc.: Danmarks Havn (on stones).

61. **Lecidea atrobrunnea** Ram. Lich. arct. p. 218. — Branth og Grønlund p. 502.

Loc.: Renskæret (on stones).

62. **Lecidea limosa** Ach. Lich. scandinav. p. 538. — Branth og Grønlund p. 501.

Sporostatia Mass.

63. **Sporostatia Morio** Ram. Lich. arct. p. 224. — Branth og Grønlund p. 503.

Loc.: North Koldewey Island (on stones), Danmarks Havn (on stones). — All the specimens belonged to the variety *coracina* Smrft.

Buellia D. Not.

64. **Buellia insignis** Naeg. Lich. arct. p. 227. — Branth og Grønlund p. 504.

Loc.: Danmarks Havn (on the ground). — The whole of the material belonged to the variety *papillata* Smrft.

65. **Buellia triphragmioides** Anzi. Lich. scandinav. p. 594.

Loc.: Danmarks Havn (on moss).

Rhizocarpon Ram.

66. **Rhizocarpon geminatum** Flot. Lich. arct. p. 234. — Branth og Grønlund p. 507.

Loc.: Termometerfjeld (on stones), Danmarks Havn (on stones), Renskæret (on a large piece of quartz).

67. **Rhizocarpon geographicum** L. Lich. arct. p. 236. — Branth og Grønlund p. 507.

Loc.: Danmarks Havn (on stones).

Sphaerophorus Pers.

68. **Sphaerophorus coralloides** Pers. Lich. arct. p. 244. — Branth og Grønlund p. 508.

Loc.: Renskæret (on ground among moss).

6—8—1910.

Fungi from prof. Warmings expedition to Venezuela and The West-Indies.

By

C. Ferdinandsen and O. Winge.

(Særtryk af „Botanisk Tidsskrift". 30. Bind.)

The fungi below mentioned, which were brought home by prof. Warming's expedition to Venezuela and The West-Indies 1891—92, are collected partly in Venezuela, especially in the neighbourhood of Las Trincheras, partly in the islands of Trinidad and Barbadoes[1]; besides prof. Warming himself, the late baron Eggers and especially the late cand. Holger Lassen (H. L.) have participated in the collections; further a few specimens have been recorded by mag. C. Levinsen (cfr. text). The records from The Danish West-Indies are not treated in this paper, as the authors intend to give collectively a more exhaustive list of the fungi from here on a subsequent occasion. The number of species determined comes to 34, among which 4 new; of these again 2, *Myxotheca hypocreoides* and *Stilbochalara dimorpha* represent types of new genera. — Besides, we have examined several fungi of the families *Auriculariaceae*, *Tremellaceae*, *Polyporaceae* and *Pezizaceae* without its being possible, however, to determine the species with any certainty. The system and the synonymy used in our paper agree with those of Saccardo.

Phycomycetae.

Cystopus Ipomaeae-panduratae (Schw.) St. et Sw.

On leaves of *Ipomaea pes caprae* Roth.: Barbadoes, 11. 11. 91.

[1]) A single species only, namely *Pilocratera tricholoma* (Mont.) was also collected in Colombia.

Rhizopus nigricans Ehrbg.

On leaves and bark in a garden near Las Trincheras. — On a cacao-fruit: Las Trincheras, 25. 12. 91.

Basidiomycetae.

Aecidium Cissi Wint.

On leaves of *Cissus? sicyoides* L.: Las Trincheras, 15. 12. 91. — On *Cissus sicyoides* L: Barbadoes, November. — On a not determined host-plant: Barbadoes, near Bathseba.

Calocera palmata (Schum.) Fr.

Barbadoes: On a sleeper near Bathseba, 7. 11. 81 (H. L.).

Clavaria fistulosa Fr.

The spores on an average 11—13 μ × 7 μ; the fungus has quite the same appearance as our Danish species.

Caracas, June 91 (Eggers).

Hirneola auriformis (Schw.) Fr.

No locality, 31. 1. 91 (H. L. and Levinsen).

Hirneola fusco-succinea Mont.

Trinidad, Maravalli Valley, 30. 11. 91 (H. L.).

Hirneola nigra (Schw.) Fr.

Las Trincheras, 15. 12. 91 (H. L.).

Hirneola polytricha Mont.

? Las Trincheras, December 91 (H. L. and Levinsen).

Polystictus sanguineus (L.) Mey.

Las Trincheras: 2. 12. 91 (H. L.). — Trinidad, Botanical Garden (H. L.).

Schizophyllum commune Fr., forma.

On a dry branch in company with *Nectria subquaternata* B. et Br.: Las Trincheras, 14. 12. 91 (H. L.).

Schizophyllum multifidum (Batsch) Fr.

A somewhat differing form on a bamboo: Trinidad, Maravalli Valley, 30. 11. 91. (H. L.).

Thelephora palmata (Scop.) Fr.

Venezuela (Eggers nr. 12361).

Tremella fuciformis Berk.

Trinidad, Maravalli Valley, 30. 11. 91 (H. L.).

Xerotus tomentosus Kl.

On earth: Trinidad, Botanical Garden, 28. 11. 91 (H. L.).

Ascomycetae.

Anthostomella Puiggarii Speg.

Our specimens of this fungus, which show quite the same macroscopic appearance as the above species, differ as to the microscopic characters by having somewhat less compressed spores. Further Spegazzini states the species *A. Puiggarii* as "aparaphysata", while our fungus — as typically in the genus *Anthostomella* — shows paraphyses, $^1/_2\,\mu$ crass.

On leaves of *Bambusa*: Trinidad, Maravalli Valley.

Cordyceps sp.

Stroma intensely yellow, slender, clavate with sterile pointed apex, 3—4 cm. in hight, 2—3 mm. thick. The fruit unripe.

On a larva of *Chalcolepideus porcatus* from rotten wood: Las Trincheras 21. 12. 91 (C. Levinsen).

Dimerosporium eutrichum Sacc. et Berk.

On the under side of leaves of *Borreria* sp.: Trinidad, Maravalli Valley.

Glaziella vesiculosa Berk.

The orange-yellow, hollow, irregularly roundish, rugose fruit-bodies were, as commonly occurring, sterile.

On a rotten stub of a tree: Trinidad, Maravalli Valley, 28. 11. 91 (H. L.).

Glonium microsporum Sacc. var. americanum Starb.

On naked wood: Las Trincheras, 25. 11. 91 (H. L.).

Helotium (Helotiella) discula sp. n. — fig. 1.

Ascomatibus gregariis, sessilibus, juvenilibus cupulatis, maturis discoideo-explanatis, disco subconvexo, carnosulis, ad 750 μ diam., flavidis vel (in sicco) succineis, extus glabris. Ascis cylindraceo-clavatis, sessilibus, $43—56\,\mu \times 4^{3}/_{4}—6^{1}/_{2}\,\mu$, sporidia nonnumquam 8, sæpius — nonnullis frustratis — pauciora foventibus. Sporidiis oblique monostichis, fusiformibus, utrinque acutiuscule rotundatis, primo bi-guttulatis, ad maturitatem medio 1-septatis, non constrictis, $10^{1}/_{2}—14\,\mu \times 2^{1}/_{2}—3^{3}/_{4}\,\mu$, hyalinis. Paraphysibus filiformibus, aseptatis, circ. 1 μ crass., hyalinis, superne in clavulam usque 5 μ crassam, substantia oleosa, flavida repletam subito dilatatis, ascos parum superantibus. Membrana tota ascorum nec non paraphysibus jodi ope intense coerulescentibus.

Ad lignum subputridum decorticatum prope Las Trincheras Venezuelae (Leg. H. Lassen).

Las Trincheras, 25. 12. 91 (H. L.).

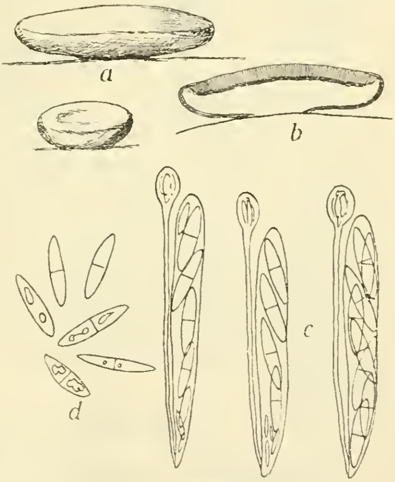


Fig. 1. *Helotium discula* sp. n.
a: Ascomata; *b*: Vertical section through an ascoma; *c*: Asci with paraphyses; *d*: Spores. (*a* and *b*: circ. $^{40}/_{1}$; *c* and *d*: $^{750}/_{1}$).

Lembosia Agaves Earle.

Our spores have at the full-ripe stage (totally brown) an average size of $17—20\,\mu \times 7—9\,\mu$ (against $14—16\,\mu \times 6—7\,\mu$ in Earles diagnose). The young asci are strongly thickened in the apex.

On *Agave* sp.: Loc. unknown, 18. 2. 92.

Leptosphaeria saccharicola P. Henn.

Our fungus on leaves of *Saccharum officinarum* shows quite the same characteristic macroscopical aspect as the above species, what also has been confirmed by comparing a type specimen of *L. saccharicola* Henn., benevolently committed to us by the Botanical Museum of Berlin. — Our asci are a little narrower (8—10 μ against 12—15 μ) and the spores somewhat broader ($5—5^{1}/_{2}\,\mu$ against 4 μ) as stated in Hennings' description of the species; unfortunately the type specimen examined did not contain any asci.

A type specimen of *Sphaerulina Sacchari* P. Henn., likewise sent to us from Berlin, is thoroughly identic with the above species as to the macroscopic aspect; in microscopic regards, however, the two species are undoubtedly differing from each other, in spite of several coincident characters.

On leaves of *Saccharum*: Trinidad, Maravalli Valley.

Meliola brasiliensis Speg.

Spores on an average 15—16 μ in breadth (against 18—20 μ in the type); sometimes are occurring perithecia, whose setae are provided with small stellated branches in the apex.

On *Hura crepitans* L. and various leaves of indeterminated host-plants: Las Trincheras, 15. 12. 91 (H. L.). — On withered, dry branches: The wood near Las Trincheras, 17. 12. 91 (H. L.). — On leaves: St. Esteban, 4. 1. 92 (H. L.). — On *Panicum divaricatum* L. and *Mangifera* sp.: Trinidad, Maravalli Valley, 30. 9. 91.

Myxotheca gen. nov.

Stroma epiphyllum, superficiale, tenue, membranaceum, structura indistincte pseudoparenchymatica, ambitu substrigosum, laeticolor. Asci in stromate singulatim sparsi, subglobosi, longiuscule stipitati, e centro communi 7—10 (— plures) orientes, membrana gelatinoso-deliquescente, ideoque quasi intra locellos mucosos inclusi, nullo autem strato parietino a stromate cingente limitati. Sporidia oblonga, curvula, dense tessellato-muriformia, flavida, deliquescentia ascorum et delapsu stromatis liberata.

Genus quoad affinitatem ambiguum, Myriangiaceis, inprimis *Ascomycetellae*, characteribus nonnullis accedens, prope Plectascineas utique inserendum.

Myxotheca hypocreoides sp. n.

Stromatibus in epiphyllo hinc inde sparsis, e mycelio intracellulari ortis, plaguliformibus, rotundatis, ad 1 mm. diam., vix 1/10 mm. altis, ex ascis maturis prominulis luteolis, zonula albida sterili substrigosa cinctis, membranaceis, structura tenuiter et indistincte pseudoparenchymatica. Ascis in stromate singulatim sparsis, monostichis vel subdistichis, juvenilibus plerumque profundius immersis, maturis — stratis cingentibus incremento protrusis — parum supra superficiem stromatis prosilientibus, subglobosis, ovoideo-globosis vel citriformibus, 70—80 μ long., 50—70 μ lat. (membrana gelatinosa excepta), deorsum in stipitem circ. 5 μ crass. (membrana excepta), long. bis—pluries diametrum ascorum superantem, transeuntibus. Stipitibus singulis seu hyphis ascigeris e centro communi 7—10 (—pluribus) egredientibus, evanescentibus. Membrana ascorum nec non stipitum mature gelatinoso-deliquescente, satis indistincte limitata, qua de causa asci singuli intra locellos gelatinosos inclusi et desuper visi circulo hyalino circumscripti videntur. Sporidiis octonis, conglobatis, e dorso cylindraceo-oblongis, medio turgidulis, e latere curvatis, utrinque rotundatis, medio (intus) ventricosis, tenuiter tunicatis, densissime murali-cellulosis, [septis transversalibus fere 20, longitudinalibus minus perspicuis, in fronte qualibet

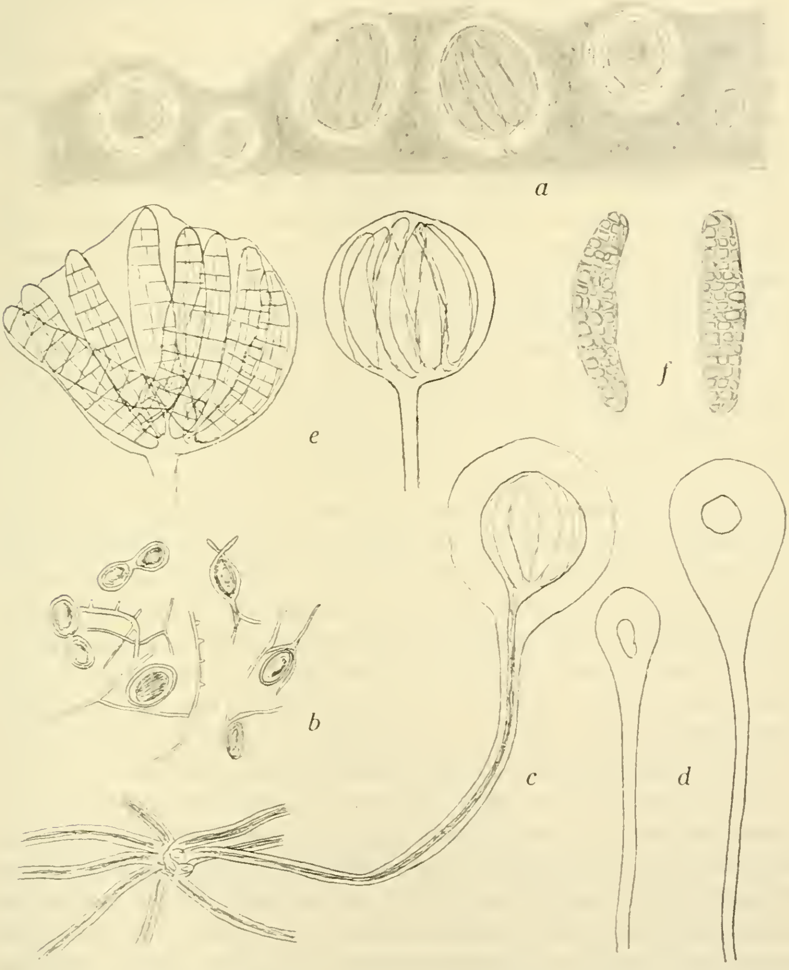


Fig. 2. *Myxotheca hypocreoides* gen. et sp. n.

a: Vertical section trough a part of the stroma; *b*: Isolated peripheral hyphae with coccoidal algae; *c*: Bundle of ascigerous hyphae; *d*: Young asci with a great nucleus; *e*: Elder asci with spores; *f*: Spores, dorsal and ventral view. (*a*: $^{200}/_1$; *b*: circ. $^{1000}/_1$; *c* and *d*: $^{225}/_1$; *e* and *f*: $^{375}/_1$).

plerumque binis], $64-74\,\mu \times 18-20\,\mu$, maturis flavidulis, deliquescentia ascorum et delapsu stromatis liberatis.

Ad pinnas languescentes *Trichomanis pinnati* Hedw. in valle Maravalli dicta insulae Trinidad. Leg. H. Lassen.

The above described interesting fungus, which lives, probably as a parasite, on the pinnae of *Trichomanes pinnatum*, was collected in the Maravalli-valley in Trinidad by H. Lassen. Unfortunately the material is very scarce, as upon the whole only a few stromata are at hand.

The small, in alcohol greyish, stromata seem at first sight to be hypocreaceous; in drying up they collapse and thereby disclose their delicate, membranaceous structure. Under the microscope they are seen (in vertical section) to be composed of a very thinwalled, small-celled, somewhat indistinct parenchyma, in which the asci come into view. In the sterile margin (and on the surface) the stroma appears somewhat byssoideous and as a rule the single hyphae can be distinguished; they are often uneven owing to very short branches, which project under a right angle. In many cases we have observed that these peripheral hyphae seize upon coccoidal algae (6—7 μ long.), the relation between the fungus and these algae however being of so superficial and fortuitous a character that there is by no means to be thought of a lichenisation (fig. 2 *b*). In the inner of the stroma appear a number of ascigerous cavities, each containing a single ascus; most frequently the asci are placed in 1—2 layers, as shows the fig. 2 *a*. The young asci are as a rule lying on a lower level and are encircled by a very thick gelatinous membrane; on increasing they distend the surrounding tissues and thereby approach to the surface of the stroma; the full-ripe ascus has a diameter almost equal to the height of the stroma and is provided with a gelatinous membrane, which, seen from above, appears as a conspicuous, light-refracting circle around the ascus. The liberation of the spores takes place by liquefaction of the asci and destruction of the upper part of the stroma; the tissues over the full-ripe ascus often project a little from the level of the surface of the stroma. There is no parietal layer around the single cavities, which however persist even when the asci are prepared out.

Owing partly to the great difference between the structure of the fungus and that of its substratum, partly to the fact that the single stromata are rather losely affixed to the surface of the leaf we did not succeed in cutting good microtome-sections of the material; the nuclei however appearing distinct in the stained sections we observed in the young asci a very great nucleus. Far better results were obtained by cutting the material, enclosed in cork, with a razor, or by gently smashing the single stromata under the microscope. By this latter method we happened to establish that the asci arise terminally on hyphae, which in a number of 7—10 (— more) go out from a common starting-point (fig. 2 *c*). The walls of these ascogeneous hyphae, the length of which surpasses the diameter of the ascus twice or more, likewise deliquesce at an early stage, owing to which the proximal parts of the hyphae easily disappear, the common origin of the latter thus being difficult to recognize. In this our fungus reminds of the *Microascus sordidus* Zukal (Bericht. Deutsch. Bot. Gesellsch. 1899 p. 297), the ripe asci namely appearing isolated in their respective cavities (fig. 2*a*).

When trying on base of the above investigations of the fungus to place it in the system a difficulty arises from the fact that its relatives evidently are to be sought for among little known forms, which are not until now decidedly placed themselves, namely the Phymatosphaeriaceae. This family was founded by *Spegazzini* 1888 (Fung. Guaran. II p. 55) and by this author looked upon as related to the Tuberaceae, differing however from these "vegetatione aërea parasitica vel saprophytica, minutie et toto habitu." Saccardo (Syll. VIII p. 743) repeats Spegazzini's remarks without adding any critical note. In his work: Ascomyceten der ersten Regnellschen Expedition (Bihang K. Svenska Vetensk.-Akad. Handl. Bd. 25, Afd. III nr. 1 p. 37) Starbäck reconsiderates the question of the systematic placing of the Phymatosphaeriaceae, for which he claims the name Myriangiaceae, the genus *Phymatosphaeria* Pass. being identic with *Myriangium* Mont. et Berk. and this latter being formerly created[1]). As chief-result of his examinations Starbäck states that the relationship between the Myriangiaceae and the Tuberaceae (i. e. the Plectascineae of Fischer) is not to be overlooked — while on the other side the Myriangiaceae are connected with the Hypocreales and particularly the Dothideales. According to this author a likeness with the Hypocreales is to be found in the structure of the stroma, while on the other hand a difference arises from the fact that the Myriangiaceae are totally wanting perithecium-walls. As to this character they are in accordance with the Dothideales, because of which the author puts forward the view that a fungus of *Myriangium's* typus is to be compared to a *Dothidea* with polystichous perithecia, whereof each contains a single ascus.

It seems to us that a connection between the Myriangiaceae and the Plectascineae of Fischer is more obvious at least as to such tender forms as *Ascomycetella* and *Cookella*. We have not been able to examine any material of the genus *Ascomycetella*, while a *Cookella* is at hand in Rabenhorst's Fungi Europ. et extraeurop. (*Cookella quercina* (Peck) Sacc., nr. 3040). The rather rich and well preserved material of this last fungus being submitted to a closer investigation we found a certain amount of likeness to *Myxotheca*, while on the other side there is a distinct difference between the two types. The stroma of *Cookella* though

[1]) In his treatise: Des genres *Atichia* Fw., *Myriangium* Mont. et Berk., *Naetrocymbe* Koerb. (Strasbourg 1869) even Millardet states that the Myriangiaceae are to be regarded as genuine fungi, because of their being quite without gonidia during their whole course of development.

being thinner and less compact has the same structure as that of *Myxotheca*; in both fungi every single ascus is situated in a loculus, but in *Cookella* the asci are lying very closely together, sometimes pressing each other and by this reason becoming somewhat irregular (cfr. as to our fungus fig. 2 *a*); further, there is no trace of the long pedicels so characteristic in *Myxotheca*, as even the young asci are quite sessile. Finally there is a distinct resemblance between the asci of *Cookella* and those of higher ascomyceteous fungi (especially Perisporiaceae), the membrane being well limited and in younger asci thickened in the apex, while the ascus-membrane of *Myxotheca* at a very early stage becomes deliquescent and indistinct.

Thus *Myxotheca* is seen to present characters partly resembling to and partly differing from those of *Cookella*, the phylogenetic position of the first upon the whole appearing more primitive. In many respects the accordance between our fungus and lower forms of the Plectascineae is not to be mistaken; in this respect is namely to be pointed out: The loculi are quite without ostiola, and the spores become liberated by liquefaction of the asci and destruction of the stroma; the asci are developed from different starting-points; further the above mentioned unevenness of the peripheral hyphae suggests not unlikely a relation to the Gymnoascaceae (cfr. *Gymnoascus*, *Ctenomyces*). The long pedicels of the asci, joining in bundles from common starting-points — and the independence of the spore-apparatus in the face of the surrounding stroma: both these characters seem to be primitive. On the other hand the spores themselves have a highly differentiated form; it ought not to be overlooked, however, that muriform sporidia appear even on the still low phylogenetic level of the Myriangiaceae.

The definitive placing of the fungus in the system can be undertaken only when comparative examinations have been made on this too little known domain — and more new forms eventually have been discovered; until that *Myxotheca* most naturally finds its place among the Plectascineae in nearest relation, as it seems, to the Gymnoascaceae. Upwards, if this term be allowed, there are connecting points with the Myriangiaceae.

Nostocotheca ambigua Starb., which benevolently was sent to us from the Riksmuseum in Stockholm, presents no nearer connection with our fungus; macroscopically it appears rather *Erysiphe*-like, and also the microscopic characters seem to point towards the Perisporiales, namely thereby, that the asci of each glomerulus are aggregated in a sort of hymenium and separated from each other by paraphyses (cfr. Starbäck l. c.).

Trinidad, Maravalli Valley, 30. 11. 91.

Nectria subquaterna B. et Br. — fig. 3.

Synonyms (sec. Weese in lit.). *N. squamuligera* Sacc. 1875, *N.*

granuligera Starb. 1892, *N. farinosa* (P. Henn.) A. Moell. 1897, *N. subsquamuligera* P. Henn. et E. Nyman 1899, ? *N. botryosa* P. Henn. 1902, *N. subbotryosa* v. Höhn. 1907, *N. Cycadis* Rehm in herb. — The species enumerated are going over in *N. ochroleuca* (Schw.) Berk. (Grev. IV p. 16), within the range of which numerous species are belonging.

Dr. Weese of Vienna, who is at present monographing the genus *Nectria*, has most kindly determined our specimens of the above species on base of type specimens and given the above list of synonyms.

As the description by Berkeley and Broome is very incomplete we are here giving a detailed diagnosis and figures of this characteristic fungus.

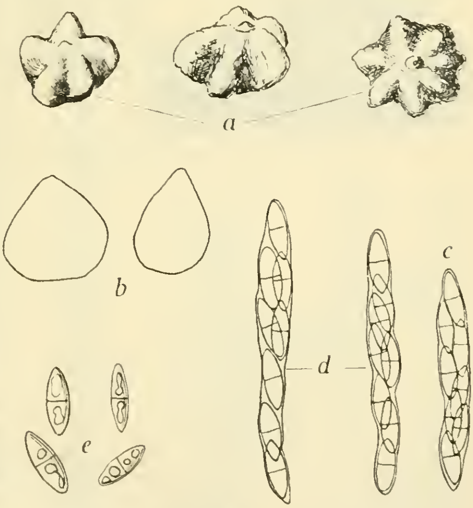


Fig. 3. *Nectria subquaternata* B. et Br.
a: Perithecia; *b*: Perithecia without covering; *c*: A young ascus; *d*: Ripe asci; *e*: Spores. (*a*: $^{45}/_1$; *b*: $^{70}/_1$; *c*, *d* and *e*: $^{800}/_1$).

Peritheciis nunc singulis, nunc in acervulos (stromatibus tubercularieis insidentes) pulvinatos, nonnumquam elongatos confluentesque coacervatis, globoso-subconicis, vestimento squamuloso profunde 5—9 longitudinaliter sulcato — ostiolis nudis exceptis — obsessis, indeque formam *Cerei* juvenis imitantibus, $^1/_1$—$^1/_3$ mm. diam., rubro-aurantiacis, in sicco subochraceis. Ascis juvenilibus subfusoideis, maturis cylindraceo-clavatis, tenuissime tunicatis, membrana sporidiis adjacente, 40—55 μ × 5—7 μ, sessilibus. Sporidiis octonis, superne subdistichis, inferne monostichis, ellipsoideo-fusoideis, 1-septatis, ad septum non constrictis, 10—14 μ × $3^1/_2$—$4^3/_4$ μ, hyalinis. Paraphysibus nullis.

Ad ramulos siccos corticatos prope Las Trincheras Venezuelae (Leg. H. Lassen).

The fungus grew in company with *Schizophyllum commune* Fr. and was collected near Las Trincheras, 14. 12. 91 (H. L.).

Pilocratera Hindsii (Berk.) P. Henn.

On earth: Venezuela, 4. 8. 91 (Eggers nr. 12413). — Trinidad, Maravalli Valley, 30. 11. 91 (H. L.).

Pilocratera tricholoma (Mont.) P. Henn., forma — fig. 4.

Ascomatibus profunde urceolatis, 1—2 cm. diam., nunc sessilibus, nunc stipite tenui, 3 mm. long, 1 mm. crass. suffultis, flavidis vel flavido-isabellinis, disco paulo obscuriore, extus costis longitudinaliter e basi in cupulam porrectis anastomosantibus venoso-rugosis, pruinosis, setis rigidis, concoloribus, ad 4—5 mm. altis, inprimis circa marginem obsessis. Setis simplicibus, coremiiformibus, ad basim usque 135 μ crass., apicem versus leniter attenuatis, ex hyphis dense septatis, 4—6 μ crassis, compositis. Ascis perfecte cylindraceis, crasse tunicatis, superne rotundatis, inferne in hypham ascigeram subito transeuntibus, 270—340 μ $\times$ 16—19 μ. Sporidiis ellipsoideis, utrinque acutiusculis, continuis, 1-pluriguttulatis, crasse tunicatis, 30—37 μ $\times$ 13—15 μ, hyalinis. Paraphysibus tenuissimis, ramosis, ascos obvallantibus, in fasciculos coremiiformes, plerumque 12 μ crass. conglutinatis, apicibus liberis, subclavatis, flavidulis. J. ÷.

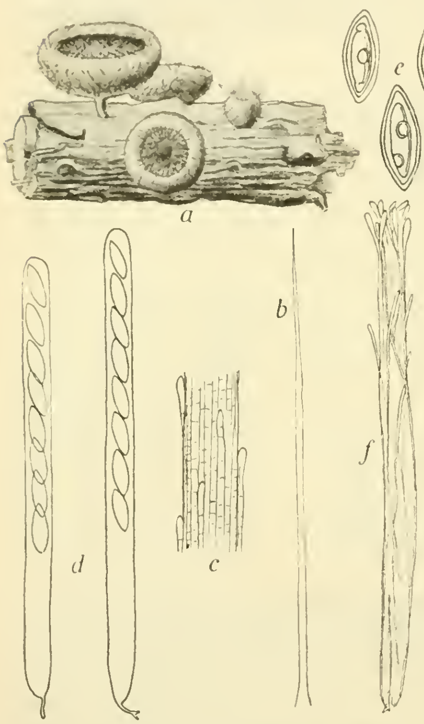


Fig. 4. *Pilocratera tricholoma* (Mont.) Henn., forma.

a: Habitus of the fungus; *b*: A seta; *c*: Part of a seta; *d*: Asci; *e*: Spores; *f*: A "coremium" of paraphyses. (*a*: 1/1; *b*: 15/1; *c*: 175/1; *d*: 225/1; *e*: 400/1; *f*: 335/1).

Ad lignum corticatum in monte Mt. Felix dicto Novae Granatae (leg. Eggers) et in silva insulae Trinidad. (Leg. H. Lassen).

Our specimens of the above species, which has been hitherto somewhat incompletely described, are differing from the type especially as to dimensions of the spores (30—37 μ $\times$ 13—15 μ against 30 μ $\times$ 10 μ).

To judge from the description *Pilocratera Engleriana* P. Henn. is quite identical with *P. tricholoma* as to the macroscopical appearance, and in microscopical regards it is only differing by having the spores somewhat broader (14—17 μ); by comparing, however, the form above diagnosed, which is found in the middle of the American area of *P. tricholoma* and undoubtedly is to be conferred to this species — it seems justified to suppose that also

P. Engleriana belongs within the range of *P. tricholoma*. As to the geographical distribution *P. tricholoma* is known from America and Ceylon, *P. Engleriana* is recorded from Kamerun.

Colombia, Mt. Felix, 1. 12. 89 (Eggers). — Trinidad, Maravalli Valley, 28. 11. 91 (H. L.).

Deuteromycetae.

Asterostomella paraguayensis Speg.

On the upper side of cacao-leaves. Our fungus shows a growth somewhat differing from that of the type, occurring namely in preference as a rather extended cover near the midrib of the leaves. Trinidad.

Coniosporium Bambusae (Thüm. et Bolle) Sacc.

Coniosporium pulvinatum A. L. Smith seems after the description not to be different.

On splinters of bamboos: Trinidad, Botanical Garden.

Penicillium glaucum Link

On bark: Las Trincheras. — On wood: Trinidad, 24. and 29. 11. 91 (H. L.).

Podosporium rigidum Schw. — fig. 5.

The figure of this fungus by Schweinitz (Syn. Fung. Amer. bor. t. XIX fig. 1, in Trans. Americ. Philos. Soc., Vol. IV, New Series, 1834) partly being somewhat indistinct, partly difficult of access[1]) we are here giving a new figure of it. The fungus grows as widely extended black covers on the band-like stem of a *Bauhinia* and is occurring in two different forms: most frequently it appears rather low and each caespitulum is composed of a bundle of stiff, brown, as a rule sterile hyphae, which are going out from a stroma being half-hidden under the periderm and formed as a truncated cone (*Exosporium*-form); in other cases, however, occurs the

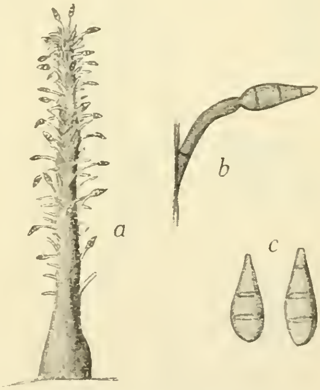


Fig. 5. *Podosporium rigidum* Schw. *a*: A coremium with conidia; *b*: A conidiophore bearing a conidium; *c*: Conidia. (*a*: 30/1; *b*: 200/1).

[1]) The plate in question thus was lacking in the copies of the above work in the Danish libraries, and we are much indebted to dr. Weese of Vienna, who was kind enough to send us a copy of the figure.

Stilbum-form as coremia being until 2 mm. in height. As shows the figure these coremia are producing conidia from their whole surface; the conidia are cylindric-clavate or obpyriform, 2—3 septated, 50—60 μ × 18—20 μ, and the average breadth of the conidiophores, which are somewhat varying in length, is about 10 μ.

On bark of *Bauhinia* sp.: Las Trincheras, 15. 12. 91 (H. L.).

Sterigmatocystis dipus sp. n. — fig. 6.

Hyphis repentibus septatis, 4—6 μ diam., hyalinis; fertilibus dipodibus, stricte erectis, non septatis nec ramosis, circ. 1 mm. alt., 13—18 μ crass., membrana 2 μ crassa praeditis, superne vesiculoso-inflatis, hyalinis, capitulum conidiorum globosum, fusco-nigrum, circ. 150 μ diam., gerentibus. Vesica globosa, hyalina, 40—45 μ diam., e basidiis affixis crebre punctata. Basidiis radiantibus, cylindraceo-clavatis, 15—25 μ long., superne $5^1/_2$—$7^1/_2$ μ crass., granuloso-farctis, fuscidulis, sterigmatibus plerumque 3 curte bacillaribus nec non subcuboideis, 7—9 μ × 5 μ, concoloribus coronatis. Conidiis catenulatis, inter se filamentis hyalinis, ad 5 μ long., circ. $^1/_2$ μ crass. conjunctis, globosis, 7—$8^1/_2$ μ diam., fuscis, verrucis echinatis, ad 1 μ long., hyalinis, nonnumquam deciduis, ornatis.

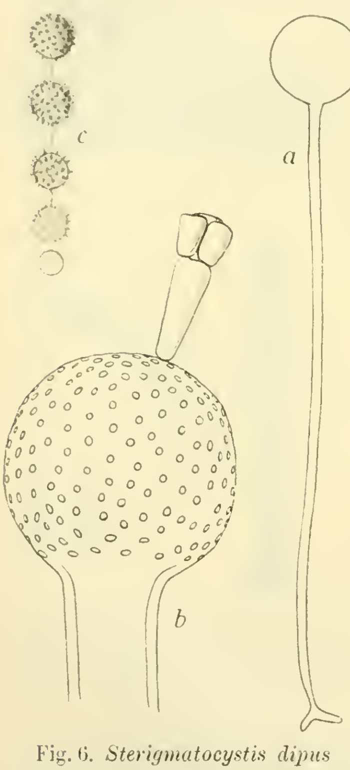


Fig. 6. *Sterigmatocystis dipus* sp. n.
a: A conidiophore; *b*: The upper part of a conidiophore with a single basidium; *c*: Part of a spore-chain. (*a*: 75/1; *b* and *c*: 450/1).

Ad fructus semiputridos *Theobromatis Cacao* L. socia *Stilbochalara dimorpha* nobis prope Las Trincheras Venezuelae. (Leg. H. Lassen).

On decaying fruits of cacao: Las Trincheras, 25. 12. 91 (H. L.).

Stilbochalara gen. nov.

Genus phaeostilbeum, conidia endogena *Chalarae* modo gignens. — Est *Chalara* stilbiformis.

Stilbochalara dimorpha sp. n. — fig. 7.

Synnematibus 2—$2^1/_2$ mm. altis, ad basim cylindraceis, alterum altero coalitis, nigro-fuscis, sursum liberis, penicillatis, e conidiis albo-pulverulentis.

Hyphis singulis pro ratione tenuissimis, flexilibus, sæpius ramosis, fuscis, crebre septatis, $4-5\,\mu$ ut plurimum crassis, superne *Chalarae* modo apertis, tubuliformibus, paulum infra tubulam apertam crassitudinem maximam, usque $9\,\mu$, attingentibus. Conidiis endogenis, seriatim e tubulis protrusis, dimorphis, aliis numerosissimis, hyalinis (catervatim brunneolo-tinctis), cylindricis, utrinque truncatis, membrana tenui, intus vacuolatis, $10-12\,\mu \times 4-5\,\mu$, aliis paucioribus, fuscis, ut plurimum ellipsoideo-cylindricis, membrana crassiore, 1—2 vacuolatis, $10-13\,\mu \times 5^1/_2-6^1/_2\,\mu$, paucis infra ultrave. Conidiis fuscis in cellulis propriis versus basim synnematis praecipue formatis, paucis autem, charactere sæpe intermedio, in iisdem tubulis, in quibus conidia hyalina gignuntur, inventis, semperque, quod si evenit, infra hyalinas observatis.

Ad fructus semiputridos *Theobromatis Cacao* L., Las Trincheras Venezuelae. Aderat *Sterigmatocystis dipus* nobis. (Leg. H. Lassen).

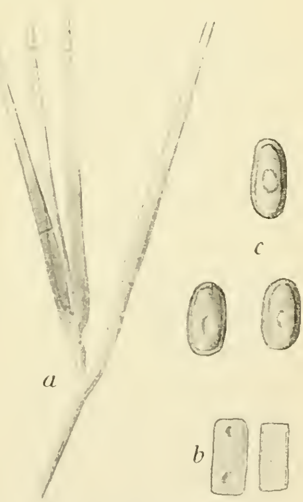


Fig. 7. *Stilbochalara dimorpha* gen. et sp. n.
a: Conidiophores from the upper part of the coremium; *b*: Hyaline, thin-walled conidia; *c*: Brown, thick-walled conidia. (*a*: $^{220}/_1$; *b* and *c*: $^{675}/_1$)

The coremia being connected with each other at their base the fungus forms a tomentose cover over the substratum; the single coremia produce from their upper part an endless multitude of hyaline, thin-walled conidia, and their habitus comes near to that of a *Stilbum*, to judge from a note of the collector: "Fungus, white-greyish in the top". — While the Chalareae until now are known but in dematieous forms, i. e. the conidiophores are always isolated, simple or seldom slightly ramified hyphae, it has by the discovery of this fungus been established that also forms of the *Stilbum*-typus are included in the family. The presence of this typus was beforehand to be expected, as so many hyphomycetes with exogene conidia are forming coremia, and as also in a well-known subgenus of *Chalara* (*Synchalara* v. Höhn.) the conidiophores are crowded closely together on a byssoideous subiculum.

As to the dimorphic conidia this phenomenon is previously noted within the range of the Chalareae. Thus *Chalara heterospora* Sacc. presents partly 1—3 septated, partly continuous conidia, and in *Thielaviopsis paradoxa* (de Seyn.) v. Höhn. is found, besides hyaline endogene conidia, oidium-like chains of bigger, brown, apparently exogene conidia. As to the dimorphic conidia of this fungus, v. Höhnel states (Hedw.

XLIII p. 295) that both forms can be referred to the same typus, that of the endogene conidia. "Zwischen beiden Sporenformen findet man alle Uebergänge, indem sich aus den hyalinen Sporen die dunklen grösseren entwickeln können. Dies geschieht aber nicht immer. Nicht selten bleibt die ganze Kette hyalin, oft sieht man solche Ketten, in denen ein Teil der Sporen hyalin, ein anderer dunkel ist. Manchmal findet das Ausreifen der Sporen so rasch statt, dass man noch in der Fruchthyphe eingeschlossene reife schwarze Sporen sieht. Die hyalinen Sporen stellen daher keine besondere Sporenform dar, sondern nur ein Entwickelungsstadium der braunen, auf dem diese letzteren zurückbleiben können. Die eigentlichen fertigen reifen Sporen sind die braunen". (v. Höhnel l. c., cited from Rabenhorsts Kryptogamenflora 1, 8, p. 757).

While also v. Höhnel states that "the spores properly so called" are represented by the brown ones, he admits on the other hand that the hyaline conidia not always are transformed into the brown ones but can remain at their earlier stage of development. — As to our fungus the production of the hyaline, thin-walled conidia is by far predominant and seems to be a quite normal form of sporulation (indeed these conidia have thoroughly the same aspect as shows generally *Chalara*-spores). It is a matter of fact that the conditions under which the brown, more thick-walled conidia become developed cannot be explored only preserved material being at hand; the thickening, however, of the membrane points towards their character of resting-spores, and not unlikely they are able to help the plant through unfavourable periods. As appearing from the diagnose the brown conidia can be found in the same tubuli as the hyaline ones (and often presenting an intermediate aspect), quite as in *Thielaviopsis*; especially, however, their formation is confined to tubuli near the basis of the coremium, i. e. as far localized. This fact suggests — coupled with the thickening of the walls in the brown conidia — that the dimorphism in this species is normal or at least being about to become established.

On decaying fruits of cacao: Las Trincheras, 25. 12. 91 (H. L.).

28—6—1910.

Arbejder fra den Botaniske Have i København. Nr. 63.

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 10

SÆRTRYK AF »MEDDELELSER OM GRØNLAND« XLIII

DIATOMS

FROM

NORTH-EAST GREENLAND

(N. OF 76° N. LAT.)

COLLECTED BY THE "DANMARK-EXPEDITION"

DETERMINED

BY

ERNST ØSTRUP

WITH PLATES XIII AND XIV

KØBENHAVN

BIANCO LUNOS BOGTRYKKERI

1910

The material on which the present work is based was given to me for investigation by the Commission for the "Danmark-Expedition."

The saltwater material consisted of (1) 13 **samples of Algæ,** as follows: —

Off **Cape Amélie**, 5 samples, preserved in glass vessels. The locality given in the text as "Off **Cape Amélie**."

Danmarks Havn, 3 samples, of which two are herbarium-material, and one in a glass vessel. The locality given in the text as "**Danmarks Havn**."

Along the peninsula, Cape Bismarck, 1 sample in a glass vessel. The locality in the text given as "Off Cape Bismarck."

Koldewey Ø, 4 samples, of which three are herbarium-material, and one in a glass vessel. The locality given in the text as "**Koldewey Isl.**"

and (2) **A series of samples from ice,** all preserved in glass vessels, 6 in all, as follows: —

76°20 N. lat., 18°20 W. long., land-ice off Germania Land, 1 sample. Given in the text as "Land-Ice."

75°14 N. lat., 4°34 W. long. The outer edge of the pack-ice, 4 samples. Given in the text as "**Margin of the Pack-Ice**."

75°14 N. Lat., 11°15 W. long., pack-ice, 1 sample. Given in the text as "**Pack-Ice**."

The freshwater samples are the same as those given to Dr. F. Börgesen for investigation of the freshwater algæ. There are in all 30 samples, partly preserved in glass vessels, and partly dried, in paper bags, but several of them contained such small quantities of material that it proved impossible to obtain serviceable preparations from the uncleansed material, let alone to submit it to a chemical cleansing! The freshwater samples are distributed among the different localities (the names of which are given unaltered in the text) as follows: —

Mallemukfjeld ...... 1 sample: some pebbles.
Hvalrosodde .... 5 samples, of which 4 in glass vessels, 1 dried material.
Dove Bugt .... 1 sample, dried powder.
Lille Snenæs .... 3 samples, of which 2 in glass vessels, 1: stone.
Snenæs .... 1 sample in a glass vessel.
Stormbugt .... 1 sample: two bones.
Stormkap .... 1 sample, dried material.
Danmarks Havn .... 2 samples in glass vessels.
Yderbugten .... 1 sample, dried material.
Vester Elv .... 7 samples, all in glass vessels.
Basiskæret .... 1 sample in a glass vessel.
Thermometerfjeld ... 3 samples, of which 2 dried material, 1: stone.
Cape Bismarck ..... 1 sample in a glass vessel.
Nostoc .... 1 sample, dried material.
Without locality .... 1 sample in a glass vessel.

As regards the distribution of the Diatoms collected by the "Danmark Expedition," I have, in the present work, exclusively considered the distribution within the Arctic region, and then I have used the following method: —

In regard to the **marine forms**: —

W. Greenl. denotes a form found along the coasts of West Greenland.
E. Greenl. — a form found along the coasts of East Greenland.
Greenl. — a form found along the coasts of both East and West Greenland.
E. of Greenl. — a form found by Ryder's Expedition on the ice or in plankton, and included in my Mar. D. f. Østg.
East Arct. S. — a form found in one of the other eastern Arctic Seas as far as the Strait of Behring.

In regard to the **freshwater forms**: —

W. Greenl. denotes West Greenland.
E. Greenl. — East Greenland.
Fz. Js. Ld. — Franz-Josef Land.
Spb. — Spitzbergen.
B. El. — Beeren Eiland.
J. M. — Jan Mayen.

MARINE DIATOMS.

PENNATÆ.

Diraphideæ.

Amphiprora Ehr., 1843.

Amphiprora gigantea Grun. var. *septentrionalis* Grun. Cl. Syn., I, 18; Cl. & Grun. A. D., Tab. V, fig. 87 (A. decussata sept.).

Loc. Danmarks Havn (Algæ), Marg. of the Pack-Ice.
Arct. Distr. Greenl., East Arct. S.

Kjellmanii Cl. var. *glacialis* Cl., Cl. Syn., I, 16; Cl. Vega Exp., Tab. XXXV, fig. 12 (A. glac.).

Loc. Marg. of the Pack-Ice.
Arct. Distr. E. Greenl., East Arct. S.

Auricula Castr., 1875.

Auricula minuta Cl., Cl. Syn., I, 21, Tab. I, figs. 7—8.

Loc. Off Cape Amélie (Algæ).
Hitherto recorded only from "Sweden, Gullmarsfjord on Zostera and among Amphipleura (Berkeleya) Dillwynii" (Cl. l. c.).

Tropidoneis Cl., 1891.

Tropidoneis longa Cl., Cl. Syn., I, 25, Tab. III, fig. 8.

Loc. Off Cape Amélie (Algæ).
Arct. Distr. Greenl., East Arct. S.

Pleurosigma W. Sm., 1852.

Pleurosigma elongatum W. Sm., Cl. Syn., I, 38; W. Sm. Syn. Tab. XX, fig. 199.

Loc. Koldewey Isl. (Algæ).
Arct. Distr. Greenl., East Arct. S.

Caloneis Cl., 1894.

Caloneis amphisbæna (Bory) Cl. var. *fuscata* Schum., Cl. Syn., I, 58; Cl. & Grun. A. D., Tab. I, fig. 27.

Loc. Dove Bugt.
Arct. Distr. East Arct. S.

Caloneis brevis (Greg.) Cl., Cl. Syn., I, 61; V. H. Trt., Tab. IV, fig. 180. (Nav. brev.).

Loc. Off Cape Amélie (Algæ, 3 sampl.)
Arct. Distr. W. Greenl., East Arct. S.

Caloneis kryophila Cl. var? *gelida* Cl., Cl. Syn., I, 64; Cl. Vega Exp., Tab. XXXVII, fig. 42. (Nav. kryoph.? gel.)

Loc. Marg. of the Pack-Ice (2 sampl.)
Arct. Distr. Greenl., East Arct. S.

Diploneis Ehr., 1840.

Diploneis borealis (Grun.) Cl., Cl. Syn., I, 96: Grun. Fz. Js. L., Tab. I, fig. 40 (Nav. Smithii bor.).

Loc. Off Cape Amélie Algæ, 5 sampl.), Koldewey Isl. (Algæ).
Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Diploneis coffæiformis (A. Sch.) Cl., Cl. Syn., I, 81; A. Sch. N. S. D., Tab. I, fig. 22.

Loc. Koldewey Isl. (Algæ).
Not before recorded from Arct. S. Several other records.

Diploneis Entomon Ehr., Cl. Syn., I, 87; Cl. & Grun. A. D., Tab. III, fig. 54 (Nav. bomboides A. Sch. var. media Grun.).

Loc. Danmarks Havn (Algæ), Koldewey Isl., (Algæ, 2 sampl.), Marg. of the Pack-Ice.
Arct. Distr. E. Greenl., East Arct. S.

Diploneis interrupta (Kütz.) Cl., Cl. Syn., I, 84; V. H. Trt., Tab. III, fig. 145.

Loc. Off Cape Amélie (Algæ, 2 sampl.), Koldewey Isl. (Algæ, 2 sampl.).
Arct. Distr. E. of Greenl., East Arct. S.

Diploneis littoralis (Donk.), Cl. var. *arctica* Cl., Cl. Baff. B., 18, Tab. I, fig. 7.

Loc. Marg. of the Pack-Ice (3 sampl.).
Arct. Distr. Davis Strait, E. of Greenl., East Arct. S.
In one of these samples a specimen of the present species has the following dimensions: Long. 66 μ, Lat. 25 μ.

Diploneis littoralis (Donk.), Cl. var. *hyperborea* Cl., Cl. l. c., Tab. I, fig. 1.

Loc. Marg. of the Pack-Ice.
Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Diploneis muscæformis (Grun.) Cl. var. *genuina* Cl., Cl. Syn., I, 83; A. S. Atl., Tab. XIII, fig. 47 (Navic. muscæf.).

Loc. Off Cape Amélie (Algæ).
Hitherto recorded only from Baku, Java and Camp. Bay.

Diploneis Smithii (Bréb.) Cl.. Cl. Syn., I, 96; W. Sm. Syn., Tab. XVII, fig. 152 a (Nav elliptic); Grun. Fz. Js. L., Tab. I, fig. 41.

Loc. Off Cape Amélie (Algæ, 3 sampl.), Danmarks Havn (Algæ, 2 sampl.).
Arct. Distr. Greenl., East Arct. S.

Diploneis splendida (Greg.) Cl., Cl. Syn., I, 87; A. Sch. N. S. D., Tab. I, fig. 3.

Loc. Danmarks Havn (Algæ), Koldewey Isl. (Algæ).
Arct. Distr. Greenl., East Arct. S.

Diploneis subcincta (A. Sch.) Cl., Cl. Syn., I, 86; Grun. Fz. Js. Ld., Tab. I, figs. 38—39.

Loc. Off Cape Amélie (Algæ, 4 sampl.), Danmarks Havn (Algæ), Koldewey Isl. (Algæ, 3 sampl.).
Arct. Distr. E. Greenl., East Arct. S.

Diploneis vacillans A. Sch. forma β, Cl. Syn., I, 95; A. S. Atl., Tab. VIII, fig. 34.

Loc. Off Cape Amélie (Algæ).
Not before recorded from Arct. S. Several other records.

Naviculæ fusiformes Cl., 1894.

Navicula fusiformis, Grun. var. *ostrearia* Gaillon, Cl. Syn., I, 106; V. H. Trt., Tab. XXVII, fig. 769.

Loc. Koldewey Isl. (Algæ).
Not before recorded from Arct. S. Several other records.

Naviculæ orthostichæ Cl., 1894.

Navicula kryokonites Cl. var. *subprotracta*, Cl. Syn., I, 109; Cl. Vega Exp., Tab. XXXVII, fig. 46.

Loc. Marg. of the Pack-Ice (3 sampl.).
Arct. Distr. E. of Greenl., East Arct. S.

Navicula rostelloides sp. nova. Tab. nost. XIII fig. 1. cf. Øst. Mar. D. Østg., 426, Tab. VI, fig. 73 (Nav. Rostellum W. Sm.).

Long. 22 μ. Lat. 10 μ. Str. minime 22 in 10 μ.

Valva lanceolata-elliptica, apicibus brevissime subrostratis. Raphe area hyalina angustissima, distincta autem, cincta. Striis parallelis, apices versus subradiantibus et, qvoad perspicere potui, altera in parte media valvæ deficientibus ibiqve fasciam unilateralem male definitam relinqventibus.

Loc. Marg. of the Pack-Ice.
Arct. Distr. E. of Greenl.

I had previously given this species as Nav. Rostellum W. Sm., which Cleve (Syn., II, 4) refers to Nav. Placenta Ehr. If, however, Nav. Rostellum should prove to be identical with Nav. Placenta then the present species cannot be Nav. Rostell., because it has not got the characteristic decussate striation of Nav. Placenta. As I have not been able to see any punctation of the striæ I place it, but with hesitation, under *Naviculæ orthostichæ* and as perhaps most nearly allied to *Nav. kryokonites* Cl.

Navicula Spicula (Hickie) Cl., Cl. Syn., I, 110; V. H. Trt., Tab. I, fig. 53 (Stauron. Spic.).

Loc. Marg. of the Pack-Ice.
Arct. Distr. E. of Greenl., East Arct. S.

Navicula Wankaremæ Cl., Cl. Syn., I, 109; Cl. Vega Exp., Tab. XXXVII, fig. 47 (Nav. kryokoniles? Wank.).

Loc. Pack-Ice, Marg. of the Pack-Ice.
Arct. Distr. East Arct. S.

Navicula vitrea Cl., Cl. Syn., I, 111; Cl. & Grun., A. D., Tab. IV, fig. 78 (Pleurosigma vitreum).

Loc. Marg. of the Pack-Ice.
Arct. Distr. Davis Strait, E. of Greenl., East Arct. S.

Gyrosigma Hass., 1845.

Gyrosigma arcticum Cl., Cl. Syn., I, 119; Perag. Pleuros., Tab. X, figs. 16—17 (Rhoicosigma arct.).

Loc. Off Cape Amélie (Algæ, 2 sampl.), Marg. of the Pack-Ice (2 sampl.).
Arct. Distr. W. Greenl., East Arct. S.

Amphipleura Kütz., 1844.

Amphipleura rutilans Trentepohl, Cl. Syn., I, 126; V. H. Trt., Tab. V, fig. 255 (Berkeleya Dillwynii).

Loc. Koldewey Isl. (Algæ, 2 sampl.).
Arct. Distr. Greenl.

Amphipleura rutilans Trentepohl var. *antarctica* (Harvey) Grun., V. H. Syn., Tab. XVI, fig. 20 (Berkeleya antarct.).

Loc. Koldewey Isl. (Algæ).
Not before recorded from Arct. S. Other records, North Sea, Falkland Isls., Friendly Isls. (Cl. l. c.).

Naviculæ decipientes Grun., 1880.

Navicula subinflata Grun., Cl. Syn., I, 141; (Cl. Vega Exp., Tab. XXXVII, fig. 50). V. H. Trt., Tab. XXVII, fig. 760.

Loc. Off Cape Amélie (Algæ, 2 sampl.), Marg. of the Pack-Ice.
Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Naviculæ microstigmaticæ Cl., 1894.

Stauroneis perpusilla Grun., Cl. Syn., I, 146; Grun., Fz. Js. L., Tab. I, fig. 50.

Loc. Marg. of the Pack-Ice (3 sampl.).
Arct. Distr. E. of Greenl., East Arct. S.

Stauroneis pellucida, Cl. var. *contracta* Øst., Øst. Mar. D. Østg., 440, Tab. V, fig. 62.

Loc. Marg. of the Pack Ice.
Arct. Distr. E. of Greenl.

Navicula Grevillei Ag., Cl. Syn., I, 152; V. H. Trt., Tab. V, fig. 243 (Schizonema Grev.).

Loc. Off Cape Amélie (Algæ), 2 sampl.).
Arct. Distr. Greenl., East Arct. S.

Navicula rhombica Greg., Cl. Syn., I, 152; Greg. T. M. S., IV, Tab. V, fig. 1.

Loc. Koldewey Isl. (Algæ).
Arct. Distr. W. Greenl.

Navicula scopulorum Bréb., var *arctica* var. nova. Tab. nost XIII, fig. 10.

Long. 57 μ. Lat. 7 μ. Str. minime 22 in 10 μ, debilissimis et ægre perpiciendis.

Valva lineari, inter apices rotundatos et mediam partem leniter contracta. Raphe area distincta hyalina cincta. Striis parallelis, sub apices, qvoad perspicere potui, convergentibus, media in parte valvæ deficientibus fasciamqve latam relinqventibus. Nodulis terminalibus ab apicibus remotis.

Loc. Koldewey Isl. (Algæ).
This form is probably most nearly allied to Nav. Scop. Bréb var. *belgica* H. V. H. (cf. Perag. Mar. Diat. d. Fr., Tab. VIII, fig. 27).

Gomphonema Ag., 1824.

Gomphonema exiguum Kütz., var. *arcticum* Grun., Cl. Syn., I, 188; V. H. Syn., Tab. XXV, fig. 30 (Gomph. arctic.).

Loc. Off Cape Amélie (Algæ), Pack-Ice.
Arct. Distr. Greenl., East Arct. S.

Gomphonema groenlandicum Øst., Øst. Mar. D. Østg., 414; Tab. III, figs. 11—12.

Loc. Koldewey Isl. (Algæ), Off Germ. L. (Land-Ice), Marg. of the Pack-Ice (3 sampl.).
Arct. Distr. Davis Strait., E. of Greenl., East Arct. S.

Gomphonema kamtschaticum Grun., Cl. Syn., I, 188; V. H. Syn., Tab. XXV, fig. 29.

Loc. Danmarks Havn (Algæ), Koldewey Isl. (Algæ, 3 sampl.).
Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Gomphonema septentrionale Øst., Øst. Mar. Diat. Østg., 414, Tab. III, fig. 9.

Loc. Pack-Ice, Marg. of the Pack-Ice.
Arct. Distr. E. of Greenl.

Gomphonema septentrionale Øst., var. *angustum* Øst., Øst. l. c., fig. 10.

Loc. Pack-Ice, Marg. of the Pack-Ice.
Arct. Distr. E. of Greenl.

Trachyneis Cl., 1894.

Trachyneis aspera (Ehr.) Cl., var. *genuina* Cl., Cl. Syn., I, 191; V. H. Trt., Tab. IV, fig. 165 (Nav. asp.).

Loc. Off Cape Amélie (Algæ).

Not before recorded from Arct. S. Several other records.

Trachyneis aspera (Ehr.) Cl., var. *vulgaris* Cl., A. S. Atl., Tab. XLVIII, figs. 2—6 (Nav. asp.).

Loc. Koldewey Isl. (Algæ).

Arct. Distr. W. Greenl.

Trachyneis aspera (Ehr.) Cl., var. *intermedia* Grun., A. S. Atl., l. c. fig. 14.

Loc. Off Cape Amélie (Algæ, 5 sampl.), Danmarks Havn (Algæ), Off Cape Bismarck (Algæ), Koldewey Isl. (Algæ, 2 sampl.), Marg. of the Pack-Ice.

Arct. Distr. Greenl., E. of Greenl., East Arct. S.

Trachyneis aspera (Ehr.) Cl., var. *intermedia* Grun. *forma robusta*. Tab. nost XIII, fig. 3.

Long. 250 μ. Lat. 38 μ. Ser. alveol. 6 in 10 μ, alveol. 4 in 10 μ.

Loc. Off Cape Amélie (Algæ).

I think this form may be a robust, sculptured *Trach. asp. intem.* Only a fragment found.

Naviculæ minusculæ Cl., 1895.

Navicula bahusiensis Grun., var. *arctica* Grun. Fz. Js. Ld., 52, Tab. 1, fig. 43. Øst. Mar. D. Østg., Tab. IV, figs. 30—31 (Nav. bahus. Grun?).

Loc. Dove Bugt.

Arct. Distr. E. of Green.. East Arct. S.

The present form is identical with the fig. 31, quoted above, in my Mar. D. Ostg. As I have there pointed out, my specimens as well as the present form, differ from Grunow's figure of a specimen from Fz. Js. L., in that the striæ at the apices are not radiate, but almost parallel. As the striæ, however, are seen only with great difficulty I think my determination may be correct.

Naviculæ lineolatæ Cl., 1895.

Navicula ammophila Grun., var. *intermedia* Grun., Cl. Syn., II, 30; Grun. D. Øst.—Ung., Tab. XXX, figs. 71—73 (Nav. ammoph. f. minuta).

Loc. Off Cape Amélie (Algæ), Danmarks Havn (Algæ), Koldewey Isl. (Algæ).

Arct. Distr. East Arct. S.

Navicula Bolleana Grun., Cl. Syn., II, 25; A. S. Atl., Tab. XLVII, fig. 18.

Loc. Marg. of the Pack-Ice.

Arct. Distr. W. Greenl., East Arct. S.

Navicula Bolleana Grun., var. *intermedia* Øst., Øst. Mar. D. Østg., 431, Tab. V, fig. 5.

Loc. Margin of the Pack-Ice.
Arct. Distr. E. of Greenl.

Navicula cancellata Donk., Cl. Syn., II, 30; V. H. Trt., Tab. III, fig. 128.

Loc. Marg. of the Pack-Ice,
Arct. Distr. Greenl., East Arct. S.

Navicula cancellata Donk., var. *Gregorii* Ralfs, A. S. Atl., Tab. XLVI, fig. 72.

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ).
Arct. Distr. E. of Greenl., East Arct. S.

Navicula cancellata Donk., var. *retusa* Bréb, V. H. Trt., Tab. II, fig. 80 (Nav. retusa var. subret.).

Loc. Koldewey Isl. (Algæ, 2 sampl.), Off Germ. L. (Land-Ice).
Arct. Distr. East Arct. S.

Navicula cancellata Donk., var. *subapiculata* Grun., A. S. Atl., Tab. XLVI, fig. 68.

Loc. Koldewey Isl. (Algæ).
Arct. Distr. W. Greenl., East Arct. S.

Navicula digito-radiata Greg., Cl. Syn., II, 20; V. H. Trt., Tab. III, fig. 130.

Loc. Off Cape Amélie (Algæ, 2 sampl.).
Arct. Distr. Greenl., E. of Greenl., East. Arct. S.

Navicula digito-radiata Greg., var. *Cyprinus* (Ehr.?) W. Sm., V. H. Trt. l. c. fig. 131.

Loc. Off. Cape Amélie (Algæ, 2 sampl.).
Arct. Distr. Greenl.

Navicula directa W. Sm., var. *genuina* Cl., Cl. Syn., II, 27: A. S. Atl., Tab. XLVII, figs. 4—5.

Loc. Off Cape Amélie (Algæ, 5 sampl.), Koldewey Isl. (Algæ, 2 sampl.), Marg. of the Pack-Ice.
Arct. Distr. Greenl., East Arct. S.

Navicula directa W. Sm., var *lata* Øst., Øst. Mar. D. Østg., 427, Tab. V, fig. 47.

Loc. Off Cape Amélie (Algæ).
Arct. Distr. E. of Greenl.

In my paper Mar. D. Østg. (l. c.) the length of the valve is erroneously stated to be 0.37 mm instead of 0.137 mm. The figure, however, is correct.

Navicula directa W. Sm., var. *remota* Grun. A. Sch. N. S. D., Tab. III, fig. 2.

Loc. Danmarks Havn (Algæ).
Arct. Distr. Greenl., East Arct. S.

Navicula directa W. Sm., var. *cuneata* Øst., Øst. Mar. D. Østg., 428, Tab. IV, fig. 42.

Loc. Marg. of the Pack-Ice.
Arct. Distr. E. of Greenl.

Navicula distans W. Sm., Cl. Syn. II, 35; V. H. Trt., Tab. III, fig. 133.

Loc. Koldewey Isl. (Algæ), Marg. of the Pack-Ice.

Arct. Distr. W. Greenl., E. of Green., East Arct. S.

Navicula inflexa Greg., Cl. Syn., II, 31; V. H. Trt., Tab. XXV, fig. 713.

Loc. Off Cape Amélie (Algæ).

Arct. Distr. East Arct. S.

Navicula jamalinensis Cl., var. *subcircularis* var. nova. Tab. nost XIII, fig. 2.

Long. 35 μ. Lat. 24 μ. Str. 7—8 in 10 μ, sub apices 10 in 10 μ, distincte transverse lineatis.

Valva elliptica fere subcirculari. Raphe area hyalina, satis augusta, cincta. Striis radiantibus. Nodulis terminalibus extremis in apicibus situatis.

Loc. Danmarks Havn (Algæ).

This form may be a variety of *Nav. Jamal.* (cf. Cl. Syn., II, 38; Cl. Grun. A. D., Tab. II, fig. 40). It differs from the main species by its almost circular outline and by its apical area being much narrower and more linear than in Nav. Jamal.

Navicula jejuna A. Sch., var. *arctica* var. nova. Tab. nost XIII, fig. 5.

Long 68 μ. Lat. 8.5 μ. Str. 8 in 10 μ, obscure punctatis.

Valva lineari, apices versus leniter attenuata. Striis radiantibus, uno in latere valvæ raphen non attingentibus. Raphe sub apices sinuosa.

Loc. Marg. of the Pack-Ice.

This form has some resemblance to *Navicula jejunoides* H. O. H. (Belgica Exp., II, Tab. I, fig. 12) but its striæ are radiate throughout, and are equally distant upon both sides of the raphe.

The habitat of *Nav. jejunoides*, according to H. Van Heurch (l. c.), is "Glace de banquise No. 141; assez frequent."

Navicula kariana Grun., var. *detersa* Grun., Cl. Syn. II, 28; Grun. Fz. Js. L., Tab. 1, figs. 23—24.

Loc. Marg. of the Pack-Ice (3 sampl.).

Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Navicula kariana Grun., var. *frigida* Grun. Grun. l. c. fig. 25.

Loc. Marg. of the Pack-Ice (2 sampl.).

Arct. Distr. W. Greenl., East Arct. S.

Navicula (Schizonema) mollis W. Sm., Cl. Syn., II, 26; V. H. Syn., Tab. XV, figs. 22—23.

Loc. Danmarks Havn (Algæ), Koldewey Isl. (Algæ).

Arct. Distr. W. Greenl.

Navicula obtusa Cl., Cl. Syn., II, 29; Cl. Vega Exp., Tab. XXXVI, fig. 25.

Loc. Marg. of the Pack-Ice (2 sampl.).
Arct. Distr. Davis Strait, E. of Greenl., East Arct.

Navicula peregrina Ehr., Cl. Syn,, II, 18; V. H. Trt., Tab. III, fig. 101.

Loc. Off Cape Amélie (Algæ, 2 sampl.).
Arct. Distr. W. Greenl., East Arct. S.

Navicula peregrina Ehr., var. *kefvingensis* Ehr., A. S. Atl., Tab. XLVII, fig. 62.

Loc. Yderbugten.
Hitherto recorded only from Firth of Tay and Franzensbad (fossil) (Cl. l. c.).

Navicula peregrina Ehr., var.? *oblonga* var. nova. Tab. nost XIII, fig. 4.

Long. 43 μ. Lat. 10 μ. Str. 11 in 10 μ transverse lineatis.

Valva lineare-elliptica, apicibus rotundatis. Raphe area augusta hyalina, media in parte valvæ in aream transapicalem curtam dilatata, cincta. Striis radiantibus, sub apices fere parallelis.

Loc. Marg. of the Pack-Ice.
I am uncertain as to the systematic position of this form. I think it may be related to the group belonging to *Navicula peregrina*, perhaps it is nearest to *Nav. peregr. Meniscus*.

Navicula (Schizonema) ramosissima Ag., *forma genuina*, Cl. Syn., II, 26; V. H. Trt., Tab. V, fig. 244.

Loc. Off Cape Amélie (Algæ), Danmarks Havn (Algæ, 2 sampl.), Koldewey Isl. (Algæ, 2 sampl.).
Arct. Distr. Greenl.

Navicula sibirica Grun., Cl. Syn., II, 29; Cl. Vega Exp., Tab. XXXVII, fig. 38 (Rhoikoneis Bolleana var.? sib.).

Loc. Marg. of the Pack-Ice (2 sampl.).
Arct. Distr. Davis Strait, E. of Greenl., East Arct. S.

Navicula subcuneata sp. nova. Tab. nost XIII, fig. 6.

Long. 32 μ. Lat. 10 μ. Str. 10 in 10 μ, distincte punctatis.

Valva sublineari, apicibus subcuneatis. Raphe area distincta hyalina cincta. Striis parallelis sub apices leniter radiantibus. Nodulis terminalibus extremis in apicibus situatis.

Loc. Danmarks Havn (Algæ).
This form may be akin to an undescribed *Navicula* in A. S. Atl., Tab. XLVI, fig. 9 (from Quarnero), but it has parallel striæ; the *Navicula*, delineated by A. Schmidt, has the striæ slightly radiate.

Navicula superba Cl., Cl. Syn., II, 29; Cl. Vega Exp., Tab. XXXVI, fig. 23.

Loc. Danmarks Havn (Algæ), Koldewey Isl. (Algæ), Marg. of the Pack-Ice (3 sampl.).
Arct. Distr. Davis Strait, E. Greenl., E. of Greenl., East Arct. S.

Navicula superba Cl., var. *subacuta* Gran. A. S. Atl., Tab. CCLIX, figs. 27—28.

Loc. Marg. of the Pack-Ice.

Arct. Distr. East Arct. S.

Navicula transitans Cl., Cl. Syn., II, 27; Cl. Vega Exp., Tab. XXXVI, fig. 31.

Loc. Pack-Ice, Marg. of the Pack-Ice (3 sampl.).

Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Navicula trigonocephala Cl., Cl. Syn., II, 27; Cl. Vega Exp., Tab. XXXVI, fig. 29.

Loc. Pack-Ice, Marg. of the Pack-Ice (4 sampl.).

Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Navicula valida Cl. & Grun., Cl. Syn., II, 25; Cl. & Grun. A. D., Tab. II, fig. 29.

Loc. Marg. of the Pack-Ice.

Arct. Distr. E. Greenl., E. of Greenl., East Arct. S.

Navicula valida Cl. & Grun., *forma minor.* Tab. nost XIII, fig. 8. Long. 46 μ. Lat. 16 μ. Str. 8 in 10 μ, transverse lineatis.

Valva elongate-elliptica. Raphe area distincta hyalina cincta. Striis radiantibus, media in parte valvæ alternatim longis abbreviatisqve.

Loc. Marg. of the Pack-Ice.

Undoubtedly a narrower and smaller form, intermediate between Nav. valida and *Nav. valida minuta* (Cl. l. c.).

Navicula Zostereti Grun., Cl. Syn., II, 31; A. S. Atl., Tab. XLVII, figs. 42—44.

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ), Marg. of the Pack-Ice (3 sampl.).

Arct. Distr. E. of Greenl.

Navicula? gomphonemoides sp. nova. Tab. nost XIII, fig. 7. Long. 32 μ. Lat. 5 μ. Str. 10 in 10 μ, delicatissime punctatis.

Valva anguste-lanceolata. Raphe leniter sinuosa. Striis radiantibus, Raphen attingentibus, media modo in parte valvæ paululum abbreviatis. Nodulis terminalibus inconspicuis.

Loc. Danmarks Havn (Algæ).

This small form may perhaps be a Gomphonema. Only a single specimen found.

Naviculæ punctatæ Cl., 1895.

Navicula Baculus Cl., Cl. Vega Exp., 474, Tab. XXXVII, fig 51 (cf. Cl. Syn., I, 124: Stenoneis inconspicua (Greg) Cl. var. Baculus Cl.). A. S. Atl., Tab. CCLXII, fig. 13.

Loc. Marg. of the Pack-Ice.

Arct. Distr. E. of Greenl., East Arct. S.

I quite agree with Dr. H. Heiden when he says (in the explanation of the Table in A. S. Atl. quoted above): "Zu Stenoneis darf diese Species, wie Cleve es tut, nicht gestellt werden."

Navicula glacialis Cl., Cl. Syn., II, 40; Tab. I, fig. 28.

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ).

Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Navicula glacialis, var. *septentrionalis* Cl., A. S. Atl., Tab. VI, fig. 37.

Loc. Koldewey Isl. (Algæ).

Arct. Distr. Greenl., East Arct. S.

Navicula punctulata W. Sm., var. *finmarchica* Grun., Cl. Syn., II, 47; Cl. & Grun. A. D., Tab. II, fig. 49 & Øst. Mar. D. Østg., Tab. VI, fig. 69.

Loc. Off Cape Amélie (Algæ, 4 sampl.), Koldewey Isl. (Algæ, 2 sampl.).

Arct. Distr. Greenl., East Arct. S.

Naviculæ lyratæ Cl., 1895.

Navicula Lyra Ehr., var. *arctica* var. nova. Tab. nost XIII, fig. 9.

Long. 46 μ. Lat. 21 μ. Str. 9—10 in 10 μ, delicatissime transverse lineatis.

Valva apices versus cuneata, media in parte marginibus fere parallelis. Media parte sulcorum, Lyram effingentium, stria sicut nebulosa instructa.

Loc. Koldewey Isl. (Algæ).

I think that this variety comes nearest to Nav. Lyra var. atlantica A. S.

Navicula pygmæa Kütz, Cl. Syn., II, 65; V. H. Trt., Tab. IV, 164.

Loc. Koldewey Isl. (Algæ, 2 sampl.), Marg. of the Pack-Ice.

Arct. Distr. East. Arct. S.

Navicula spectabilis Greg., Cl. Syn., II, 60; A. S. Atl., Tab. III, figs. 20—21.

Loc. Koldewey Isl. (Algæ).

Arct. Distr. Greenl.

Navicula spectabilis Grey., var. *densestriata* Øst., Øst. Mar. D. Østg., 436; Tab. VI, fig. 67.

Loc. Off Cape Amélie (Algæ. 2 sampl.), Koldewey Isl. (Algæ).

Arct. Distr. E. Greenl.

Pinnularia Ehr., 1843.

Marinæ Cl., 1895.

Pinnularia bistriata Leud. Fortm., Cl. Syn., II, 95; Perag. D. mar. d. Fr., Tab. XI, fig. 14.

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ).

Hitherto recorded only from the Mediterranean, Ceylon, Labuan, Siam.

Pinnularia qvadratarea A. Sch., Cl. Syn., II, 95; A. Sch. N. S. D., Tab. III, fig. 26.

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ), Marg. of the Pack-Ice.
Arct. Distr. Greenl., E. of Greenl., East Arct. S.

Pinnularia qvadratarea A. Sch., var. *constricta* Øst., Øst. Mar. D. Øslg. 419, Tab. IV, fig. 23.

Loc. Marg. of the Pack-Ice (2 sampl.).
Arct. Distr. E. of Greenl., East Arct. S.

Pinnularia qvadratarea A. Sch., var. *dubia* Heiden, A. S. Atl., Tab. CCLX, fig. 13.

Loc. Marg. of the Pack-Ice.
Arct. Distr. East Arct. S.

Pinnularia qvadratarea A. Sch., var. *gibbosa* Øst., Øst. Mar. D. Øslg., 420, Tab. IV, fig. 28.

Loc. Off Cape Amélie (Algæ).
Arct. Distr. E. of Greenl., East Arct. S.

Pinnularia Stuxbergii Cl., Cl. Syn., II, 96 (Pinn. qvadrat. Stuxb.) A. S. Atl., Tab. CCLX, figs. 37—38.

Loc. Off Germ. L. (Land-Ice), Marg. of the Pack-Ice (3 sampl.).
Arct. Distr. Davis Strait, E. of Greenl., E st Arct. S.

Amphora Ehr., 1840.

Subg. *Amphora* Cl., 1895.

Amphora gigantea Grun., Cl. Syn., II, 105. Tab. nost. XIII, fig. 11.

Long. 70 μ. Lat. 15 μ. Str. 7 in 10 μ.

Loc. Koldewey Isl. (Algæ).

Not before recorded from Arctic Seas. Several other records.

The present form is smaller than the typical species. I have given a figure of it, as it seems to me not to agree exactly with *Amph. gig.* forma *minor*. (Cl. l. c. A. S. Atl., Tab. XL, figs. 28—29).

Amphora marina (W. Sm.), H. V. H. Cl. Syn., II, 103; V. H. Trt., Tab. I, fig. 14.

Loc. Off Cape Amélie (Algæ), Danmarks Havn (Algæ), Koldewey Isl. (Algæ, 4 sampl.).
Arct. Distr. E. Greenl., E. of Greenl.

Amphora Proteus Greg., Cl. Syn., II, 103; A. S. Atl., Tab. XXVII, fig. 3.

Loc. Off Cape Amélie (Algæ, 4 sampl.), Koldewey Isl. (Algæ, 4 sampl.).
Arct. Distr. Greenl., East Arct. S.

Amphora Proteus Greg., var. *contigua* Cl., A. S. Atl., Tab. XXVII, figs. 7—9.

Loc. Off Cape Amélie (Algæ, 4 sampl.), Danmarks Havn (Algæ), Koldewey Isl. (Algæ, 2 sampl.).
Arct. Distr. E. Greenl.

Amphora virgata sp. nova. Tab. nost. XIII, fig. 12.

Long. 58 μ. Lat. 12 μ. Str. 10 in 10 μ, ad marginem numeratis.

Valva lunata, apicibus obtusis. Striis in parte dorsali valvæ linea mediana nuda interruptis. Raphe propior linea altera, minus autem distincta, adest.

Loc. Danmarks Havn (Algæ).

This species may be a form intermediate between *Amphora ovalis* Kütz. and *Amph. Proteus* Greg.

Subgen. *Diplamphora* Cl., 1895.

Amphora crassa Greg., Cl. Syn., II, 109; A. S. Atl., Tab. XXVIII, figs. 30—33 (A. crass. punctata).

Loc. Off Cape Amélie (Algæ, 3 sampl.), Danmarks Havn (Algæ), Koldewey Isl. (Algæ).

Arct. Distr. Greenl., East Arct. S.

Amphora margaritifera Cl., Cl. Syn., II, 117; Tab. III, figs. 30—31, Øst. Kyst D. f. Grønl., 325; Tab. II, fig. 6 (A. cruciata Øst.).

Loc. Danmarks Havn (Algæ).

Arct. Distr. W. Greenl.

I am now quite sure that this form, which, in my paper quoted above, I recorded as a new species (referring however to its affinity to A. margar.) is identical with *A. marg.* Cl., a form from Galapagos Islands.

Subg. *Halamphora* Cl., 1895.

Amphora acutiuscula Kütz., Cl. Syn., II, 121; V. H. Trt., Tab. I, fig. 5.

Loc. Danmarks Havn (Algæ, 2 sampl.), Koldewey Isl. (Algæ).

Arct. Distr. W. Greenl., East Arct. S.

Amphora costata W. Sm., Cl. Syn., II, 122; W. Sm. Syn., Tab. XXX, fig. 253.

Loc. Danmarks Havn (Algæ), Koldewey Isl. (Algæ).

Arct. Distr. E. Greenl.

Amphora Eunotia Cl., Cl. Syn., II, 122; A. S. Atl., Tab. XXV, fig. 35.

Loc. Off Cape Amélie (Algæ, 3 sampl.), Koldewey Isl. (Algæ).

Arct. Distr. Greenl., East Arct. S.

Amphora granulata Greg., Cl. Syn., II, 123; Greg. D. Clyde, Tab. XIV, fig. 96.

Loc. Off Cape Amélie (Algæ).

Not before recorded from Arctic Seas. Other records, Scotland, South-Asia.

Amphora macilenta Greg., Cl. Syn., II, 121; Perag. D. mar. de Fr., Tab. L, fig. 26.

Loc. Off Cape Amélie (Algæ).

Not before recorded from Arctic Seas. According to Peragallo (l. c. p. 231): "Repandu."

Amphora Terroris Ehr., Cl. Syn., II, 122; A. S. Atl., Tab. XXV, figs. 17—19.

Loc. Off Cape Amélie (Algæ, 5 sampl.), Danmarks Havn (Algæ, 2 sampl.), Koldewey Isl. (Algæ, 2 sampl.).

Arct. Distr. Greenl., East Arct. S.

Amphora Terroris Ehr., var. *inflata* Øst., Øst. mar. D. Østg., 410, Tab. III, fig. 6 (Amphora inflata Grun.?).

Loc. Off Cape Amélie (Algæ, 4 sampl.), Koldewey Isl. (Algæ, 2 sampl.).
Arct. Distr. E. Greenl.

Especially because of the slight inward curvation of the apices I think this form may more correctly be referred to Amph. Terr.

Subg. *Oxyamphora* Cl., 1895.

Amphora lævis Greg., var. *lævissima* Greg., Cl. Syn., II, 130; A. S. Atl., Tab. XXVI, figs. 3, 13, 14.

Loc. Off Cape Amélie (Algæ).
Arct. Distr. E. of Greenl., East Arct. S.

Amphora lineolata Ehr., Cl. Syn., II, 126; V. H. Syn., Tab. I, fig. 13.

Loc. Danmarks Havn (Algæ), Koldewey Isl. (Algæ).
Arct. Distr. East Arct. S.

Subg. *Amblyamphora* Cl., 1895.

Amphora venusta sp. nova. Tab. nost. XIII, fig. 16.

Long. 68 μ. Lat. 10.8 μ. Str. 16—17 in 10 μ, punctatis.

Valva lunata, apicibus rotundatis paululum marginem ventralem versus inclinatis. Margine ventrali leniter arcuata. Striis dorsalibus Raphen attingentibus, striis ventralibus marginalibus.

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ).

I am somewhat in doubt as to the systematic position of this species. It may perhaps be considered a slender form of Amphora obtusa Greg., Trans. M. S. V, 72, Tab. I, fig. 34.

Subg. *Cymbamphora* Cl., 1895.

Amphora angusta Greg., Cl. var. *typica* Cl., Cl. Syn., II, 135; A. S. Atl., Tab. XXV, fig. 15.

Loc. Off Cape Amélie (Algæ, 2 sampl.), Danmarks Havn (Algæ).
Arct. Distr. W. Greenl., East Arct. S.

Monoraphideæ.

Rhoicosphenia Grun., 1860.

Rhoicosphenia curvata Kütz., Cl. Syn., II, 165; V. H. Trt., Tab. VII, fig. 319.

Loc. Off Cape Amélie (Algæ, 3 sampl.), Danmarks Havn (Algæ, 2 sampl.), Koldewey Isl. (Algæ).
Arct. Distr. Greenl., E. of Greenl., East Arct. S.

Cocconeis (Ehr., 1835) Grun., 1868
subgen. *Cocconeis* Cl,, 1895 pro gen.

Cocconeis Scutellum Ehr., var. *genuina* Cl., Cl. Syn., II, 170; V. H. Trt., Tab. VIII, fig. 338.

Loc. Danmarks Havn (Algæ, 2 sampl.), Koldewey Isl. (Algæ).
Arct. Distr. Greenl., East Arct. S.

Cocconeis Scutellum Ehr., var. *minutissima* Grun., Grun. Fz. Js. L., Tab. I, fig. 1.

Loc. Off Cape Amélie (Algæ).
Arct. Distr. Franz-Josef Land.

Cocconeis Scutellum Ehr., var. *californica* Grun., A. S. Atl., Tab. CXCI, figs. 40—43.

Loc. Danmarks Havn (Algæ), Off Cape Bismarck (Algæ), Koldewey Isl. (Algæ).
Hitherto recorded only from California and Kamtschatka.

Subg. *Eucocconeis* Cl., 1895 pro. gen.

Cocconeis dirupta Greg. var. *decipiens* Cl., Cl. Syn., II, 175; Cl. Arct. S., Tab. I, fig. 6 (Cocc. decip.) & Tab. II, fig. 11 a (Cocc. arctica).

Loc. Off Cape Amélie (Algæ), Danmarks Havn (Algæ), Koldewey Isl. (Algæ).
Arct. Distr. W. Greenl., East Arct. S.

Cocconeis pseudomarginata Greg., Cl. Syn., II, 178; V. H. Trt., Tab. XXIX, fig. 824.

Loc. Danmarks Havn (Algæ, 2 sampl.).
Arct. Distr. Greenl., East Arct. S.

Cocconeis septentrionalis Grun., Cl. Syn., II, 174; Grun. Fz. Js. L., Tab. I, fig. 2.

Loc. Off Cape Amélie (Algæ, 4 sampl.), Danmarks Havn (Algæ, 2 sampl.), Koldewey Isl. (Algæ, 2 sampl.), Marg. of the Pack-Ice.
Hitherto recorded only from Franz-Josef Land (Assistance Bay).

Subg. *Disconeis* Cl., 1895 pro. gen.

Cocconeis pinnata Greg., Cl. Syn., II, 181; V. H. Trt., Tab. XXIX, fig. 818.

Loc. Danmarks Havn (Algæ), Koldewey Isl. (Algæ, 2 sampl.).
Arct. Distr. East Arct. S.

Cocconeis pinnata var. *arctica* var. nova. Tab. nost. XIII, fig. 13. Long. 24 μ. Lat. 11 μ. Costis 5,5 in 10 μ utrisqve in valvis, duplice serie punctorum alternantium interpositis. Valva elliptica apicibus paululum attenuatis. Epitheca: Area apicali satis angusta. Hypotheca: Raphe area angusta hyalina cincta. Costis utrisqve in valvis subradiantibus.

Loc. Danmarks Havn (Algæ).
This variety differs from the main species in its somewhat attenuated apices and its narrow apical area.

Subg. *Pleuroneis*, Cl., 1895 pro. gen.

Cocconeis costata Greg., Cl. Syn., II, 182; V. H. Trt., Tab. XXIX, fig. 816.

Loc. Off Cape Amélie (Algæ), Danmarks Havn (Algæ, 2 sampl.), Koldewey Isl. (Algæ, 4 sampl.).

Arct. Distr. Greenl., East Arct. S.

Cocconeis costata var. *pacifica* Grun., V. H. Syn., Tab. XXX, figs. 13—14.

Loc. Danmarks Havn (Algæ).

Arct. Distr. Greenl.

Cocconeis ornata Greg? cf. Greg. D. Clyde, 19, Tab. I, fig. 24. Tab. nost. XIII, Fig. 14.

Long 32 μ. Lat. 16 μ, costis 8 in 10 μ, utrisqve in valvis.

Valva elliptica, area apicali distincta. Costis leniter radiantibus, in Hypotheca vitta submarginali nuda interruptis.

Loc. Koldewey Isl. (Algæ).

This species may be Gregory's *Cocc. ornata*, although Gregory (l. c.) describes the apical area as a "long lanceolate blank space" and figures the striæ as strongly radiate towards the apices. Cleve (Syn. II, 171) mentions *Cocc. ornata* as a form which possibly may be a variety of *Cocc. Scutellum* Ehr., but in this matter I cannot agree with him. *Cocconeis ornata* occurs in "Lamlash Bay" and in "Loch Fine."

Cocconeis sp. Tab. nost. XIII, fig. 17.

Long. 31 μ. Lat. 20 μ. Str. 11 in 10 μ, ad marginem numeratis, delicatissime punctatis.

Hypotheca: Valva elliptica. Raphe area angusta distincta, media in parte valvæ in aream parvulam centralem acuminatam dilatata, cincta. Striis ubiqve in marginem perpendicularibus. Nodulis terminalibus paululum ab apicibus remotis. Hypothecam modo observavi.

Loc. Koldewey Isl. (Algæ).

As I have only seen the hypotheca I have not given this form as a new species.

Achnanthes Borg., 1822,

Subg. *Heteroneis* Cl., 1895, pro. gen.

Achnanthes hyperborea Grun., Cl. Syn., II, 183; Grun., Fz. Js. Ld., Tab. I, figs. 4—5. Tab nost. XIII, fig. 15.

Loc. Off Cape Amélie (Algæ).

Arct. Distr. Franz-Josef Land.

Subg. *Microneis* Cl., 1895 pro. gen.

Achanthes debilissima sp. nova? Tab. nost. XIII, fig. 24, cf. Grun., Fz. Js. Ld., 52, Tab. I, fig. 42 (Navicula debiliss. Grun.).

Long. 6,3—7 μ. Lat. 2,7 μ.

Valva elliptica. Striis perdifficiliter perspiciendis.

Loc. Koldewey Isl. (2 sampl).

This hyaline and exceedingly small species may be identical with Navicula debilissima Grun. Grunow's figure shows both the terminal nodules and a central nodule and the latter he describes in the text (l. c.) as "minutissimo." As to the present specimens the matter stands as follows: — On all my specimens I have seen a median apical line (a "raphe" or an "apical area"), on some specimens I have observed the terminal nodules a little remote from the apices. On a few specimens I think I have seen a trace of a central nodule, but I am not quite sure of it and therefore I have not put a central nodule in my figures. On the other hand I have been able in some specimens to see a striation at right-angles to the apical axis. A specimen in zone-view, which I had the good fortune to observe showed the frustule bent along the transapical axis after the manner of an Achnanthes, but I have not been able to see the frustules united into a band, on the contrary I think I observed them attached separately to the narrow branches of other Algæ after the manner of a Cocconeis.

Achnanthes rhombica sp. nova. Tab. nost. XIII, fig. 18.

Long. 34 μ. Lat. 12 μ. Str. 11 in 10 μ, utrisqve in valvis, transverse lineatis.

Valva elongate-rhombica. Epitheca: Striis parallelis, area apicali distincta.

Hypotheca: Striis valde radiantibus, mediis aliqvantum spatiatis.

Raphe area hyalina, media in parte valvæ in aream conspicuam rotundatam dilatata, cincta.

Loc. Off Cape Amélie (Algæ).

The epitheca of this species resembles that of *Ach. Lorenziana* Grun., but is somewhat more closely striated. As I have seen both valves in situ I am quite certain that the present species cannot be *Achn. Lorenz.* in which the number of striæ on the hypotheca is stated to be 18—27 in 10 μ (cf. Cl. Syn., II, 187).

Achnanthes septentrionalis sp. nov. Tab. nost. XIII, fig. 21.

Long. 19 μ. Lat. 9 μ. Str. 11 in 10 μ utrisqve in valvis, transverse lineatis.

Valva lanceolata, apicibus subrostratis. Epitheca: Striis parallellis, area apicali distincta. Hypotheca: Striis radiantibus, media in parte valvæ aliqvantum spatiatis. Raphe area hyalina, media in valva in aream rotundatam dilatata, cincta.

Loc. Off Cape Amélie (Algæ).

Achnanthes septentrionalis var. *subcapitata* var. nova. Tab. nost. XIII, fig. 22.

This variety agrees entirely with the main species in the dimensions and the number of striæ, but differs in the subcapitate apices and in the absence of a central area on the hypotheca.

Loc. Off Cape Amélie (Algæ).

Achn. sept. is probably most nearly allied to *Achn. Hauckiana* Grun. (V. H. Syn., Tab. XXVII, figs. 14—15).

Subg. *Achnanthidium* (Kütz., 1844) Heib., 1864, Cl., 1895 pro. gen.

Achnanthes brevipes Ag. var. *typica*, Cl. Syn., II, 193; V. H. Trt., Tab. VIII, fig. 324.

Loc. Off Cape Amélie (Algæ, 3 sampl.), Danmarks Havn (Algæ), Off Cape Bismarck (Algæ), Koldewey Isl. (Algæ, 2 sampl.).

Arct. Distr. Greenl., East Arct. S.

Achnanthes brevipes Ag. var. *intermedia* Kütz. V. H. Trt., l. c. fig. 325 (Achn. subsessilis Ehr.).

Loc. Off Cape Amélie (Algæ, 3 sampl.), Danmarks Havn (Algæ), Koldewey Isl. (Algæ).

Arct. Distr. E. Greenl., East Arct. S.

Achnanthes brevipes Ag. var. *parvula* Kütz., V. H. Trt. l. c. fig. 326 (Achn. parvula).

Loc. Off Cape Amélie (Algæ, 2 sampl.).

Arct. Distr. Greenl.

Achnanthes brevipes Ag. var. *forma elliptica*, Øst. Kystd. f. Grönl., Tab. II, fig. 13.

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ, 2 sampl.).

Arct. Distr. E. Greenl.

Achnanthes groenlandica Cl., Cl. Syn., II, 195; Cl. A. D., Tab. IV, fig. 23.

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ).

Arct. Distr. Greenl., E. Arct. S.

KALYPTORAPHIDEÆ.

Eschatoraphideæ.

Surirella Turp., 1827.

Surirella insignis sp. nova. Tab. nost. XIII, fig. 19.

Long. 137 μ. Lat. 54 μ. Canaliculis 1,5 in 10 μ. Striis subtilissimis.

Valva ovata, area apicali angusta. Striis delicatissimis, vix perspiciendis.

Loc. Danmarks Havn.

As I have not seen this species in zone-view I am uncertain of its systematic position. Possibly it may be considered a robust form of an unnamed *Surirella* from "Hayes Exp." figured in A. S. Atl., Tab. XXI, fig. 15, which I have recorded from E. Greenl (cf. Øst. Mar. D. Østg., p. 334).

Surirella Oestrupii Gran., Gran., F. N. Exp., 46; Øst. Mar. D. Østg., Tab. VI, fig. 68 (Sur. splendida var? minima).

Loc. Off Cape Amélie (Algæ).

Arct. Distr. E. Greenl., E. of Greenl., East Arct. S.

Campylodiscus Ehr., 1841.

Campylodiscus angularis Greg., V. H. Trt., 378, Tab. XXXV, fig. 909.

Loc. Off Cape Amélie (Algæ, 3 sampl.).
Arct. Distr. Greenl., East Arct. S.

Tropidoraphideæ.

Hantzschia Grun., 1877.

Hantzschia Weyprechtii Grun., Fz. Js. Ld., 55, Tab. I, fig. 60.

Loc. Koldewey Isl. (Algæ), Pack-Ice.
Arct. Distr. E. of Greenl., East Arct. S.

Nitzschia (Hass., 1845), Grun., 1880.

Tryblionella Grun., 1880.

Nitzschia Tryblionella Hantsch var. *levidensis* W. Sm., V. H. Trt. 385, Tab. XV, fig. 494.

Loc. Off Cape Amélie (Algæ).
Arct. Distr. E. Greenl. (in freshwater), East Arct. S.

Apiculatæ Grun., 1880.

Nitzschia marginulata Grun. var. *genuina* Grun. *forma minuta*? Cl. & Grun., A. D., 72. Tab. nost. XIII, fig. 20.

Long. 35 μ. Lat. 7 μ & 6 μ. Punct. carinal. 16 in 10 μ, striis delicatis, minime 23 in 10 μ.

Loc. Off Cape Amélie (5 sampl.).
This form may be the *forma minuta* (from Esquimault harbour) of *Nitz. marg. gen.*, of which Grunow has not given a figure.

Bilobatæ Grun., 1880.

Nitzschia bilobata W. Sm., V. H. Trt. 389, Tab. XV, fig. 512.

Loc. Danmarks Havn (Algæ).
Arct. Distr. W. Greenl.

Nitzschia hybrida Grun., Cl. & Grun. A. D., 79, V. H. Syn., Tab. LX, figs. 4—5.

Loc. Off Cape Amélie (Algæ).
Arct. Distr. E. of Greenl., East Arct. S.

Insignes Grun., 1880.

Nitzschia insignis W. Sm., var. *arctica* Grun., Cl. & Grun. A. D., 84; Øst. Mar. D. Østg., Tab. VII, fig. 81.

Loc. Off Cape Amélie (Algæ).
Arct. Distr. E. Greenl., East Arct. S.

Bacillaria Grun., 1880.

Nitzschia paradoxa (Gmel.) Grun. V. H. Trt. 392, Tab. XVI, fig. 518.

Loc. Koldewey Isl. (Algæ).

Arct. Distr. East Arct. S.

Nitzschia socialis Greg. var. *kariana* Grun., Cl. & Grun. A. D. 85, Tab. VI, fig. 108.

Loc. Off Cape Amélie (Algæ, 2 sampl.), Danmarks Havn (Algæ).

Arct. Distr. East Arct. S.

Spathulatæ Grun., 1880.

Nitzschia angularis W. Sm. V. H. Trt. 393, Tab. XVI, fig. 521.

Loc. Off Cape Amélie (Algæ), Danmarks Havn (Algæ).

Arct. Distr. Greenl., E. of Greenl., East Arct. S.

Nitzschia angularis var. *borealis* Grun., Cl. & Grun. A. D. 89, Tab. V, fig. 99.

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ).

Arct. Distr. Greenl., East Arct. S.

Nitzschia distans Greg. V. H. Trt. 394, Tab. XXXIII, fig. 878.

Loc. Off Cape Amélie (Algæ).

Arct. Distr. W. Greenl., East Arct. S.

Sigmoideæ Grun., 1880.

Nitzschia Brébissonii W. Sm., var. *borealis* Grun., Cl. Baff. B. 21, Tab. I, figs. 28—32; Øst. Mar. D. Østg., Tab. VII, fig. 80 (Nitz. socialis septentrionalis).

Loc. Danmarks Havn (Algæ).

Arct. Distr. Davis Strait, E. of Greenl., East Arct. S.

Nitzschia lævissima Grun., Grun. Fz. Js. Ld., 54, Tab. I, figs. 65—66.

Loc. Off Cape Amélie (Algæ), Marg. of the Pack-Ice (4 sampl.).

Arct. Distr. E. of Greenl., East Arct. S.

Sigmata Grun., 1880.

Nitzschia scabra Cl., Cl. Vega Exp. 480, Tab. XXXVIII, fig. 73.

Loc. Marg. of the Pack-Ice.

Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Nitzschia Sigma W. Sm. V. H. Trt. 396, Tab. XVI, fig. 531.

Loc. Off Cape Amélie (Algæ).

Arct. Distr. W. Greenl., East Arct. S.

Nitzschia Sigma W. Sm., var *robusta* var. nova. Tab. nost XIII, fig. 26.

Long. 270 μ. Lat. 10 μ. Punct. carinal. 2—3 in 10 μ, Str. 16—17 in 10 μ, distinte punctatis, carena admodum excentrica. Striis carenam versus obliterantibus.

Loc. Koldewey Isl. (Algæ).

I think this large *Nitzschia* may be related to the group belonging to *Nitz. Sigma*, perhaps it comes nearest to *Nitz. Sigma valida*.

Nitzschia Sigma W. Sm. var. *Sigmatella* Grun., V. H. Trt. 397, Tab. XVI, fig. 535.

Loc. Off Cape Amélie (Algæ).

Not before recorded from Arctic Seas. According to Perag. (Diat. mar. d. Fr. 290) "Repandu."

Nitzschia Sigma W. Sm., var. *valida* Cl. & Grun. *forma longissima*. V. H. Syn., Tab. LXV, fig. 4.

Loc. Koldewey Isl. (Algæ, 3 sampl.).

Arct. Distr. W. Greenl.

Lineares Grun., 1880.

Nitzschia polaris Grun. Grun. Fz. Js. Ld., 54, Tab. I, figs. 62—63.

Loc. Off Germ. L. (Land-Ice), Marg. of the Pack-Ice (4 sampl.).

Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Lanceolatæ Grun., 1880.

Nitzschia lanceolata W. Sm., V. H. Trt. 400, Tab. XVII, fig. 548.

Loc. Off Cape Amélie (Algæ, 2 sampl.), Koldewey Isl. (Algæ).

Arct. Distr. E. of Greenl.

Arraphideæ.

Synedra Ehr., 1831.

Synedra affinis Kütz., *genuina*. V. H. Trt. 314, Tab. X, fig. 430.

Loc. Off Cape Amélie (Algæ, 3 sampl.), Danmarks Havn (Algæ).

Synedra affinis Kütz., *acuminata* Grun., V. H. Syn., Tab. XLI, fig. 14.

Loc. Koldewey Isl. (Algæ).

Synedra affinis Kütz., *fasciculata* Kütz., V. H. Trt., Tab. X, fig. 433.

Loc. Off Cape Amélie (Algæ), Danmarks Havn (Algæ), Koldewey Isl. (Algæ).

Synedra affinis Kütz,, *hybrida* Grun. *forma elongata*, V. H. Syn., Tab. XLI, fig. 9 B.

Loc. Koldewey Isl. (Algæ).

Synedra affinis Kütz., *lancettula* Grun., V. H. Syn., Tab. XLI, fig. 28.

Loc. Off Cape Amélie (Algæ).

Synedra affinis Kütz., *parva* Kütz., V. H. Trt., Tab. X, fig. 432.

Loc. Koldewey Isl. (Algæ).

Synedra affinis Kütz.? *rupicola* Grun., V. H. Syn., Tab. XLI, fig. 27.

Loc. Koldewey Isl. (Algæ, 2 sampl.).

Synedra affinis Kütz., var. *subtilis* Grun., V. H. Syn., Tab. XLI, fig. 18.

Loc. Danmarks Havn (Algæ).

Synedra affinis Kütz., var. *tabulata* Kütz., Perag. Mar. D. d. Fr., Tab. LXXX, figs. 13—14.

Loc. Off Cape Amélie (Algæ, 2 sampl.), Koldewey Isl. (Algæ).

Synedra affinis Kütz. var. *tabulata forma curta acuminata.* V. H. Trt., Tab. X, fig. 431 (Syn. aff. tabul.).

Loc. Off Cape Amélie (Algæ).

Among the numerous scarcely discernable varieties of Synedra affinis only the following are recorded from the Arctic Seas, viz.

Synedra aff. *lancettula:* W. Greenl.
— - *parva:* W. Greenl., East Arct. S.
— - *tabul. curta acumin.:* Greenl., East Arct. S.

Synedra investiens W. Sm. V. H. Trt., 313, Tab. X, fig. 425.

Loc. Off Cape Amélie (Algæ, 5 sampl.), Danmarks Havn (Algæ), Koldewey Isl. (Algæ).

Arct. Distr. W. Greenl., East Arct. S.

Synedra kamtschatica Grun. Øst. Mar. D. Østg., 450, Tab. VII, fig. 85.

Loc. Off Cape Amélie (Algæ, 3 sampl.), Danmarks Havn (Algæ, 3 sampl.), Koldewey Isl. (Algæ, 3 sampl.), Marg. of the Pack-Ice (2 sampl.).

Arct. Distr. Greenl., East Arct. S.

I have found this species to vary in length from 160 μ to 260 μ.

Fragilaria Lyngb., 1819.

Fragilaria Cylindrus Grun. Grun. Fz. Js. Ld., 55, Tab. II, fig. 13.

Loc. Marg. of the Pack-Ice (2 sampl.).

Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Fragilaria islandica Grun., var. *hyperborea* Cl., Cl. Vega Exp., 484. Tab. nost XIII, fig. 25.

Long. 66 μ. Lat. 7 μ. Str. 11 in 10 μ.

Valva lineare-lanceolata. Striis media in parte valvæ deficientibus, ceterum axin apicalem non attingentibus itaqve aream apicalem magnam relinqventibus.

Loc. Marg. of the Pack-Ice (2 sampl.).

Arct. Distr. According to Cleve: "Greenl., Bessel's Bay."

This species must undoubtedly be Cleve's *Frag. isl. hyp.* about which he says (l. c.): "Area longer, striæ 12 in 0,01 mm."

Fragilaria striatula Lyngb. V. H. Trt., 324, Tab. XXX, fig. 841.

Loc. Koldewey Isl. (3 sampl.).

Arct. Distr. W. Greenl., East Arct. S.

Plagiogramma Grev., 1859.

Plagiogramma Gregorianum. Grev., V. H. Trt., 338, Tab. X, fig. 390.

Loc. Koldewey Isl. (Algæ, 2 sampl.).
Arct. Distr. W. Greenl., East Arct. S.

Licmophora Ag., 1827.

Licmophora gracilis (Ehr.) Grun., V. H. Trt. 343, Tab. XXXI, fig. 851.

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ, 3 sampl.).
Arct. Distr. W. Greenl.

Licmophora paradoxa (Lyngb.) Ag., V. H. Trt. 344, Tab. XXXI, fig. 855.

Loc. Off Cape Amélie (Algæ), Off Cape Bismarck (Algæ), Koldewey Isl. (Algæ, 3 sampl.).
Arct. Distr. Greenl.

Grammatophora Ehr., 1839.

Grammatophora arctica Cl., Cl. Diat. f. Spb. 664; V. H. Syn., Tab. LIII bis, fig. 3.

Loc. Off Cape Amélie (Algæ), Danmarks Havn (Algæ), Koldewey Isl. (Algæ, 2 sampl.).
Arct. Distr. Greenl., E. of Greenl., East Arct. S.

Grammatophora islandica Grun., Østerr. Diat. I, 418., V. H. Syn., Tab. LIII, fig. 7.

Loc. Danmarks Havn (Algæ), off Cape Bismarck (Algæ), Koldewey Isl. (Algæ, 3 sampl.).
Arct. Distr. Greenl., East Arct. S.

Rhabdonema Kütz., 1844.

Rhabdonema arcuatum (Ag.) Kütz., V. H. Trt. 360, Tab. XII, fig. 487 a.

Loc. Off Cape Amélie (Algæ, 3 sampl.), Danmarks Havn (Algæ), Koldewey Isl. (Algæ, 2 sampl.)
Arct. Distr. Greenl., E. of Greenl., East Arct. S.

Rhabdonema minutum Kütz., V. H. Trt. 361, Tab. XII, fig. 488 a.

Loc. Off Cape Amélie (Algæ), Danmarks Havn (Algæ), Off Cape Bismarck (Algæ) Koldewey Isl. (Algæ, 4 sampl.)
Arct. Distr. Greenl., East Arct. S.

Centricæ.

Rhizosolenia (Ehr. Brigtw.), Peragallo, 1892.

Rhizosolenia hebetata Bail. *forma semispina* (Hensen) Gran, Gran. Nord. Plankt., 55, fig. 67 b.

Loc. Marg. of the Pack-Ice.
Arct. Distr. East Arct. S.

Chætoceros Ehr., 1844.

Chætoceros Diadema (Ehr.) Gran, Gran. Nord. Plankt., 84, fig. 102 b.

Loc. Koldewey Isl. (Algæ, 3 sampl.), Marg. of the Pack-Ice.
Arct. Dist. W. Greenl., East Arct. S.
Only spores found.

Chætoceros septentrionale Øst., Øst. Mar. D. Østg., 457, Tab. VII, fig. 88.

Loc. Off Cape Amélie (Algæ), Marg. of the Pack-Ice.
Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Chætoceros sociale Laud., Gran. Nord. Plankt., 96, fig. 123.

Loc. Koldewey Isl. (Algæ).
Arct. Distr. Sea W. of Greenl., East Arct. S.
Only spores found.

Stephanopyxis Ehr., 1844.

Stephanopyxis Turris (Grev., Ralfs) Grun. var. *Cylindrus* Grun. *forma inermis*. Grun., Fz. Js. Ld. 35, Tab. V, figs. 10—13.

Loc. Koldewey Isl. (Algæ).
Arct. Distr. Franz-Josef Land.

Thalassiosira Cl., 1872.

Thalassiosira decipiens (Grun.) Gran, Gran. nord. Plankt. 17, fig. 10.

Loc. Off Germ. L. (Land-Ice), Marg. of the Pack-Ice.
Not before recorded from Arctic Seas. Several other records.

Thalassiosira gravida Cl., Gran. Nord. Plankt., 18, fig. 12.

Loc: Off Germ. L. (Land-Ice), Marg. of the Pack-Ice.
Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Thalassiosira Nordenskiöldii Cl., Gran. Nord. Plankt., 16, fig. 9.

Loc. Off Germ. L. (Land-Ice), Marg. of the Pack-Ice.
Arct. Distr. Greenl., E. of Greenl., East Arct. S.

Melosira Ag., 1824.

Melosira Jürgensii Ag., V. H. Trt. 442, Tab. XVIII, fig. 612.

Loc. Off Cape Amélie (Algæ).
Hitherto recorded only from the northern coasts of Europe.

Melosira (mediterranea Grun. var?) **gelida** Cl., Cl. Vega Exp., 490, Tab. XXXVIII, fig. 83.

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ, 4 sampl.).
Arct. Distr. According to Cleve (l. c.) “Mushroom Point.”

Melosira hyperborea (Grun.) Gran, Gran. Fr. N. Exp., 52, V. H. Syn., Tab. LXXXV, figs. 3—4.

Loc. Koldewey Isl. (Algæ), Pack-Ice, Marg. of the Pack-Ice (3 sampl.).
Arct. Distr. Greenl., E. of Greenl., East Arct. S.

Podosira Ehr.

Podosira hormoides Mont., Grun. Kasp. S. 130; V. H. Syn., Tab. LXXXIV, fig. 3.

Loc. Off Cape Amélie (Algæ, 3 sampl.), Danmarks Havn (Algæ), Off Cape Bismarck (Algæ), Koldewey Isl. (Algæ, 2 sampl.).

Arct. Distr. Greenl., E. of Greenl.

Podosira hormoides Mont., var.? *minima* Grun., V. H. l. c. figs. 7—8.

Loc. Off Cape Amélie (Algæ), Off Cape Bismarck (Algæ), Koldewey Isl. (Algæ).

According to Grunow (in the explanation of the Tab., quoted above, of V. H. Syn.) "accompagnement le *Podos. hormoides.*"

Podosira Montagnei Kütz., Grun. Kasp., S. 129, V. H. Syn., Tab. LXXXIV, figs. 11—12.

Loc. Off Cape Amélie (Algæ, 3 sampl.), Danmarks Havn (Algæ), Off Cape Bismarck (Algæ), Koldewey Isl. (Algæ. 2 sampl.).

Arct. Distr. Not before recorded from Arctic Seas. Several other records.

Hyalodiscus Ehr., 1854.

Hyalodiscus scoticus (Kütz.) Grun., Cl. & Grun. A. D. 116, V. H. Syn., Tab. LXXXIV, figs. 15—17.

Loc. Danmarks Havn (Algæ), Koldewey Isl. (Algæ, 3 sampl.).

Arct. Distr. Greenl., E. of Greenl., East Arct. S.

Hyalodiscus subtilis Baill. Cl. & Grun. A. D. 116; Perag. D. mar. d. Fr., Tab. CXIX, fig. 7.

Loc. Off Cape Amélie (Algæ, 2 sampl.), Danmarks Havn (Algæ, 2 sampl.), Off Cape Bismarck (Algæ), Koldewey Isl. (Algæ, 4 sampl.).

Arct. Distr. Greenl., East Arct. S.

Biddulphia Gray., 1831.

Biddulphia arctica (Brightw.) Boyer, Brightw. Micr. Journ. IV, 250, Tab. IV, fig. 11 (Triceratium arcticum).

Loc. Danmarks Havn (Algæ, 2 sampl.), Off Cape Bismarck (Algæ), Koldewey Isl. (Algæ, 4 sampl.).

Arct. Distr. Greenl., East Arct. S.

Biddulphia arctica *forma Balæna* Ehr., A. S. Atl., Tab. CXXI, figs. 5—6.

Loc. Off Cape Bismarck (Algæ), Koldewey Isl. (Algæ, 4 sampl.).

Arct. Distr. Greenl., East Arct. S.

Biddulphia aurita (Lyngb.) Bréb., V. H. Trt. 471, Tab. XX, fig. 631.

Loc. Koldewey Isl. (Algæ, 2 sampl.).

Arct. Distr. Greenl., E. of Greenl.. East Arct. S.

Biddulphia suborbicularis Grun. var. *arctica* Øst., Øst. Kyst. D. f. Grønl., 343, Tab. II, fig. 14 (Bidd. suborb. var.).

Loc. Koldewey Isl. (Algæ, 4 sampl.).

Arct. Distr. Greenl.

Biddulphia sp., Tab. nostr. XIII, fig. 23.

Striis 11 in 10 μ, punctatis.

Valva biddulphoidea, cornubus satis brevibus, obtusis. Facie connectivali ad apicem leniter triundulata spinamqve singulam longam ostendente.

As I have only seen the valve in zone-view I cannot give this form as a new species.

Actinocyclus Ehr., 1840.

Actinocyclus alienus Grun. var. *arcticus* Grun., Cl. Baff. B. 18, Tab. II, figs. 11—12.

Loc. Marg. of the Pack-Ice.

Arct. Distr. Davis Strait, East Arct. S.

Coscinodiscus Ehr., 1838.

Coscinodiscus concinnus W Sm., V. H. Trt. 531 (Cosc. radiatus var. conc.), Perag. D. mar. d. Fr., Tab. LXV, fig. 12.

Loc. Koldewey Isl. (Algæ).

Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Coscinodiscus radiatus Ehr., V. H. Trt. 530.; Perag. D. mar. d. Fr., Tab. CXVII, fig. 3.

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ), Marg. of the Pack-Ice.

Arct. Distr. Greenl., E. of Greenl., East Arct. S.

Coscinodiscus subtilis Ehr. var.? *glacialis* Grun., Grun. Fz. Js. Ld. 56, Tab. III, fig. 27.

Loc. Marg. of the Pack-Ice.

Arct. Distr. Mouth of Yennissey (According to Grunow l. c.).

Coscinodiscus (lacustris Grun. var.?) **septentrionalis** Grun., Grun. Fz. Js. Ld., 33, Tab. IV, fig. 33.

Loc. Marg. of the Ice.

Arct. Distr. W. Greenl., E. of Greenl., East Arct. S.

Distribution of the Marine Diatoms.

		W. Gr.	E. Gr.	E. of Gr.	E. A. S.
	Achnanthes				
1	— brevipes	x	x	..	x
2	— — *intermedia*	..	x	..	x
3	— — *elliptica*	..	x	..	..
4	— — *parvula*	x	x	..	..
5	— groenlandica	x	x	..	x
6	— hyperborea	..	..	.	x
	Actinocyclus				
7	— alienus *arcticus*	x	..	..	x
	Amphipleura				
8	— rutilans	x	x	..	..
9	— — *antarctica*	..	..	..	..
	Amphiprora				
10	— gigantea *sept.*	x	x	..	x
11	— Kjellm. *glacial.*	..	x	..	x
	Amphora				
12	— acutiuscula	x	..	..	x
13	— angusta	x	..	..	x
14	— costata	..	x	..	..
15	— crassa	x	x	..	x
16	— Eunotia	x	x	..	x
17	— granulata	..	..	..	..
18	— lævis lævissima	..	..	x	x
19	— lineolata	..	..	..	x
20	— macilenta	..	..	..	..
21	— margaritifera	x	..	..	..
22	— marina	..	x	x	..
23	— Proteus	x	x	..	x
24	— — *contigua*	..	x	..	..
25	— Terroris	x	x	..	x
26	— — *inflata*	..	x	..	..
	Auricula				
27	— minuta	..	..	..	..
	Biddulphia				
28	— arctica	x	x	..	x
29	— — *Balæna*	x	x	..	x
30	— aurita	x	x	x	x
31	— suborbicularis *var.*	x	x	..	..
	Caloneis				
32	— amphisb. *fuscata*	..	..	..	x
		17	20	3	19

		W. Gr.	E. Gr.	E. of Gr.	E. A. S.
33	(Caloneis) brevis	x	..	..	x
34	— kryophila	x	x	..	x
	Campylodiscus				
35	— angularis	x	x	..	x
	Chætoceros				
36	— Diadema	x	..	..	x
37	— septentrionale	x	..	x	x
38	— sociale	x	..	..	x
	Cocconeis				
39	— costata	x	x	..	x
40	— — *pacifica*	x	x	..	..
41	— dirupta *decipiens*	x	..	..	x
42	— pinnata	..	..	..	x
43	— pseudomarginata	x	x	..	x
44	— Scutellum	x	x	..	x
45	— — *minutissima*	..	..	..	x
46	— — *californica*	..	..	..	x
47	— septentrionalis	..	..	..	x
	Coscinodiscus				
48	— concinnus	x	..	x	x
49	— radiatus	x	x	x	x
50	— septentrionalis	x	..	x	x
51	— subtilis	..	..	..	x
	Diploneis				
52	— borealis	x	..	x	x
53	— coffæiformis	..	..	..	..
54	— Entomon	..	x	..	x
55	— interrupta	..	..	x	x
56	— littoralis *arctica*	x	..	x	x
57	— — *hyperborea*	x	..	x	x
58	— muscæformis	..	..	..	..
59	— Smithii	x	x	..	x
60	— splendida	x	x	..	x
61	— subcincta	..	x	..	x
62	— vacillans	..	..	..	..
	Fragilaria				
63	— Cylindrus	x	..	x	x
64	— islandica *hyperb.*	x	..	..	..
65	— striatula	x	..	..	x
	Gomphonema				
66	— exiguum arctic.	x	x	..	x
		23	12	9	29

		W. Gr.	E. Gr.	E. of Gr.	E. A. S.
67	(Gonophonema) groenland.	x	..	x	x
68	— kamschaticum	x	..	x	x
69	— septentrionale	..	..	x	..
70	— — *angustum*	..	..	x	..
	Grammatophora				
71	— arctica	x	x	x	x
72	— islandica	x	x	..	x
	Gyrosigma				
73	— arcticum	x	..	..	x
	Hantschia				
74	— Weyprechtii	..	..	x	x
	Hyalodiscus				
75	— scoticus	x	x	x	x
76	— subtilis	x	x	..	x
	Licmophora				
77	— gracilis	x	..	..	..
78	— paradoxa	x	x	..	..
	Melosira				
79	— hyperborea	x	x	x	x
80	— Jürgensii	..	..	..	..
81	— mediterr. *gelida*	x	..	..	..
	Navicula				
82	— ammophila	..	..	..	x
83	— Baculus	..	..	x	x
84	— bahusiensis	..	..	x	x
85	— Bolleana	x	..	..	x
86	— — *intermedia*	..	..	x	..
87	— cancellata	x	x	..	x
88	— — *Gregorii*	..	..	x	x
89	— — *retusa*	..	..	..	x
90	— — *subapicul.*	x	..	..	x
91	— digitoradiata	x	x	x	x
92	— — *Cyprinus*	x	x	..	..
93	— directa *genuina*	x	x	..	x
94	— — *cuneata*	..	..	x	..
95	— — *lata*	..	..	x	..
96	— — *remota*	x	x	..	x
97	— distans	x	..	x	x
98	— fusif. *ostrearia*	..	..	..	..
99	— glacialis	x	..	x	x
100	— — *septent.*	x	x	..	x
101	— Grevillei	x	x	..	x
		22	13	17	24

		W. Gr.	E. Gr.	E. of Gr.	E. A. S.
102	(Navicula) inflexa	..	..	..	x
103	— kariana *detersa*	x	..	x	x
104	— — *frigida*	x	..	..	x
105	— kryok. *subprot.*	..	..	x	x
106	— mollis	x	..	..	..
107	— obtusa	x	..	x	x
108	— peregrina	x	..	..	x
109	— — *kefvingensis*	..	..	..	..
110	— punctulata	x	x	..	x
111	— pygmæa	..	..	..	x
112	— ramosissima	x	x	..	..
113	— rhombica	x	..	..	..
114	— rostelloides	..	..	x	..
115	— sibirica	..	..	x	x
116	— spectabilis	x	x	..	..
117	— — *densestriata*	..	x	..	..
118	— Spicula	..	..	x	x
119	— subinflata	x	..	x	x
120	— superba	x	x	x	x
121	— — *subacuta*	..	..	..	x
122	— transitans	x	..	x	x
123	— trigonocephala	x	..	x	x
124	— valida	..	x	x	x
125	— Wankaremæ	..	..	..	x
126	— vitrea	x	..	x	x
127	— Zostereti	..	..	x	..
	Nitschia				
128	— angularis	x	x	x	x
129	— — *borealis*	x	x	..	x
130	— bilobata	x	..	..	..
131	— Brébiss. *borealis*	x	..	x	x
132	— distans	x	..	..	x
133	— hybrida	..	..	x	x
134	— insignis *arctica*	..	x	..	x
135	— lanceolata	..	..	x	..
136	— lævissima	..	..	x	x
137	— paradoxa	..	..	..	x
138	— scabra	x	..	x	x
139	— Sigma	x	..	..	x
140	— — *Sigmatella*	..	..	..	..
141	— — *valida*	x	..	..	..
142	— polaris	x	..	x	x
143	— socialis *kasiana*	..	..	..	x
344	— Trybl. *levidensis*	..	x	..	x
	Pinnularia				
145	— bistriata	..	..	..	..
		23	10	20	31

		W. Gr.	E. Gr.	E. of Gr.	E. A. S.
146	(Pinnularia) qvadratarea	x	x	x	x
147	— — *constricta*	..	..	x	x
148	— — *dubia*	..	..	..	x
149	— — *gibbosa*	..	..	x	x
150	— Stuxbergii	x	..	x	x
	Plagiogramma				
151	— Gregorianum	x	..	..	x
	Pleurosigma				
152	— elongatum	x	x	..	x
	Podosira				
153	— hormoides	x	x	x	..
154	— — *minima*	..	..	..	..
155	— Montagnei	..	..	..	..
	Rhabdonæma				
156	— arcuatum	x	x	x	x
157	— minutum	x	x	..	x
	Rhizosolenia				
158	— hebet. *semisp.*	..	..	..	x
	Rhoicosphenia				
159	— curvata	x	x	x	x
	Stauroneis				
160	— pellucida *constr.*	..	..	x	..
161	— perpusilla	..	..	x	x
		8	6	9	12

		W. Gr.	E. Gr.	E. of Gr.	E. A. S.
	Stephanopyxis				
162	— Turris *var.*	..	..	..	x
	Surirella				
163	— Oestrupii	..	x	x	x
	Synedra				
164	— affinis *genuina*	..	..	..	..
165	— — *acuminata*	..	..	..	..
166	— — *fasciculata*	..	..	..	..
167	— — *hybrida*	..	..	..	..
168	— — *lancelettula*	x	..	..	..
169	— — *parva*	x	..	..	x
170	— — *rupicola*	..	..	..	..
171	— — *subtilis*	..	..	..	..
172	— — *tabulata*	..	..	..	..
173	— — *curta acum*	x	x	..	x
174	— investiens	x	..	..	x
175	— kamtschatica	x	x	..	x
	Thalassiosira				
176	— decipiens	..	..	..	..
177	— gravida	x	..	x	x
178	— Nordenskiöldii	x	x	x	x
	Trachyneis				
179	— asp. *genuina*	..	..	..	..
180	— — *vulgaris*	x	..	..	..
181	— — *intermedia*	x	x	x	x
	Tropidoneis				
182	— longa	x	x	..	x
		10	6	4	10
	Total...	103	66	62	123

In the above list I have given an account of the distribution of the individual species within different districts of the Arctic Seas.

I have in all 182 marine forms, of which 24 have until now been unrecorded from the Arctic Seas. Hence 158 (86.8 %), therefore by far the greater part, have previously been recorded from these districts. If we now investigate the more detailed distribution, the result will be as follows: —

(1) From W. Greenl. are known .... 103 (56.6 %)
— E. Greenl. + E. of Greenl. are known 120 (66.0 %)
— East Arct. S. are known .... 125 (68.7 %)

(2) From W. Greenl. only, and from nowhere else in the Arctic districts.............. 10 (5.5 %)
— E. Greenl. + E. of Greenl. only, and from nowhere else in the Arctic districts.. 15 (8.2 %)
— East Arct. S. only, and from nowhere else in the Arctic districts......... 19 (10.4 %)

(3) From W. Greenl. + E. Greenl.............. 53 (29.1 %)
— W. Greenl. + Eastward............. 90 (49.5 %)
— Eastward on the whole.............. 149 (81.9 %)

These three percentage tables show, that there is a rise in the percentages as regards the eastern districts, and therefore the Diatoms found in the material at hand indicate an easterly tendency as regards their Arctic distribution.

As the material examined consists partly of Alga-samples, partly of ice-samples, I have in the following table given an account of the occurrence of the genera in these samples.

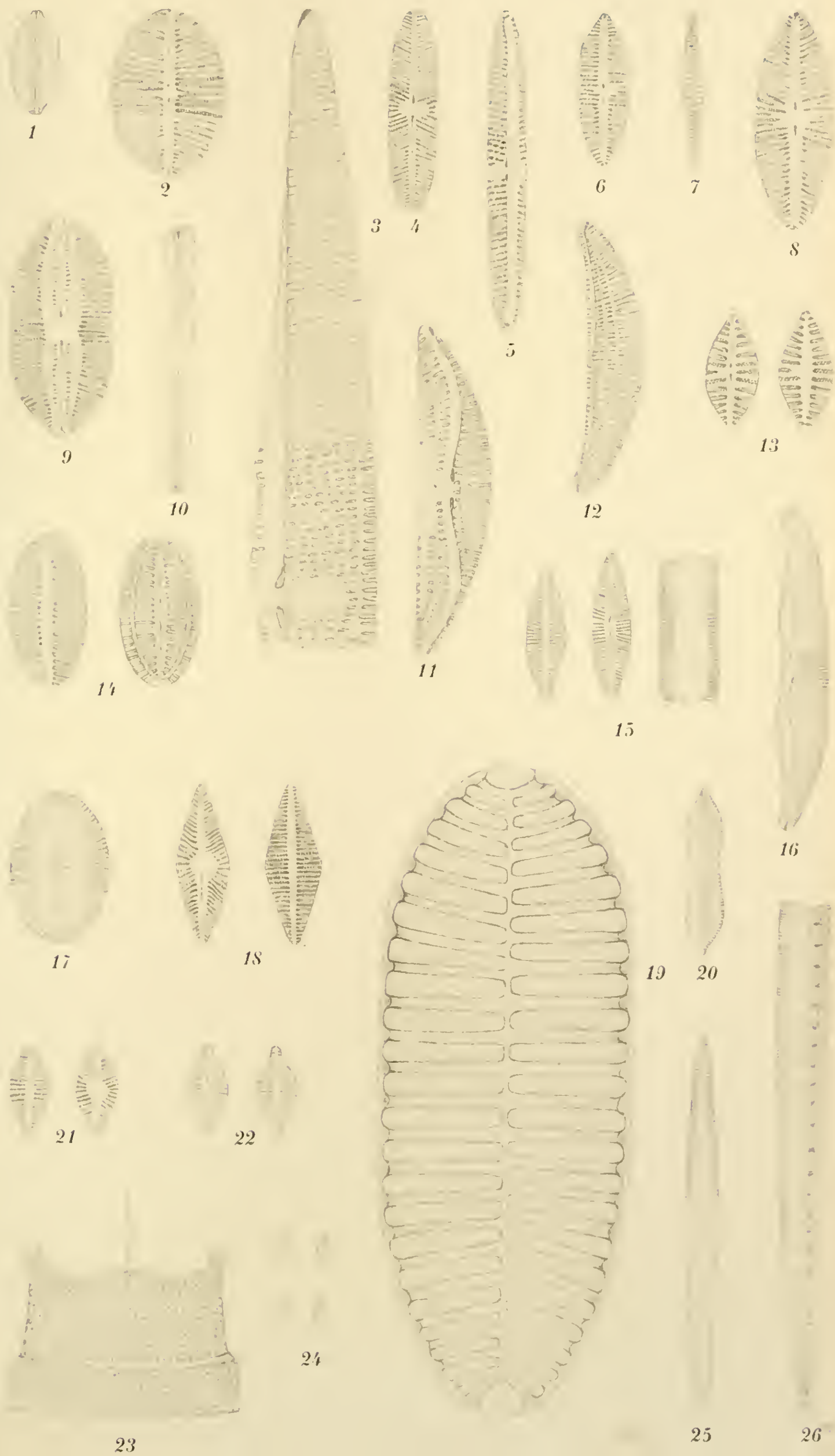
	Predominant in the Alga-samples are the genera	Number of species and varieties		Predominant in the ice-samples are the genera	Number of species and varieties		In both Alga- and ice-samples occur the genera	Number of species and varieties	In Alga-samp.	In ice-samp.	Both in Alga- and ice-samp.
1	Achnanthes....	6	1	Actinocyclus...	1	1	Caloneis.......	3	2	1	..
2	Amphipleura...	2	2	Amphiprora...	2	2	Chætoceros....	3	1	..	2
3	Amphora......	15	3	Rhizosolenia...	1	8	Coscinodiscus..	4	2	2	..
4	Auricula.......	1	4	Stauroneis.....	2	4	Diploneis......	11	9	2	..
5	Biddulphia....	4	5	Stephanopyxis.	1	5	Fragilaria......	3	1	2	..
6	Campylodiscus.	1	6	Thalassiosira...	3	6	Gomphonema..	5	1	3	1
7	Cocconeis......	9				7	Gyrosigma.....	1	..	..	1
8	Grammatophora	2			10	8	Hantzschia.....	1	..	..	1
9	Hyalodiscus....	2				9	Melosira.......	3	2	1	..
10	Licmophora....	2				10	Navicula.......	46	25	18	3
11	Plagiogramma..	1				11	Nitzschia......	17	14	3	..
12	Pleurosigma....	1				12	Pinnularia.....	6	3	3	..
13	Podosira.......	3						103	60	35	8
14	Rhabdonema...	2									
15	Rhoicospenia...	1									
16	Surirella.......	1									
17	Synedra.......	12									
18	Trachyneis.....	3									
19	Tropidoneis....	1									
		69									

The above table shows that the following is the distribution in the samples of the 37 genera which occur — 19 (51.4 %) in Alga- and ice-samples, 12 (32.4 %) both in Alga- and ice-samples, and 6 (16.2 %) in ice-samples.

With regard to the species and varieties we find the proportions to be as follows: —

In the Alga-samples are found .... 129 (70.9 %)
In the ice-samples are found............... 45 (24.7 %)
Both in the Alga- and ice-samples are found 8 (4.4 %)

All the figures were drawn magnified 1000 times by the author, and then photographically reduced to a magnification of 660.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FRESHWATER-DIATOMS.

PENNATÆ.

Diraphideæ.

Caloneis Cl., 1894.

Caloneis Clevei (Lgst.) Cl., Cl. Syn., I, 51; Lgst., Spb., Tab. I, fig. 10 (Nav. Clevei).

Loc. Vester Elv.

Arct. Distr. E. Greenl., Spb., J. M.

Caloneis fasciata (Lgst.) Cl., Cl. Syn., I, 50; V. H. Syn., Tab. XII, fig. 34 (Nav. fasciata).

Loc. Off Cape Amélie (Algæ), Danmarks Havn (Algæ).

Arct. Distr. Spb., J. M.

In a sample from Thermometerfjeld I found a form agreeing with *Navicula fonticola* Grun (V H. Syn., Tab. XII, fig. 32) which Cleve (l. c.) refers to *Caloneis fasciata*.

Caloneis lepidula (Grun.) Cl., Cl. Syn., I, 50; V. H. Trt., Tab. V, fig. 236 (Nav. lepid.).

Loc. Vester Elv.

Not before recorded from Arctic regions.

Caloneis septentrionalis sp. nova. Tab. nost. XIV, fig. 1.

Long. 70 μ. Lat. 8 μ. Str. 14 in 10 μ, delicatissime punctatis.

Valva lineari, apicibus rotundatis. Raphe area satis lata hyalina cincta. Striis parallelis, sub apices convergentibus media in valva deficientibus ibiqve fasciam transapicalem angustam relinqventibus. Linea inframarginali difficulter perspicienda. Nodulis terminalibus figuram sicut flammulæ præbentibus.

Loc. Hvalrosodde, Vester Elv.

Possibly this species, in spite of its coarse striation, may be most nearly allied to the group belonging to *Caloneis fasciata*.

Caloneis Silicula (Ehr.) Cl. var. *alpina* Cl., Cl. Syn., I, 51; Lgst., Spb., Tab. I, fig. 6 (Nav. limosa).

Loc. Hvalrosodde, Vester Elv (2 sampl.).

Arct. Distr. E. Greenl., Spb., J. M.

Caloneis Silicula var. *ventricosa* (Ehr.) Donk., Cl. Syn., I, 52; V. H. Trt., Tab. V, fig. 209 (Nav. ventric.).

Loc. Vester Elv.

Arct. Distr. Fz. Js. Ld.

Neidium Pfitz., 1871.

Neidium affine Ehr. var. *genuina* Cl. *forma minor*, Cl. Syn., I, 68; Lgsl., Spb., Tab. I, fig. 9 (Nav. bisulcata turgidula).

Loc. Vester Elv.

Arct. Distr. Spb.

Neidium affine Ehr. var *longiceps* Greg., Greg. M. J., IV, Tab. I, fig. 27 (Nav. longic.).

Loc. Vester Elv.

Arct. Distr. W. Greenl.

Neidium bisulcatum Lgst., Cl. Syn., I, 68; Lgst., Spb., Tab. I, fig. 18 (Nav. bisulc.).

Loc. Vester Elv.

Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld., Spb., J. M.

Neidium decoratum Brun, Brun, Jan M. & Est-Groenl., 18, Tab. II, figs. 6—7.

Loc. Hvalrosodde, Vester Elv (2 sampl.).

Arct. Distr. E. Greenl.

Neidium Iridis (Ehr.) Cl., Cl. Syn., I, 69; V. H. Trt., Tab. V, fig. 212 (Nav. Ir.).

Loc. Hvalrosodde.

Arct. Distr. E. Greenl., Fz. Js. Ld.

Diploneis Ehr., 1840.

Diploneis oculata (Bréb.) Cl., Cl. Syn., I, 92; V. H. Syn, Tab IX, fig. 10 (Nav. ocul.).

Loc. Off Cape Amélie (Algæ).

Not before recorded from Arctic regions. Other record, France.

Diploneis Puella (Schum?) Cl., Cl. Syn., I, 92; V. H. Trt., Tab. IV, fig. 158 (Nav. ellipt. minima).

Loc. Off Cape Amélie (Algæ).

Arct. Distr. W. Greenl., Spb.

Frustulia Ag., 1824.

Frustulia rhomboides Ehr. var. *leptocephala* Øst., Øst. Ferskv. D. f. Østg., 257, Tab. I, fig. 1.

Loc. Vester Elv (2 sampl.).

Arct. Distr. E. Greenl.

Naviculæ merolejæ Cl., 1894.

Navicula bacilliformis Grun, Cl. Syn., I, 131; V. H. Trt., Tab. XXVII, fig. 774.

Loc. Nostoc.

Not before recorded from Arctic regions. Several other records.

Navicula Heufleriana Grun., Cl. Syn., I, 130; V. H. Syn., Tab. IV, fig. 1 a.

Loc. Hvalrosodde.

Arct. Distr. Fz. Js. Ld.

Navicula mutica Kütz. *forma Cohnii Hilse*, Cl. Syn., I, 129; V. H. Trt., Tab. 4, fig. 167 (Nav. mut.).

Loc. Lille Snenæs, Danmarks Havn, Vester Elv.

Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld., Spb., J. M.

Navicula mutica *forma Gøppertiana* Bleisch, V. H. Syn., Tab. X, figs. 18—19.

Loc. Off Cape Amélie (Algæ, 2 sampl.).

Not before recorded from Arctic regions. Several other records.

Navicula mutica *forma ventricosa* Kütz., V. H. Trt., Tab. IV, fig. 171 (Nav. ventric.).

Loc. Lille Snenæs (2 sampl.), Vester-Elv, Thermometerfjeld.

Arct. Distr. E. Greenl., Fz. Js. Ld., J. M.

Navicula nivalis Ehr., Cl. Syn., Tab. I, 130; V. H. Syn., Tab. X, fig. 21 (Nav. qvinqvenodis Grun.).

Loc. Thermometerfjeld.

Arct. Distr. Fz. Js. Ld.

Navicula Rotæana Rabh., Cl. Syn., I, 128; Lgst., Spb., Tab. I, fig. 13 (Stauroneis minutissima).

Loc. Lille Snenæs.

Arct. Distr. E. Greenl., Spb., B. El., J. M.

Navicula Seminulum Grun., Cl. Syn., I, 128; V. H. Trt., Tab. V, fig. 228.

Loc. Thermometerfjeld.

Arct. Distr. W. Greenl., Spb.

Naviculæ entolejæ Cl., 1884.

Navicula contenta Grun., Cl. Syn., I, 132; V. H. Trt., Tab. V, fig. 239.

Loc. Dove Bugt, Vester Elv.

Arct. Distr. E. Greenl.

Naviculæ decipientes Grun., 1880.

Navicula gibbula Cl., Cl. Syn., I, 140; Lgst., Spb., Tab. I, fig. 7 a (Nav. gibberula).

Loc. Hvalrosodde, Lille Snenæs (2 sampl.), Vester Elv (2 sampl.), Thermometerfjeld.

Arct. Distr. E. Greenl., Fz. Js. Ld., Spb., J. M.

Navicula gibbula var. *capitata* Lgst., Lgst. l. c., fig. 7 a[1], Tab. nost. XIV, fig. 2.

Loc. Hvalrosodde, Nostoc.

Arct. Distr. E. Greenl., Spb.

This form, of which I have given a figure, differs in the striation, which in the main species is radiate, but here is radiate only in the middle and parallel towards the apices. Lagerstedt has not shown the striation in his fig. 7 a[1], but with regard to the outline and general appearance his figure agrees very well with the present form. Therefore I have no doubt that the present form is identical with *Nav. gibb. capitata* Lgst.

Navicula Lagerstedtii Cl., Cl. Syn., I, 141; Lgst., Spb., Tab. II, fig. 12 (Navicula sp.).

Loc. Hvalrosodde.

Arct. Distr. E. Greenl., Spb.

Naviculæ microstigmaticæ Cl., 1894.

Stauroneis anceps Ehr., Cl. Syn., I, 147; V. H. Trt., Tab. I, figs. 55—57 (including also St. anc. linearis and St. anc. amphicephala).

Loc. Hvalrosodde, Dove Bugt, Lille Snenæs, Vester Elv (3 samples).

Arct. Distr. W. Greenl., E. Greenl., Spb., J. M.

Stauroneis dilatata Ehr. *forma minor* Tab. nost XIV, fig. 3.

Long. 37 μ. Lat. 8 μ. Striis subtilissimis.

Valva elliptice-lanceolata, apicibus capitatis. Raphe area hyalina, mediam valvam versus patescente, cincta. Stauro lato margines non attingente. Striis radiantibus. Nodulis terminalibus inconspicuis.

Loc. Off Cape Amélie (Algæ).

Arct. Distr. The main species: Europe, Siberia.

Stauroneis javanica Grun., var. *oblonga* Øst., Øst., Ferskv. D. f. Østgr., 260, Tab. I, fig. 4.

Loc. Hvalrosodde (2 sampl.), Lille Snenæs.

Arct. Distr. E. Greenl.

Stauroneis javanica Grun., var. *truncata* Øst., Øst. l. c. fig. 5.

Loc. Stormkap, Vester Elv.

Arct. Distr. E. Greenl.

Stauroneis obtusa Lgst., Cl. Syn., I, 149; Lgst., Spb., Tab. I, fig. 11.

Loc. Hvalrosodde.

Arct. Distr. Fz. Js. Ld., Spb.

Stauroneis parvula Grun., Cl. Syn., I, 149; O. Müll., Riesengeb., Tab. III, fig. 33.

Loc. Hvalrosodde, Lille Snenæs.

Not before recorded from Arctic regions. Other record, Europe.

Stauroneis Phoenicenteron Ehr., var. *amphilepta* Ehr., Cl. Syn., I, 149; Herib., Diat. d'Auv., Tab. III, fig. 18.

Loc. Hvalrosodde, Vester Elv (2 sampl.).

Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld.

In a sample from Lille Snenæs I found a Stauroneis which corresponds very well with the form in my "Danske Diatoméer," Tab. II, fig. 36, which I consider intermediate between *Staur. anceps* and *Staur. Phyllodes* Ehr.

Cymbella Ag., 1830.

Cymbella æqvalis W. Sm., Cl. Syn., I, 170; V. H. Syn., Tab. III, fig. 1 a.

Loc. Hvalrosodde (2 sampl.).

Arct. Distr. W. Greenl., E. Greenl.

Cymbella affinis Kütz., var. *tumida* Lgst., Cl. Syn., I, 171 (ad Cymb. aff.?). Lgst., Spb., 43, Tab. II, fig. 19.

Loc. Hvalrosodde (2 sampl.), Nostoc.

Arct. Distr. E. Greenl., Spb.

Cymbella angustata W. Sm., Cl. Syn, I, 161; W. Sm., Syn., Tab. XVII, fig. 156; Lgst., Spb., Tab. II, fig. 10 (Nav. inæqvilatera).

Loc. Hvalrosodde (2 sampl.), Vester Elv.

Art. Distr. W. Greenl., E. Greenl., Spb.

Cymbella Botellus Lgst., Cl. Syn., I, 172; Lgst., Spb., Tab. II, fig. 22 (Cymb. variabilis var. Bot.).

Loc. Hvalrosodde.

Arct. Distr. E. Greenl., Spb.

Cymbella Cesatii Rabh., Cl. Syn., I, 160; V. H. Trt., Tab. III, fig. 143 (Nav. Ces.).

Loc. Hvalrosodde.

Arct. Distr. W. Greenl., E. Greenl.

Cymbella gracilis Rabh., Cl. Syn., I, 169; V. H. Trt., Tab. XXVIII, fig. 791 bis, c (Encyonema lunatum).

Loc. Hvalrosodde.

Arct. Distr. W. Greenl., E. Greenl., Spb.

Cymbella hebridica Grun., Cl. Syn., I, 169; Cl., Diat. Finl., Tab. II, figs. 16—17 (Encyonema hebr.).

Loc. Hvalrosodde.

Not before recorded from Arctic regions. Several other records.

Cymbella heteropleura Ehr. var. *minor* Cl., Cl. Syn., I, 167; Lgst., Spb., Tab. II, fig. 17 (Cymb. Ehrenb. var.).

Loc. Hvalrosodde (4 sampl.), Vester Elv.

Arct. Distr. E. Greenl., Fz. Js. Ld., Spb.

Cymbella leptoceros Ehr., Cl. Syn., I, 162; V H. Syn., Tab. II, fig. 18.

Loc. Hvalrosodde, Vester Elv.
Not before recorded from Arctic regions. Several other records.

Cymbella naviculiformis Auersw., Cl. Syn., I, 166; Lgst., Spb., Tab. II, fig. 18 (Cymb. anglica).

Loc. Hvalrosodde.
Arct. Distr. W. Greenl., E. Greenl., Spb., B. El.

Cymbella septentrionalis sp. nova. Tab. nost. XIV, fig. 4.

Long. 32—56 μ. Lat. 7—8 μ. Str. 14 in 10 μ, delicatissime transverse lineatis.

Valva fere cymbiformi, apicibus marginem dorsalem versus paululum recurvatis. Margine ventrali subundulata. Raphe leniter arcuata, area hyalina distincta, media in valva in aream centralem longinam dilatata, cincta. Nodulis terminalibus marginem dorsalem versus recurvatis.

Loc. Hvalrosodde (2 sampl.).
Very nearly linear specimens of this species sometimes occur.

Cymbella sinuata Greg., Cl. Syn., I, 170; V. H. Trt., Tab. XXV, fig. 699 (Cymb. abnormis).

Loc. Hvalrosodde.
Not before recorded from Arctic regions. Several other records.

Cymbella stauroneiformis Lgst., Cl. Syn., I, 165; Lgst., Spb., Tab. I, fig. 15.

Loc. Hvalrosodde (2 sampl.), Vester Elv.
Arct. Distr. E. Greenl., Fz. Js. Ld., Spb.

Cymbella ventricosa Kütz., Cl. Syn., I, 168; V. H. Syn., Tab. III, fig. 15 (second fig. Encyon. ventr.).

Loc. Vester Elv.
Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld., Spb.

Cymbella ventricosa var. *ovata* Grun., V. H. Trt., Tab. I, fig. 48 (Encyon. cæspit. lata).

Loc. Vester Elv.
Not before recorded from Arctic regions. Several other records.

Cymbella ventricosa var. *semicircularis* Lgst., Lgst., Spb., Tab. II, fig. 20 (Cymb. affinis semicirc.).

Loc. Dove Bugt.
Arct. Distr. E. Greenl., Spb.

This variety, which Cleve (Syn. I, 168) places under *Cymb. ventricosa* seems to be so peculiar in appearance that it certainly may be considered a distinct variety.

In a sample labelled "Nostoc" I found a Cymbella, which is figured in V. H., Syn., Tab. III, fig. 18 as a "Forme moyenne entre *l'Encyonema cæspitosum* et *l'Encyonema Lunula*."

Gomphonema Ag., 1824.

Gomphonema boreale sp. nova. Tab. nost. II, fig. 5.

Long. 60 μ. Lat. 5,5 μ. Str. 8 in 10 μ, punctatis; punct. 10—11 in 10 μ.

Valva clavata, apicibus rotundatis. Raphe area hyalina satis lata cincta. Striis subradiantibus, media in valva deficientibus ibiqve fasciam transapicalem latam relinqventibus. Nodulis terminalibus inconspicuis. Punctum unilaterale non perspicere potui.

Loc. Off Cape Amélie (Algæ). Only a single specimen met with.

Judging from its appearance as a whole this form may be a freshwater-species, although it occurred in a sample of marine Algæ.

Naviculæ minusculæ Cl., 1895.

Navicula Atomus Nægeli var. *circularis* Øst., Øst., Kossog., 84, Tab. I, fig. 10.

Loc. Vester Elv.

Not before recorded from Arctic regions. Other record, Kossogol.

Navicula lucidula Grun., Cl. Syn., II, 4; V. H. Syn., Tab. XIV, fig. 40.

Loc. Hvalrosodde.

Not before recorded from Arctic regions. Other records, Denmark, Kossogol.

Anomoeoneis Pfitz., 1871.

Anomoeoneis exilis (Kütz.), Grun., Cl. Syn., II, 8; V. H. Trt., Tab. IV, fig. 198 (Nav. exil.).

Loc. Hvalrosodde.

Arct. Distr. W. Greenl., E. Greenl.

Anomoeoneis Zellensis Grun., Cl. Syn., II, 7; V. H. Syn., Tab. XII, fig. 14 (Nav. Zell.).

Loc. Hvalrosodde.

Arct. Distr. W. Greenl., E. Greenl.

Anomoeoneis Zellensis var. *linearis* Øst., var. nova. Tab. XIV, fig. 6.

Long. 22 μ. Lat. 4 μ. Striis inconspicuis.

Valva lineari, apicibus leniter attenuatis. Raphe area hyalina angusta media in valva in aream transapicalem parvam rotundatam dilatata, cincta. Structura valvæ sicut scabrosa, an elevationes apicales laterales ostendente? Nodulis terminalibus inconspicuis.

Loc. Hvalrosodde (2 sampl.).

This small form recalls in its structure that of *Anomoeon. Zell.*, but in outline it recalls *Navicula difficilis* Grun. (V. H. Syn., Tab. XII, fig. 17) a species which perhaps may belong to the genus *Anomoeoneis*.

Naviculæ heterostichæ Cl., 1895.

Navicula cocconeiformis Greg., Cl. Syn., II, 9; V. H. Trt., Tab. XXVII, fig. 779.

Loc. Vester Elv (5 sampl.).

Arct. Distr. W. Greenl., E. Greenl., Spb., B. El., J. M.

Naviculæ lineolatæ Cl., 1895.

Navicula anglica Ralfs., Cl. Syn., II, 22; V. H. Trt., Tab. III, fig. 136.

Loc. Danmarks Havn (Algæ).

Not before recorded from Arctic regions. Several other records.

Navicula anglica Ralfs *forma elongata*. Tab. nost. XIV, fig. 7.

Long. 28 μ. Lat. 8 μ. Str. 11 in 10 μ, transverse lineatis.

Valva elliptica, apicibus rostratis. Raphe area hyalina, mediam valvam versus gradatim patescente, cincta. Striis radiantibus, media in valva alternatim longis abbreviatisqve. Nodulis terminalibus inconspicuis.

Loc. Koldewey Isl. (Algæ).

This form may be considered a somewhat narrow *Nav. anglica*.

Navicula capitata Cl., Cl. Diat. f. Fz. Js. Ld., 5, fig. 2.

Loc. Vester Elv,

Arct. Distr. Fz. Js. Ld.

Navicula cincta Ehr., Cl. Syn., II, 16; V. H. Trt., Tab. III, fig. 105.

Loc. Off Cape Amélie (Algæ).

Arct. Distr. Fz. Js. Ld.

Navicula dicephala (Ehr.?) W. Sm., Cl. Syn., II, 21; V. H. Trt., Tab. III, fig. 138.

Loc. Hvalrosodde (2 sampl.), Vester Elv.

Arct. Distr. J. M.

Navicula falaisensis Grun., Cl. Syn., II, 21; V. H. Trt, Tab. V, fig. 232.

Loc. Off Cape Amélie (Algæ), Vester Elv.

Arct. Distr. W. Greenl.

Navicula Gastrum Ehr., Cl. Syn., II, 22; V. H. Trt., Tab. III, fig. 134.

Loc. Off Germ. L. (Land-Ice), Marg. of the Pack-Ice.

Arct. Distr. W. Greenl., E. of Greenl.

Navicula gracilis Ehr. var. *obesa* var. nova. Tab. nost XIV, fig. 8.

Long. 33 μ. Lat. 9 μ. Str. 11 in 10 μ transverse lineatis.

Valva elongate-elliptica apicibus rotundatis. Raphe area angusta hyalina, media in valva in aream transapicalem dilatata, cincta.

Striis radiantibus, sub apices leniter convergentibus, media in valva spatiatis.

Loc. Dove Bugt.

I think this form may be a variety of *Nav. gracilis*, perhaps most nearly allied to *Nav. grac.* var. *schizonemoides* figured in V. H. Syn., Tab. XV, fig. 37 (the second figure).

Navicula lanceolata (Ag.?) Kütz, Cl. Syn., II, 21; V. H. Trt., Tab. III, fig. 139.

Loc. Off Cape Amélie (Algæ), Hvalrosodde, Vester Elv.

Not before recorded from Arctic regions. Several other records.

Navicula lanceolata var. *tenella* A. S., A. S. Atl., Tab. XLVII, figs. 45—46.

Loc. Off Cape Amélie (Algæ), Danmarks Havn (Algæ).

Not before recorded from Arctic regions. Other records, Sweden, Loka (Cl. l. c.).

Navicula Placentula Ehr., Cl. Syn., II, 23; V. H. Trt., Tab. III, fig. 135 (Nav. Gastrum Placentul.).

Loc. Off Cape Amélie (Algæ), Marg. of the Pack-Ice (2 sampl.).

Arct. Distr. Yenissey.

Navicula radiosa Kütz., Cl. Syn., II, 17; V. H. Trt., Tab. III, fig. 112.

Loc. Hvalrosodde.

Arct. Distr. W. Greenl., E. Greenl., Spb., B. El.

Navicula rhyncocephala Kütz., Cl. Syn., II, 15; V. H. Trt., Tab. III, fig. 119.

Loc. Off Cape Amélie (Algæ, 2 sampl.).

Arct. Distr. B. El.

Navicula viridula Kütz. var. *slesvicensis* Grun., Cl. Syn., II, 15; V. H. Trt., Tab. III, fig. 118.

Loc. Dove Bugt.

Arct. Distr. W. Greenl., E. Greenl.

Navicula sp. Tab. nost XIV, fig. 9.

Long. 21 μ. Lat. 5,4 μ. Striis inconspicuis.

Valva lanceolata apicibus capitatis. Raphe distincta.

Loc. Dove Bugt.

This small form shows only very few, if any, distinct characters. I think I have seen indications of a striation which, at least in the middle of the valve, seemed to me to be radiate, but I am not quite certain; therefore I do not feel justified in recording it as a new species.

Naviculæ punctatæ Cl., 1895.

Navicula pusilla W. Sm. var. *capitata* var. nova. Tab. nost. XIV, fig. 10.

Long. 45 μ. Lat. 22 μ. Str. 10—11 in 10 μ, sub apices densioribus, distincte punctatis.

Valva sub-orbiculari, apices plane-capitatos versus valde attenuata. Raphe area hyalina distincta, media in parte valvæ in aream centralem rotundatam dilatata, cincta. Striis radiantibus, media in valva alternatim longis abbreviatisqve. Nodulis terminalibus summis in apicibus situatis.

Loc. Hvalrosodde.

Pinnularia (Ehr.), 1843.

Gracillimæ Cl., 1895.

Pinnularia leptosoma Grun., Cl. Syn., II, 74; V. H. Syn., Tab. XII, fig. 29.

Loc. Off Cape Amélie (Algæ), Vester Elv.

Arct. Distr. E. Greenl., Fz. Js. Ld., J. M.

Capitatæ Cl., 1895.

Pinnularia appendiculata Ag., Cl. Syn., II, 75; V. H. Trt., Tab. II, fig. 93 (Nav. append.).

Loc. Hvalrosodde, Lille Snenæs.

Arct. Distr. W. Greenl.

Pinnularia interrupta W. Sm., *forma stauroneiformis*, Cl. Syn., II, 76; V. H. Trt., Tab. II, fig. 97 (Nav. mesolepta Termes).

Loc. Off Cape Amélie (Algæ).

Arct. Distr. E. Greenl.

Pinnularia mesolepta Ehr. var. *angusta* Cl., Cl. Syn., II, 76; A. S. Atl., Tab. XLV, fig. 62 (Nav. gracillima).

Loc. Hvalrosodde, Nostoc.

Not before recorded from Arctic regions. Several other records.

Pinnularia microstauron Ehr., Cl. Syn., II, 77; V. H. Syn., Tab. VI, fig. 9 (Nav. bicapitata hybrida).

Loc. Koldewey Isl. (Algæ).

Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld., J. M.

Pinnularia subcapitata Greg., Cl. Syn., II, 75; A. S. Atl., Tab. XLV, fig. 65 (Nav. Hilseana).

Loc. Hvalrosodde.

Arct. Distr. W. Greenl., E. of Greenl., Spb.

Divergentes Cl., 1895.

Pinnularia Brébissonii Kütz. var. *diminuta* H. V. H., Cl. Syn., II, 78; V. H. Trt., Tab. II, fig. 84 (Nav. Breb. dimin.)

Loc. Lille Snenæs, Vester Elv.

Arct. Distr. J. M.

Pinnularia Brébissonii var. *linearis* O. Müll. *forma curta*, O. Müll., Riesengeb., 25, Tab. III, fig. 3.

Loc. Vester Elv.

Not before recorded from Arctic regions. Other record, Riesengebirge.

Pinnularia divergens W. Sm. var. *linearis* var. nova. Tab. nost. XIV, fig. 11.

Long. 52 μ. Lat. 11 μ. Str. 8 in 10 μ.

Valva lineari apicibus rotundatis. Raphe area hyalina satis lata, media in valva in fasciam transapicalem dilatata, cincta. Incrassationibus marginalibus fasciæ evidentibus. Striis radiantibus sub apices convergentibus. Fissuris terminalibus figuram "commatis" præbentibus.

Loc. Vester Elv, Thermometerfjeld.

I have placed this form under *Pinn. divergens* because of the marginal incrassations of the fascia.

Pinnularia divergentissima Grun., Cl. Syn., II. 77; V. H. Syn., Tab. VI, fig. 32.

Loc. Hvalrosodde (2 sampl.), Vester Elv, Thermometerfjeld.

Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld., Spb., B. El., J. M.

Pinnularia Legumen Ehr., Cl. Syn., II, 78; V. H. Trt., Tab. II, fig. 98 (Nav. Legum.).

Loc. Vester Elv.

Not before recorded from Arctic regions. Several other records.

The present form is a forma parva; long. 54 μ.

Distantes Cl., 1895.

Pinnularia borealis Ehr., Cl. Syn., II, 80; V. H. Trt., Tab. II, fig. 77 (Nav. bor.).

Loc. Hvalrosodde (2 sampl.), Dove Bugt, Stormbugt, Stormkap, Vester Elv (2 sampl.), Thermometerfjeld.

Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld., Spb., B. El., J. M.

Pinnularia lata Bréb., Cl. Syn., II, 81; V. H. Trt., Tab. II, fig. 76 (Nav. lata).

Loc. Stormkap, Thermometerfjeld.

Arct. Distr. E. Greenl., Fz. Js. Ld., J. M.

Tabellarieæ Cl., 1895.

Pinnularia mesogongyla Ehr., Cl. Syn., II, 84; Cl., Diat. Finl., Tab. I, fig. 11.

Loc. Hvalrosodde, Vester Elv (3 sampl.).

Arct. Distr. E. Greenl.

Pinnularia stauroptera Grun. var. *interrupta* Cl. *forma parva*, Cl. Syn., II, 83; V. H. Trt., Tab. II, fig. 86 (Nav. staur. parva).

Loc. Hvalrosodde (2 sampl.), Lille Snenæs.

Arct. Distr. E. Greenl., Fz. Js. Ld.

Brevistriatæ Cl., 1895.

Pinnularia parva (Ehr.) Greg. var. *Lagerstedtii* Cl., Cl. Syn., II, 87, Lgst.; Spb., Tab. II, fig. 4 (Nav. parvula)

Loc. Dove Bugt, Lille Snenæs.

Arct. Distr. Spb., B. El.

Amphora Ehr., 1840.

Subgen. *Amphora* Cl., 1895.

Amphora ovalis Kütz var. *libyca* Ehr., Cl. Syn., II, 104; V. H. Trt., Tab. I, fig. 17 (Amph. oval. affinis).

Loc. Off Cape Amélie (Algæ), Koldewey Isl. (Algæ).

Arct. Distr. W. Greenl., E. of Greenl., Spb.

Monoraphideæ.

Cocconeis (Ehr., 1835) Grun., 1868.

Subg. *Cocconeis* Cl., 1895 pro gen.

Cocconeis Pediculus Ehr., Cl. Syn., II, 169; A. S. Atl., Tab. CXCII, fig. 61.

Loc. Koldewey Isl. (Algæ).

Not before recorded from Arctic regions. Several other records.

Cocconeis Placentula Ehr. var. *euglypta*, Cl. Syn., II, 170; V. H. Syn., Tab. XXX, figs. 33—34.

Loc. Danmarks Havn (Algæ).

Arct. Distr. Fz. Js. Ld.

Subg. *Eucocconeis* Cl., 1895 pro gen.

Cocconeis flexella Kütz. Cl. Syn., II, 179; V. H. Trt., Tab. VIII, fig. 322 (Achnantidium flexell.).

Loc. Hvalrosodde, Lille Snenæs.

Arct. Distr. E. Greenl., Spb., B. El.

Cocconeis flexella Kütz. var. *intermedia* var. nova. Tab. nost XIV, fig. 12.

Long. 38 μ. Lat. 14 μ. Str. media in valva 22 in 10 μ, apices versus densioribus.

Epitheca: Area centrali subqvadrata, satis magna.

Hypotheca: Raphe sigmoidea, area angusta hyalina, media in parte valvæ in aream centralem acuminatam dilatata, cincta.

Loc. Hvalrosodde.

Especially on account of the subquadrate area of the epitheca I think this form may be intermediate between *Coccon. flex.* and *Coccon. maxima forma minor.* As I have not seen the epitheca and the hypotheca separated, but only in situ I have indicated in my figure of the hypotheca the extent of the central area of the epitheca.

Cocconeis maxima (A. Cl.) Øst. *forma minor*, cf. A. Cl., Lul. Lappm., 24, Tab. I, figs. 22—23 (Achnanthid. maxim. A. Cl.).

Loc. Hvalrosodde.

A. Cleve states that the length of *Achnanthidium maximum* is 0.065 mm (an epitheca) and 0.075 mm (a hypotheca) and she says (l. c.) "Though not seen together, the two valves described above, found in the same sample, certainly belong to the same species."

On an average my specimens are somewhat smaller (Length 48—56 μ, only one specimen measures 60 μ), but otherwise they agree well with A. Cleve's figures.

As I have seen both valves in situ I can affirm that they are corresponding valves.

Cocconeis maxima var. *lanceolata* var. nova. Tab. nost XIV, fig. 14.

Long. 74 μ. Lat. 22 μ. Str., media in valva, 16—17 in 10 μ, apices versus densioribus.

Valva rhombice-lanceolata, apicibus rotundatis. Epitheca: Area centrali qvadrata magna. Hypotheca: Raphe sigmoidea, area hyalina angustissima, media in parte valvæ in aream parvam subcircularem dilatata, cincta. Striis radiantibus. Nodulis terminalibus, paululum a margine remotis, in spatio laterali nudo situatis.

Loc. Hvalrosodde.

As in the figure of *Cocc. flex. interm.*, so also here, I have indicated the extent of the central area of the epitheca as I have only seen both valves in situ.

Cocconeis minuta Cl., Cl. Syn., II, 179; Lgst., Spb., Tab. XIV., fig. 16 (Cocc. Thwaitesii var. β arctica).

Loc. Hvalrosodde, Nostoc.

Arct. Distr. E. Greenl.; Spb.

Achnanthes Bory, 1822.

Subg. *Microneis* Cl. 1995 pro gen.

Achnanthes linearis W. Sm., Cl. Syn., II, 188; V. H. Trt., Tab. VIII, fig. 335.

Loc. Hvalrosodde.

Not before recorded from Arctic regions. Several other records.

Achnanthes microcephala Kütz., Cl. Syn., II, 188; V. H. Trt., Tab. VIII, fig. 332.

Loc. Hvalrosodde (2 sampl.).

Arct. Distr. E. Greenl.

Subg. *Achnanthidium* Cl., 1895 pro gen.

Achnanthes coarctata Bréb., Cl. Syn., II, 192; Lgst., Spb., Tab. I, fig. 16 (Achnanthid. coarct. elineata).

Loc. Hvalrosodde (2 sampl.), Dove Bugt.

Arct. Distr. E. Greenl., Spb., J. M.

Brachyraphideæ.

Eunotia Ehr., 1837.

Eunotia Arcus Ehr.; V. H. Trt., 299, Tab. IX, fig. 362.

Loc. Hvalrosodde, Vester Elv.

Arct. Distr. W. Greenl., E. Greenl., Spb.

Eunotia Arcus var. *bidens* Grun.; V. H. Trt., l. c., fig. 365.

Loc. Hvalrosodde.

Arct. Distr. E. Greenl.

Eunotia Arcus var. *hybrida*; V. H. Syn., Tab. XXXIV, fig. 4.

Loc. Hvalrosodde.

Arct. Distr. E. Greenl.

Eunotia Arcus var. *minor* Grun.; V. H. Trt., l. c., fig. 363.

Loc. Hvalrosodde.

Not before recorded from Arctic regions. "Cum specie hinc inde" (De Toni Syll., p. 791).

Eunotia Arcus var. *uncinata* Grun.; V. H. Trt., 299, Tab. IX, fig. 364.

Loc. Vester Elv, Basiskæret, Nostoc.

Arct. Distr. W. Greenl.

Eunotia Diodon Ehr.; V. H. Trt., 303, Tab. XXX, figs. 829—830.

Loc. Hvalrosodde.

Arct. Distr. W. Greenl., E. Greenl., Spb.

Eunotia divisa Hérib. var. *arctica* var. nova. Tab. nost. XIV, fig. 13, cf. Hérib., Diat. foss. d'Auv., III, 1908, 35, Tab. XIV, fig. 4.

Long. 44 μ. Lat. 7 μ. Str. 15—17 in 10 μ sub apices, ceterum irregulariter distributis.

Valva margine dorsali curvata margine ventrali recta, apicibus rotundatis, marginem ventralem versus leniter incurvatis.

Loc. Off Cape Amélie (Algæ). Only a single specimen found.

The present variety differs from the main species especially by its irregularly arranged striæ. Otherwise it agrees well with the figure by Héribaud referred to above, but is somewhat smaller. It may perhaps be considered as only an abnormal specimen of the main species, which is a fossil recorded from "Dépot de Fraisse-Bas" (France).

Eunotia Faba (Ehr.) Grun.? var. *densestriata* Øst., Øst., Danske Diat., Tab. V, fig. 107.

Loc. Vester Elv.

Not before recorded from Arctic regions. Other record, Denmark.

The present form is somewhat larger (18 μ) than the Danish specimens (14 μ) and — as far as I can see — is also somewhat more coarsely striated (16 striæ in 10 μ, as compared with 20 in 10 μ); but as the striæ can be seen only with great difficulty, they may after all be identical.

Eunotia gracilis (Ehr.) Rabh.; V. H. Trt., 300, Tab. IX, fig. 368.
Loc. Hvalrosodde.
Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld., Spb., B. El., J. M.

Eunotia lunaris (Ehr.) Grun.; V. H. Trt., 303, Tab. IX, fig. 384.
Loc. Lille Snenæs.
Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld., J. M.

Eunotia lunaris (Ehr.) var. *subarcuata* (Næg.) Grun.; V. H. Trt., 304, Tab. IX, fig. 385.
Loc. Vester Elv.
Arct. Distr. J. M.

Eunotia major (W. Sm.) Rabh.; V. H. Trt., 300, Tab. IX, fig. 366.
Loc. Hvalrosodde (2 sampl.), Vester Elv (3 sampl.).
Not before recorded from Arctic regions. Several other records.

Eunotia paludosa Grun., Grun., Østerr. Diat. (1862), 336; V. H. Syn., Tab. XXXIV, fig. 9.
Loc. Vester Elv.
Arct. Distr. W. Greenl., Spb.

Eunotia parallela Ehr., A. Cl., Lul. Lappm., 28; V. H Syn., Tab. XXXIV, fig. 16 (Eun. par. forma angustior).
Loc. Vester Elv.
Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld.. Spb.

Eunotia parallela Ehr. var. *arcuata* var. nova. Tab. nost. XIV, fig. 15.
Long. (sc: chordæ arcus) 40 μ. Lat. 4 μ. Long. sagittæ arcus 10 μ. Str. 14 in 10 μ, transverse lineatis.
Valva arcuata, margine dorsali sub apices paululum declinante.
Loc. Lille Snenæs.

Eunotia pectinalis (Kütz) Rabh. *forma elongata*; V. H. Trt., 301, Tab. IX, fig. 371.
Loc. Lille Snenæs.
Not before recorded from Arctic regions. Other record, Lule Lappmark.

Eunotia pectinalis (Kütz.) var. *minor* (Kütz.) Rabh., A. Cl., Lul. Lappm., 31; V. H. Syn., Tab. XXXIII, figs. 20—21.
Loc. Vester Elv.
Arct. Distr. Fz. Js. Ld.

Eunotia prærupta Ehr. V. H. Trt., 302, Tab. IX, fig. 376.
Loc. Hvalrosodde.
Arct. Distr. E. Greenl.

Eunotia prærupta var. *bidens* Grun.; V. H. Trt. l. c. fig. 379.
Loc. Hvalrosodde.
Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld., J. M.

Eunotia prærupta var. *bigibba* Kütz. V. H. Trt. l. c., fig. 380.

Loc. Hvalrosodde, Lille Snenæs, Vester Elv.

Arct. Distr. E. Greenl., Fz. Js. Ld.

Eunotia prærupta var. *curta* Grun. V. H. Trt. l. c., fig. 377.

Loc. Hvalrosodde, Danmarks Havn, Vester Elv.

Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld.

Eunotia prærupta var. *inflata* Grun. V. H. Trt. l. c., fig. 378.

Loc. Hvalrosodde.

Not before recorded from Arctic regions. Other records unknown to me.

Eunotia prærupta var. *laticeps* Grun., A. Cl., Lul. Lappm., 34; V. H. Syn., Tab. XXXIV, fig. 25 (forma curta).

Loc. Hvalrosodde (2 sampl).

Arct. Distr. E. Greenl., Fz. Js. Ld., J. M.

Eunotia prærupta var. *Monodon* Øst., Øst., Ferskv. D. f. Østg., 273, Tab. I, fig. 11.

Loc. Hvalrosodde (2 sampl.).

Arct. Distr. E. Greenl.

Eunotia robusta Ralfs var. *Papilio* Grun. V. H. Syn., Tab. XXXIII, fig. 8.

Loc. Hvalrosodde (3 sampl.), Stormkap, Vester Elv (3 sampl.), Thermometerfjeld.

Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld., Spb.

Eunotia septentrionalis Øst., Øst., Ferskv. D. f. Østg., 274, Tab. I, fig. 10.

Loc. Hvalrosodde, Dove Bugt, Lille Snenæs, Vester Elv.

Arct. Distr. E. Greenl., Fz. Js. Ld.

Eunotia Triodon Ehr. V. H. Trt, 303, Tab. IX, fig. 387.

Loc. Stormkap.

Arct. Distr. W. Greenl., E. Greenl., Spb.

Eschatoraphideæ.

Surirella Turp., 1827.

Surirella ovalis Bréb. var. *minuta* Bréb. V. H. Trt., 373, Tab. XIII, fig. 588.

Loc. Off Cape Amélie (Algæ).

Arct. Distr. E. Greenl., B. El.

Surirella ovalis var. *ovata* Kütz. V. H. Trt. l. c., fig. 587.

Loc. Off Cape Amélie (Algæ).

Arct. Distr. E. Greenl.

Tropidoraphideæ.

Hantzschia Grun., 1877.

Hantzschia amphioxys (Ehr.) Grun., V. H. Trt., 381, Tab. XV, fig. 483 b.

Loc. Lille Snenæs (2 sampl.), Thermometerfjeld.

Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld., Spb., B. El., J. M.

Hantzschia amphioxys (Ehr.) var. *leptocephala* Øst., Øst., Ferskv. d. f. Østg., 276, Tab. I, fig. 8.

Loc. Hvalrosodde (3 sampl.), Lille Snenæs, Vester Elv, Thermometerfjeld.

Arct. Distr. E. Greenl.

Hantzschia amphioxys (Ehr.) var. *robusta* var. nova. Tab. nost. XIV, fig. 17.

Long. 176 μ. Lat. 15 μ. Punct. carinal. 4—5 in 10 μ. Str. 15 in 10 μ, punctatis.

Valva hantzschoidea, apicibus rostratis. Punctis carinalibus paululum in valvam prolongatis. Nodulo centrali eximie conspicuo.

Loc. Hvalrosodde.

Nitzschia (Hass., 1845, W. Sm.), Grun., 1880.

Dubiæ.

Nitzschia Nathorstii Brun, Brun, J. M. & E. Greenl., 9, Tab. II, fig. 5.

Loc. Hvalrosodde, Lille Snenæs.

Arct. Distr. Fz. Js. Ld., J. M.

Nitzschia thermalis (Kütz.) Grun. var. *intermedia* Grun. V. H. Trt., 389, Tab. XV, fig. 510.

Loc. Off Cape Amélie (Algæ).

Not before recorded from Arctic regions. Other record, Ard. Liég. (V. H. Trt. l. c.).

Grunowia.

Nitzschia Denticula Grun., V. H. Trt., 390, Tab. 15, fig. 514.

Loc. Hvalrosodde.

Arct. Distr. W. Greenl., E. Greenl., Spb.

Obtusæ.

Nitzschia subcapitata sp. nova. Tab. nost. XIV, fig. 18.

Long. 94 μ. Lat. 4 μ. Punct. carinal. 8 in 10 μ. Str. delicatissimis.

Valva fere lineari, apices subcapitatos versus unilateraliter attenuata. Nodulo centrali obscuro, an præsente?

Loc. Vester Elv.

Lanceolatæ Grun.

Nitzschia fonticola Grun. var.? Tab. nost. XIV, fig. 16.

Long. 13 μ. Lat. 4 μ. Punctis carinalibus 11—12 in 10 μ. Striis inconspicuis. Valva lanceolata, carena valde excentrica.

Loc. Hvalrosodde.

This small form may be allied to *Nitz. fontic.*, V. H. Syn., Tab. LXIX, figs. 16—17.

Nitzschia Hantzschiana Rabh. Cl. & Grun. A. D., 99; V. H. Syn., Tab. LXIX, figs. 1—2.

Loc. Vester Elv.

Arct. Distr. Fz. Js. Ld., Spb.

Nitzschia Palea (Kütz) W. Sm. var. *minuta* Bleisch., Cl. & Grun. A. D., 96; V. H. Syn., Tab. LXIX, fig. 23.

Loc. Danmarks Havn (Algæ).

Arct. Distr. E. Greenl., Fz. Js. Ld., J. M.

Nitzschia Palea var. *tenuirostris* Grun.; V. H. Trt., 402, Tab. XVII, fig. 556 (the second figure).

Loc. Hvalrosodde.

Arct. Distr. B. El., J. M.

Arraphideæ.

Ceratoneis Ehr., 1840.

Ceratoneis Arcus Kütz.; V. H. Trt., 306, Tab. X, fig. 401.

Loc. Lille Snenæs.

Arct. Distr. W. Greenl., E. Greenl., Fz. Js. Ld., Spb., B. El.

Synedra Ehr, 1831.

Synedra radians (Kütz.) Grun.; V. H. Trt., 312, Tab. X, fig. 423.

Loc. Hvalrosodde.

Not before recorded from Arctic regions. Several other records.

Synedra Ulna (Nitsch.) Ehr.?

Loc. Hvalrosodde, Koldewey Isl. (Algæ).

I have only seen a few fragments, so that an exact determination is impossible.

Synedra Vaucheriæ Kütz. var. *septentrionalis* var. nova. Tab. nost. XIV, fig. 19.

Long. 23—30 μ. Lat. 3,6 μ. Str. 16 in 10 μ, an punctatis?

Valva lineari apicibus capitatis subcapitatisve. Striis parallelis, altera in parte media valva deficientibus ibiqve areolam unilateralem relinqventibus.

Loc. Vester Elv (4 sampl.), Lille Snenæs.

As this small species occurs in the samples both free and also attached to the narrow branches of algæ, but never in the form of long bands, I think it may be a *Synedra*, not a *Fragilaria*. A. Cleve (Beitr. z. Fl. d. Bär. Ins., 17, fig. 10) describes and figures a *Synedra Vaucheria* Kütz. var. *perminuta* Grun., which may be a smaller and non-capitate form of the present species.

Fragilaria Lyngb.

Fragilaria construens (Ehr.) Grun.; V. H. Trt., 325, Tab. XI, fig. 450.

Loc. Hvalrosodde.

Arct. Distr. W. Greenl., B. El.

Fragilaria (*mutabilis* (W. Sm.) Grun. var.?) *elliptica* Schumann de Toni Syll., 687 (Frag. ellipt.); V. H. Syn., Tab. XLV, fig. 15.

Loc. Hvalrosodde.

Not before recorded from Arctic regions.

Diatoma De Cand., 1805.

Diatoma hiemale (Lyngb.) Kütz. var. *mesodon* Kütz. V. H. Trt., 350, Tab. XI, fig. 471.

Loc. Off Cape Amélie (Algæ), Danmarks Havn (Algæ), Koldewey Isl. (Algæ).

Arct. Distr. W. Greenl.

Tabellaria Ehr., 1839.

Tabellaria flocculosa (Roth.) Kütz. V. H. Trt., 357, Tab. XI, fig. 478.

Loc. Hvalrosodde, Dove Bugt, Vester Elv (7 sampl.).

Arct. Distr. W. Greenl., E. Greenl., Spb., B. El., J. M.

Centricæ.

Melosira Ag.

Melosira varians Ag. V. H. Trt., Tab. XVIII, fig. 611.

Loc. Danmarks Havn.

Not before recorded from Arctic regions. Several other records.

Cyclotella Kütz., 1833.

Cyclotella antiqva W. Sm. V. H. Trt., 446, Tab. XXII, fig. 652.

Loc. Hvalrosodde (2 sampl.).

Arct. Distr. W. Greenl., E. Greenl., Spb.

Stephanodiscus (Ehr., 1845) Grun., 1880.

Stephanodiscus Astræa (Ehr.) Grun. var. *spinulosus* Grun., Grun., Fz. Js. Ld., 49, Tab. V., fig. 2.

Loc. Danmarks Havn (Algæ).

Arct. Distr. E. Greenl., Fz. Js. Ld.

Distribution of the Freshwater Diatoms.

No.	Species	W. Gr.	E. Gr.	Fz. Js. Ld.	Spb.	B. El.	J. M.
	Achnanthes						
1	— coarctata	..	x	..	x	..	x
2	— linearis	..	..	..	..	..	..
3	— microcephala	..	x	..	..	..	..
	Amphora						
4	— ovalis *libyca*	x	x	..	x	..	..
	Anomoeoneis						
5	— exilis	x	x	..	..	..	..
6	— zellensis	x	x	..	..	..	..
	Caloneis						
7	— Clevei	..	x	..	x	..	x
8	— fasciata	..	..	..	x	..	x
9	— lepidula	..	..	..	..	..	..
10	— Silicula *alpina*	..	x	..	x	..	x
11	— — *ventricosa*	..	..	x	..	..	..
	Ceratoneis						
12	— Arcus	x	x	x	x	x	..
	Cocconeis						
13	— flexella	..	x	..	x	x	..
14	— minuta	..	x	..	x	..	..
15	— Pediculus	..	..	..	..	..	..
16	— Placentul. *euglypt.*	..	..	x	..	..	..
	Cyclotella						
17	— antiqva	x	x	..	x	..	..
	Cymbella						
18	— æqvalis	x	x	..	..	..	..
19	— angustata	x	x	..	x	..	..
20	— affinis *tumida*	..	x	..	x	..	..
21	— Botellus	..	x	..	x	..	..
22	— Cesatii	x	x	..	..	..	..
23	— gracilis *lunata*	x	x	..	x	..	..
24	— hebridica	..	..	..	..	..	..
25	— heteropleur. *minor*	..	x	x	x	..	..
26	— leptoceros	..	..	..	..	..	..
27	— naviculiformis	x	x	..	x	x	..
28	— sinuata	..	..	..	..	..	..
29	— stauroneiformis	.	x	x	x	..	..
30	— ventricosa	x	x	x	x	..	..
31	— — *ovata*	..	..	..	..	..	..
32	— — *semicircular.*	..	x	..	x	..	..
		11	22	6	18	3	4

No.	Species	W. Gr.	E. Gr.	Fz. Js. Ld.	Spb.	B. El.	J. M.
	Diatoma						
33	— hiemale *mesodon.*	x	..	..	..	..	..
	Diploneis						
34	— oculata	..	..	..	..	..	..
35	— Puella	x	..	..	x	..	..
	Eunotia						
36	— Arcus	x	x	..	x	..	..
37	— — *bidens*	..	x	..	..	..	..
38	— — *hybrida*	..	x	..	..	..	..
39	— — *minor*	..	..	..	..	..	..
40	— — *uncinata*	x	..	..	..	..	..
41	— Diodon	x	x	..	x	..	..
42	— gracilis	x	x	x	x	x	x
43	— lunaris	x	x	x	..	..	x
44	— — *subarcuata.*	..	..	..	..	..	x
45	— major	..	..	..	..	..	..
46	— paludosa	x	..	..	x	..	..
47	— parallela	x	x	x	x	..	..
48	— pectinalis *elong.*	..	..	..	..	..	..
49	— — *minor*	..	..	x	..	..	..
50	— prærupta	..	x	..	..	..	..
51	— — *bidens*	x	x	x	..	..	x
52	— — *bigibba*	..	x	x	..	..	..
53	— — *curta*	x	x	x	..	..	..
54	— — *inflata*	..	..	..	..	..	..
55	— — *latic. curta*	..	x	x	..	..	x
56	— — *monodon*	..	x	..	..	..	..
57	— septentrionalis	..	x	x	..	..	..
58	— Triodon	x	x	..	x	..	..
59	— robusta *Papilio*	x	x	x	x	..	..
	Fragilaria						
60	— construens	x	..	..	..	x	..
61	— mutabilis *elliptica*	..	..	..	..	..	..
	Frustulia						
62	— rhomboid. *leptoc.*	..	x	..	..	..	..
	Hantzschia						
63	— amphioxys	x	x	x	x	x	x
64	— — *leptocephala*	..	x	..	..	..	..
	Melosira						
65	— varians	..	..	..	..	..	..
		15	19	11	9	3	6

		W. Gr.	E. Gr.	Fz. Js. Ld.	Spb.	B. El.	J. M.
	Navicula						
66	— anglica	..	..	..	..	..	..
67	— Atomus *circul.*	..	..	..	..	..	..
68	— bacilliformis	..	..	..	..	..	..
69	— capitata	..	..	x	..	..	..
70	— cincta	..	..	x	..	..	..
71	— cocconeiformis	x	x	..	x	x	x
72	— contenta	..	x	..	..	..	..
73	— dicephala	..	..	..	..	..	x
74	— gibbula	..	x	x	x	..	x
75	— — *capitata*	..	x	..	x	..	..
76	— Lagerstedtii	..	x	..	x	..	..
77	— falaisensis	x	..	..	..	..	..
78	— Gastrum	x	x	..	..	..	..
79	— lanceolata	..	..	..	..	..	..
80	— — *tenella*	..	..	..	..	..	..
81	— lucidula	..	..	..	..	..	..
82	— mutica f. *Cohnii*	x	x	x	x	..	x
83	— — *Goeppertiana*	..	..	..	..	..	..
84	— — *ventricosa*	..	x	x	..	..	x
85	— nivalis	..	..	x	..	..	..
86	— Heufleriana	..	..	x	..	..	..
87	— Placentula	..	..	..	..	..	..
88	— radiosa	x	x	..	x	x	..
89	— rhyncocephala	..	..	..	..	x	..
90	— Rotæana	..	x	..	x	x	x
91	— Seminulum	x	..	..	x	..	..
92	— viridula *slesvicens.*	x	x	..	..	..	..
	Neidium						
93	— affin. gen. *minor*	..	..	..	x	..	..
94	— — *longiceps*	x	..	..	..	..	..
95	— bisulcatum	x	x	x	x	..	x
96	— decoratum	..	x	..	..	..	..
97	— Iridis	..	x	x	..	..	..
	Nitzschia						
98	— Denticula	x	x	..	x	..	..
99	— Hantzschiana	..	..	x	x	..	..
100	— Nathorstii	..	..	x	..	..	x
		10	15	11	12	4	8

		W. Gr.	E. Gr.	Fz. Js. Ld.	Spb	B. El.	J. M.
101	(Nitzschia) Palea *minuta*	..	x	x	..	..	x
102	— — *tenuir*	..	..	..	..	x	x
103	— thermal. *intens*	..	..	..	..	..	..
	Pinnularia						
104	— appendiculata	x	..	..	..	..	..
105	— borealis	x	x	x	x	x	x
106	— Brébissonii *dimin.*	..	..	..	..	..	x
107	— linearis *curta*	..	..	..	..	..	..
108	— divergentissima	x	x	x	x	x	x
109	— interrupta *staur.*	..	x	..	..	..	..
110	— lata	..	x	x	..	..	x
111	— Legumen	..	..	..	..	..	..
112	— leptosoma	..	x	x	..	..	x
113	— mesogongyla	..	x	..	..	..	..
114	— mesolepta *angusta*	..	..	..	..	..	..
115	— microstauron	x	x	x	..	..	x
116	— parva *Lagerstedtii*	..	..	..	x	x	..
117	— staur. *interr.* parva	..	x	x	..	..	..
118	— subcapitata	x	x	..	x	..	..
	Stauroneis						
119	— anceps	x	x	..	x	..	x
120	— javanica *oblonga*	..	x	..	..	..	..
121	— — *truncata*	..	x	..	..	..	..
122	— obtusa	..	..	x	x	..	..
123	— parvula	..	..	..	..	..	..
124	— Phoenic. *amphil.*	x	x	x	..	..	..
	Stephanodiscus						
125	— Astræa *spinul.*	..	x	x	..	..	..
	Surirella						
126	— ovalis *minuta*	..	x	..	..	x	..
127	— — *ovata*	..	x	..	..	..	..
	Synedra						
128	— radians	..	..	..	..	..	..
	Tabellaria						
129	— flocculosa	x	x	..	x	x	x
		8	18	10	7	6	10
	Total	44	74	38	46	16	28

The above list shows, that the total number of freshwater forms is 128, and of these there were previously known

from W. Greenland .... 44 (34.1 %)
— E. Greenland .... 74 (57.4 %)
— Franz-Josef Land .... 38 (29.5 %)

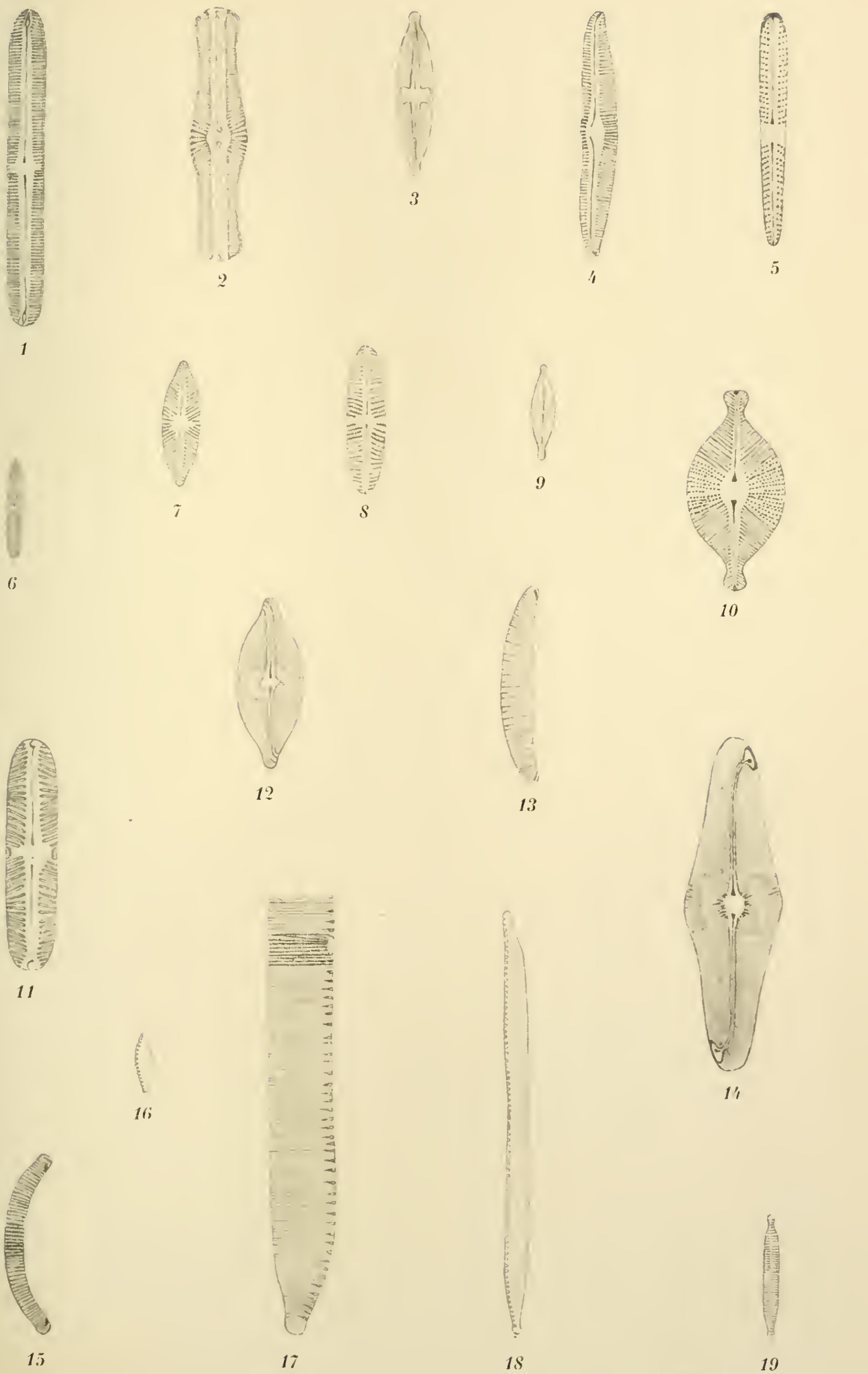
from Spitzbergen	46 (35.7 %)
— Beeren Eiland	16 (12.4 %)
— Jan Mayen	28 (21.7 %)
not recorded	28 (21.7 %),
hence previously known from the Arctic regions	101 (78.3 %).
From W. Greenl. only, and from no other Arctic locality	11 (8.5 %).
From the localities east of E. Greenl., taken as a whole	76 (58.9 %).

This proves that the freshwater-Diatom-flora from East Greenland which we are here considering obviously originates from the east, and as regards the eastern localities, more particularly from Spitzbergen.

To this may be added that five of the forms which have been found, viz.

Cymbella affinis *tumida*
— Botellus
— ventricosa *semicircularis*
Navicula gibbula *capitata* and
— Lagerstedtii,

have hitherto — outside Greenland — been found only in Spitzbergen; and a similar origin is indicated for some of the Desmidiaceæ found by Dr. F. BÖRGESEN (cf. F. Börgesen: Freshw. Algæ, p. 73).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26—9—1910.

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 11

SÆRTRYK AF »MEDDELELSER OM GRØNLAND« XLIII

MARINE PLANKTON

FROM

THE EAST-GREENLAND SEA

(W. OF 6° W. LONG. AND N. OF 73° 30′ N. LAT.)

COLLECTED DURING THE "DANMARK EXPEDITION" 1906—1908

I. LIST OF DIATOMS AND FLAGELLATES

BY

C. H. OSTENFELD

KØBENHAVN

BIANCO LUNOS BOGTRYKKERI

1910

INTRODUCTION

During the outward and homeward voyages of the Danmark-Expedition in 1906 and 1908 to and from N. E. Greenland the botanical collector Mr. A. LUNDAGER has procured a large series of samples af surface plankton by means of using tow-nets with fine-meshed silk-gauze (Millergauze No. 20). Also during the stay in Danmarks Havn (Denmark Harbour), Germania Land, 76°46′ N. Lat., 18°43′ W. Long., some collections were made.

Of late years several expeditions have crossed the Greenland Sea and brought home collections of plankton. Therefore it was not likely that the plankton samples of the Danmark Expedition should give much new, especially not with regard to the samples taken in the open Greenland Sea east and south of the pack-ice (drift-ice). The main interest must lie in the samples from the pack-ice itself and from the coastal water inside it, and further in the samples from Danmarks Havn. I have consequently limited my examination to the samples taken in these regions and have not wasted my time by examining the other samples which would have given only a feeble and chance knowledge of the plankton of the open Greenland Sea, based, as it must have been, upon material from two crossings alone and both in July—August.

It would have been of the highest value if the Expedition had taken samples at regular intervals, e. g. fortnightly, during the whole time of the stay in Danmarks Havn from August 1906 to July 1908, as we know very little of the seasonal changes in arctic coast-plankton. The only source is VANHÖFFEN's investigations from Karajak Fjord in West Greenland, ca, 70° N. Lat., (Drygalski Expedition 1892—93), and it is easily understood that a comparison with those would have been much appropriate. Unfortunately the collection from Danmarks Havn is very incomplete; it consists of some samples from the time between June 15th and September 10th 1907 and a couple from July 21st 1908 when the steamer left the harbour. There is here lost a chance which, perhaps, will not come again for years.

As to the samples collected before and after the stay in Danmarks Havn, we have (1°) a fair collection from August 1906 and July 1908 taken in the more or less ice-filled water along the coast from off Koldewey Island (ca. 76°30′ N. Lat.) to ca. 78° N. Lat., and further (2°) an interesting collection from the traversing of the pack-ice in both years (July—August). During the homeward voyage in July 1908 the samples from the coastal water and the pack-ice were taken with intervals of only one or a few hours, and a preliminary examination soon showed that it was not necessary to work out more than a selected number. In the following list I have enumerated the species of Diatoms and Flagellates, in another paper Mr. Ove Paulsen will treat of the Peridinians. With regard to the Zooplankton the collecting method with small open conical nets of fine-meshed silk-gauze is not well adapted to the capture of the larger organisms, metazoa; other samples taken by the Expedition with larger coarse-meshed nets and at different depths give better results; they will form the subject of papers by zoologists; it will, therefore, not be necessary to undertake a closer examination of the surface samples in this respect. On the other hand, the Protozoa, at least the Tintinnodea, require fine-meshed nets for catching, and in a little separate paper I shall enumerate the species of protozoa found in the samples.

Finally Mr. Paulsen and I in common will write on the surface plankton samples as a whole describing the general character of the plankton, the supposed origin of the organisms, etc. under comparison with the hydrographical conditions and using the papers published by other planktologists on the plankton of the East Greenland Sea.

The list here given contains the names of all the plankton Diatoms and Flagellates determined from the samples, with quotations of the first description, of the more important synonyms and figures, as well as of the general works (e. g. Gran's Diatoms in Nordisches Plankton). Critical remarks elucidated by figures are annexed to several species. The list further gives the occurrence in the region, divided into the three above mentioned areas: Danmarks Havn, the coastal water and the pack-ice, and the time for the presence in the plankton, as far as the scanty data allow it. At last the area of distribution is given summarily. The examination did comprise 64 samples.

The littoral diatoms and the diatoms of the ice-floes are determined by Mr. E. Østrup who publishes his results together with a treatment of the freshwater diatoms.

The following papers deal with the phytoplankton from the East Greenland Sea:

Broch, Hj., (1909): Plankton-tables, in D. Damas et E. Koefoed, Le Plankton de la Mer du Grønland. — Duc d'Orleans: Croisière Océanographique accomplie à bord de La Belgica dans la Mer du Grønland 1905. Bruxelles.

Cleve, P. T., (1900): Report on the Plankton collected by the Swedish Expedition to Greenland in 1899. — K. Svenska Vet. Akad. Handl., Bd. 34, Nr. 3. Stockholm.

Østrup, E., (1895): Marine Diatoméer fra Øst-Grønland. — Medd. om Grønland, XVIII, København.

Hereto the two general works may be added:

Gran, H. H., (1904): Die Diatomeen der arktischen Meere. I. Teil: Die Diatomeen des Planktons — Fauna Arctica, herausgegeben von F. Römer u. F. Schaudinn, Bd. III, Heft 3. Jena.

— (1905): Diatomeen. — Nordisches Plankton, herausgegeben von K. Brandt. XIX. Kiel u. Leipzig.

I. Bacillariales (Diatoms).

A. Centricæ.

Melosira Ag., 1824[1].

1. **Melosira hyperborea** (Grun.) Schütt, in Engler & Prantl, Nat. Pflanzenfam., I. 1 b, 1896, p. 59; Gran, Norweg. North Polar Exp., Scientif. Results, vol. 4, No. 11, 1900, p. 52. pl. 3, figs. 11–15. *M. nummuloides*, var.? *hyperborea* Grunow in V. Heurck, Synopsis, pl. 85, figs. 3–4.

The species is one of the most characterizing diatoms from the ice-floes. It often occurs in practically pure mass cultures in holes in the ice-floes and in spaces between them. Both in 1906 and in 1908 several samples from the pack-ice had this species as their main organism. In most samples from July and August it had resting spores, answering well to the excellent figures in GRAN's paper quoted above. In October 1906 the samples from Danmarks Havn contained a few empty frustules, and in September 1907 the case was nearly the same, i. e. at that time the vegetation period was over. In June (15th) 1907 a sample collected in a crack of the land-ice shows us the species in full growth, the chains consisting of frustules in rapid division and with no trace of resting spores. In the later half of July 1908 most of the samples from the coastal water and some from the inner part of the pack-ice contained it, in several of them even as common, and in nearly all samples resting spores were present. Thus we get an idea of its life-cycle, as we must suppose that it winters as resting spores, probably frozen in the ice.

Distrib. Arctic neritic species known from the arctic coast regions and from the inner Baltic.

Thalassiosira Cleve, 1873.

2. **Thalassiosira Nordenskiöldii** Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. I, No. 13, 1873, p. 6, pl. II, fig. 1; Gran, Norske Nord-

[1] I have followed the consecutive order of genera and species given in GRAN, Nord. Plankton XIX.

havs-Exp., Protophyta, 1897, p. 28, pl. IV, fig. 59; Nord. Plankton XIX, 1905, p. 16, fig. 9.

This species is rather rare in the collection; it has been found in a single sample from the pack-ice in 1906, in some samples from Danmarks Havn in 1907 and 1908, and in several ones from the coastal water and the pack-ice in 1908, but never commonly. The time where it "flowers" must be very short in these high latitudes as it has not been present in the June and July (first half) samples from Danmarks Havn. No resting spores were seen. July—September.

Distrib. Northern neritic species widely distributed along the coast regions of the northern countries.

3. **Thalassiosira decipiens** (Grun.) Jørgensen, Bergens Museums Skrifter, 1905, p. 96, pl. 6, fig. 3; Gran, Nord. Plankton, 1905 XIX, p. 17, fig. 10; Ostenfeld, Wiss. Ergeb. Aral See Exp., VIII, 1908, p. 144, pl. 6, figs. 6—8; *T. gelatinosa* Hensen, 5. Ber. Komm. Deutsch. Meere, 1887, p. 87; *Coscinodiscus excentricus,* var.? *decipiens* Grunow, Sitzungsber. naturw. Ges. Isis, Dresden, 1878, p. 28, pl. 6, fig. 18; *C. decipiens* Grunow in Van Heurck, Synopsis, 1883, pl. 91, fig. 10.

Found sparingly in four samples from the outer margin of the pack-ice in 1906, not elsewhere. July—August.

Distrib. Northern temperate species known from the coast regions of North and West-Europe, further from the Caspian and Aral Seas; not formerly found in arctic water, where it has not its home.

4. **Thalassiosira hyalina** (Grun.) Gran, Bibliotheca bot. Heft 42, 1897, p. 4, pl. 1, figs. 17—18; Nord. Plankton XIX, p. 17; E. Jørgensen, Bergens Museums Skrifter, 1905, p. 96, pl. VI, fig. 5; *Th. Clevei* Gran, Norske Nordhavs Exp., Protophyta, 1897, p. 29, pl. 4, figs. 60—62; *Coscinodiscus hyalinus* Grun. in Cleve & Grunow, K. Svenska Vet. Akad. Handl., Bd. 17, No. 2, 1880, p. 113, pl. 7, fig. 128; Grunow, Diat. v. Franz Josefs Land, 1884, p. 30, pl. C, fig. 28.

It is rather curious that I have found this species, so characteristic for the ice-floes, only very rarely and in a few samples from the pack-ice in August 1906.

Distrib. Arctic-neritic species known from the ice-floes and the coasts of the arctic Sea (reaching as far south as Stadt in Norway).

5. **Thalassiosira gravida** Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. 22, afd. 3, No. 4, 1896, p. 12, pl. 2, figs. 14—16; Gran, Norske Nordhavs-Exp., Protophyta, 1897, p. 28, pl. 4, figs. 57—58; Nord. Plankton XIX, p. 18, fig. 12; *Coscinodiscus subglobosus* Cleve & Grun. in Grunow, Diat. v. Franz Josefs Land, 1884, p. 32, pl. D, figs. 19—20.

In the samples from 1906 this species was only found twice and in very few specimens; also in 1907, in the samples from Danmarks Havn it was rare. In 1908, on the other hand, it was common in many of the samples on the whole way from Danmarks Havn through the pack-ice. In several samples the cells were very small, so-called hunger-specimens. The resting spores (*Coscinod. subglobosus*) were present in two samples (Septm. 1907, July 1908). July—August—September.

Distrib. Northern neritic species widely distributed along the coast bordering the Arctic and North Atlantic Oceans and their tributaries.

6. **Thalassiosira bioculata** (Grun.) Ostenfeld, Bot. of the Færöes. vol. 2, 1903, Copenhagen, p. 564, figs. 120—121; Gran, Nord. Plankton XIX, p. 19, fig. 14; *Coscinodiscus b.* Grunow, Diat. v. Franz Josefs Land, 1884, p. 30 et 56, pl. C, fig. 30, pl. D, figs. 1—2.

Single individuals were found in several of the samples from Danmarks Havn, the coast water and also in the pack-ice. Chains are not seen and the species was not found in stage of strong growth. July—August—September.

Distrib. Northern neritic species known from the coast regions of the northern countries bordering the Davis Strait, northern Atlantic and Arctic Oceans.

Bacterosira Gran, 1900.

7. **Bacterosira fragilis** Gran, Nyt Mag. Naturvid., Christiania, 38, 1900, p. 114; Nord. Plankton, 1905, XIX, p. 21; *Lauderia f.* Gran, Bibliotheca botanica, Heft 42, 1897, p. 18, pl. 1, figs. 12—14.

Found very sparingly in samples from Danmarks Havn and the coast-water, not in the pack-ice. July—August.

Distrib. Arctic neritic species known from the coasts of the arctic Sea (West- and East-Greenland, Spitsbergen, Nova Zembla) and from the northern coast of Norway.

Lauderia Cleve, 1873.

8. **Lauderia glacialis** (Grun.) Gran, Nyt Magaz. Naturvid., Christiania, Bd. 38, 1900, p. 111, pl. 9, figs. 10—14; Nord. Plankton, XIX, p. 23; *Podosira hormoides*, var. *glacialis* Grunow, Diat. Franz Josefs Land, 1884, p. 56, pl. C, fig. 32; *P. glacialis* Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. 22, afd. 3, No. 4, 1896, p. 12, pl. 2, figs. 17—20; *Porosira g.* Jørgensen, Bergens Museums Skrifter, 1905, p. 97, pl. 6, fig. 7.

Rare in the samples, found in Danmarks Havn and in the coast water, not in the pack-ice. July—August.

Distrib. Northern (subarctic) species known from the coastal regions of the arctic Sea and along the coasts of North-Europe (in winter).

Hyalodiscus Ehrbg., 1845.

9. **Hyalodiscus laevis** Ehrbg., Monatsber. Berlin. Akad. Wissensch. 1845, p. 78; Cleve u. Grunow, K. Svenska Vet. Akad. Handl., Bd. 17, No. 2, 1880, p. 116; Peragallo, Diatom marin. de France, pl. 119, fig. 20; *H. subtilis* Bailey, Smithson. Contrib. to knowledge, vol. 7, 1854, p. 10, fig. 12; W. Hendry, Quart. Journ. Microsc. sc., 1861, p. 179; Cleve u. Grunow, l. c.; Gran, Bibliotheca botanica, Heft 42, p. 5, pl. 1, fig. 19; Peragallo, l. c., pl. 119, fig. 7. Cfr. Stockmayer, Annal. k. k. naturh. Hofmuseum, Wien, XXIII, 1909, p. 69.

In some samples from Danmarks Havn I found sparingly a large species (150+170 μ in diameter of the valve) of *Hyalodiscus* which, I think, is identical with Gran's *H. subtilis* from Karajak Fjord. On the other hand I cannot find any difference of valve between *H. lævis* Ehrbg. and *H. subtilis* Bail. Already Hendy (l. c.) has suggested that the distinctive marks in the proportion between the entire valve and the central part *(umbilicus)* as well as in the structure of the "*umbilicus*" are value-less, and my here given figures (Fig. 1) which

Fig 1. *Hyalodiscus laevis* Ehrbg. 250 t. m.

are chosen as extremes will, taken together with the figures by Peragallo, show that these characters are subject to great variability. Therefore, I find it necessary to unite the two species in one to which *H. scoticus* (Kutz.) Grun. must be referred as a dwarfy variety. — July—September.

Distrib. Coast-species, not true plankton form, found scattered over the earth, especially in colder regions; often found in fossil depots.

Coscinodiscus Ehrbg., 1838.

10. **Coscinodiscus centralis** Ehrbg., Abhandl. Berl. Akad., 1838, p. 129; Mikrogeologie, pl. 18, fig. 39. pl. 22, fig. 1; Jørgensen, Bergens Museums Skrifter, 1905, p. 93, pl. 6, fig. 1; Gran, Nord. Plankton XIX,

1905, p. 33, fig. 33; Ostenfeld, Wiss. Ergebn. Aral-See Exped., VIII, St. Petersburg, 1908, p. 149, pl. 7, figs. 4—5.

In a sample from the outer part of the pack-ice a single dead frustuce of this species was found. August 1906.

Distrib. Widely distributed oceanic species, according to Gran common, especially during winter, in the Gulf-Stream area of the Norwegian Sea and in the North Atlantic; not at home in arctic water.

11. **Coscinodiscus subbuliens** Jorgensen, Bergens Museums Skrifter 1905, p. 94, pl. VI, fig. 2; Gran, Nord. Plankton XIX, 1905, p. 32, fig. 32; *C. oculus iridis* Gran, Fauna Arctica, III, Lief. 3, 1904, p. 519, pl. XVII, figs. 17—19.

The species which I refer to Jorgensen's *C. subbuliens* is very common in some of the samples from the autumn, indeed forming the main part of the phytoplankton.

Owing to the abundance of material I have been able to add some points to the descriptions given by Jorgensen and Gran. As to the size of the species Jorgensen gives a diameter of "usually 50—100 μ", and Gran says 65—150 μ, while my measurements extend it to 240 μ (185 μ as mean of 20 measurements) for the normal vegetative cells. The valves are coarsely areolated in a radiate manner, and in contradistinction to the descriptions of the two quoted authors I have found that, at a certain adjustment, a single row of very small points or *apiculi* are discernible a little inside the margin and further, asymmetrically among them, two larger *apiculi* or knots, at a distance from one another of between 120° and 150°. The *apiculi* which are difficult to see, best upon ignified material mounted in styrax-balsam, stand rather closely, as between two usually 3—4 radii of areoles originate. The existence of the two larger apiculi shows that *C. subbuliens* must be referred to the Group *Biapiculati* created by me in 1908 (Wiss. Ergebn. d. Aralsee-Exp., Lief. VIII, St. Petersburg, 1908, p. 147). Further investigations must decide, if all species of the sectio *Radiati* Rattr. possess these two *apiculi*; hitherto they have been found in *C. biconicus* Van Breem., *C. aralensis* Ostf., *C. Granii* Gough, *C. centralis* Ehrbg. and *C. concinnus* W.

Gran (1904, fig. 19) has figured the construction of the girdle of a specimen which just has divided into two daughter-cells and where the matter is more complicated than in the ordinary cells. Therefore I have given a figure (Fig. 2) showing the girdle of a normal cell[1]. This figure represents only a part of the girdle, but it is seen distinctly, that in the connecting part of each valve two structure-lines

[1] The fig. 32 c in Gran's paper of 1905 is not quite clear in this respect.

run parallel to its margins, one thin line near the margin and one much coarser line situated more or less half way between the margin and the margin of the valve. The first named line makes a deviation from the parallel in one place, where it bends rather abruptly towards the coarse line and merges into it on a very short way, thus forming a V-shaped figure with the tip cut off; in this place the line is coarser than elsewhere and coarsest where it disappears in the other line. The V-shaped places of the two connecting parts of a cell never face each other, oftenest they are on the opposite halfs of the girdle, but sometimes rather near each other, as e. g. shown in fig. 3, to the right. The narrow part of the V is always directed towards the corresponding valve.

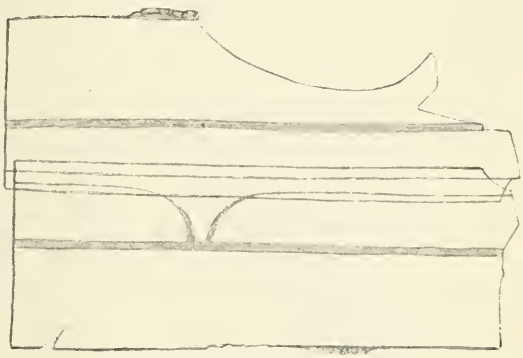

Fig. 2. *Coscinodiscus subbuliens* Jørg. An empty and partly broken frustule. Height 85 μ. 500 t. m.

In two samples from August—September 1907 where *Cosc. subbuliens* was dominant, I happened to find among the numerous normal cells some few auxospores or more correctly cells developed from auxospores.. Figs. 3—4 represent such cases: A large cell (diameter in a few measured specimens 280—320 μ) carries on the one valvar side the folded and crumpled rest of the *perizonium*; the cell itself is very young which is seen from the absence of a distinct girdle-part; the nucleus is situated close to the innerside of that valve, which turns away from the *perizonium*. I did not succeed in finding other stages, but the knowledge at hand is sufficient to show that the auxospore formation probably goes on in the same manner as in *Thalassiosira gravida* (Gran, Norske Nordhavs-Exp., Protophyta 1897) or in *Melosira* (see f. i. G. Karsten, Wissensch. Meeresunters., 1899, p. 183), with the difference that follows from the fact that the cells of *Cosc. subbuliens* occur solitary, not in chains. Hence it results that the auxospores immediately become separated from their mother-cells, which makes it difficult to observe them.

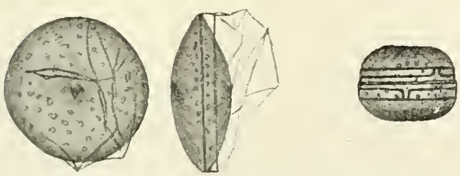

Fig. 3. *Coscinodiscus subbuliens* Jørg. The two figures to the left represent the same cell. All 71 t. m.

G. Karsten (l. c., p. 185) reports that he has found auxospores in *Cosc. radiatus* and Klebahn in *Cosc. excentricus*, but closer informations are not, as far as I know, given concerning the occurrence of this phenomenon in the genus *Coscinodiscus*.

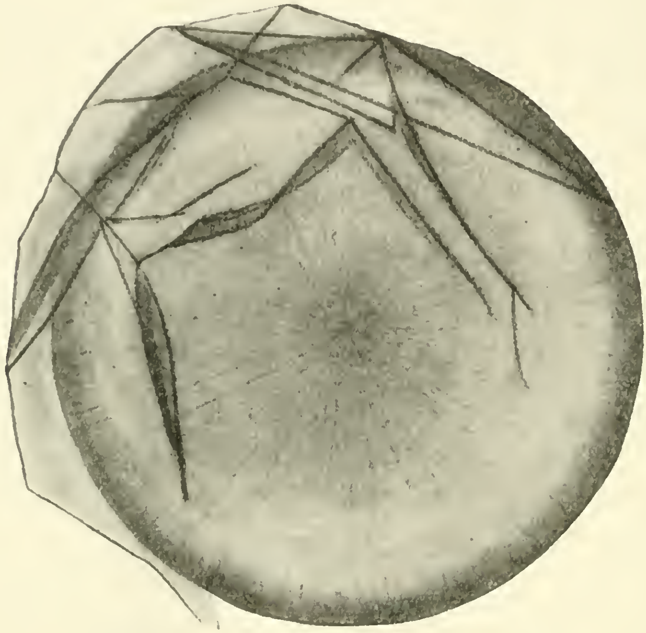

Fig. 4. *Coscinodiscus subbuliens* Jørg. 250 t. m.

Cosc. subbuliens was dominant in samples from Danmarks Havn and from the coast water in 1906, 1907 and 1908 in July—September. Few living specimens were present in two samples from October 1906 taken in cracks in the ice of Danmarks Havn. In the pack-ice it was very rare, only few specimens seen in a couple of samples.

Distrib. According to Gran a boreal species occurring especially in the regions where polar and atlantic currents meet, often in large quantities.

12. **Coscinodiscus marginatus** Ehrbg., Abhandl. Berlin. Akad. Wissensch., 1841, p. 142; A. Schmidt, Atlas Diatom.-Kunde, pl. 62, figs. 1—5, 9—11; pl. 59, fig. 11; *C. fimbriato-limbatus* A. Schmidt, l. c., pl. 65, figs. 3—6; pl. 113, fig. 2; *C. limbatus* A. Schmidt, l. c., pl. 63, fig. 7; Ostenfeld & Paulsen, Medd. Grønland, XXVI, 1904, p. 160.

Som few empty frustules of this coarsely areolated species were found in a sample from the outer part of the pack-ice in August 1906.

Distrib. Oceanic temperate species known from the plankton af the North Atlantic west of 26° W. Long., not at home in arctic water.

13. **Coscinodiscus curvatulus** Grun. var. **karianus** Cleve et Grunow, K. Svenska Vet. Akad. Handl., Bd. 17, No. 2, 1880, p. 113, pl. 7, fig. 129; *C. curvatulus*, var. *genuina* Grun., Diat. v. Franz Josefs Land, 1884, p. 31, ex parte, pl. D, fig. 13 (non fig. 14); *C. curvatulus* Gran, Nord. Plankton XIX, p. 35, ex parte, fig. 37 a.

In two samples from the pack-ice, taken in July 1908, I found rather sparingly a *Coscinodiscus* which agrees well with the form quoted above, var. *karianus* of *C. curvatulus*, and to this form I also refer the fig. 13 by Grunow's diatoms from Franz Josefs Land. It has a single row of distinct *apiculi*.

Gran has pointed out that probably several species are included in Grunow's *C. curvatulus*. He gives figures of a form from the Norwegian Sea which has no *apiculi* and in which the low girdle consists of the two connecting parts and a plain intercalary hoop. Our form has a somewhat higher girdle in which each connecting part has an intercalary hoop and the line between the connecting part and the intercalary part is elevated and with a V-shaped curvature, see fig. 5. I think that it is a distinct arctic species, but my material is too scanty to decide the question.

Fig. 5. *Coscinodiscus curvatulus* Grun., var. *karianus* Cl. & Grun.

Distrib. (of var. *karianus*): Arctic Sea, in pack-ice; (of the main species): widely distributed both in colder and warmer seas.

14. **Coscinodiscus Joergensenii** nom. nov.; *C. polyacanthus*, var. *intermedius* Grunow, Diat. v. Franz Josefs Land, p. 29, pl. C, fig. 25; Jørgensen, Bergens Museums Skrifter, 1905, p. 92; non *C. intermedius* Ehrbg.

In some samples from the pack-ice (July—August 1906 and 1908) and from Danmarks Havn (October 1906, August 1907) I have found rather scattered, specimens of a fasciculate *Coscinodiscus* of the *subtilis*-group, which agrees well with Grunow's quoted description and figure. As Jorgensen (l. c.) has suggested, it is distinct from the true *C. polyacanthus* Grun. by having one row of small interfasciculate apiculi and is closely related to *C. curvatulus* (at least to var. *karianus*) from which it differs e. g. by a finer structure and straight *fasciculi*. On the other hand it is allied to *Thalassiosira bioculata* from which it is easily recognised by having only one (not two) central areole and by a less fine structure. I have not succeeded in finding out the construction of the girdle exactly, but it has not the many intercalary connecting parts of *Th. bioculata* and the cells are not high.

My figures Fig. 6 will show the structure of the valves and the number of apiculi which is considerably lower than in *C. polyacanthus*.

Grunow (l. c.) gives the size to 60 μ, I have found it ranging from 50 til 80 μ.

In the samples from Danmarks Havn in October 1906 I found

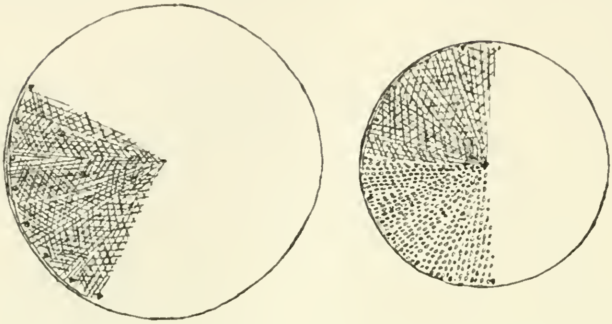

Fig. 6. *Coscinodiscus Joergensenii* n. nom. 500 t. m.

two specimens just coming from the auxospores and having one valve developed while the other half of the cell had the *perizonium* wall kept; and in the same samples I also found some globular bodies of just the same size and with the same contents of chromatophores, etc.; these globules I consider as the auxospores of this species. In the figures 7 I have given such a globule and the auxospore-cell at the same magnification. As the cells seem to live solitary, the mature auxospore — as in *C. subbuliens* — does not occur adherent to its mother-cell.

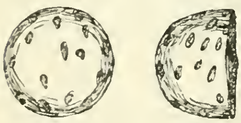

Fig. 7. Auxospore of *Coscinodiscus Joergensenii* n. nom.

Distrib. Probably arctic neritic species, known from Cape Wankarema (Grunow) and Arctic Norway (Jørgensen).

Note. It has been said many times before, but I cannot help repeating that the genus *Coscinodiscus* is in a great confusion and that the limits of the species are very indistinct. It is to be hoped that a monographer will be found who may have a happy hand to clear up this difficult matter.

Asteromphalus Ehrbg., 1844.

15. **Asteromphalus Hookeri** Ehrbg., Monatsber. Berlin. Akad. Wissensch., 1844, p. 200, fig. 3; Gran, Nord. Plankton, 1905, XIX, p. 45, fig. 50; *A. Brookei* Bail., var., Cleve Bih. K. Svenska Vet. Akad. Handl., Bd. 1, 1873, p. 10, pl. 4, fig. 19; *A. atlanticus* Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. 22, afd. 3, No. 4, 1896, p. 5; K. Svenska Vet. Akad. Handl. Bd. 34, No. 1, 1900, p. 19, pl. 8, figs. 7—9.

A single specimen was met with in a sample from the outer part of the pack-ice; August 1906.

Distrib. Northern-temperate, oceanic species, known from the North-Atlantic and the Antarctic.

Rhizosolenia (Ehrbg.) Brightw. 1858.

16. **Rhizosolenia styliformis** Brightw., Quart. Journ. Microsc. Science, VI, 1858, pl. V, fig. 5; Peragallo, in Le Diatomiste, vol. I, 1892, p. 111, pl. 4, figs. 1—5; Gran, Rep. Norweg. Marine- and Fishery-Investig., vol. 2, No. 5, 1902, pl. 1, figs. 1—9; Nord. Plankton, 1905, XIX, p. 54.

Found in Danmarks Havn (September—October 1906, August 1907) and in the coastal water (1906 and 1908), but nearly absent from the pack-ice. It occurs in most samples very rarely, but in a single one not uncommon.

Distrib. Widely distributed oceanic species. often character organism over large areas of water, mostly a temperate species, but here and in some other exceptional cases behaving as an arctic organism.

17. **Rhizosolenia hebetata** Bailey, American Journ. of Sc. and Arts, Ser. 2, vol. 22, 1856, pl. 1, figs. 18, 19; Cleve, Vega-Exp. vetensk. iakttag., Bd. 3, 1883, pl. 6, fig. 69; Gran, Fauna Arctica, Bd. 3, Lief. 3, 1904, p. 524; Nord. Plankton 1905, XIX, p. 55, fig. 67.

f. **semispina** (Hensen) Gran, l. c., p. 55; *Rh. semispina* Hensen, V. Ber. Komm. Unters. Deutschen Meere, 1887, p. 84, pl. 5, fig. 39.

Only found in the pack-ice and here — especially in August 1906 — the dominant species in some samples. In July—August 1908 not so common.

Only the f. *semispina* was seen.

Distrib. Northern oceanic species of wide distribution.

18. **Rhizosolenia obtusa** Hensen, V. Ber. Komm. Unters. Deutschen Meere, 1887, p. 86, pl. 5, fig. 41; Gran, Nord. Plankton XIX, p. 56; *R. alata*, var. *truncata* Gran, Norske Nordhavs Exp., Protophyta, 1897, p. 6, pl. 4, fig. 67.

Only found in the pack-ice and in the same samples where *R. hebetata*, f. *semispina* was present. Dominant in some samples from August 1906, not common in 1908.

Distrib. Northern oceanic species known from the colder parts of the North Atlantic and the Norwegian Sea, etc.

Eucampia Ehrbg., 1839.

19. **Eucampia groenlandica** Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. 12, afd. 3, No. 4, 1896, p. 10, pl. 2, fig. 10; Jørgensen, Bergens Museum Skrifter, 1905, p. 99, pl. 6, fig. 8; Gran, Nord. Plankton, XIX, 1905, p. 99, fig. 127.

Single chains were found in four samples of July 1908 from Danmarks Havn and the coastal water, not in the pack-ice.

In some cases the chains were like Gran's f. *atlantica* (fig. 127 d), in others they stand intermediate and in others again they were typical (fig. 127 c); thus the f. *atlantica* has probably a very restricted value.

Distrib. Arctic neritic species; known from the coasts of arctic countries; also (rarely) found at Bohuslen, Scotland and in the Norwegian Sea.

Chætoceras Ehrbg., 1844.

20. **Chætoceras atlanticum** Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. I, No. 13, 1873, p. 11, pl. 2, fig. 8; Gran, Nord. Plankton, XIX, 1905, p. 64, fig. 74.

This species is found in several samples from Danmarks Havn, the coast water and the pack-ice, but always in single specimens. July—September 1906—1908.

Distrib. Widely distributed in the Atlantic Ocean and its tributaries, also in the Antarctic Ocean; oceanic species.

21. **Chætoceras convolutum** Castracane, Report of the Challenger Exp., Botany, II, 1886, p. 78; Gran, Fauna Arctica, III, Heft 3, 1904, p. 530, fig. 1; Nord. Plankton XIX, 1905, p. 69.

In the pack-ice this species was dominant in some samples from August 1906; in 1908 it was also present, but not in greater quantities. It was further found in samples from the coastal water and from Danmarks Havn, but only sporadically and in single specimens.

Distrib. Northern oceanic species, known from the North Atlantic and the Antarctic Oceans.

22. **Chætoceras criophilum** Castracane, Report of the Challenger Exp., Botany, II, 1886, p. 78; Gran, Fauna Arctica, III. Heft 3, 1904, p. 532, fig. 3; Nord. Plankton XIX, 1905, p. 71.

If we follow Gran (l. c.) in the distinctive marks between this and the foregoing species, i. e. *C. criophilum* has none or a very rudimentary connecting zone and *C. convolutum* a well developed one, it results that this species is very rare in the area, only some solitary specimens were found in two samples from the pack-ice, one in 1906 and one in 1908. It is rather unexpected that it is so rare, as it is one of the characteristic and dominant species of the sea between Iceland and Jan Mayen.

Distrib. Northern oceanic species, widely distributed in the northern parts of the Atlantic and its tributaries, further known from the Antarctic.

23. **Chætoceras boreale** Bailey, Smitsonian Contrib. to knowledge, vol. 7, 1854, p. 8, figs. 22—23; Gran, Fauna Arctic. III, Heft 3, 1904, p. 533, fig. 5, Nord. Plankton XIX, p. 73.

One of the most common species in the area. Both in 1906 and 1908 it was the dominant species in many samples from the coastal water and present also both in Danmarks Havn and in the inner border of the pack-ice. In August 1906 it was not uncommon at ca. 13° W. Long., and dominant in the samples taken along the coast from Koldewey Island to Cape Amélie; in October 1906 some specimens were found in Danmarks Havn, but mostly empty frustules. In August—September 1907 single specimens occurred in the samples from Danmarks Havn. In July 1908 it was dominant in Danmarks Havn and from that place northwards along the coast until ca. 78° N. Lat., and it was further found in some samples a little more eastwards, until ca. 11° W. Lat.

In some of the samples from August 1906 and July 1908 taken in the coastal water (the temperature of the water being between ÷ 0,5 and 4,2°) I often found chains in which the awns of many of the cell-walls had aborted. As the fig. 8 shows, such a chain gets a rather curious aspect: The two latest divisions of the chain figured have produced new cells which bear no awns from the valves while the oldest division has given normally developed awns of which only the bases have been drawn. At the places of the awns we find only small protuberances on the valves, and the protuberances of two cohering valves correspond to each other. It looks as if the cell-division has stopped too early, when only the division of the contents has been fulfilled and the development of the foramen has begun. In some cells I found very short and curved awns in stead of the protuberances, thus showing the reduction in a somewhat less degree.

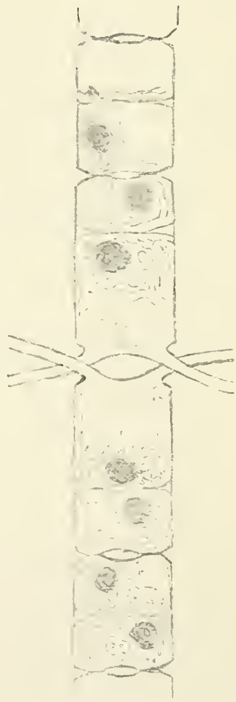

Fig. 8. *Chaetoceras boreale* Bail. with aborted awns. 500 t. m.

I have no real explanation of the phenomenon. Perhaps it shows that the cell-division takes place very rapidly, or perhaps it designates a state of hunger, or perhaps it has something to do with microspore formation, as it occurred in the some samples in which microspore formation in *Ch. decipiens* was observed (but no microspores were found in *Ch. boreale!*). K. Okamura (Bot. Magaz., Tokyo, XXI, 1907, pl. III, fig. 36) has figured the same phenomenon in a chain of *Ch. criophilum*, but has no remarks on it in the text, while in the explanation of the figures the says (p. 105): "One of the cells of another chain many times divided".

Also G. Karsten (Valdivia-Exp., Phytoplankton des antarkt. Meeres, 1905, p. 118, Pl. 15, figs. 8 d, e) has found *Ch. criophilum* in the antarctic ocean with aborted awns. He tells that the chains of this abnormal aspect occur in depths of 100—80 m. and supposes that the phenomenon is connected hereto: „Darin ist eine Minderung des Formwiderstandes gegeben . . . Diese Zellen resp. Zellreihen schweben dementsprechend in tieferen Wasserschichten; . . . .“ But this explanation does not hold good in our case where the abnormal chains occur in the surface layers of the water.

Distrib. Widely distributed species of northen Oceanic character, known from all Oceans.

24. **Chætoceras decipiens** Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. I, No. 13, 1873, p. 11, pl. 1, fig. 5; Gran, Norske Nordhavs-Exp., Protophyta. 1897, p. 13, pl. 1, figs. 2—3, pl. 3. fig. 34; Fauna Arctica, III, Heft 3, 1904, p. 535, pl. 17, figs. 1—6; Nord. Plankton XIX, p. 74, fig. 88.

As *C. boreale* one of the most common species in the area. It was rather rare in the pack-ice both in 1906 and in 1908, but dominant in both years in the whole series of samples from the coastal water (July—August) and in 1908 in Danmarks Havn. At the last named place it was also observed in October 1906, some of the frustules being empty, and in July—September 1907, but not in larger quantities. It seems thus as if the species has its real place of thriving in our area in the coastal water between the coast and the pack-ice. In a number of samples, especially in the samples from July 1908 the terminal awns had the peculiar structure which is characteristic for *C. Lorenzianum* Grun.; and also in the coarser awns from the other cells of the chains the structure was discernible, but more difficult to see. In other respects the specimens were quite typical, e. g. the awns being coherent at a part of their length, the terminal awns making the curvature at their proximal ends and then slightly divergent or nearly parallel. It is then not possible to refer our specimens to *C. Lorenzianum* Grun., nor to the arctic species *C. mitra* (Ehrbg.) Cleve. More probably a closer examination of the coarser specimens of *C. decipiens* from other regions will result in finding the same structure of the awns.

Besides this observation, another matter of some interest was found:

In two samples from August 1906 and in two from July 1908 I have found *microspore formation* in the cells. All these samples have been taken in the ice-filled coastal water north of 77° N. Lat. the temperature of the water being between ÷ 0,5° and 1,4°. The examination of this microspore development does not give much new, as we have the excellent description and drawings of this processus in *Chæt. decipiens* by Gran (1904). I have only to refer the reader to this paper and to Gran's paper of 1902 (Rep. Norweg. Mar. Fish. Investig., vol. 2, No. 5) in which the microspore formation in *Rhizosolenia styliformis* was described and where considerations on the microspore problem in general were put down. Similar considerations embrazing all the known cases of microspore formation, are given by G. Karsten (Valdivia-Exp., Phytoplankton d. Atlant. Meeres, 1908).

The annexed figures (Fig. 9) show the different stages in the development of the microspores; they correspond rather closely to Gran's figures (1904). In the left drawing we find a chain the end cell of which is a normal cell in rest and contains but one nucleus, while the two other cells have fulfilled the division of the nucleus into two daughter nuclei. It might be supposed that this stage could illustrate the beginning of an ordinary cell-division as well as the beginning of the microspore formation, but this is not right as there is a great difference which will be clear if we compare this drawing with the fig. 1 by Gran (1904); this author gives here the corresponding stage of an ordinary cell-division, and his drawing shows that contemporaneously with the division of the nucleus a fissure in the plasma appears as the first beginning of the future foramen between two cells. This fissure does not exist in my case, whereby it is proved that we have here the first stage of microspore formation.

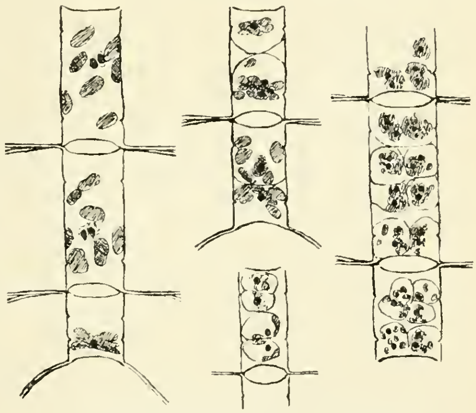

Fig. 9. *Chaetoceras decipiens* Cl. Cells in microspore-formation. 250 t. m.

The other figures show stages with 2, 4, 8 and 16 daughter nuclei corresponding rather well to the figures by Gran, but his material has been better stained than mine. Perhaps we have herein the explanation of the following difference, viz.: that the division of the nuclei in my material goes on a good time before the division of the plasma, thus e. g. in the figure to the right we have 16 nuclei, but only (7—)8 plasma-lumps each containing 2 nuclei. With regard to the further fate of the microspores preserved material does not allow observations, and to the theoretical considerations set forth by Gran, Bergon and Karsten I have nothing to add. Only one new case of microspore formation has been discovered since Karsten's paper, viz. the microspore formation in *Chæt. Lorenzianum* Grun. found by J. Schiller (Ber. Deutsch. Bot. Ges., XXVII, 1909, p. 352) in the Gulf of Triest. The formation described corresponds rather well to the manner of sporulation found by Gran in *Chæt. decipiens* and by George Murray (Proc. Roy. Soc. Edinburgh, XXI, 1896, p. 207) in *Chæt. boreale*; as to the hypothesis advanced by the author on the cause of the rarity of microspores — viz.: that the microspore formation in most species should take place by the germination of the resting cysts —, I have only to say that it is a purely theoretical supposition, for which we have no basis as long as we do not know a single case of germination of a resting spore. It is a very remarkable fact that in spite of the numerous studies on the plankton diatoms during the last two decennia, nothing has been discovered with regard to this important matter. It is to be hoped that we may soon get this mystery solved.

Distrib. Oceanic species of a northern character, a dominant species over wide areas of the North Atlantic and its tributaries.

25. **Chætoceras diadema** (Ehrbg.) Gran, Norske Nordhavs Exp., Protophyta, 1897, p. 20, pl. 2, figs. 16—18; Nord. Plankton XIX, p. 84; *C. groenlandicum* Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. 22, afd. 2, No. 4, 1896, p. 7, pl. 2, figs. 3—5; *Syndendrium diadema* Ehrbg. Mikrogeologie, pl. 35, A, XVIII, 13.

Found sparingly in one sample (Aug. 1906) in the pack-ice, rather sparingly in some samples from the coastal water (July 1908) and not uncommon in samples from Danmarks Havn in August—September 1907 and here with resting spores.

Distrib. Northern neritic species of wide distribution.

26. **Chætoceras Wighami** Brightw., Quart. Journ. Microsc. Science, IV, 1856, p. 108, pl. 7, figs. 19—36; Gran, Nord. Plankton, XIX, 1905, p. 88; Ostenfeld, Wiss. Ergebn. Aralsee-Exp., Lief. VIII, St. Petersburg, 1908, p. 153, pl. 5, figs. 9—12; *C. bottnicum* Cleve in Aurivillius, Bih. K. Svenska Vet. Akad. Handl., Bd. 21, afd. 4, No. 8, 1896, p. 14, pl. 1.

Found rather sparingly in Aug.—Septm. 1907 in Danmarks Havn; rather often occurring in the coastal water in July 1908 and here common in a few samples; further single chains found in a sample from the pack-ice (July 1908).

Distrib. Euryhaline neritic species, known from the coasts of Europe and Arctic countries, further from the Caspian and Aral Seas.

27. **Chætoceras debile** Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. 20, afd. 3, No. 2, 1894, p. 13, pl. 1, fig. 2; Østrup, Medd. om Grøn-

land, XVIII, 1895, p. 456, pl. 7, fig. 89; Gran, Norske Nordhavs Exp., Protophyta, 1897, p. 23, pl. 2, figs. 14—15; Nord. Plankton XIX, 1905, p. 92.

Rare in the collection, only found in three samples from Danmarks Havn in Aug.—Septm. 1907, and, in a dwarfy state, in two samples from the pack-ice in July 1908.

Distrib. Northern neritic species, known from the coasts of Europe and Arctic countries, further from Japan.

28. **Chætoceras furcellatum** Bail., American Journ. of sc. & arts, ser. 2, vol. 22, 1856, pl. 1, fig. 4; Cleve u. Grunow, K. Svenska Vet. Akad. Handl., Bd. 17, No. 2, 1880, p. 120, pl. 7, figs. 136—137; Gran, Bibliotheca Botanica, Heft 42, 1897, p. 7, pl. 1, figs. 15—16; Nord. Plankton, XIX, 1905, p. 95.

Occurs as one of the characterizing species in a group of samples from the inner part of the pack-ice, in July 1908. Further some *Chætoceras*-chains in samples from Danmarks Havn in 1907 and in the coastal water in 1908 may perhaps be referred to this species, but the determination is not sure.

Distrib. Arctic neritic species, known from the Arctic Seas, reaching along the Norwegian coast as far southwards as Cape Stadt.

29. **Chætoceras sociale** Lauder, Transact. Microsc. Soc., vol. 12, N. S., 1864, p. 77, pl. 8, fig. 1; Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. 22, afd. 3, No. 4, 1896, p. 9, pl. 2, fig. 9; Gran, Nord. Plankton XIX, 1905, p. 96, fig. 123.

Occurs in great quantities in samples from Danmarks Havn in Aug.—Septm. 1907, and with resting spores. Further common in some samples from the coastal water in July 1908 and rare in others; also here mostly with resting spores.

Distrib. Northern neritic species known from the coasts of Europe, Iceland, Arctic countries and Hongkong.

30. **Chætoceras gracile** Schütt, Ber. Deutsch. bot. Ges., 1895, p. 42, pl. 5, fig. 13; vix Paulsen, Medd. Komm. Havundersøg., Plankton I, 3, 1905. København, p. 5, figs. 6—7; non Apstein, Wiss. Meeresunters., Abt. Kiel, N. F., Bd. 11, 1909, p. 135, fig. 1; *C. septentrionale* Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. 22, afd. 3, No. 4, 1896, p. 9, pl. 2, fig. 8; vix Østrup, Medd. Grønland, XVIII, 1895, p. 457, pl. 7, fig. 88.

In two samples from Danmarks Havn, August 1907, and in one sample from the coast water, July 1908, I found a small solitary *Chætoceras* with resting spores. As my figures (Fig. 10) show, it must be identified with Cleve's *C. septentrionale* from Baffin Bay, but hardly with Østrup's original species of that name. On the other hand it is probable that *C gracile* Schütt is the same species, because if we compare Schütt's figures of cells with chromatophores with my fig. 10, we will find a close resemblance; on the contrary his figures of resting spores differ from mine, but he has not drawn these spores in situ within cells, and it is perhaps permitted to doubt, if they belong to the species in question.

Paulsen (l. c.) has given figures from Østrup's original material and considers his form as identical with Schütt's *C gracile*, but I

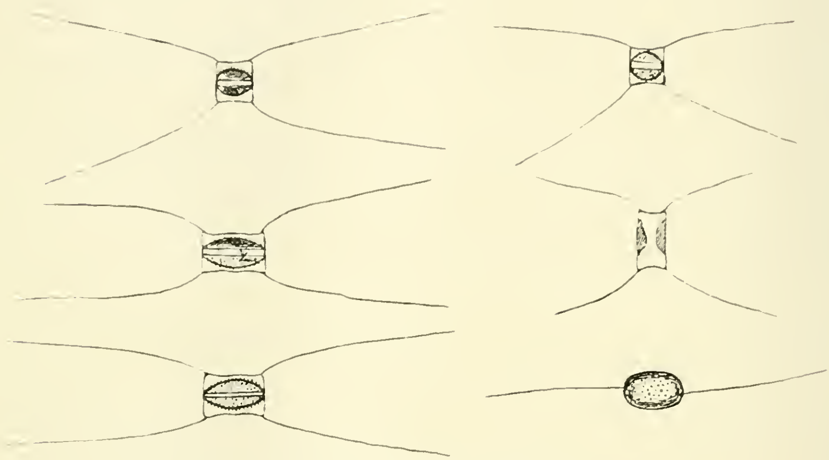

Fig. 10. *Chætoceras gracile* Schütt. 500 t. m.

doubt if he is right in doing so. The question is a much intricate one.

The latest note by Apstein about these small solitary species contains drawings of a species from the Baltic — the locality of Schütt's species — which the author names *C. gracile* but, I think, hardly correct; I myself know Apstein's form from the Belt Sea (Baltic) and have found it with resting spores which differ considerably from those of *C. gracile*; they have two rather large spines on the primary spore-valve (in the same manner as the spores of *C. debile*) and often also small spines, while the secondary valve is smooth. The species has only one chromatophore, as also drawn correctly by Apstein, and the corners of the cell in side view are not contracted; all these distinctive marks separate it from the true *C. gracile*, and I propose to name it *C. ceratosporum* nov. sp.; it is only known from the Baltic, where it occurs in the spring and seems to have its true home in the inner part, as I have seen it in samples kindly sent me by Dr. K. M. Levander of Helsingfors.

Anyhow the small solitary *Chætoceras* species require a revision, as the treatement given by Lemmermann (Arkiv f. Botanik, Stockholm, Bd. 2, No. 2, 1904) is not a good one.

Distrib. (of *Ch. gracile. sens. lat.*): Euryhaline neritic species known from coasts of Greenland and Europe.

Biddulphia Gray, 1831.

31. **Biddulphia arctica** (Brigtw.) Boyer, Proc. Acad. of Nat. Sc., Philadelphia, 1900, p. 714; Gran, Nord. Plankton, XIX, 1905, p. 109, fig. 143; *B. balæna* Brightw., Quart. Journ. Microsc. Sc., vol. 8, 1859, p. 181, pl. 9, fig. 15; *Triceratinm arcticum* Brightw.. ibid, vol. 1, 1853, p. 250, pl. 4, fig. 11.

Found sparingly in three samples from Danmarks Havn, Aug.—Septm. 1907.

Distrib. Littoral form (not true plankton form) from the Arctic coasts.

B. Pennatæ.

Fragilaria Lyngb., 1819.

32. **Fragilaria islandica** Grun. in V. Heurck, Synopsis, 1883, pl. 45, fig. 37; Jørgensen, Bergens Museums Skrifter 1905, p. 102, pl. 6, fig. 10; Gran. Nord. Plankton. XIX, 1905, p. 114, fig. 153.

Only found in Danmarks Havn, where it was present in the plankton, although only scattered, in all three years. July—October.

Distrib. Arctic neritic species, known from the coasts of the European Arctic sea; probably not a real plankton form.

33. **Fragilaria oceanica** Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. 1, No. 13, 1873, p. 22, pl. 4, fig. 25; Grunow, Diat. v. Franz Josefs Land. 1884, p. 55, pl. 2, fig. 14; Gran, Bibliotheca Botanica, Heft 42, 1897, p. 20, pl. 1, figs. 6—9; Nord. Plankton XIX, 1905, p. 114, figs. 154—155.

In 1906 only very few samples contained this species, and only in few specimens, while in 1907 and 1908 it was a dominant feature in July and August samples from Danmarks Havn and the coastal water. In the pack-ice it was not at home, recorded in few specimens from three samples (two in 1906 and one in 1907). July—October.

Several of the forms distinguished by Gran (1905) according to the curvature and twisting of the chains, were seen. In all samples from 1907 and 1908 resting spores were present, often in large quantities.

Distrib. Arctic neritic species known from Davis Strait and the Euopean Arctic Sea and a little more southwards.

34. **Fragilaria cylindrus** Grunow, Diat. v. Franz Josefs Land, 1884, p. 55, pl. 2, fig. 13; Gran, Bibliotheca Botanica, Heft 42, 1897, p. 20, pl. 1, figs. 4—5; Nord. Plankton, XIX, 1905, p. 115; Jørgensen, Bergens Museums Skrifter, 1905, p. 102, pl. 6, fig. 9.

This species resembles the foregoing one very much, and it is only possible to distinguish them when the ignified frustules are seen in valvar view. Hence it may be that some of the records of *F. oceanica* include this species of which I have seen sure specimens only in one sample from Danmarks Havn, July 1908.

Distrib. Arctic neritic species of about the same distribution as the foregoing, but often overseen.

Thalassiothrix Cleve et Grun., 1880.

35. **Thalassiothrix longissima** Cleve et Grun., K. Svenska Vet. Akad. Handl., Bd. 17, No. 2, 1880, p. 108; G. Karsten, Wiss. Meeresunters., Abt. Kiel, N. F., Bd. 4, 1899, p. 28, fig. 11; Gran, Nord. Plankton, XIX, 1905, p. 116; *Synedra thalassiothrix* Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. 1, No. 13, 1873, p. 22, pl. 4, fig. 24.

Only a single specimen found in a sample from the pack-ice in Aug. 1906.

Distrib. Northern oceanic species, often occurring in great quantities, e. g. in Denmark Strait and Irminger Sea.

Achnanthes Bory, 1822.

36. **Achnanthes tæniata** Grun. in Cleve et Grunow, K. Svenska Vet. Akad. Handl., Bd. 17, No. 2, 1880, p. 22, pl. 1, fig. 5; Gran, Bibliotheca Botanica, Heft 42, 1897, p. 9, pl. 1. fig. 10; Nord. Plankton, XIX, 1905, p. 122, fig. 165; Jørgensen, Bergens Museums Skrifter, 1905, p. 105, pl. 8, fig. 27.

As Gran (1905, l. c., in nota) has pointed out, Grunow's and Jørgensen's figures represent chains with resting spores, while in Gran's two quoted papers we find the normal vegetative chains.

Found in three samples from Danmarks Havn (Aug. 1907 and July 1908) and, with resting spores, in one sample from the pack-ice (July 1908). Perhaps overseen in other samples, as it resembles *Fragilaria oceanica* and *Navicula septentrionalis* very much.

Distrib. Arctic neritic species known from the Arctic Sea and the inner Baltic (in spring).

Navicula Bory, 1826.

37. **Navicula septentrionalis** (Grun.) Gran, Bibliotheca Botanica, 1897, Heft 42, p. 9; Nord. Plankton, XIX, 1905, p. 124, fig. 167; *Stauroneis septentrionalis* Grunow, Diat. v. Franz Josefs Land, 1884, p. 105,

pl. 1, fig. 48; Jørgensen, Bergens Museums Skrifter, 1905, p. 106, pl. 7, fig. 24; *Libellus (?) septentrionalis* Østrup, Medd. om Grønland, 1895, p. 439, pl. 8, fig. 97.

Found in some samples from Danmarks Havn and the coastal water, in 1906—1908, but scattered, and perhaps, as said under *Achnanthes*, sometimes not distinguished from the other band-like species.

Distrib. Arctic neritic species, known from the coasts of Greenland, from Barent and from Murman Sea.

38. **Navicula Vanhöffenii** Gran, Bibliotheca Botanica, Heft 42, 1897, p. 9, pl. 1, figs. 1—3; Nord. Plankton, XIX, 1905, p. 124; Jørgensen, Bergens Museums Skrifter, 1905, p. 105, pl. 7, fig. 22; *N. septentrionalis* Cleve, Bih. K. Svenska Vet. Akad. Handl., Bd. 22, afd. 3, No. 4, 1896, p. 11, non Østrup, nec Grunow.

Recorded from four samples from Danmarks Havn (Aug.—Septm. 1907, July 1908), but rare, and perhaps overseen.

Distrib. Arctic neritic species, known from the coast of Greenland and arctic Norway, from Barent and Murman Seas, further from the inner Baltic (in spring).

Amphiprora Ehrbg., 1843.

39. **Amphiprora hyperborea** (Grun.) Gran, Bibl. Botanica, Heft 42, 1897, p. 10; Fauna Arctica, III, 3, 1904, p. 543, pl. 17, fig. 14; Nord. Plankton, XIX, 1905, p. 127; *A. paludosa*, var.? *hyperborea* Grun. in Cleve et Grunow, K. Svenska Vet. Akad. Handl., Bd. 17, No. 2, 1880, p. 62, pl. 5, fig. 86.

In 1906 only found in one sample from the pack-ice and in 1907 in two samples from Danmarks Havn, in 1908 found scattered over the whole area from Danmarks Havn to the outer part of the pack-ice; always in few specimens. June—September.

Distrib. Arctic neritic species known from Greenland, arctic Norway, Barent and Murman Seas.

Nitzschia Hassall, 1845.

40. **Nitzschia frigida** Grun., in Cleve et Grunow, K. Svenska Vet. Akad. Handl., Bd. 17, No. 2, 1880, p. 94, pl. 5, fig. 101; Gran Bibl. botanica, Heft 42, 1897, p. 10, pl. 1, fig. 11; Nord. Plankton, XIX 1905, p. 129.

Found scattered in three samples from Danmarks Havn (Aug. 1907) and in three samples from the coastal water (Aug. 1906, July 1908).

Distrib. Arctic coast species, not true plankton form, known from the Arctic coast and the inner Baltic.

41. **Nitzschia seriata** Cleve, Vega Exp. vetensk. iaktt., Bd. 3, 1883, pl. 38, fig. 75; Gran, Nord. Plankton, XIX, 1905, p. 129, fig. 174; *N. fraudulenta* Cleve, 15. Ann. Rep. Fishery Board for Scotland, part III, 1897, p. 300, fig. 11; *Synedra Holsatiæ* Hensen, 5. Ber. Komm. Unters. Deutschen Meere, 1887, p. 91, pl. 5, fig. 50.

Only found in Danmarks Havn (Aug. 1907, July 1908) in four samples, but mostly rare.

Distrib. Widely distributed in open seas and along the coasts, probably a neritic species of northern, but not arctic character.

42. **Nitzschia delicatissima** Cleve, A Treatise of Phytoplankton, 1897, p. 24, pl. 2, fig. 22; Gran, Nord. Plankton, XIX, 1905, p. 130.

Found together with the preceding species in two samples from Danmarks Havn, Aug. 1907.

Distrib. Much like the preceding, but more restricted.

Nitzschiella Rabenh., 1864.

43. **Nitzschiella closterium** (Ehrbg.) Rabenh., Fl. Europ. Algar., I, 1864, p. 163; *Ceratoneis closterium* Ehrbg., Kreidethierchen, 1840, p. 64, pl. 4, fig. 7; *Nitzschia closterium* W. Smith, Syn. British Diatoms I, p. 42, pl. 15, fig. 120; Gran, Nord. Plankton, XIX, 1905, p. 129, fig. 172.

Found together with the preceding in two samples from Danmarks Havn (Aug. 1907) and further in one sample from the coastal water (July 1908); a littoral species which sometimes occurs in plankton as it often inhabits mucilage of other organisms.

Distrib. Ubiquitous along the coasts.

II. Flagellatæ.

A. Chrysomonadineæ.

Dinobryon Ehrbg., 1838.

1. **Dinobryon pellucidum** Levander, Acta Soc. Fauna & Flora Fenn., 12, No. 2, 1894, p. 31, pl. 2, fig. 1; *Dinodendron balticum* Schütt; *Dinobryon b.* Lemmermann, Ber. Deutsch. bot. Ges., 1900, p. 514, pl. 18, figs. 9—10; Nord. Plankton, XXI, p. 4, figs. 13—14.

Single specimens occurred in a sample from Danmarks Havn in 1906, but besides that the species was distributed in the outer parts of the pack-ice, east of ca. 12° W. Long., in some samples it was common, especially in 1908 (in 1906 found only in two samples). When the temperature rose above 7° and the salinity over 34 ‰ it disappeared. July—August.

Distrib. A boreal neritic species, known from the coastal waters of Greenland, Iceland, Spitsbergen, Norway, Færöes and the Baltic.

Phæocystis Lagerheim, 1893.

2. **Phæocystis Pouchetii** (Hariot) Lagerh., Botan. Notiser, 1893, p. 32; Öfv. K. Sv. Vet. Akad. Förhandl., 1896, p. 277, figs. 1—5; Ostenfeld, Arch. f. Protistenkunde, III, 1904, p. 295, fig. 1.

Found scattered over the area, in two samples of 1908 rather common, but not in great quantities, probably because the season has been too late. Not seen in the samples taken in Danmarks Havn, but only recorded from the coastal water and the pack-ice. July—August.

Distrib. A boreal-arctic neritic species which often plays a conspicuous part in the plankton, f. i. in Davis and Denmark Straits, around Iceland, off northern Norway, etc.

B. Coccolithophoridæ.

Coccolithophora Lohmann, 1902.

3. **Coccolithophora pelagica** (Wallich) Lohmann, Arch. f. Protistenkunde, I, 1902, p. 138; *Coccosphæra p.* Wallich, Ann. Mag. Nat.

Hist., 1877, p. 348, pl. 17; Murray and Blackman, Trans. Roy. Soc., London, Ser. B, 1898, vol. 190, p. 439, pl. 16, figs. 6—10; *C. atlantica* Ostenfeld, Zool. Anzeiger, 22, 1899, p. 436, fig. 1.

Is was rather surprising to find a *Coccolithophora* in the plankton from such high latitudes and in such arctic water. It was seen in 1905 in three samples from outside the pack-ice and in 1908 in three samples also outside the pack-ice, but a little more southwards; in two of the latter ones it was rather common, especially in lumps of mucilage. It did not occur in any of the samples west of 11° W. Long. On closer examination it appeared that all the specimens examined were dead, as no nucleus nor chromatophores, etc., were present. July—August.

Disrib. A temperate oceanic organism, very distributed and common in the Atlantic Ocean.

Pontosphæra Lohmann, 1902.

4. **Pontosphæra borealis** nov. sp. *Cellulæ solitariæ globosæ, 17—22 μ; coccolithi elliptici, 3—4 μ longi, plani vel leviter concavi, omnes similes; flagella et chromatophori in spec. preservatis non distincti; nucleus adest.* Fig. 11.

In seven samples (three from 1908 and four from 1906) from the outer part of the pack-ice and outside it (i. e. not W. of 11° W. Long.) I found an interesting organism, viz.: a species of the genus *Pontosphæra*. As mentioned above the occurrence of *Coccolithophoridæ* in arctic water was a new thing, but the *Coccolithophora* present was dead. It is another matter with the *Pontosphæra*, as its plasma showed that the cells most probably were living when caught. It is then the first record of a species of *Coccolithophoridæ* living in arctic water. The species found must be referred to the genus *Pontophæra*, as it is understood by H. Lohmann, but I can not identify it with the species hitherto described (Lohmann, l. c., p. 129—332). The cells are mostly globose, rarely of a more oblong form, the coccoliths are plane or slightly concave, all of the same shape, elliptic and lying closely together, covering the whole surface of the cell. As only preserved material was examined no flagella were found, and it was not possible to discover chromatophores, whereas a nucleus was seen. By using acids the coccoliths disappeared immediately.

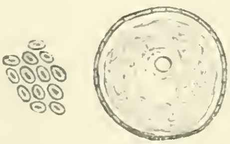

Fig. 11. *Pontosphæra borealis* n. sp. 800 t. m.

The new species resembles *P. inermis* Lohm., but has not the distinct naked pole ("Geisselpol") for the flagella. July—August.

In most of the samples it occurred together with *Cocc. pelagica*, but it did not occur in greater quantities, perhaps because it is so small that it is only in a small part caught by the nets.

C. Silicoflagellatæ.

Distephanus Stöhr, 1880.

5. **Distephanus speculum** (Ehrbg.) Haeckel, Challenger Rep., Radiolaria, 1889, p. 1560; Lemmermann, Ber. Deutsch. bot. Ges., 1901, p. 263, pl. XI, figs.; Nord. Plankton, XXI, p. 31, figs. 103—104.

Most of the specimens found in the samples must be referred to var. *septenarius* (Ehbg.) Jørg., f. *regularis* Lemm., l. c., fig. 104.

Found scattered over the area; in 1907 in three samples from Danmarks Havn, in 1908 also in the coastal water, and in 1906 in three samples in the outer part of the pack-ice. As the specimens examined had plasma, they must have been living when caught.

Distrib. (of the form) Karajakfjord in West-Greenland, Baltic; (of the species) oceanic species of worldwide occurrence, but hardly arctic.

Appendix: Pterospermataceæ.

Pterosperma Pouchet, 1894.

Pterosperma Vanhöffenii (Jørg.) Ostenfeld, Vidensk. Medd. Naturh. For., København 1901, p. 151; *Pterosphæra* V. Jørgensen; *Pterocystis* V. Lohmann, Eier u. sogen. Cysten der Plankton-Expedition, 1904, p. 44, pl. 7, fig. 10.

Single specimens found in several samples (10) in 1908, both near the coast (in Danmarks Havn) and in the outer part of the pack-ice. At least some of the specimens were empty. July—August.

Distrib. A temperate oceanic organism, known especially from the North Atlantic.

28—9—1910.

XI.

MARINE PLANKTON

FROM

THE EAST-GREENLAND SEA

(W. OF 6° W. LONG. AND N. OF 73° 30′ N. LAT.)

COLLECTED DURING THE "DANMARK EXPEDITION" 1906—1908

II. PROTOZOA

BY

C. H. OSTENFELD

1910

INTRODUCTION

The present paper is based upon the examination of a number of plankton samples collected during the "Danmark Expedition" to N. E.-Greenland 1906—1908. The samples have been collected by means of fine-meshed tow-nets and are all surface samples.

In the introduction to another paper on the Diatoms and Flagellates of the same samples I have rendered, more in details, an account of the data concerning the collection, etc. It will therefore, I think, be sufficient to repeat here the more important data.

The samples examined originate all from more or less ice-filled water which may be divided into three areas:

1°. Samples taken in the pack-ice (drift-ice) in August 1906 and July 1908. The geographical area is about 73° 30'—76° N. Lat. and 6°—13° W. Long.

2°. Samples taken in the coastal water west of the pack-ice and east of the coast of Greenland, between 76°—78° N. Lat.; August 1906 and July 1908.

3°. Samples taken in Danmarks Havn, Germania Land, 76° 46' N. Lat., 18° 43' W. Long., during the stay of the Expedition from the autumn of 1906 to July 21st 1908.

As already pointed out in my above mentioned paper, the samples from the last area are of greatest interest, but unfortunately it has not been possible for the Expedition to take samples during the whole time of the stay, at regular short intervals. There are only a few samples from October 1906, circa 10 from June—September 1907 and a couple from July 1908 when the steamer left the harbour.

From the opposite coast of Greenland, the west coast, we have Vanhöffen's valuable regular collection of the plankton of Karajak Fjord, ca. 70° N. Lat., upon which K. Brandt (1896) has based his interesting paper on arctic *Tintinnodea*. It is but natural that the samples from these two points on the coasts of Greenland are to be compared; and the following list will show a close resemblance between them. Almost the same species of *Tintinnodea* occur in both places, but it is remarkable that three species of *Tintinnopsis* (viz.: *T. nitida* Bdt., *T. sinuata* Bdt. and *T. sacculus* Bdt.) described by Brandt from the Karajak Fjord, have not been seen in our samples; perhaps the more northern latitude of Danmarks Havn (6—7° higher) and the thereof resulting more strictly arctic conditions of life may have some relation to the absence.

Besides the *Tintinnodea* which are best taken by means of surface hauls with fine-meshed nets, the samples contain but few *Protozoa*, viz.: two *Radiolaria*, one *Foraminifera* and the resting stage of an unknown organism.

The *Radiolaria* have, taken in general, not their home in the surface water, and, no doubt, vertical hauls would have given many more species. *Globigerina bulloides*, one of the few pelagic Foraminifera, is an atlantic organism. Lastly we have the peculiar resting stage, Hensen's "Sternhaarstatoblast" which has hitherto been known only from the Baltic and the occurrence of which consequently is of some zoogeographical interest. Nothing is known on its place in the system, and it may perhaps be a stage of some Metazoon.

In the following papers remarks on the species mentioned in the list and on their occurrence in the East-Greenland Sea are to be found:

Brandt, K.: Die Tintinnen, in Zoologische Ergebn. d. von d. Ges. für Erdkunde zu Berlin unter Leitung Dr. von Drygalski's ausges. Grönlandexp. nach Vanhöffen's Sammlungen bearbeitet. — Bibl. Zoologica, Heft 20, 1896.

—: Die Tintinnodeen der Plankton-Expedition. Atlas u. Tafelerklärungen 1906; Systematischer Teil 1907.

Cleve, P. T.: Plankton coll. by the Swedish Exp. to Spitsbergen in 1898. — K. Svenska Vet. Akad. Handl., Bd. 32, No. 3, 1899.

—: Report on the Plankton coll. by the Swedish Exp. to Greenland in 1899. — Ibidem, Bd. 34, No. 3, 1900.

Damas, D. et Koefoed, E.: Le Plankton de la Mer du Grönland, in: Duc d'Orléans: Croisière Océanographique accomplie à bord de La Belgica dans la Mer du Grönland 1905. Bruxelles 1909.

Jørgensen, E.: Ueber die Tintinnodeen der norwegischen Westküste. — Bergens Museums Aarbog 1899, No. II, 1899.

—: Protophyten und Protozoën im Plankton aus der norwegischen Westküste. — Ibid.. No. VI, 1900.

—: Protistenplankton aus dem Nordmeere in den Jahren 1897—1900. — Ibid., 1900, No. VI, 1901.

—: Protistplankton, in: O. Nordgaard: Hydrographical and biological Investigations in Norwegian Fiords. — Bergens Museums Skrifter, 1905.

Hensen, V.: Über die Bestimmung des Planktons. — 5. Bericht der Kommission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel für die Jahre 1882—86. Kiel 1887.

Popofsky, A.: Die nordischen Acantharien. — In: K. Brandt u. C. Apstein: Nordisches Plankton, Kiel u. Leipzig. 3. Lief. 1905.

I. Tintinnodea.

In the list of species given beneath I follow Brandt's large work of 1907 where we find nearly all our knowledge concerning the systematical matters of this group of Infusorians put down.

Tintinnopsis Stein, 1867.

1. **Tintinnopsis karajacensis** Brandt, 1896, p. 57, pl. 3, fig. 5; 1906—07, p. 162, pl. 19, figs. 5, 7, 10—12, pl. 26, fig. 3, (varr.) pl. 19, figs. 1—2, 9, 19, 20, pl. 26, fig. 9; H. Laackmann, Wiss. Meeresunters., Bd. 10, Abt. Kiel, 1906, p. 21, pl. 1, figs. 12—14.

Nov. var. **lagenoides** (Fig. 1).

Differs from the main species in the inflated lower end of the house and in the scarceness of foreign bodies upon its wall.

In three samples (August—Septm. 1907) from Danmarks Havn I found rather sparsely a *Tintinnopsis* form which has caused me much trouble. It stands in many respects between *T. karajacensis* Bdt. and *T. sacculus* Bdt., but as I had not been able to find the peculiar structure of the "Primärwaben" characterizing *T. sacculus* (see Brandt 1907, p. 164), I prefer to keep my form under *T. karajacensis*. From this it differs in the inflated lower end of the house and the distinct neck. The foreign bodies are small and rather few. I have not seen more than one nucleus.

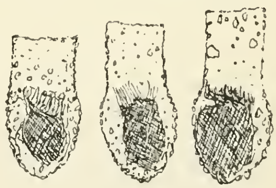

Fig. 1. *Tintinnopsis karajacensis* Brandt *var. lagenoides* n. var. 250 t. m.

The dimensions are as follows:

Length	80—88 μ,
Breadth of the neck	32 μ,
— of the lower part ..	40 μ.

It seems related to the var. *b* from Tocantin figured by Brandt 1906, and perhaps to Laackmann's *T. Lohmanni* (l. c., p. 20, pl. 1, figs. 10—11).

Distrib.: (main species) Karajak Fjord, Davis Strait; Kiel Fjord; Norwegian Fjords; off Helder; (varr.) off Borneo; Tocantin; off Bombay; Iceland.

2. **Tintinnopsis? pellucida** (Cleve) Brandt, 1906, p. 18, 1907, p. 172, pl. 23, figs. 8, 14, 15; *Tintinnus* (?) *pellucidus* Cleve, 1899, p. 24, pl. 1, fig. 4; *T. bottnicus* Brandt, 1896, p. 53, pl. 3, fig. 11; *Leprotintinnus bottnicus* Jørgensen, 1899, p. 10; 1900, pl. 2, fig. 3; *L. pellucidus* Jørgensen, 1901, p. 18. (Fig. 2).

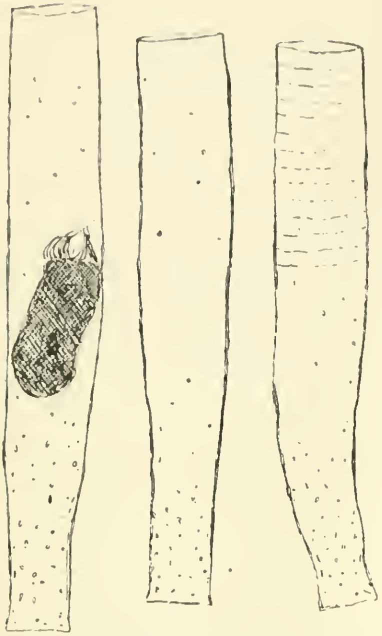

Fig. 2. *Tintinnopsis pellucida* (Cleve) Brandt. 250 t. m.

In one sample from September 1907 from Danmarks Havn and in two July-samples from the pack-ice *T. pellucida* was present, but rather rare. The annexed figures show the variability of the houses: rings are present or not, the lower part is straight or faintly curved, the foreign bodies are more os less abundant, etc.

The contracted animal figured in the left figure had two distint nuclei.

Length of the houses 330—344 μ (Brandt 0,2—0,27 mm.) Breadth 32 and 48 μ (narrowest and largest part).

Distrib.: Karajak Fjord; Davis Strait; N. and W. of Spitsbergen; Norwegian Coast off Bergen.

Cyttarocylis Fol, 1881.

3. **Cyttarocylis pseudannulata** Jørgensen, 1901, p. 15, pl. 2, fig. 28; Brandt 1906—07, p. 269, pl. 28, fig. 8, pl. 29, fig. 1; *C. annulata* Jørgensen, 1899, p. 36.

Only found in few specimens in a single sample from the pack-ice in August 1006.

Distrib.: Irminger Sea; N. E. of Jan Mayen; Norwegian West-coast.

4. **Cyttarocylis denticulata** Ehrbg., Jørg. emend.; Jørgensen 1899, p. 31, pl. 2, figs. 13, 15; 1901, p. 12, pl. 3, figs. 25—26; 1905, p. 144; Brandt 1906—07, p. 232, pl. 37, figs. 9—10, 15—17; non *C. denticulata* Brandt 1896, p. 62, nec Ostenfeld, in M. Knudsen & C. Ostenfeld, Iagttagelser over Overfladevandets Temperatur, Saltholdighed og Plankton paa islandske og grønlandske Skibsrouter i 1898, København 1899, p. 62.

The forms belonging to the group *C. denticulata* are of great importance for the plankton of the area here treated of. When we follow Jørgensen (l. c.) and Brandt's latest paper (1906—07), we have the following three "varieties" in the samples, all neritic varieties.

a. var. **typica** Jørg., 1899, p. 31, etc. (Fig. 3). This variety shows

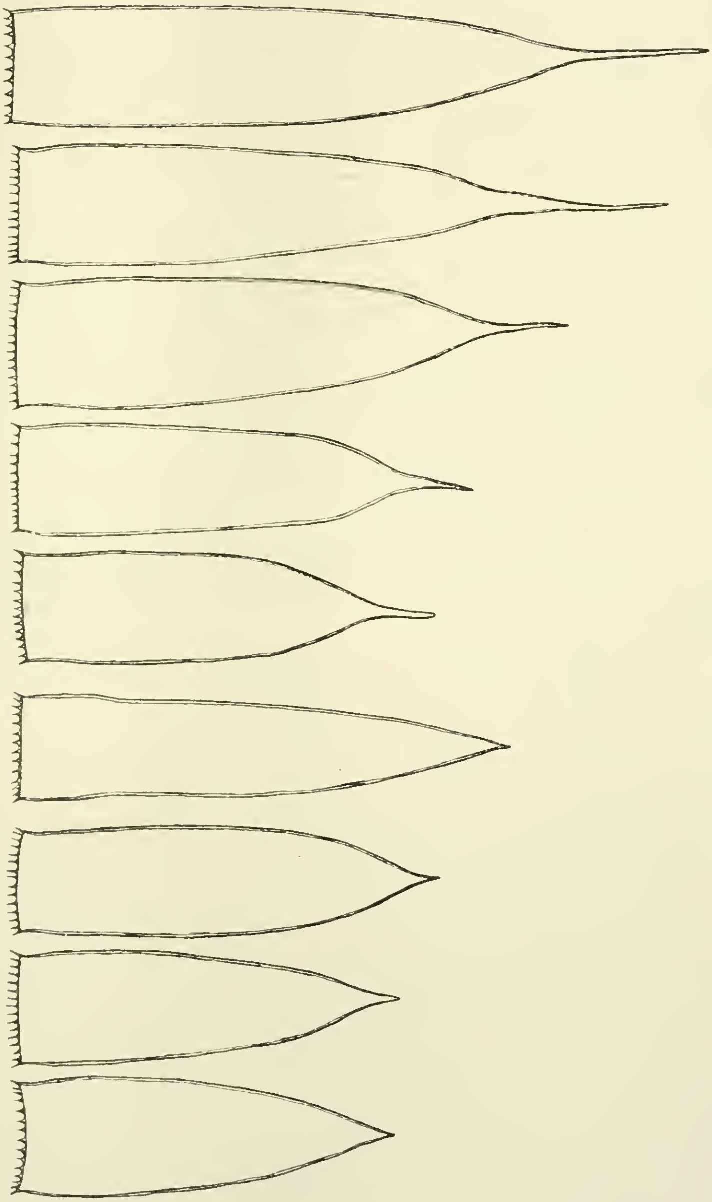

Fig. 3. *Cyttarocylis denticulata* Ehrbg. var. *typica* Jørg. 250 t. m.

a great variability; all the specimens given in the fig. 3 are from one sample (Danmarks Havn, Aug. 15th 1907) with exception of the largest one (placed most at right). If we compare the specimens with the figures quoted above from Jorgensen's and Brandt's papers, we shall find a close resemblance. The smaller specimens answer to Jorgensen's f. *acuta* (1901, p. 12), the larger ones to his f. *caudata* (1901. p. 12), but I have not succeeded in finding any definite limit between them.

All the specimens which I reckon to the var. *typica* have in common: long and well-developed teeth in the mouth of the house, the lower end not sharply set off from the main part, but of variable length and often forming a distinct "Fortsatz"; the structure of the house-wall is not coarse.

Var. *typica* was dominant in the samples from the pack-ice in August 1906, but not present in the coastal water. It was found sparingly in the samples from Danmarks Havn in October 1906 (under the ice), but mostly only empty houses. In 1907 it was dominant in Danmarks Havn in Aug.—September. In July—August 1908 it occurred sparingly in the samples from the coastal water, while dominant in those from the pack-ice and again rare outside this, when the temp. rose from 0°—2° C. to 6°—7°. In the last region where I found it with resting spores (cfr. Laackmann, Wiss. Meeresunters., Abt. Kiel, 1906), the specimens were small and approached the oceanic species *C. edentata* Bdt. (f. *parumdentata* Bdt.).

The dimensions of the houses of some of the measured specimens follow here:

Length	Breadth	Length	Breadth
265 μ	85 μ	320 μ	75 μ
300 -	80 -	384 -	84 -
305 -	80 -	416 -	84 -
312 -	80 -	440 -	75 -

b. var. **gigantea** (Bdt.) Jørgensen, 1899, p. 35, pl. 3, figs. 26—28; 1901, p. 14; Brandt, 1906—07, p. 233, pl. 38, figs. 2, 3, 8, 9; *C. gigantea* Brandt, 1896, p. 63, pl. 3, figs. 21—24; Ostenfeld, l. c., 1899, p. 62. (Fig. 4).

In the samples from Danmarks Havn, Sept. 1907, I found together with the preceding form a still larger one, which agrees well with var. *gigantea*. It differed from var. *typica* in its greater length and the short teeth in the mouth of the house; the structure of the house-wall was the same.

Besides in the two mentioned samples, it was found very sparingly in July 1908 in and off Danmarks Havn (two samples) and in the pack-ice (two samples). It was not always easy to distinguish it from var. *typica*.

Dimensions (in μ): Length and Breadth 615×78 and 650×80.

c. var. **robusta** Jørgensen, 1901, p. 13, pl. 3, fig. 22; 1905, p. 144; Brandt, 1906–07, p. 234, pl. 38, figs. 4, 10. (Fig. 5).

In many samples where var. *typica* was present, another probably well-distinguished form also was found. It had about the same size as that, but differed in the rather sharply set-of "Fortsatz", the small and broad teeth of the mouth and in the much coarser wall of the house-wall. The latter character was very easily seen under low power of magnification as the transparence of the wall was quite another. No doubt it is the var. *robusta* of Jørgensen (l. c.), as my fig. 5 will prove. Sometimes specimens were found which had not the well-developed "Fortsatz", but elsewhere agreed with the var. *robusta*; these may be named f. *subrotundata* Jørg. (1899, p. 34, pl. 2, figs. 20—21, pl. 3, figs. 22, 25, 29; Brandt, 1906—07, p. 235, pl. 37, figs. 12—14), which I subordinate under var. *robusta*.

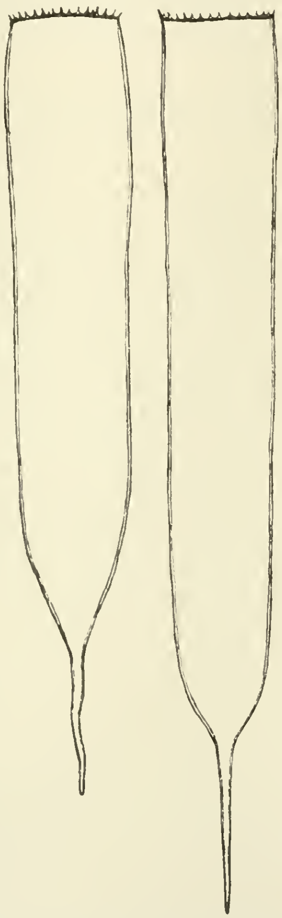

Fig. 4. *Cyttarocylis denticulata* Ehrbg. var. *gigantea* (Bdt.) Jørg. 250 t. m.

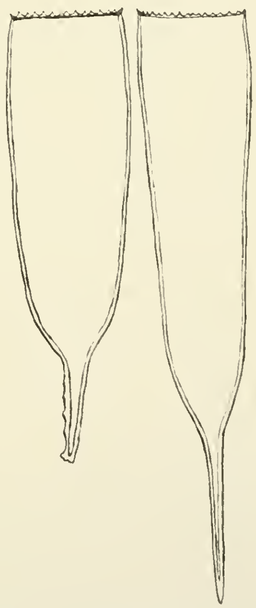

Fig. 5. *Cyttarocylis denticulata* Ehrbg. var. *robusta* Jørg. 250 t. m.

The variety was dominant, together with var. *typica*, in the samples from the pack-ice in August 1906 and disappeared together with it when reaching the coastal water, but more slowly (the empty houses are perhaps more persistent than those of var. *typica*). It was present together with var. *typica* in Aug.—Sept. 1907 in Danmarks Havn, but not common. In 1908 (July—August) it was not present in the coastal water, but appeared in the pack-ice (probably only empty houses) and became common in the samples from the outer margin of and outside the ice.

Dimensions (in μ): 325 × 80, 420 × 80.

Distrib. (of *C. denticulata*): Neritic northern species of wide distribution, known along the coasts from New Foundland north- and eastwards to the Baltic Sea.

Ptychocylis Brandt, 1886.

5. **Ptychocylis obtusa** Brandt, 1896, p. 59, pl. 3, figs. 13, 15; 1906—07, p. 310, pl. 57, fig. 8; *P. urnula*, var. *obtusa* Jørgensen, 1901, p. 18, pl. 3, fig. 32; *P. Drygalskyi* Brandt, 1896, p. 59, pl. 3, fig. 14; *P. obtusa*, var. *Drygalskyi* Bdt., 1906—07, p. 312, pl. 55, figs. 1—3; pl. 56, figs. 3, 4; pl. 57, fig. 10; *P. urnula* var. *digitalis*, Jørgensen 1901, p. 17, pl. 2, figs. 29, 30, pl. 3, fig. 31; 1905, p. 143. (Fig. 6).

In samples from Danmarks Havn, Aug.—Septm. 1907, *P. obtusa* was found in some numbers, but not common; further it was present in July 1908 in some samples from the coastal water and here not so uncommon. It was with some hesitation that I named all the specimens examined *P. obtusa*, as at least the smaller ones also may be named var. *Drygalskyi*, but it has been impossible to me to find any distinct boundary between the main species and the so-called variety. To me it seems, as if var. *Drygalskyi* is only the smaller individuals of *P. obtusa*; and the annexed sketchs will show my meaning. Therefore I name them all *P. obtusa*.

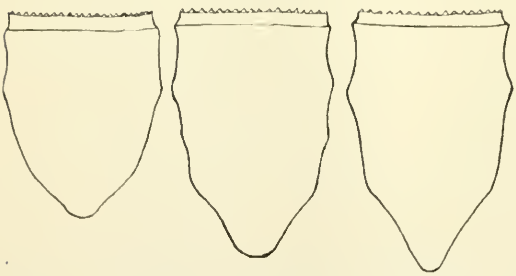

Fig. 6. *Ptychocylis obtusa* Brandt. 250 t. m.

Distrib. Arctic neritic species known from Davis Strait, Labrador Stream, Norwegian Sea, Norway, Spitsbergen.

6. **Ptychocylis urnula** (Clap. & Lachm.) Bdt., var. **acuta** Brandt, 1906, p. 28, pl. 56, figs. 1, 2, 6; pl. 57, fig. 7; *P. acuta* Brandt, 1896, p. 59, pl. 3, fig. 16.

In two samples from the outer part of the pack-ice in August 1906 a few specimens of a *Ptychocylis* were observed which I refer to the arctic variety of *P. urnula* characterized (in spite of its name) by a less acute lower end of the house and smaller size. It forms a transition to the above mentioned species.

Distrib. (of var. *acuta*) Davis Strait; (main species) northern oceanic species.

Tintinnus Schrank, 1803.

7. **Tintinnus acuminatus** Clap. & Lachm., var. **secatus** Brandt, 1906, p. 32, pl. 66, fig. 5; 1907, p. 389; *T. secatus* Brandt, 1896, p. 51, pl. 3, fig. 12.

Only found once in a sample from the outer part of the pack-ice (Aug. 1906).

Distrib. (of var. *secatus*) Karajak Fjord, Davis Strait, Labrador Stream; (main species) northern oceanic species of wide distribution.

8. **Tintinnus norvegicus** (Daday) Brandt, var. **gracilis** Brandt, 1906, p. 30, pl. 62, figs. 2, 7; 1907, p. 407; *T. gracilis* Brandt, 1896, p. 54, pl. 3, fig. 7.

The form of the group *T. norvegicus* present in the area has the cylindrical shape of the house and the well-developed teeth of the mouth, characterizing Brandt's *T. gracilis*.

It was found in the samples from the pack-ice in August 1906 and in July 1908 and further outside the ice in August 1908; it was always rather rare, but because of its small size it is only to a small degree kept by the nets.

Distrib. (of the var. *gracilis*): Karajak Fjord, Davis Strait; (of the main species) Davis Strait, Labrador Stream, North Atlantic, off Bergen.

9. **Tintinnus vitreus** Brandt, 1896, p. 54, pl. 3, figs. 8—9; 1906—07, p. 438, pl. 66, fig. 7. (Fig. 7).

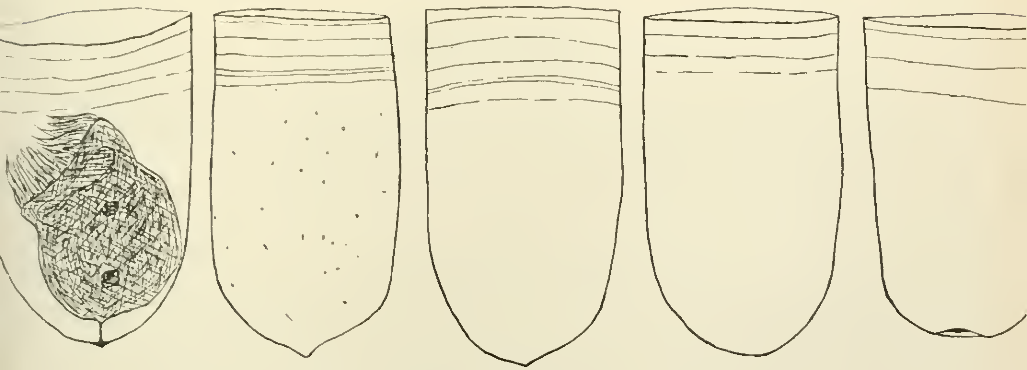

Fig. 7. *Tintinnus vitreus* Brandt. 250 t. m.

In his paper on the *Tintinnodea* from Vanhöffen's material from Karajak Fjord Brandt has described a rare *Tintinnus* which has not been seen since then. This species I have found not rarely in a single sample from Danmarks Havn, Aug. 15th 1907, and I have been able to study it a little more in details. A single specimen was further found in a sample from the coastal water off Cape Amelie in Aug. 1906.

My specimens differ in some points from Brandt's description, but I think it correct to retain them under his species. The houses are 210—240 μ long (Brandt gives 0,14—0,15 mm.) and 120—140 μ broad. The lower end has mostly a small tip, more rarely it is rounded as in Brandt's figure; and near the mouth a varying number of rings are seen, but they are very fine and often difficult to observe. The wall of the cylindrical house is hyaline and with high power of magnification the fine "Primärwaben" are discernible; sometimes very small foreign bodies are sparingly fixed upon the wall. The animal itself has two nuclei and a large vacuole; it is adherent to the innerside of the tip of the house by means of a stalk, — as far as preserved material (in alcohol) allows to judge.

The species seems to have a very short time of plankton life; it was present in Danmarks Havn in one sample from Aug. 15, but not in samples from Aug. 4th or 24th of 1907, and further in one sample from Aug. 15th 1906; temperature of the water was + 0,4° and ÷ 0,4° C. respectively.

Distrib. Arctic neritic species, hitherto only known from Karajak Fjord (March) and in our area (August).

II. Radiolaria.

As said above (p. 290), surface samples are not suitable for Radiolarians, and besides arctic waters have few species; it is then but natural that very few forms were seen in the collection.

A. Acanthometrida.

In three samples from the autumn 1907 from Danmarks Havn and in five samples from the coast water in July 1908 undetermined forms of *Acanthometrida* were seen. As far as I could find, the transverse section of the spines was quadrangular and no basal wing-cross was developed; it may then have been a species of *Acanthonia*, most probably *A. tigurina* Hæckel (cfr. Popofsky 1905).

B. Nassellaria, Dicyrtida.

Amphimelissa Jørg., 1905.

Amphimelissa setosa (Cleve) Jørgensen, 1905, p. 137, pl. 18, fig. 109; *Botryopyle setosa* Cleve, 1899, p. 27, pl. 1, fig. 10.

Two specimens of the group *Dicyrtida* were seen in a sample from Danmarks Havn, Aug. 15th 1907, and they agreed well with the species here quoted.

Distrib. West of Norway; fjords of northern Norway; north and west of Spitsbergen; East Greenland Sea at 71°—72° N. Lat.; Atlantic 45° N. Lat. 49° W. Long.

III. Foraminifera.

In a single sample from the inner part of the pack-ice, July 1908, I found a few specimens of *Globigerina*, most probably *G. bulloides* d'Orb., a well known, widely distributed oceanic plankton organism.

IV. Incertae sedis.

In his famous work on plankton Hensen (1887) has mentioned and figured an obscure organism which he named "Sternhaar-statoblast", as occurring in the Baltic; this organism was found in a sample from September 10th 1907 from Danmarks Havn, but very rare.

3—10—1910.

Arbejder fra den Botaniske Have i København. Nr. 65.

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 11

SÆRTRYK AF «MEDDELELSER OM GRØNLAND» XLIII

MARINE PLANKTON

FROM

THE EAST-GREENLAND SEA

(W. OF 6° W. LONG. AND N. OF 73° 30′ N. LAT.)

COLLECTED DURING THE "DANMARK EXPEDITION" 1906—1908

III. PERIDINIALES

BY

OVE PAULSEN

KØBENHAVN

BIANCO LUNOS BOGTRYKKERI

1911

The plankton samples collected during the Danmark-Expedition by Mr. A. Lundager may be grouped in the following categories:

1. Samples collected in the open ocean east of the Greenland ice on the way out in 1906 and homeward in 1908. Like Dr. Ostenfeld, who has worked out the Diatoms and Flagellates, I think these samples are of no special interest. All of them have been taken in July—August, and on the way home they were collected with so small intervals that it has been quite sufficient to examine only a selected number of them.

2. Samples collected in the drifting ice (pack-ice) off East Greenland in August 1906 as the "Danmark" went in to the Greenland coast, and in July 1908 when it was homeward bound. On the way out a great many samples were collected, until 12 in a day and a night, and as the speed was moderate and the course very curved they are very close together and many of them quite like each other. Therefore, only a certain number of them has been thoroughly investigated.

3. Samples collected in August 1906 and July 1908 near the coast of East-Greenland, from off Koldewey Island (ca. 76° 30′ N. Lat.) to ca. 78° N. Lat., thus in the coastal water.

4. Samples collected in Danmarks Havn (Denmark harbour), at 76° 46′ N. Lat., 18° 43′ W. Long., where the expedition stayed about two years, from August 1906 till July 1908. Unfortunately these samples were not taken with regular intervals but rather occasionally: there is about a dozen of samples from the summer 1907, and in 1908 samples were collected on July 21st when "Danmark" left the harbour.

In the following pages a list is given of all the Peridiniales found in these samples, and some of the species are accompanied by figures and remarks. A general description of the plankton will be giwen in a concluding paper by Dr. Ostenfeld and the present author.

The following papers deal with the Peridiniales of the East-Greenland sea:

Cleve, P. T.: Report on the Plankton collected by the Swedish expedition to Spitzbergen in 1898. (K. Svenska Vet. Akad. Handl. 32, 1899).

Paulsen, Ove: Plankton investigations in the waters round Iceland in 1903 (Meddel. fra Kommis. for Havundersøg. Ser. Plankton. Bd. I. No. 1. 1904). (Cited as: Plankton invest Iceland 1903).

Broch, Hj.: Plankton tables. In Damas et Koefoed: Le plankton de la mer du Grönland. (Duc d'Orléans: Croisière océanographique accomplie à bord de la Belgica dans la mer du Grönland 1905). Bruxelles 1909.

Paulsen, Ove: Plankton investigations in the waters round Iceland and in the North Atlantic in 1904. (Meddel. fra Kommis. for Havundersøg. Ser. Pankton. Bd. I. No. 8). 1909.

Broch, Hjalmar: Das Plankton (Zoologische Ergebnisse der Schwedischen Expedition nach Spitzbergen 1908. Teil I, 2). (K. Svenska Vet. Akad. Handl. 45, No. 9. 1910)[1]. (Cited as: Broch, Spitzbergen Plankton.

Yet, for easy reference, by each species the following paper is cited:

Paulsen, Ove: Peridiniales (Nordisches Plankton, herausgeg. v. Brandt u. Apstein XVIII). Kiel 1908.

Dinophysis Ehrenberg.

1. **Dinophysis norvegica** Claparède & Lachmann, Mém. inst. nat. Genév. 1859, p. 407, tab. XX, fig. 19. Paulsen Nord. Plankton, p. 14, fig. 11—12. Broch Spitzbergen plankton 1910, p. 31, fig. 1, I. *D. acuta* auct. plur., non Clap. Lachm.

Single specimens, agreeing with var. *crassior*, Paulsen l. c. and also with Brochs drawing, were found in the outer part of the pack-ice and in the open sea.

Distrib. Seems to be a neritic and boreal but hardly arctic species.

2. **Dinophysis arctica** Mereschkowsky, Archiv f. mikroskop. Anatomie 1879, p. 177, tab. XI, fig. 19. Paulsen Nord. Plankton p. 15, fig. 14 (a bad figure), Broch Spitzbergen plankton p. 31, fig. 1, II. *D. granulata* Cleve & auct. plur.

Broch (l. c.) says that this species bears fine and distant poroids on the surface while *D. norvegica* is coarsely areolated. My annexed fig. 1 shows that this is not always the case, this specimen (and many others) being very coarsely areolated. Besides, I have often found cells of this species provided with small protuberances at the

[1] In this paper which appeared as I had finished the examination of the plankton samples, Bütschli's theory on the intercalary striae as growth-marks is shown to hold good, the growth of the different species is studied in detail, and the arrangement of their plates is expressed in formulae. It will really be an advantage if the plate-arrangement proves to be so constant as supposed by Broch. — A lack in Broch's paper is that he gives no measures of the organisms, he confines himself to criticise those given by me. His paper will be often mentioned in the following.

lower end (see the drawing), like those of *D. acuminata*. Nevertheless I think it would be premature to unite these two species *D. arctica* having a much shorter and broader form. JÖRGENSEN (Bergens Museums Aarbog 1900, No. III, p. 19) names the species *D. acuminata var. granulata*. Length 36—42 μ. — *D. arctica* was found in several samples from the pack-ice and the open sea outside it, mostly few specimens, and as single ones in the coast water and in Danmarks Havn.

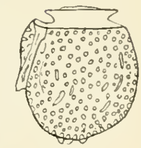

Fig. 1. *Dinophysis arctica*. 375 t. m.

Distrib. Arctic species.

3. **Dinophysis rotundata** Claparède & Lachmann Mém. inst. nat. Génévois 1859, p. 409, tab. XX, fig. 16; Paulsen Nord. Plankton p. 17, fig. 18.

Fig. 2 represents a cell with a very coarsely areolated wall and broad intercalary band. The epitheca is relatively large, and oblique. This cell, whose length was 60 μ, is supposed to be an old one. Other cells with finer areolated surfaces were 40—52 μ long. From this it may be seen that the arctic specimens are somewhat bigger than those from southern waters, whose length was given by Bergh and in Nordisches Plankton by me as 48 μ.

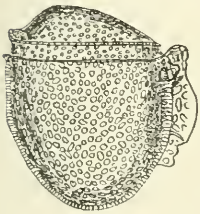

Fig. 2. *Dinophysis rotundata*. 375 t. m.

Dinophysis rotundata was found very sparingly both in the coastal water, the pack-ice and outside it.

Distrib. Boreal oceanic species, widely distributed in the northern Atlantic and its tributaries.

Gonyaulax Diesing.

4. **Gonyaulax triacantha** Jørgensen, Bergens Museums Aarbog 1899, No. VI, p. 35. Paulsen Nord. Plankton p. 28.

A single specimen was found in a sample from the pack-ice (1906) but a great many in a sample from Danmarks Havn in September 1907 (Water 0°).

Distrib. Arctic neritic species, known from Alaska, Iceland, West coast of Norway. In the North Sea very rare.

5. **Gonyaulax** sp.

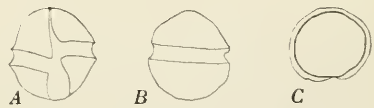

Fig. 3. *Gonyaulax* sp. 375 t. m.

In some samples from the pack-ice (1906) the little organism represented in fig. 3 was found. Length 20—24 μ. I have not succeeded in finding out its plates. In some cases the surface was covered by a great-meshed reticulation of a similar kind as that figured by KLEBS in Botanische Zeitung 1884 fig. 2—5 for *Glenodinium trochoideum* (now. *Peridinium trochoideum* (Stein) Lemmermann).

Goniodoma Stein.

6. **Goniodoma Ostenfeldii** Paulsen, Plankton invest. Iceland 1903, p. 20, fig. 2; Nord. Plankton p. 34, fig. 43; Broch Spitzbergen Plankton p. 32, fig. 3.

Found in single specimens in Danmarks Havn, the coastal water, and the open sea.

Distrib. Arctic, neritic species, known from North-Iceland and Spitzbergen.

Peridinium Ehrenberg.

Of late years different methods of shortly designating the plates composing the skeleton of *Peridinium* have been proposed. The first was that of Fauré-Fremiet, whose paper "Étude descriptive des péridiniens et des infusoires ciliés du plankton de la baie de la Hougue" was published in 1908 in Annales des sc. naturelles, zoologie. Fauré-Fremiet designates the plates by letters with annexed numbers, so e. g. the precingulars are named d_1—d_7, d_1 being to the right, d_2 to the left, d_3 to the right and so on. This method seems to me not to be practical.

Next to Fauré-Fremiet comes Kofoid, the well-known investigator of the Dinoflagellates. His paper "On Peridinium Steini Jørgensen, with a note on the nomenclature of the skeleton of the Peridinidae" was published in 1909 in Archiv für Protistenkunde 16. Kofoid employs only numerals, the different series of plates being distinguished by different numbers of apostrophes or other signs annexed to the numerals. So, the apicals are $1'$—$4'$, intercalaries 1°—3°, precingulars $1''$—$7''$, postcingulars $1'''$—$5'''$, antapicals $1''''$—$2''''$. Each series begins on the left side of the body and goes round it to the right side. This system is a clear one, but not very practical because of the apostrophes as to whose numbers mistakes are likely to arise[1].

Broch in his paper on Spitzbergen plankton (1910) gives a new method of designating the plates. He uses both numerals and letters. In the same year the method was modified in "Die Peridinium-Arten des Nordhafens (Val di Bora) bei Rovigno im Jahre 1909" (Arch. f. Protistenk. 20). Here, the apicals are named 1—4 and the precingulars a—g, 1 being the rhomb-plate and a the precingular neighbouring it to the left, and both series go round the body to

[1] From the table where Kofoid has arranged previous nomenclatures it appears that he has not realized the difference between „tafeln" and „platten" as these termini were used by Schütt and after him also by the present author who in Nord. Plankton did use Schütts nomenclature. It might have been mentioned that Schütt's „tafeln" represent transverse series of „plates". Only the intercalaries were not recognised as a series by Schütt.

the left (descending screw). The intercalaries neighbouring c, d and e are named γ, δ and ε, which is more appropriate than in Kofoid's system where 3″, 4″ and 5″ are neighbours to respectivety 1°, 2° and 3°. The antapicals are named by Broch A and B and the postcingulars I—V. It seems to me that if we here change letters to Roman numbers and vice versa we get a more practical mode of designation. Then, the apicals will be 1—4 and the antapicals I—II, the precingulars a—g and the postcingulars A—E. Thus, we have letters along both margins of the girdle and numerals at the top and at the bottom. Fig. 4 illustrates this method of denominating.

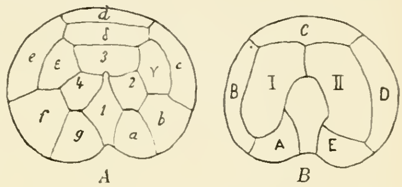

Fig. 4. Diagram of plates of *Peridinium.*

7. **Peridinium Cerasus** Paulsen, Meddel. Kommis. for Havundersøgelser, Ser. Plankton, Bd. I, No. 5. 1907, p. 12, fig. 12; Paulsen, Nord. Plankton p. 43, fig. 52. vix *P. quarnerense* (Br. Schröder) Broch, Arch. f. Protistenk. 22. 1910, p. 183.

Fig. 5 represents a specimen (36 μ long) of *P. Cerasus* which species was found rather rarely in asingle sample from Danmarks Havn (Sept. 5th 1907). I think Broch is not right in uniting this species with *P. quarnerense*, he does it because of the resemblance in the arrangement of the plates of the two species, taking a reservation on account of the incompleteness of my figures of *P. Cerasus*. In any case, my figures are clearly showing that *P. Cerasus* has a long and well marked apical horn, while *P. quarnerense* has a short one, and just this horn is the characteristic of *P. Cerasus*. The dimensions of *P. quarnerense* are unknown, so in this respect it cannot be compared with *P. Cerasus*.

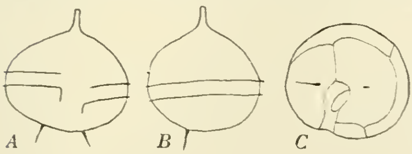

Fig. 5. *Peridinium Cerasus.* 375 t. m.

Distrib. Known from the North Sea and Iceland.

8. **Peridinium roseum** Paulsen, Plankton invest. Iceland 1903, p. 23, fig. 9; Nord. Plankton p. 44, fig. 53.—? *P. ovatum* Fauré-Fremiet, Ann. sc. nat. zool. 9. sér. 1908, p. 218, fig. 5, tab. XV, fig. 6, non Pouchet.

Found in several samples from the pack-ice and Danmarks Havn, mostly in rather few specimens.

Distrib. Boreal-neritic and arctic species, known from Norway and Iceland.

9. **Peridinium ovatum** (Pouchet) Schütt, Die Perid. d. Plankton Exp. 1895 tab. XVI, fig. 49, 1896 fig. 19. Paulsen Nord. Plankton p. 44, fig. 54. Broch, Spitzbergen Plankton p. 40, fig. 9—10, non Fauré-Fremiet 1908 p. 219, tab. XV, fig. 6. — *Protoperidinium ovatum* Pouchet Journ. Anat. Physiol. 1883 p. 35, tab. 18—19, fig. 13. *Peridinium lenticulatum* Fauré-Fremiet, Ann. sc. nat. zool. 9. sér. 1908, p. 217, fig. 4, tab. XV, fig. 5.

Occurred in single specimens in Danmarks Havn and in the coastal water. Rather common in the outer part of the pack-ice but common in the open sea outside it.

Distrib. Boreal oceanic species, widely distributed in the Atlantic and its tributaries.

10. **Peridinium curvipes** Ostenfeld, in Botany of the Faeroës 1906 p. 15, fig. 128. Paulsen Nord. Plankton p. 45, fig. 55.—? Broch, Spitzbergen Plankton p. 42, fig. 11—13.

The cells represented in the annexed fig. 6 are such as have been considered by me as *P. curvipes* although its form is broader

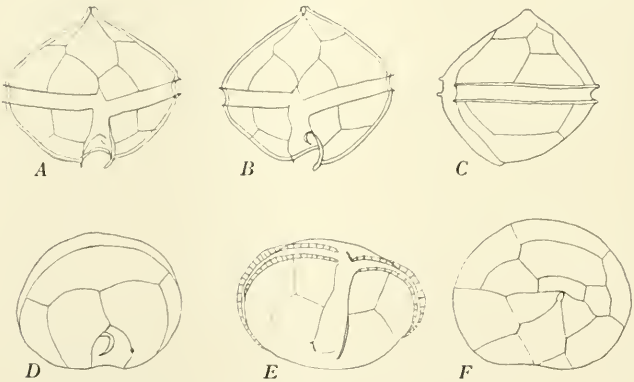

Fig. 6. *Peridinium curvipes.* 250 t. m.

and shorter than the original figure published by Ostenfeld. But those figured by Broch l. c. are different. Unfortunately Broch gives no figure of his species in ventral view (nor measures), but from his figures of epitheca and hypotheca it appears that the plates of his "*P. curvipes*" are arranged otherwise than in mine. Thus Broch has the rhombplate (1) oblique, δ small, and the plates 1, b, 2 and a touch each other in a point, 1 and f do not touch each other. My fig. 6 shows that the rhomb-plate is not oblique and that 1 and b, 1 and f meet along vertical lines. The intercalary δ is long as in *P. pellucidum* and *P. islandicum*. From this difference it follows that Broch and the present author have had different species before us. Which is the true *P. curvipes*? From

Ostenfeld's original figure (l. c.) we learn that the rhomb-plate is not oblique and that it apparently does touch nor b nor f. As to δ, Ostenfeld's figure gives no evidence. An attempt to find the original specimens was without result. But as the form of the rhomb-plate is the most conspicuous difference between Broch's and my specimens I venture to maintain that Broch has not had *P. curvipes* before him. He says his species is in habit very like *P. ovatum*, and this statement as well as his fig. 13 representing "*P. curvipes* (?) ... Ein Individuum ... mit ausserordentlich stark entwickelten Intercalarstreifen" call to mind *P. decipiens* Jørgensen, which, however, has no spines.

P. curvipes was found in many samples from the pack-ice, the coastal water, and Danmarks Havn, as a rule in few specimens only, but in larger quantities in samples collected in the pack-ice in August 1906.

Distrib. Arctic(?) neritic species, known from W.-Greenland, Iceland, the Faeroës, and the North Sea.

11. **Peridinium breve** Paulsen, Meddel. fra Kommis. for Havundersøg. Ser. Plankton, Bd. 1, No. 5. 1907, p. 13; Nord. Plankton p. 46, fig. 56; Broch, Spitzbergen Plankton p. 47, fig. 21. *P. Steinii* Jørgensen *f. brevis*, Paulsen, Meddel. Kom. Havund., Ser. Plankton Bd. 1, No. 3, 1905, p. 4, fig. 3 a—c, f.

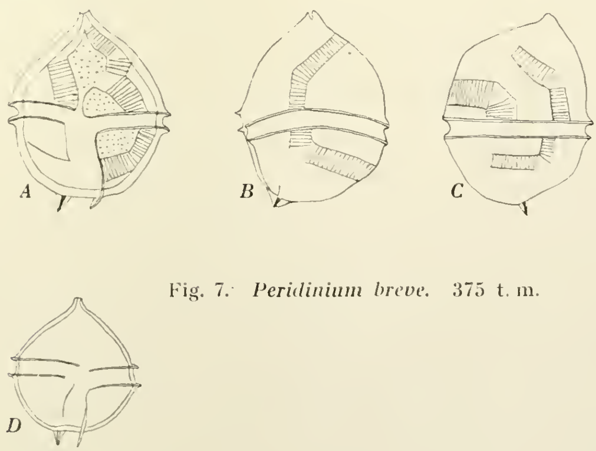

Fig. 7. *Peridinium breve.* 375 t. m.

Fig. 7 shows four cells of this species, which is indeed difficult to discern from its relatives *P. Steinii* Jørg., and *P. pyriforme* Pauls.

A—C has grown very old, thick and thick-walled, and the intercalary bands are very broad. Length 56 μ, surface finely reticulated. D is a small form, 40 μ long.

This species was found sparingly in few samples from the pack-ice and the coastal water.

Distrib. Arctic species, known from Spitzbergen and Iceland.

12. **Peridinium pyriforme** Paulsen, Meddel. fra Kommis. for Havundersøg. Ser. Plankton, Bd. 1, No. 5, 1907, p. 13, fig. 15; Nord. Plankton p. 46, fig. 57. *P. Steinii* Jørgensen *f. pyriformis* Paulsen, Meddel. Kom. Havund. Ser. Plankton Bd. 1, No. 3. 1905, p. 4, fig. 3 d—e.

Fig. 8 shows a species which was fairly common in some of the samples taken in August 1908 in the open water outside the pack-ice, and which I cannot refer to any other species than *P. pyriforme*. Length 42—52 μ. It differs from *P. breve* by the taller form, the irregular position of the intercalary δ, which in *P. breve* is regular (Broch l. c.) and in the very narrow rhomb-plate, but, as stated above, these two species are closely allied to each other.

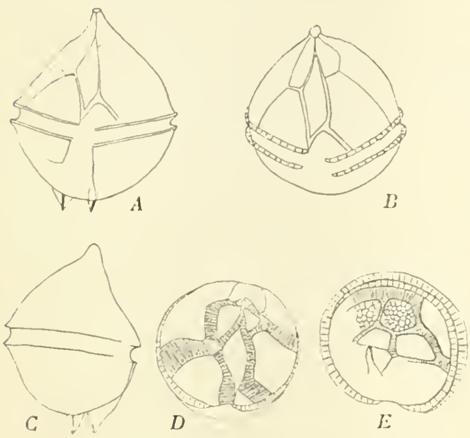

Fig. 8. *Peridinium pyriforme*. 375 t. m.

On the other hand, our species is nearly related to *P. Steinii* Jørgensen. As to the arrangement of the plates (see fig. 8 D, E) they are nearly identical, so the precingular a is small, the rhomb-plate narrow, and the intercalary δ has an oblique position (Kofoid in Arch. f. Protistenk. 1909, Taf. 2; Broch, Spitzbergen Plankton p. 49, Broch in Arch. f. Protistenk. 1910, fig. 4). Our species differs from *P. Steinii* in its much thicker and shorter form and in the thecal wall being reticulate and not porulate as in *P. Steinii*. Broch says (Spitzb. Pl., p. 49): "ein näheres Studium von *Peridinium pyriforme* wird möglicherweise zeigen, dass die Individuen dieser Art nur kräftig entwickelte Exemplare von *Peridinium Steini* sind." On the other hand, Kofoid (l. c. p. 39) declares *P. pyriforme* not to be identical with *P. Steinii*.

Anyhow, it seems to me to be the best to keep the two species distinct at any rate provisionally until further evidences may come to hand.

Distrib. Boreal oceanic species, known from the northern Atlantic and its tributaries.

13. **Peridinium pallidum** Ostenfeld, in Knudsen & Ostenfeld: Iagttag. over Overfladevandets Temperatur, Saltholdighed og Plankton paa islandske og grønlandske Skibsrouter i 1898 (1899), p. 60. Paulsen, Nord. Plankton p. 48, fig. 60. Broch, Spitzbergen Plankton p. 45, fig. 17.

Fig. 9 shows an exceptionally low cell (length 56 μ without spines) with broad intercalary bands. The relation between 1 and

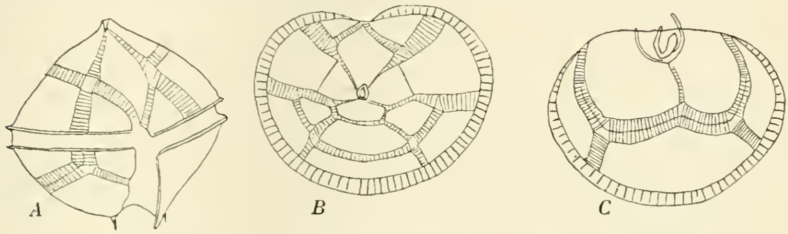

Fig. 9. *Peridinium pallidum.* 375 t. m.

f is not as shown in Broch's figure. Found in few specimens but in many samples from the pack-ice, the coastal water, and Danmarks Havn. Common in the open sea outside the ice.

Distrib. Oceanic, boreal species, widely distributed in the northern Atlantic and its tributaries.

14. **Peridinium pellucidum** (Bergh) Schütt, Die Perid. der Plankton-Exp., tab. XIV, fig. 45; Paulsen, Nord. Plankton p. 49, fig. 61; Broch, Spitzbergen Plankton, p. 44, fig. 15, 16. — *Protoperidinium pellucidum* Bergh, Morphol. Jahrb. 1881, p. 227, fig. 46—48.

All the cells seen belong to the *forma spinosa* Broch (l. c) the antapical spines being without fins. Only a single cell with fins was seen (from Danmarks Havn). In fig. 10 two specimens are drawn. A and B represent a very young cell (length 36 μ) having thin walls, and the sutures are not conspicuous without chemical treatment. D—E are showing another cell (length 40 μ) thickwalled and with broad intercalary bands. The cell represented in fig. 11 has a length of 60 μ, and the intercalary striae are very broad. Such big and thick specimens were common in some of the samples, and I refer them to *P. pellucidum* because of the girdle being not oblique as in *P. pallidum.* — Other length-

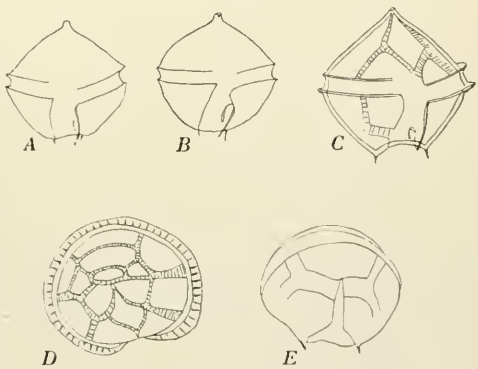

Fig. 10. *Peridinium pellucidum.* 375 t. m.

measures of this species: 38, 45, 48, 52, 56, 66 μ. *P. pellucidum* was the commonest Dinoflagellate in the samples, it occurred in Dan-

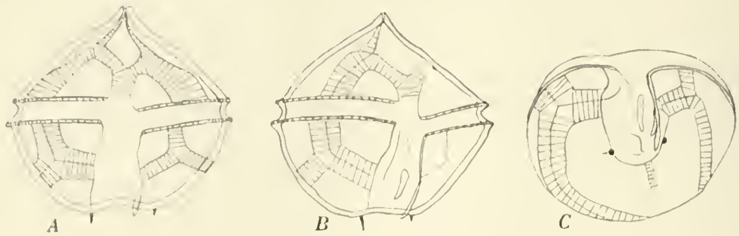

Fig. 11. *Peridinium pellucidum.* 375 t. m.

marks Havn, the coastal water, the pack-ice and in the open sea, and often frequently.

Distrib. Widely distributed neritic species, occurring from the Mediterranean to Spitzbergen and Greenland.

15. **Peridinium islandicum** Paulsen, Meddel. fra Kommis. f. Havundersog., Ser. Plankton, Bd. I, No. 1, 1904, p. 23, fig. 7; Paulsen Nord. Plankton, p. 49—50, fig. 62; Broch, Spitzbergen Plankton, p. 46, fig. 18—20.

The cells were rather flat, es they have been figured by Broch. A single specimen measured was 44 μ long. Icelandic specimens are 53—62 μ (Nord. Plankton.) The species was fairly common in Danmarks Havn, the coastal water, and the pack-ice, but in the open sea it was found once only.

Distrib. Arctic neritic species, known from North Iceland, Spitzbergen and Greenland.

16. **Peridinium varicans** n. sp. (fig. 12).

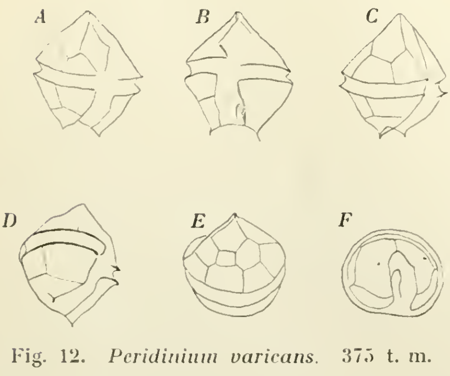

Fig. 12. *Peridinium varicans.* 375 t. m.

Cellula globoso-rhomboidea, epitheca acuta, hypotheca spinas duas divergentes (varicantes) a fissura longitudinali remotas gerente et inter spinas linea paulum et regulariter curvata terminante, cingulo transverso dextrorsum circumiente, fossa longitudinali lata ad marginem sinistram ala augusta praedita. Epitheca tabulis 14, intercalari δ parvo, hypotheca tabulis 7 constructa. Long. cell. 36 μ. Hab. rarissime in mare gelido prope oram orientatem Groenlandiae.

This species which was found in two samples from the coastal water and the interior part of the pack-ice (July 31th and Aug. 15th 1906) is characterized by the following features: The cell is in ventral wiew rhombic, the epitheca is pointed (*acutus*) but not tapering (*acuminatus*), the hypotheca ends in two diverging fin-less spines which are distant from the longitudinal furrow. The girdle forms a descending screw to the right. Of the plates of the epitheca, δ is small and almost quadratic whereas γ and ε are bigger and many-sided.

17. **Peridinium brevipes** Paulsen, Nord. Plankton, p. 108, fig. 151 (without description); Broch, Spitzbergen Plankton p. 48, fig. 22.

In 1908 I published the name and an outline-figure of this species which I had seen at Iceland. Broch in his paper on Spitzbergen Plankton gives detailed figures of the species, and these agree well with the annexed fig. 13. Length 36 μ (different cells measured). The form of the body and the arrangement of the plates are seen in the drawings. As to the plates, δ is small and quadratic, the rhomb-plate being broad and oblique does not touch f but touches b along a vertical line. The two small spines at the lower end of the cell may be wanting. I have seen only specimens with broad intercalary bands, but Broch has them broader yet. After his theory we have then old cells before us, but if this is the case it seems to me that they cannot be "Jugendstadium" of *P. breve*, what Broch presumes. The adult cells are much smaller than *P. breve*, and also in form they seem to differ from *P. breve*.

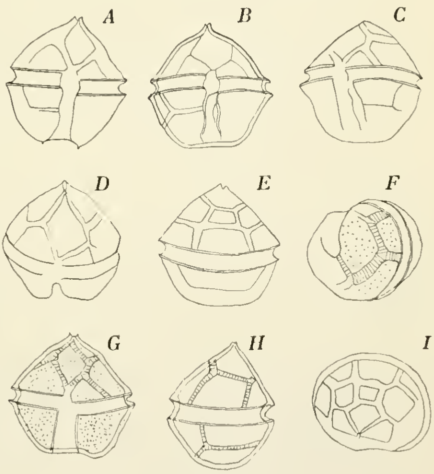

Fig. 13. *Peridinium brevipes.* 375 t. m.

P. brevipes was not common in the samples, but it is very likely that this small organism passes through the net-meshes. It was found in several samples from Danmarks Havn but in few from the coastal water, the pack-ice and the open sea.

Distrib. Arctic neritic species, known from Iceland and Spitzbergen.

18. **Peridinium depressum** Bailey, in Smithsonian contrib. to knowledge VII, 1855, p. 12, fig. 33—34; Paulsen, Nord. Plankton p. 53, fig. 67; Broch, Spitzbergen Plankton p. 51, fig. 26.

In all the specimens seen by me the antapical horns were long and hollow, so that, strange to tell, the arctic species *P. parallelum* Broch was not found in the present material.

P. depressum was found in single specimens only in the neighbourhood of the coast, repeatedly but rarely in the pack-ice and in the open sea.

Distrib. Boreal oceanic species, widely distributed.

19. **Peridinium oceanicum** Vanhöffen, in Grönl.-Exp. d. Gesellsch. für Erdk. zu Berlin II, 1897, tab. V, fig. 2; Paulsen, Nord. Plankton, p. 54, fig. 69.

var. typicum Broch, Nyt Magaz. f. Naturvid. Christiania, 44, 1906. fig. 3.

Found as a single cell in the open sea outside the ice.

Distrib. Oceanic boreal species.

20. **Peridinium conicoides** Paulsen, Meddel. fra Kommis. f. Havundersøg. Ser. Plankton, Bd. I, Nr. 3, 1905, p. 3, fig. 2; Nord. Plankton, p. 58, fig. 75; Broch, Spitzbergen Plankton, p. 53.

Not rare in several samples from the coastal water and the pack-ice in 1908.

Distrib. Arctic neritic species, known from Iceland, Spitzbergen and Greenland.

21. **Peridinium** sp.

A small species (length 20 μ) represented in fig. 14 was found in three samples from Danmarks Havn in 1907. I suppose it is a young stage of the preceeding species. In favour of this conception speeks: the whole form of the body, with convex outlines, the small hollow protuberances distant from each other, the orbicular girdle and the characteristic curvature of the longitudinal furrow's left margin. On the other hand, the number and arrangement of the plates do not permit to unite the two species at once. There is only one intercalary plate, as illustrated in fig. E, at least I have not been able to find any sutures to separate between γ, δ and ε.

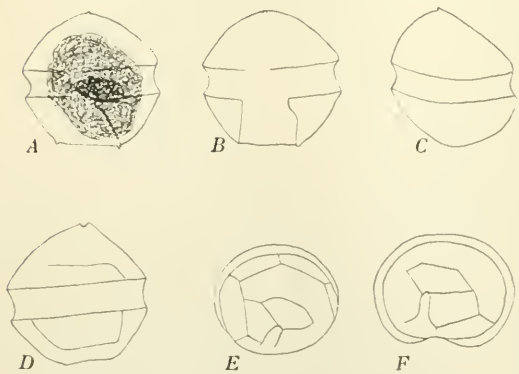

Fig. 14. *Peridinium* sp. 750 t. m.

22. **Peridinium subinerme** Paulsen, Plankton invest. Iceland

1903, p. 24, fig. 10; Nord. Plankton, p. 60, fig. 78; Broch, Spitzbergen Plankton, p. 54, fig. 28.

One of the commonest species in the samples from the pack-ice in 1906. More rarely it occurred in Danmarks Havn, the coastal water (in 1909) and in the open sea.

Distrib. Oceanic (?) arctic or boreal species, known from Iceland Greenland, Spitzbergen and (in spring) from the North Sea.

23. **Peridinium catenatum** Levander, Acta soc. pro fauna et flora fennica, IX, 1894; Paulsen, Nord. Plankton, p. 63, fig. 84.

This species, represented in fig. 15, was found rarely but in several samples from Danmarks Havn, the coastal water, and the pack-ice.

Distrib. Neritic species, known from the inner part of the Baltic, Limfjorden (Denmark), and West-Greenland.

Fig. 15. *Peridinium catenatum.* 375 t. m.

24. **Peridinium minusculum** Pavillard, Flore pélagique de l'étang de Thau, Montpellier 1905, p. 57, tab. III, fig. 7—9 (I have seen Pavillards specimens); Lemmermann, Arch. f. Hydrobiol. u. Planktonkunde, V, 1910, p. 336; *Glenodinium bipes* Paulsen, Plankton invest. Iceland 1903 (1904), p. 21, fig. 3—4; Nord. Plankton, p. 25, fig. 31.

Lemmermann (l. c.) in pointing out that *Glenodinium trochoideum* is a *Peridinium* says in a footnote that also *G. bipes* is a *Peridinium* and that it is to be named *P. minusculum (P. bipes* it cannot be named because another species, of Stein, bears that name.) It is very likely that the species is a *Peridinium*. I have seen that it has two antapicals.

P. minusculum was found, always in single specimens, in several samples from Danmarks Havn, the coast water, and the pack-ice. Without doubt most of the cells pass through the net-meshes.

Distrib. Neritic species, known from the Mediterranean, the North Sea, the Baltic, Iceland, and Greenland.

Ceratium Schrank.

25. **Ceratium arcticum** (Ehrenberg) Cleve, The seasonal distrib. of atl. Plankton-org., Gøteborg 1900, p. 207. Paulsen, Nord. Plankton, p. 86, fig. 118; E. Jørgensen, Die Ceratien, Leipzig 1911, p. 85, fig. 181. *Peridinium arcticum* Ehrenberg, Bericht üb. Verhandl. d. Berliner Akad. d. Wiss. 1853, p. 528.

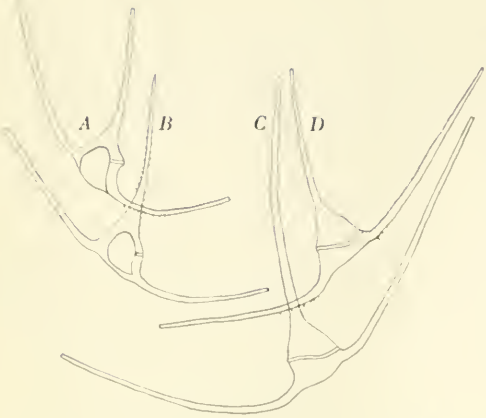

Fig. 16. *Ceratium arcticum*, different cells. 94 t. m.

This species of which fig. 16 gives some outline-figures, was very common in Aug. 1908 in the sea outside the ice. In the pack-ice and the coastal water in 1908 it was scarce though found in several samples. In Danmarks Havn and in the pack-ice and the coastal water in 1906—07 it was rare and occurred always as dead specimens.

Distrib. Arctic oceanic species.

Apodinium Chatton.

26. **Apodinium (?) Chaetoceratis** n. sp.

Cellulae globosae nucleiferae membrana cellulosoidea tectae, ad setas Chaetoceratis borealis appendicula adharentes et membranam ejus perforantes: parasitus igitur plasma hospitis exhauriens. Divisionibus cellulae binae et quaternae nascuntur. Long. cell. ca. 13—25 μ. Hab. in mare gelido ad oram orientalem Groenlandiae.

Dr. Ostenfeld who has worked out the Diatoms and Flagellates of the present samples before I got them for investigation, called my attention to this organism which he had examined believing it was a Diatom. But as the wall gave cellulose-reaction with chloriodide of zinc and as it was without silicium he saw it would be nearer a Dinoflagellate than a Diatom, and he gave me his drawings and notes.

Once only I have found a cell of *Apodinium Chaetoceratis* upon an awn of *Chaetoceras decipiens*, all other specimens seen were fixed on the awns of *Ch. boreale*. Whether this is because the awns of *Ch. boreale* are set with fine hairs I cannot tell with certainty. I have never seen the cells spit upon the hairs or otherwise fixed to them. But it seems likely that awns set with setae afford better chance for fastening than smooth ones. How the cell is fixed to the awn is difficult to discern. Fig. 17, C and D show a little process by aid of which the cell is fixed. In other cases it seems that there are two processes. Fig. F shows a cell made pellucid by aid of Eau de Javelle, and on both sides of the awn is seen a thickening not belonging to the awn but to the *Apodinium*. Fig. I (drawed by Ostenfeld) shows two cells in a mucilage which is fixed to the awn, such a thing I have not seen, and perhaps it does not belong to *Apodinium*.

The wall of the awn is perforated. In fig. G the perforation is distinctly seen. Through this hole the contents of the *Chaetoceras*-

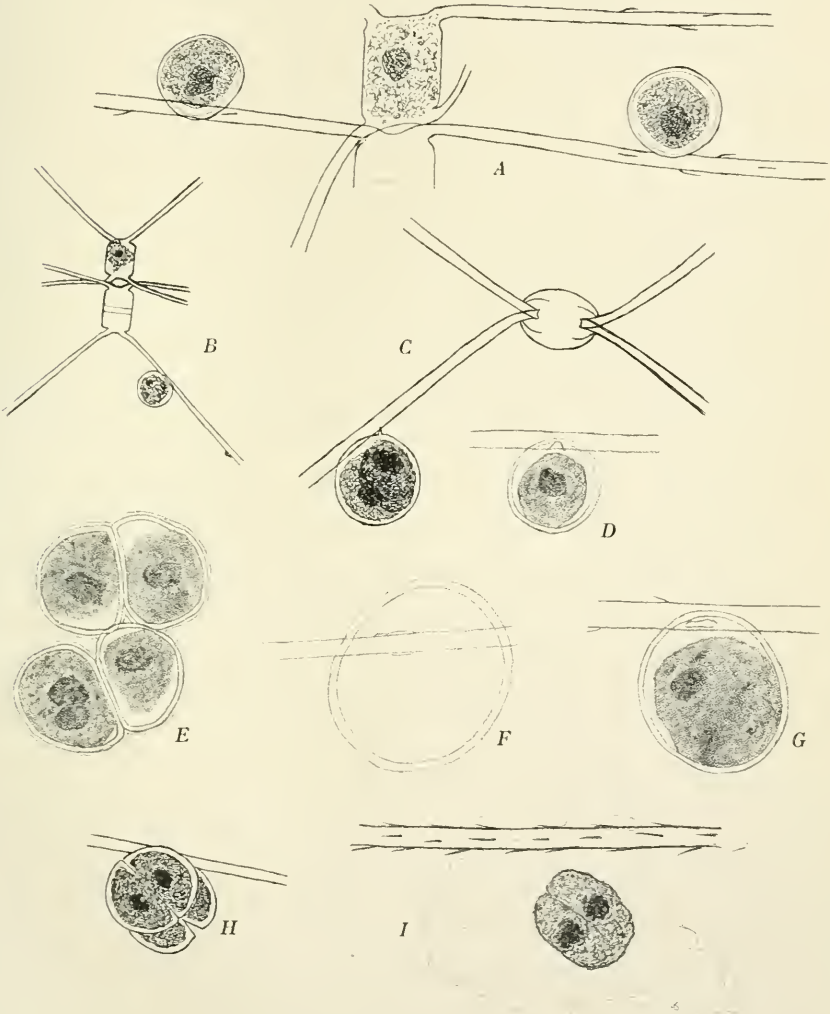

Fig. 17. *Apodinium* (?) *Chaetoceratis*. (See the text) A, C, D 375 t. m. B 125 t. m. E, F, G 750 t. m. H, I 500 t. m. (Fig. B, C, H, I were drawn by Dr. Ostenfeld.)

cell must be sucked out, — and all the *Chaetoceras*-cells seen bearing an *Apodinium* were empty, see fig. A, B, C.

The contents of the *Apodinium*-cell consists of a granular plasma and a rather big nucleus which often is seen to have been divided (fig. C, E). The divisions must follow speedily after each other, as two or four cells are often seen to be together and again dividing. The cell-wall is rather thick, in some cases I have been able to see a three-fold outline (fig. E); the outmost layer is very thin and inconspicuous, by treatment with chloriodide of zinc it disappears but not with Eau de Janelle (a mucilage?) The wall itself is coloured brownish violet by chloriodide of zinc. In spite of eager research it has not been possible to find other stages of this organism than those here mentioned and figured.

The systematic position of this species, imperfectly known as it is, must of course be uncertain. I refer it with some doubt to the genus *Apodinium* Chatton (Comptes rendus Ac. sc. Paris 144. 1907, p. 283, with figures. Se also: ibid. 143, Chatton: Les Blastodinides, ordre nouveau des Dinoflagellés parasites.) The other Blastodinidae described and figured by Chatton are far from being like our species, but *Apodinium mycetoides*, a parasite upon *Appendicularia*, shows some features which call to mind *A. Chaetoceratis*. *A. mycetoides* is fixed upon the host by a long stalk. Growing up and dividing it has at first some resemblance to our species, being two-celled and of about the same form, but it is only partly filled by plasma, a great "lacune aqueuse" taking most of the room in the two cells. Later on the distal cell ("blastocyte") divides again forming many spores which again divide, and so a lot of small *Gymnodinium*-like spores are formed. The proximal blastocyte after a rest divides, and the new distal cell forms a new generation of spores, as described above.

Of all this I have found no trace by *Apodinium(?) Chaetoceratis*. As a whole this species may be called rather dubious.

14–3–1911.

6

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 11
SÆRTRYK AF »MEDDELELSER OM GRØNLAND« XLIII

MARINE PLANKTON

FROM

THE EAST-GREENLAND SEA

(W. OF 6° W. LONG. AND N. OF 73°30′ N. LAT.)

COLLECTED DURING THE "DANMARK EXPEDITION" 1906—1908

IV. GENERAL REMARKS ON THE MICROPLANKTON

BY

C. H. OSTENFELD AND OVE PAULSEN

KØBENHAVN
BIANCO LUNOS BOGTRYKKERI
1911

Introduction.

As remarked in the introduction to the foregoing lists of the organisms of the microplankton (see list of literature p. 336), only the plankton from the region west of 6° W. L. and north of 73° 30′ N. L. has been worked up by us. The series of samples from this region, the principal contents of which are shown in the accompanying Tables (I—III), can be most conveniently considered under three divisions, namely:

I. Samples from Danmarks Havn (76°46′ N. L., 18° 43′ W. L.).
IIa. Samples collected during the passage of the ship through the ice on the outward journey.
IIb. Samples collected during the passage of the ship through the ice on the return journey.

In the following the samples from Danmarks Havn will be dealt with separately and the remaining samples together. With regard to the grouping of the latter into two divisions, reference may be made to our previous papers. Here all the species found are also named as well as details about the places where they were found.

The first information regarding the plankton of these waters came from the Danish Expedition to Scoresby Sound (1891—92). In a large paper on the marine diatoms published in 1895, E. Østrup also dealt with a number of plankton samples from the ice-filled sea, but did not deal with the plankton associations as such. The Swedish Expedition to East Greenland in 1899 collected a quantity of plankton which was investigated by P. T. Cleve (1900). His report contains tables and short remarks on the commoner species. Of special interest to us here are the samples collected in the drift-ice in July between 70° 30′ N. L. and 74° 29′ N. L., and the samples from the fjords of North-East Greenland, 71°—73° N. L., collected in August.

The drift-ice samples are specially characterized by such organisms as *Chaetoceras decipiens*, *C. furcellatum* and *C. sociale*, *Coscinodiscus oculus iridis* (= *subbuliens*), *Fragilaria oceanica*, *Thalassiosira gravida* — all of which are regarded by Cleve as arctic forms — and thus show a good agreement with the samples dealt with here.

The fjord samples are all very poor; the most prominent species are *Chaetoceras decipiens*, *Dinobryon pellucidum* (only in some samples), *Calanus finmarchicus*, whilst *Ceratium arcticum*, *Cyttarocylis gigantea* and *Oithona similis* occurred in quantity in a few samples.

Lastly, from the Duke of Orleans' Expedition of 1905 we have an interesting work by D. Damas and E. Koefoed, which in the introduction speaks of the rich phytoplankton found in July—August in the drift-ice and in the coastal waters of East Greenland, in contrast to the small quantities found in the open Greenland Sea, but otherwise does not deal with the microplankton. The phytoplankton was determined by H. Broch, who has arranged it in tabular form without text.

According to Broch's tables the most prominent species in the phytoplankton are *Ampiprora hyperborea*, *Bacterosira fragilis*, *Chaetoceras atlanticum*, *C. boreale*, *C. criophilum*, *C. decipiens*, *C. furcellatum*, *C. Wighami*, *Fragilaria oceanica*, *Navicula Vanhöffenii*, *Nitzschia delicatissima*, *Thalassiosira gravida*, *T. hyalina*, *T. Nordenskiöldii*, *Phaeocystis Pouchetii*. Specially prominent are *Fragilaria oceanica* and *Thalassiosira gravida*. *Chaetoceras criophilum* was predominant in a single sample from the open sea, whilst *Ceratium arcticum*, just as in the other samples, was rare. These samples show good agreement on the whole with ours, except that *Thalassiosira gravida* and *Chaet. criophilum* play a much smaller role in our samples.[1]

I. Plankton from Danmarks Havn. (Table I).

It has several times been emphasized in our previous papers, that the collecting of plankton in Danmarks Havn, where the Expedition was stationed for ca. 22 months (1906—1908), has unfortunately been very incomplete. A series of samples collected at regular intervals could have given an excellent picture of the development of the plankton throughout the year, but from the few samples collected occasionally which we have, we obtain only an imper-

[1] Unfortunately there is not always agreement between Broch's tables and the published „Journal des stations" of the Expedition. Thus for Station 44 the table has a haul of 390—300 m. with a rich diatom plankton, which seems peculiar at this great depth. In the Journal this haul is not mentioned, but a corresponding one of 300—0 m. with almost the same organisms. Other differences also occur.

fect impression of the annual cycle of plankton. The following samples were collected: 4 in October 1905, 2 in June, 4 in August and 2 in September 1907, and one sample on July 21st 1908, when the Expedition left the station.

Table I gives the principal species and their occurrence in the samples; the rarer species have been omitted (with regard to them, see the systematic lists in our previous papers).

The samples from the beginning of October 1905, which were all taken in holes in the ice from water with a temperature of ca. — 1·7° C.,[1] contain very few organisms. They are the last remnants of the summer plankton, mostly dead shells of diatoms, *Ceratium arcticum* and *Cyttarocylis denticulata,* as also a few living *Chaetoceras boreale, Ch. decipiens, Rhizosolenia styliformis* and Peridinians, with some *Oithona* and Nauplii. Lastly, it was interesting to find that *Coscinodiscus Joergensenii* was in process of forming auxospores at this time of year, though in very few individuals.

The two spring samples from June 1907 were also from holes in the ice (water temperature ca. — 1·7° C.) and contained even fewer organisms. It was only in the last of the two samples that any fair quantity of *Melosira hyperborea* was taken, its chains in process of active division, as also some *Oithona* and Nauplii.

The August samples (the first was taken on July 30th) contain a rich diatom plankton. The principal species are *Chaetoceras sociale* and *Fragilaria oceanica*, in the later also *Chaetoceras diadema, Ch. Wighami* and *Coscinodiscus subbuliens*, as well as *Cyttarocylis denticulata* and in smaller numbers *Nitzschia seriata, Thalassiosira gravida, Peridinium pellucidum* and *P. islandicum,* further *Ptychocylis obtusa* and *Tintinnus vitreus.*

The September samples show almost the same plankton, yet are somewhat poorer for most species; only *Peridinium pellucidum, P. islandicum, Synchaeta sp., Oithona*, as also *Cyttarocylis denticulata typica* and *gigantea* are more frequent, and *Gonyaulax triacantha* is added.

Among the diatoms in September resting-spore formation is found in *Chaet. sociale, Ch. diadema, Thalassiosira gravida,* and also in *Fragilaria oceanica,* the resting-spores of which, however, already occurred in August, though less frequently. The rare *Ch. gracile* had resting spores in August. In *Coscinodiscus subbuliens* auxospores were present, but in small quantity, in August and September.

The salinity of the water was highest in June (32·3‰) and de-

[1] The hydrographical data (surface temperature and salinity) have been kindly placed at our disposal by the Captain of the "Danmark", First-Lieutenant H. Trolle, to whom we wish here to express our thanks.

Table I. Danmarks Havn. 1906—1907.

Date	2. X	4. X	5. X	5. X	3. VI	15. VI	30. VII	4. VIII	15. VIII	24. VIII	5. IX	10. IX
Time W. Latitude N. Longitude	Opening in the ice, harbour	Ice-edge at harbour-point	Opening in the ice, at harbour-mouth	Opening in the ice, the fjord	Opening in the ice	Chink in the ice, the fjord	Surface-haul harbour	Surface-haul harbour	11.30 a. Western harbour-point	1.30 p. Western harbour-point	Between harbour-point and Koldewey	Mouth of harbour
Temperature of water	ca. ÷ 1·7				ca. ÷ 1·7		4·5	3·6	÷ 0·4	÷ 0·8	0·0	
Salinity of water	30·8				32·3		0·6	1·8	27·1	27·1	15·4	28·0
No. of sample	88	89	90	91	26 (27)	134 (135)	402	403	404	405 (406)	408	409
Bacillariaceae												
Amphiprora hyperborea	...		...	..	...	rr	...	...	rr	rr	...	...
Chaetoceras atlanticum	...	...	...	...	...	...	...		rr	rr	..	r
— boreale	rr[1]	r[1]	r[1]	...	...	...	...	...	rr	rr	rr	rr
— convolutum	...	...	...	...	...	...	...	...	rr	rr	...	rr
— decipiens	rr[1]	+[1]	r[1]	rr	...	rr[1]	...	rr	r	.	rr	r
— diadema	...	...	...	...	...	...	...	...	+	+	+ (c. sp. rr)	+ (c. sp. rr)
— furcellatum	...	...	...	...	...	...	...	...	.	...	...	...
— sociale	...	...	...	...	...	...	cc[1]	cc	cc	cc (c. sp. +)	rr (sp.)	+ (c. sp. rr)
— Wighami	...	...	...	...	...	...	...	...	+	r	...	rr
Coscinodiscus subbuliens	...	...	rr	rr	rr	...	rr[1]	rr	cc	c	c	c
Fragilaria oceanica	rr	rr	...	...	...	...	+[1] (c. sp. rr)	+ (c. sp. rr)	cc (c. sp. c)	c (sp.)	r (sp.)	rr (sp.)
Melosira hyperborea	rr[1]	rr[1]	...	rr[1]	...	+	rr[1]	...	...	rr[1]	...	
Navicula septentrionalis	...	...	...	...	...	rr	...	...	...	...	...	
Nitzschia seriata	...	...	...	...	...	...	...	r	+	r	...	
Rhizosolenia hebetata f. semispina	...	...	...	...	...	...	...	...	...	...	...	...
— obtusa	...	...	...	...	...	...	...	...	...	...	...	.
— styliformis	rr	rr	rr	rr[1]	...	...	...	...	...	rr	...	rr
Thalassiosira bioculata	...	...	...	...	...	...	...	...	...	rr	...	rr
— gravida	...	...	...	...	...	...	rr[1]	rr	r	rr	rr	rr (c. sp. rr)
— Nordenskiöldii	...	...	...	...	...	...	...	..	rr	rr	...	rr
Flagellata												
Dinobryon pellucidum									rr			

Pontosphaera borealis	...	...	...	...	...	...	...	...	...	...	...	...
Tintinnodea												
Cyttarocylis denticulata, typica	rr[1]	r[1]	r[1]	+[1]	...	rr[1]	...	...	+	+	+	c
— — gigantea	...	...	...	...	...	...	...	...	...	...	+	+
— — robusta	...	...	...	...	...	...	...	...	...	...	...	r
Ptychocylis obtusa	...	rr[1]	rr[1]	...	...	...	...	...	r	+	r	r
Tintinnus norvegicus, gracilis	...	...	...	...	...	...	...	...	...	...	...	...
Peridiniales												
Apodinium (?) Chaetoceratis	...	...	...	...	...	...	...	...	...	...	...	...
Ceratium arcticum	r[1]	r[1]	rr[1]	rr[1]	...	...	...	...	...	...	...	rr
Dinophysis arctica	...	...	...	rr	...	...	...	...	...	...	...	...
— rotundata	rr	...	...	...	...	...	...	...	...	...	...	...
Goniodoma Ostenfeldii	...	...	...	...	...	...	...	...	...	rr	...	...
Gonyaulax triacantha	...	...	...	...	...	...	...	...	...	...	+	rr
— sp.	...	...	rr	...	...	...	...	...	...	...	...	...
Peridinium breve	...	...	...	rr	...	...	...	...	...	...	...	...
— brevipes	...	...	rr	...	...	...	...	...	...	rr	r	rr
— catenatum	...	...	...	...	...	...	...	...	rr	...	rr	rr
— conicoides	...	...	...	...	...	...	...	...	...	...	...	...
— curvipes	...	rr	...	...	...	...	...	...	...	...	...	...
— depressum	...	rr	...	...	...	...	...	...	...	...	...	...
— islandicum	...	rr	...	rr	...	...	...	rr	r	r	+	...
— minutum	r	...	...	...	...	...	...	rr	rr	rr	rr	...
— ovatum	...	...	...	...	...	...	...	...	...	...	...	rr
— pallidum	rr	...	...	...	...	...	...	...	...	...	rr	...
— pellucidum	...	...	rr	...	...	...	...	rr	r	r	+	r
— pyriforme	...	...	...	...	...	...	...	...	...	...	...	...
— roseum	...	...	...	...	...	...	...	...	...	rr	rr	r
— subinerme	...	...	...	rr	...	...	...	...	rr	...	...	...
Metazoa												
Calanus finmarchicus	...	rr	...	...	...	...	...	...	...	...	...	r
Oithona similis et Nauplii	r	r	r	r	rr	+	...	...	r	rr	cc	cc

[1] Mostly dead specimens.

Table II. 1906.

Date	31. VII	1. VIII	2. VIII	2. VIII	3. VIII	5. VIII	7. VIII	13. VIII	15. VIII	15. VIII	16. VIII
Time	9·30 p.	12·30 p.	4·30 a.	2 p.	1·30 p.	12 n.	12·30 a.	3 a.	1 a.	5·30 a	2·30 p.
N. Latitude	75·26	75·35	75·19	75·38	75·58	75·58	75·48	76·20	77·16	77·25	77·0
W. Longitude	6·10	8·15	10·35	11·05	10·15	11·31	12·52	18·20	18·30	18·25	18·09
Temperature of water	1·9	1·0	÷ 0·7	÷ 0·4	÷ 0·4	÷ 1·2	÷ 0·7	0·5	÷ 0·5	0·4	0·5
Salinity of water	32·8	31·9	31·2	31·3	31·9	31·8	31·2	—	30·6	—	—
No. of sample	12	13	14	15	16	17	18	19	21	22	23
Bacillariaceae											
Amphiprora hyperborea	...	...	...	rr	...	.	...	...	...	..	
Chaetoceras atlanticum	...	rr	...	...	...	..	rr	...	r	...	rr
— boreale	...	...	...	...	..	...	+	c	c	c	c
— convolutum	c	+	+	c	c	rr	...	...	...		rr
— decipiens	rr	rr	r	+	r	...	c	c	cc	c	cc
— diadema	...	...	...	rr	...	...	...	...	...		..
— furcellatum	...	...	...	...	...	...	...	...	...	..	...
— sociale	...	...	...	...	...	...	...	...	...	...	..
— Wighami	...	...	...	...	...	...	...	...	...	...	...
Coscinodiscus subbuliens	...	...	...	...	...	rr[1]	...	c	+	+	r
Fragilaria oceanica	...	...	...	rr[1]	rr[1]	...	..	...	...	...	
Melosira hyperborea	...	...	...	rr (sp.)	...	c (c, sp. +)	rr (sp.)	rr	...	..	rr
Navicula septentrionalis	...	...	...	...	...	...	...	...		...	...
Nitzchia seriata	...	...	...	...	...	...	...	...	...	...	...
Rhizosolenia hebetata f. semispina	c	+	+	cc	cc	rr	...	...	...	...	...
— obtusa	r	c	+	c	c	rr	...	...	..	...	...
— styliformis	...	...	...	...	...	rr	r	r	+	r	rr
Thalassiosira bioculata	...	...	...	...	...	rr	rr	...	r	...	rr
— gravida	...	...	rr	rr	...	...	...	...	...	...	...
— Nordenskiöldii	...	...	rr	...	...	...	...	...	..	..	
Flagellata											

Pontosphaera borealis	rr	r	rr	rr	rr	...	...	...	...	...	...
Tintinnodea											
Cyttarocylis denticulata, typica	cc	cc	c	c	c	rr[1]	...	...	...	...	...
— — gigantea	...	...	...	...	...	...	...	...	...	...	...
— — robusta	c	cc	c	c	c	c[1]	+[1]	r[1]	...	rr[1]	...
Ptychocylis obtusa	...	...	...	...	...	...	...	...	...	...	...
Tintinnus norvegicus, gracilis	rr	...	...	r	...	+	...	...	...	...	...
Peridiniales											
Apodinium (?) Chaetoceratis	...			...	...	...	...	rr	rr	rr	rr
Ceratium arcticum	rr[1]	rr[1]	rr[1]	rr[1]		rr	rr[1]	rr[1]	rr	rr[1]	rr[1]
Dinophysis arctica	rr	rr	...	rr	rr	...	rr	rr[1]	...	rr	rr[1]
— rotundata	rr	...	rr	rr	rr	rr	rr	...	...	...	...
Goniodoma Ostenfeldii	...	...	...	...	...	...	...	...	...	...	...
Gonyaulax triacantha	...	...	rr[1]	...	...	...	...	...	...	...	...
— sp.	...	r	...	rr	...	rr	...	...	...	rr	rr
Peridinium breve	...	...	...	...	...	...	...	...	...	...	...
— brevipes	...	...	...	...	...	...	...	...	...	...	...
— catenatum	...	...	...	...	...	...	...	...	...	rr	rr
— conicoides	...	...	...	...	...	...	...	...	...	...	...
— curvipes	+	rr	c	+	+	r	...	...	...	...	...
— depressum	...	...	...	...	...	...	...	...	...	...	...
— islandicum	rr	...	+	r	...	...	...	rr[1]	...	...	...
— minutum	...	...	...	...	...	rr	...	...	...	rr	...
— ovatum	...	...	...	...	...	...	...	...	...	...	...
— pallidum	...	...	...	...	r	...	...	...	rr	...	...
— pellucidum	r	+	+	+	r	r	...	rr	...	...	rr
— pyriforme	...	...	...	...	...	...	...	...	...	...	...
— roseum	r	rr	...	r	+	rr	...	...	...	...	...
— subinerme	rr	+	c	c	c	r	...	...	...	...	...
Metazoa											
Calanus finmarchicus	...			...	...	c	r	...	+	c	...
Oithona similis et Nauplii	+	...		rr	r	+	+		+	+	...

[1] Mostly dead specimens.

creased greatly in the course of the summer owing to the inflow of fresh water from the melting snow of the land, so that on the surface it was brought down to 0·6—1·8‰ at the end of July, at the same time that the temperature rose to 3·6°—4·5° C., the effect of which was that the marine organisms were for a great part killed, and only the resting-spores of diatoms were living. The samples from this period really contained in the main freshwater organisms, which had been carried out by the freshwater from land, for example, *Coelastrum microporum*, *Gomphosphaeria lacustris*, *Anabaena sp.*, *Spirotaenia sp.*, *Staurastrum sp.*, *Hyalotheca sp.*, and many freshwater diatoms. In August—September the salinity again rose and the temperature sank (ca. 27—28‰ and ca. 0°), and at the same time the freshwater forms disappeared and marine species ruled again. The samples from October 1906 permit us to conclude, that the salinity continues to rise, most probably owing to the formation of ice, and the temperature to fall, just as they presumably show the demise of the plankton (see above).

The planton of Danmarks Havn is thus an arctic coast-plankton with a flowering period of short duration in late summer. It is somewhat poor in species and consists mainly of neritic diatoms, which have a wide distribution in northern seas, also outside the arctic region. Truly arctic are probably only the following species, none of which were very abundant in the samples: *Bacterosira fragilis*, *Eucampia groenlandica*, *Chaetoceras gracile*, *Biddulphia arctica*, *Navicula septentrionalis*, *N. Vanhöffenii*, *Peridinium islandicum*, *P. brevipes*, *P. catenatum*, *Gonyaulax triacantha*, *Tintinnopsis karajacensis*, *T. pellucida* and *Tintinnus vitreus*.

II. Plankton of the drift-ice and coastal waters.

a. August 1906. (Table II).

The samples (11) belonging here were collected during the period from July 31st to August 16th in the ice-filled waters; they fall naturally into two groups:

The outermost group (5 samples) are from water with a temperature of −0·7° to −1·9° C. and a salinity of 31·2—32·8‰ and they were taken between ca. 6°—11° W. L. (ca. 120—180 miles from the coast). The plankton is very uniform in all the samples; it consists mainly of diatoms and tintinnids; the most frequent species are *Chaetoceras convolutum*, *Rhizosolenia hebetata f. semispina*, *Rh. obtusa*, *Cyttarocylis denticulata typica* and *robusta*, *Peridinium subinerme*, *P. curvipes* and *P. pellucidum*. Characteristic, though occurring in smaller quantities, were *Coccolithophora pelagica* (dead), *Pontosphaera borealis*, *Dinophysis arctica*, *Peridinium roseum*, *Dinobryon pellucidum* and *Distephanus speculum*. From the transition to the inner group we have a single sample (No. 17 in the Table), which mainly consists of *Melosira hyperborea* (with resting spores) and *Calanus finmarchicus*; the very low temperature (—1·2°) implies special conditions in the water, e. g. that the sample might have come from the immediate vicinity of an ice-floe.

The inner group (5 samples) come from water with a temperature of ca. 0° and a salinity of 30·6—31·2 ‰ and the samples were taken from ca. 13° W. L. (ca. 90 miles from land) in towards the coast (Germania Land and Koldewey Island). The principal species are *Chaet. boreale*, *Ch. decipiens*, which in small quantities were also found in the samples from the outer group, and *Oithona similis*; *Rhizosolenia styliformis* replaces the other two *Rhizosolenia* species. *Coscinodiscus subbuliens* and *Apodinium Chaetoceratis* only occur in the samples from near the coast. In a couple of the samples *Calanus finmarchicus* was present in large numbers. With regard to the Peridinians, *Ceratium arcticum* was found in small quantity and usually only as empty shells in all the samples (also of the outer group), whilst the other species had practically disappeared.

b. **July—August 1908.** (Table III).

We have examined 28 samples taken on the return voyage during the period from July 21st to August 3rd in almost the same region as the samples from 1906.

The samples can be divided naturally into three groups:

The inner group (15 samples) goes from the coast to ca. 14° W. L. The salinity determinations are few; they vary between 28·1 and 31·7 ‰ and the temperature on the surface lies between 0° and —4° C. The samples are somewhat rich in species, the most prominent being the following diatoms: *Chaetoceras decipiens*, *Ch. boreale* and *Coscinodiscus subbuliens*, and common to all is the small quantity of Peridinians: *Per. conicoides*, *P. curvipes* and *Ceratium arcticum* being the near most characteristic. Three samples taken west of Germania Land (Nos. 1276, 1279, 1289) in water with 3—4° temperature (and presumably low salinity) are wanting in, among others, *Chaet. Wighami* and *Fragilaria oceanica*, which are found otherwise in larger or smaller number in most samples. *Chaet. sociale* appears first further away from land (from No. 1290), but is then constantly present and usually in quantity. *Calanus finmarchicus* and *Thalassiosira gravida* (to a smaller extent) chiefly keep on the other hand to the samples from nearer land. The two northernmost (ca. 78° N. L.) samples (Nos. 1301, 1303) are remarkable for a large quantity of *Melosira*

Table

Date	21. VII	21. VII	21. VII	22. VII	22. VII	22. VII	22. VII	23. VII	23. VII	23. VII	24. VII	24
Time	7 p.	8 p.	9 p.	11 a.	6. p.	10 p.	12 p.	5 a.	8 a.	11·30p.	10 a.	
W. Latitude	Mouth of the harbour	C. Bismarck — Maroussia	Off Maroussia	N. of Maroussia	northwards along the coast			77.0	77·15	ca.78·0	ca.78.0	
N. Longitude								17.15	16·0	c.15·30	c.15 30	
Temperature of water	ca. 0·0			ca. 1·0	ca. 1·0	ca. 3·0	ca. 3.0	3.15	2·10	1·4	0·7	
Salinity of water	31·7	31·7	31·7	ca. 30·0	—	—	—	28.06	29·36	—	28·7	
No. of sample	1242	1243	1244	1270	1276	1279	1289	1290	1291	1299	1301	1
Bacillariaceae												
Amphiprora hyperborea	r	rr	r	r	..	..	...	rr	...	...	rr	
Chaetoceras atlanticum	..	rr	...	...	...	...	..		rr	...	rr	
— boreale	cc	c	c	cc	cc	cc	cc	c	cc	c	+	
— convolutum	...	...	.	...		..	...	...	...	...	rr	
— decipiens	c	c	c	c	c	c	c	c	cc	c	c	
— diadema	...	..	.	..	...	...	...	r	...	...	.	
— furcellatum	....	...	...	..	..	...	...	...	...	...	..	
— sociale	...	..	...	..	...	..	...	c	r	r	+ (c sp. rr)	(c.
— Wighami	r	r	+	r	..	...	...	cc	+	...	rr	
Coscinodiscus subbuliens	+	c	c	c	c	cc	c	c	c	cc	rr	
Fragilaria oceanica	cc (c. sp. +)	cc (c. sp. +)	cc (c sp. +)	cc (c. sp. r)	...	...	.	rr	r (sp.)	r (sp.)	r (sp.)	(c.
Melosira hyperborea	rr (sp.)	rr (sp.)	rr (sp.)	rr (sp)	...	rr (sp.)	rr (sp.)	...	+	+	c (c sp. +)	(c
Navicula septentrionalis	...	r	+	r	...	...	...	...	...	...	rr	
Nitzschia seriata	rr	...	...	...	...	...	...	...	...	...	..	
Rhizosolenia hebetata f. semispina	...	...	...		...	...	...	...	...	...	.	
— obtusa	...	...	...	.	...	...	...	...	...	...	...	
— styliformis	rr	...	rr	...	...	...	...	...	r	...	rr	
Thalassiosira bioculata	rr	rr	...	...	rr	...	..	...	..	...	rr	
— gravida	+	+ (c. sp. rr.)	+	+	rr	...	...	r	rr	rr	rr	
— Nordenskiöldii	rr	...	...	...	...	...	...	rr	rr	rr	rr	
Flagellata												
Dinobryon pellucidum	...	...	...	...	...	...	...	...	...	...	...	
Distephanus speculum	rr	r	r	rr	...	...	...	...	...	rr	...	
Phaeocystis Pouchetii	...	...	...	...		...	...	+	...	...	...	
Coccolithophora pelagica	...	..	...	...	...	...	...	...	...	...	...	
Pontosphaera borealis	...	..	...	...	...		...	...	...	...	...	

[1] Mostly dead specimens.

)08.

VII	25. VII	28. VII	28. VII	29. VII	30. VII	30. VII	31. VII	31. VII	31. VII	31. VII	1. VIII	1. VIII	1. VIII	2. VIII	3. VIII
a.	8 p.	2·15 a.	2 p.	1·45 p.	8·30 a.	12·15 p.	11·30 a.	1·45 p.	3 p.	5.30 p.	2·15 a.	8 a.	4 p.	12·30 a.	1 p.
—		—	75·45	—	—	75·15	75·08	—	ca. 75·0		—	74·20	73·58	73·30	73·4
—	—	—	12·15	—	—	8·45	8.0	—	ca. 7·30		—	7·0	7·0	6·0	—
·0	2·0	1·7	1·53	0·9	÷ 0·6	0·5	1.5	2·1	0·6		4.5	6·2	7·2	7·0	7·1
—	—	—	31·06	—	—	31·00	30.9	—	29·56		—	32.9	33·2	34·0	—
304	1312	1319	1332	1335	1340	1344	1350	1353	1355	1358	1381	1383	1386	1388	1398
. .	rr	rr	. . .	.	. . .	rr	. . .	. . .	. . .	.	. . .	. .	.	. . .	. .
rr	rr	rr	. . .		rr	. . .	rr	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
c	+	c	. . .	rr	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	.	. . .
. .	. . .	. . .	r	. . .	. . .	. . .	r	rr	rr	rr	rr	rr	rr	. . .	. . .
cc	c	c	r	rr	rr	rr	. . .	. . .	. . .	. .	. . .	rr[1]	rr[1]	rr[1]	. . .
. .	. . .	rr	. . .	. . .	r	+	r	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. .	. . .	. . .	cc	cc	c	c	+	. . .	. . .	. . .	. . .	+[1]	r	. . .	. . .
c	c	cc	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. .	rr	+	. . .	. . .	. . .	. . .	rr	. . .	. . .	. . .	. . .	. . .	. . .	. . .	.
c	c	r	. . .	. . .	rr	. . .	. . .	rr	. . .	. . .	. . .	. . .	. . .	. . .	. . .
r	rr	. . .	rr	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
(. rr.)	(sp.)														
r	rr	r	. . .	r	rr	. . .	rr	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
(. rr.)															
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. .	. . .	. . .	+	r	rr	rr	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. .	. . .	. . .	rr	rr	rr	. . .	rr	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. .	. . .	rr	. . .	rr	rr	rr	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
r	rr	+	r	rr	+	+	r	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
r	. . .	rr	r	+	rr	rr	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. .	. . .	. . .	rr	+	r	+	+	+	r	r	. . .	c	c	rr[1]	. .
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. .	. . .	. . .	rr	. . .	rr	. . .	. . .	. . .	. . .	. . .	. . .	+	. . .	. . .	. . .
. .	. . .	. . .	. . .	rr	. . .	. . .	. . .	. .	. . .	. . .	. . .	+	+	. . .	. .
. .	. . .	. . .	. . .	. . .	. . .	rr	. . .	. . .	. . .	. . .	. . .	r	rr	. . .	. .

Table I

Date	21.VII	21.VII	21.VII	22.VII	22.VII	22.VII	22.VII	23.VII	23.VII	23.VII	24.VII	24
Time	7 p.	8 p.	9 p.	11 a.	6 p.	10 p.	12 p.	5 a.	8 a.	11·30p.	10 a.	2
W. Latitude	Mouth of the harbour	C. Bismarck—Maroussia	Off Maroussia	N. of Maroussia	northwards along the coast			77·0	77·15	ca.78·0	ca.78·0	–
N. Longitude								17·15	16·0	c.15·30	c.15·30	
Temperature of water	ca. 0 0			ca. 1·0	ca. 4·0	ca. 3·0	ca. 3·0	3·15	2·10	1·4	0·7	0
Salinity of water	31·7	31·7	31·7	ca. 30·0	—	—	—	28·06	29·36	—	28·7	
No. of sample	1242	1243	1244	1270	1276	1279	1289	1290	1291	1299	1301	13
Tintinnodea												
Cyttarocylis denticulata. typica	.			...	rr	rr	...	...	...	...	...	.
— — gigantea	.	..	rr[1]	..	...	...		r	..	...	...	.
— — robusta	.	...	..	.	...	...	...	..	...	...	..	.
Ptychocylis obtusa	...	rr	...	..	..	..	..	rr	rr	r	...	.
Tintinnus norvegicus, gracilis	...	. .	..	...	.	...	...	...	...	...	...	.
Peridiniales												
Apodinium ? Chaetoceratis	rr	...	rr	...	rr	...	...	...	...	...	.	.
Ceratium arcticum		rr	rr	rr	rr	rr	...	rr	rr	...	...	1
Dinophysis arctica		...	...	...	...	...	...	...	...	..	...	.
— rotundata	...	.	..	..	...	...	...	...	...	..	rr	.
Goniodoma Ostenfeldii	...	...	rr	..	...	..	...	rr	...	...	...	.
Gonyaulax triacantha	...	..	.	.	...	...	...	...	...	...	...	.
— sp.	...	...	..	...	...	..	...	...	...	...	...	.
Peridinium breve	..	...	..	...	...	..	...	...	rr	rr	...	.
— brevipes	r	...	..	.	...	...	...	rr	...	...	...	.
— catenatum	rr	rr	r	.	rr	...	..	...	...	...	...	1
— conicoides	...	...	...	...	...	...	...	rr	+	r	...	.
— curvipes	r	+	r	rr	rr	rr	...	r	r	rr	...	.
— depressum	...	rr	rr	...	...	rr	rr	...	...	...	...	.
— islandicum	r	...	...	r	...	...	...	rr	...	...	..	.
— minutum	...	...	...	...	...	..	...	rr	...	...	...	.
— ovatum	...	...	rr	...	...	rr	..	...	...	r	..	.
— pallidum	r	...	..	...	...	...	...	...	...	...	...	.
— pellucidum	+	r	r	r	...	..	..	rr	r	rr	...	.
— pyriforme	...	...	...	...	....	..	...	...	...	...	...	.
— roseum	...	r	rr	rr	...	...	...	...	...	rr	...	.
— subinerme	...	rr	...	...	...	...	...	...	...	..	...	.
Metazoa												
Calanus finmarchicus	...	+	c	r	+	c	cc	...	rr	c	...	.
Oithona similis et Nauplii	...	...	—	...	...	...	...	...	r	+	+	

[1] Mostly dead specimens.

08 (continued).

.VII	25.VII	28.VII	28.VII	29.VII	30.VII	30.VII	31.VII	31.VII	31.VII	31.VII	1.VIII	1.VIII	1.VIII	2.VIII	3.VIII
a.	8 p.	2·15 a.	2 p.	1·45 p.	8·30 a.	12·15 p.	11·30 a.	1·45 p.	3 p.	5.30 p.	2·15 a.	8 a.	4 p.	12·30 a.	1 p.
—	—	—	75·45	—	—	75·15	75·08	—	ca. 75·0		—	74·20	73·58	73·30	73.4
—	—	—	12·15	—	—	8·45	8·0	—	ca. 7·30		—	7 0	7.0	6·0	—
·0	2·0	1 7	1·53	0·9	÷ 0·6	0·5	1·5	2·1	0·6		4·5	6·2	7.2	7·0	7·1
	—		31·06	—	—	31·00	3·09	—	29·56		—	32·9	33.2	34·0	—
304	1312	—	1332	1335	1340	1344	1350	1353	1355	1358	1381	1383	1386	1388	1398
..	rr	rr	r	+	+	rr	r	+	+	c	c	+	r	rr	..
..	...	...	...	..	...	...	...	...	...	...	...	...	rr	rr	...
..	...	...	...	...	...	..	rr	+	r	rr	+	r	+	r	...
rr	+	r	...	..	...	..:	...	...	...	...	...	...	...	...	...
..	...	..	...	...	rr	...	...	...	rr	...	r	r	+	+	.
..	...	...	...	.	...	...	...	...	...	...	...	...	...	...	...
rr	rr	...	rr		...	...	...	...	...	rr	rr	rr	+	c	c
..	..	...	rr	..	...	rr	...	...	...	rr	rr	...	rr	rr	+
..	...	...	r	r	...	...	rr	...	...	...	...	..	...	...	rr
..	...	...	...	...	...	...	..	...	...	...	...	...	...	...	rr
..	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...
..	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...
r	...	rr	...	...	...	...	...	...	...	...	...	...	...	...	...
r	...	...	...	rr	rr	...	...	...	...	...	...	...	...	r	...
..	rr	rr	...	...	...	...	...	...	rr	...	...	...	...	...	...
r	...	r	...	r	r	rr	...	rr	...	...	...	...	...	...	...
r	r	...	...	rr	...	rr	...	...	rr	rr	...	...	...	...	...
..	...	...	rr	...	rr	...	r	r	rr	rr	...	rr	...	...	r
r	rr	...	rr	...	rr	...	rr	...	...	...	...	...	...	...	...
..	rr	...	rr	...	...	...	...	...	...	...	...	...	...	...	...
..	r	+	rr	+	r	r	+	+	+	r	r	+	+	c	+
r	...	rr	r	r	r	r	r	rr	...	rr	rr	rr	r	+	r
r	+	r	+	+	r	r	+	r	r	r	rr	r	+	+	..
..	...	...	...	...	...	...	...	...	...	...	...	...	...	rr	+
..	...	r	..	...	...	...	rr	...	r	...	...	...	...	...	...
..	...	...	...	rr	...	...	rr	rr	...	...	...	...	rr	r	...
..	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...
r	c	r	r	+	+	rr	c	c	c	+	c	+	c	c	...

hyperborea, small quantity of *Coscinodiscus subbuliens*, *Chaet. boreale* and *Ch. Wighami*.

The intermediate group (5 samples) extends from ca. 12° to 8° W. L.; here we have a salinity of ca. 31‰ and a surface temperature of −0·6° to −1·5° C. It is characterized by the following species, which are hardly at all found inside: *Chaetoceras furcellatum*, *Rhizosolenia obtusa*, *Rh. hebetata f. semispina*, *Dinobryon pellucidum*, *Cyttarocylis denticulata typica*. A few species, which very seldom occur in the inner group, appear here more regularly, namely, *Chaet. diadema*, *Peridinium pallidum*, *P. pellucidum* and *P. ovatum*. *Thalassiosira gravida*, which was much reduced, again becomes more frequent in this region. Most of the species prominent in the inner group disappear here or are only present in small quantity.

A couple of samples form the transition to the outer group, to which we ascribe the region from ca. 7° to 6° W. L. and from 75° to 73° N. L. The salinity is here higher (33—34‰) and also the temperature on the surface (6°—7°) than in the other regions; we are here outside the pack-ice. The quantity of the plankton is but small; the diatoms have almost entirely disappeared; characteristic however is the regular occurrence of *Chaetoceras convolutum* in small quantities; further, a number of diatoms of more temperate origin appear irregularly and in few individuals and likewise some Protozoa (see our preceding papers). The most abundant organisms are: *Peridinium ovatum*, *Dinobryon pellucidum*, *Cyttarocylis denticulata typica* and *robusta*, *Oithona* and Nauplii, and in most samples *Ceratium arcticum*, *Tintinnus norvegicus gracilis* and *Peridinium pyriforme*. In a few samples occurred *Phaeocystis Pouchetii*, *Pontosphaera borealis* and *Coccolithophora pelagica*.

The plankton in the outermost samples corresponds nearest to the “Ceratium arcticum plankton”, which Paulsen (1909) has described from North Iceland (the southern boundary of which is placed at ca. 64 N. L. in his fig. 2), but differs from this in the absence of *Ceratium longipes* (the *C. arcticum* most resembling *longipes* is figured in the foregoing paper fig. 16 A).

A general review of the plankton of the pack-ice and coastal waters, according to the samples examined, would appear somewhat as follows. In the accompanying sketch map the plankton regions and the places of the samples (the figures refer to the Tables) have been marked out. There are three regions.

1. Innermost the plankton region of the coastal waters (inner group in 1906 and 1908), characterized by diatoms, namely *Chaetoceras* species, *Coscinodiscus subbuliens*, *Fragilaria oceanica* and by *Calanus finmarchicus*.

2. The plankton region of the pack-ice (outer group in 1906, intermediate group in 1908), characterized by *Cyttarocylis denticulata, Rhizosolenia hebetata semispina* and *R. obtusa, Chaet. furcellatum, Peridinium subinerme, P. pellucidum* and *P. curvipes*, and *Dinobryon.*

3. The plankton region of the open water (outermost group in 1908) with small quantities of characteristic species: *Cera-*

Sketch-map of the area investigated. The full line signifies the path of the Expedition into the coast, the broken line the way out. The figures refer to nos. of samples in the plankton tables.

tium arcticum, Peridinium ovatum, (*Pontosphaera borealis* and *Coccolithophora?*).

There is the probability that the plankton region of the pack-ice corresponds to the East Icelandic Polar Current, whilst the plankton region of the coastal water corresponds to the coastal waters mixed with water from the melting snow of the land. Lastly, the plankton region of the open sea may probably be referred to the circulating central area of the Greenland Sea. This agrees with what Damas and Koefoed say (l. c. p. 328): "les diatomées qui seules jouent un rôle important dans le phytoplankton, prennent un developpement beaucoup plus considérable dans le courant polaire que dans la région centrale de la Mer du Groenland".

We must remember here, however, that our knowledge of the plankton of these waters is restricted to the summer season.

We may remark, finally, that oceanic plankton forms, e. g. *Rhizosolenia styliformis*, *Certium arcticum*, are carried right in to the coast, where they may be considered to perish sooner or later.

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14.—3.—1911.

The vegetation of Northeast Greenland

69° 25′ lat. n.—75° lat. n.

by

N. Hartz and Chr. Kruuse.

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Arbejder fra den Botaniske Have i København. Nr. 67.

During the Danish expedition to East Greenland 1900, under the charge of G. Amdrup, we investigated the flora and vegetation of the tracts of land visited by the expedition.

The route followed by the expedition has been mentioned by N. Hartz in "Medd. om Grønl." vol. XXVII. List of discovered phanerogams and vascular cryptogams is furnished by Chr. Kruuse in "Medd. om Grønl." vol. XXX, in which volume is made mention also of the algae, mosses, fungi and lichens collected by us.

Sabine Island (N. Hartz.)

July 11th—12th. The "Antarctic" was riding at anchors in Griper Roads southwest of the extreme point of the cape where the ruins of the German observatory were still to be seen. Across the low tongue of land and across low, flat ground I went towards WNW, away to the big stream which borders Hasenberg towards the east; the stream and the whole of the cleft through which it runs, were as yet for a great deal hidden under huge snow-drifts; here and there the stream had however burst through the ice- and snowcover; at such places steep snow walls bordered its course.

Animal life was rather rich; in the course of this day's march I saw 3 musk-oxen [1], 3 hares, one hen-ptarmigan with a numerous hatch of chickens, numbers of snow-sparrows, a

[1] In the stomach of a shot musk-ox were found by washing of the exceedingly evil-smelling contents of the stomach abt. 99 p. cent of leaves and small branches of *Salix arctica*; besides single leaves of *Luzula*, gramineous plants, *Dryas* and fragments of *Stereocaulon*.

few ravens, and excrements of foxes and a great many tracks of lemmings; a great many insects were seen visiting the flowers.

In the low ground by Germania Harbour were found enormous numbers of *Papaver radicatum*[1]); it was now in full flower and so luxuriant as hardly anywhere else in Greenland; one big tuft near the beach bore — beside a number of capsules from 1899 — a young fruit from 1900, 38 fully developped, large flowers and 34 big, black-haired buds. At the summit of Hasenberg grew comparatively many white-flowered poppies, many white-flowered specimens being seen as well on moist ground near the harbour.

On the numerous decumbent little bushes of *Salix arctica* on the slopes of the stream was seen beautiful wind-erosion[2]); the predominant wind in the valley is the northwind, in the direction of the valley.

A special character was given to the vegetation by the occurrence of divers northern species, such as *Saxifraga flagellaris* and *hirculus*; the first mentioned being particularly frequent; *Polemonium humile* with its large vividly coloured flowers is known to belong to the rare constituents of the Greenland-flora; it was common here, partly on the dry, naked basalt-plateaus, partly in humid cracks where, on humus, it formed big, luxuriant, flowery "mats".

Taken as a whole it was the ordinary, northern insular vegetation: In the hollows *Carex*-bogs, moss-bogs or combined moss-*Carex*-bogs; on the dry mountain slopes rocky-flat formation[3]) more or less luxuriant all in proportion to exposition, mouldformation etc. Considerable continuous tracts of heath-moor-land we did not see in the island.

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[1]) We are using the same plant names as in Chr. Kruuse's above quoted paper (Medd. om Grønl., XXX).

[2]) cp. truncs from Scoresby Sund mentioned and pictured by Hartz Medd. om Grønland, XVIII, p. 310.

[3]) Eug. Warming's "Fjældmark" (fell-field).

Sabine Island (Chr. Kruuse).

On the strand round Germania Harbour was found a rather broad zone of a strand-flora consisting of: *Carex glareosa, C. salina v. subspathacea, Glyceria vilfoidea, Halianthus peploides, Stellaria humifusa, Cochlearia officinalis v. groenlandica* and *Armeria vulgaris v. sibirica.*

Behind (north of) the harbour is a small bog, or rather a riverbed with very flat bottom and gentle inclination. Here were noted:

Ranunculus pygmæus, R. hyperboreus, Saxifraga rivularis, S. nivalis f. tenuis, Koenigia islandica, Juncus biglumis, Eriophorum Scheuchzeri, E. polystachium, Carex lagopina, Alopecurus alpinus.

Between the phanerogams and along the margin of the bog the following mosses were coverforming:

Polytrichum sexangulare, Astrophyllum hymenophylloides, Timmia austriaca, Philonotis fontana, Bryum obtusifolium, B. arcticum, Pohlia nutans, Leersia spathulata, Ditrichum flexicaule, Amblystegium giganteum, Hypnum turgidum, Myurella julacea, Schwartzia montana and *Stereodon chryseus.*

Contiguous to this bog was a sharp-cut, V-shaped, streamlet-cleft, on the sandy sides of which were noted:

Chamænerium latifolium, Draba alpina, Cardamine bellidifolia, Ranunculus pygmæus, Saxifraga cernua, S. decipiens, S. stellaris f. comosa, S. oppositifolia v. pulvinata, Juncus biglumis, Luzula confusa, Festuca ovina, Poa abbreviata and *Equisetum arvense.* The tufts, which were but few cm apart, were all large and richly flowering.

In the valley itself, between the Hasenberg and the Germaniaberg, and up the low foot of the latter the loose soils consisted of red, sanded clay strown with loose, abt. 10 cm large blocks. Both the clay and the blocks originate with the basalt which forms the rocks of the island. On the foot of the mountain lie many large snowdrifts, from which the meltingwater oozes down and steeps the ground to a soft, soaked, sliding mud; only farther down towards the bottom of the valley does it collect in brooks which have cut in the gravel stony beds which drain the localities. Round them the bottom is stone-hard, dry as a bone and often scarred by cracks forming a diagonal net. The vegetation of the valley was rocky-flat formation with wide intervals between the vascular plants. Cryptogams were almost totally wanting.

The side of the Germaniaberg consists partly of steep basalt crags, which are totally devoid of vegetation at their bases; uppermost on the talus the plants of the rocky-flat formation collect to a dense cover with a height of from 5 to 10 cm, the main part of which is formed by gramineous species, *Alsine biflora* and *Potentillas.* Denser and more pronounced the herby-slope appears, however, on the edges of step-shaped ledges east of Germania Harbour. It is chiefly made up of *Salix arctica, Vaccinium uliginosum v., Campanula uniflora, Polygonum viviparum, Carex rupestris* and *Poa cenisia.*

The cover is complete, 5—10 cm high and fresh-green. Between the named species are found interspersed in lesser numbers the following vascular plants: *Potentilla nivea, P. maculata, P. emarginata, Stellaria longipes, Draba Fladnizensis, Saxifraga hirculus, S. decipiens, Cassiope tetragona, Pedicularis flammea, Gentiana tenella, Taraxacum phymatocarpum, Erigeron uniflorus, Salix herbacea, Oxyria digyna, Elyna Bellardi, Trisetum, Alopecurus alpinus, Equisetum variegatum f. anceps, E. arvense, Cystopteris fragilis, Woodsia ilvensis* and *Lycopodium Selago f. appressa.*

On the flat summit of the Germaniaberg the earth in the depressions is often covered with boulders with a diameter of 30—40 cm, which form a depressed mesh-plexus. Their dark coatings of dessicated algæ and horizontal stripes of clay show that they are covered by water a certain time of the year; in the spaces between them are found the largest associations of *Polemonium*, which often forms patches of 2 m^2.

The plants of the rocky-flat formation were as follows:

Dryas octopetala f. argentea.
— — *f. minor.*
Potentilla pulchella f. humilis
— *maculata.*
— *nivea.*
Melandrium apetalum.
— *involucratum v. affine.*
Silene acaulis.
Sagina nivalis.
Alsine biflora.
— *verna v. rubella.*
Arenaria ciliata v. humifusa.
Stellaria longipes.
Cerastium alpinum.
Draba alpina.
— *nivalis.*
— *Fladnizensis.*
— *hirta.*
— *arctica.*
Cardamine bellidifolia.
Ranunculus glacialis.
— *nivalis.*
— *altaicus.*
— *arcticus.*
Saxifraga stellaris v. comosa.
Alopecurus alpinus.
Trisetum subspicatum.
Dupontia Fisheri.
Arctagrostis latifolia.
Hierochloa alpina.
Aira cæspitosa v. alpina.
Poa glauca.
Saxifraga cernua.
— *decipiens.*
— *hirculus.*
— *oppositifolia.*
— *flagellaris v. setigera.*
— *nivalis.*
Papaver radicatum.
Armeria vulgaris v. sibirica.
Pedicularis hirsuta.
Cassiope tetragona.
Empetrum nigrum.
Vaccinium uliginosum v. microphyllum.
Polemonium humile.
Erigeron compositus.
— *uniflorus v. pulchellus.*
Arnica alpina.
Taraxacum phymatocarpum.
Polygonum viviparum.
Luzula confusa.
— *arctica.*
Elyna Bellardi.
Carex capillaris.
— *misandra.*
— *nardina.*
— *rupestris.*
Poa abbreviata.
Festuca ovina.
Woodsia ilvensis.
Equisetum variegatum.
— — *f. anceps.*
— *arvense.*

Cape Borlase Warren (N. Hartz).

July 14th. The next place in which we landed was abt. 1 km. to the north of Cape Borlase Warren; we did not stay but 3 hs. here.

Inside a low sea-margin, made up of gneiss-blocks, was found a small lagoon with fresh water, originating from a snow-drift close to the beach. The sea nevertheless once in a while sets into the lagoon, a circumstance of which numerous *Laminaria*-leaves and sea-mussels in the water bore witness.

Animal life in the lagoon was rich and swarming; great swarms of *Apus glacialis* were stirring the mud on the bottom[1]; brown *Daphniae* and countless gnatworms were rooting the bottom or swimming in the water; on mosses in the water was seen a rich *Chlorophyllaceae*-vegetation.

On the inside of the lagoon (western side) was found a narrow green fringe made up of *Glyceria vilfoidea*, sprinkled with flowering *Stellaria humifusa*, some few *Cochleariae, Carex ursina* (largely cropped by geese), *Ranunculus hyperboreus* (partly with floating leaves, now in flower), *Phippsia algida* and *Koenigia* — besides numerous mosses. The whole of the vegetation along the lagoon had a white salt-covering; numerous excrements of geese were scattered everywhere on the beach; in the fat, moist marshy ground and in the half moulded geese-excrements were found quantities of small worms. The humus-layer along the inside of the lagoon appeared by the very wrinkles of its surface to be made up mostly of excrements of geese, a quite characteristic form of mould met with again later on in many places frequented by the geese.

[1] The grey colour of *Apus* completely matches the grey mire at the bottom of the lagoon; the animal was hardly discernible when lying quietly on the bottom. Now and then a solitary *Apus* might be seen swimming on its back and with its mouth in the very surface of the water searching and skimming this latter most carefully; every single air-bubble on the surface was thoroughly investigated.

The water in the lagoon was quite tepid close to the beach where the current from the little brook did not reach. At 5^{30} p. m. were read the following temperatures:

Temperature of the air (swing thermometer), fog, sun hardly breaking through	+ 1° C.
Temperature of the water, 5 cm depth, ball reposing on cover of *Chlorophyllaceae*	+ 14,5° C.
Temperature of water, 14 cm depth, ball on mud-bottom	+ 13° C.

At an Esquimaux-ruin near the beach was found the usual vegetation of *Alopecurus alpinus* on the thick mould-layer. In the vicinity of the ruin was seen a magnificent growth of *Polemonium humile*, whole, large, unmixed "beds" of almost one m^2 size. Here also was found a very big decumbent *Salix arctica*, the foliage of which covered abt. 10 m^2.

Vascular plants from Sabine Island and Cape Borlase Warren.

Dryas octopetala.
Potentilla pulchella f. humilis.
— *emarginata.*
— *nivea.*
— *maculata.*
Chamænerium latifolium.
Empetrum nigrum.
Silene acaulis.
Melandrium involucratum v.
— *apetalum.*
— *triflorum.*
Sagina nivalis.
— *cæspitosa.*
Alsine biflora.
Alsine verna v. rubella.
Halianthus peploides.
Arenaria ciliata v. humifusa.
Stellaria humifusa.
— *longipes.*
Cerastium alpinum.
Cochlearia officinalis f. minor.
Draba alpina.
— *nivalis.*
— *Fladnizensis.*
— *hirta*
— *arctica.*
— *glacialis.*
Braya purpurascens.

Cardamine bellidifolia.
Papaver radicatum.
Ranunculus glacialis.
— *pygmæus.*
— *hyperboreus.*
— *nivalis.*
— *altaicus.*
— *arcticus.*
Saxifraga nivalis.
— *stellaris v. comosa.*
— *cernua.*
— *rivularis.*
— *decipiens.*
— *hirculus.*
— *flagellaris v. setigera.*
— *oppositifolia.*
Armeria vulgaris var.
Pedicularis flammea.
— *hirsuta.*
Polemonium humile.
Gentiana tenella.
Cassiope tetragona.
Rhododendron lapponicum.
Vaccinium uliginosum v.
Campanula uniflora.
Taraxacum phymatocarpum.
Erigeron uniflorus.
— *compositus.*
Arnica alpina.
Koenigia islandica.
Polygonum viviparum.
Oxyria digyna.
Salix arctica.
— *herbacea.*
Juncus biglumis.
Juncus triglumis.
Luzula confusa.
— *nivalis.*
Eriophorum Scheuchzeri.
— *polystachium.*
Elyna Bellardi.
Carex nardina.
— *lagopina.*
— *ursina.*
— *misandra.*
— *glareosa.*
— *salina f.*
— *rupestris.*
— *incurva.*
Alopecurus alpinus.
Hierochloa alpina.
Aira cæspitosa f.
Trisetum subspicatum.
Dupontia Fisheri.
Phippsia algida.
Arctagrostis latifolia.
Glyceria vilfoidea.
Poa abbreviata.
— *glauca.*
— *alpina.*
— *cenisia.*
Festuca ovina.
— *rubra.*
Lycopodium Selago.
Cystopteris fragilis.
Woodsia ilvensis.
Equisetum variegatum.
— — *f. anceps.*
— *arvense.*

Cape Dalton (N. Hartz).

July 18—21th. In the lee of (south of) Cap Dalton is a considerable lagoon, cut off from the open sea by a low, black, barren sea-margin, which in the northernmost part reaches abt. 4 m above the sealevel.

In the northern part of the lagoon the winter-ice was still solid; in the shallow water near the margin was found here a peculiar *Fucus inflatus* var. *membranacea*; a quantity of drift-wood had been washed ashore.

The rocks here were basalt. Here, as everywhere on the outer coast it was a very conspicuous fact that the vegetation doesn't reach a passably luxuriant development till at a hundred or a few hundred metres above the the sea level; and not only is the vegetation more vigorous at this elevation, it was also far more advanced in development than the vegetation of the low-land. Thus e. g. *Pedicularis hirsuta*, which in the lowland was not even fully blown, had shed its flowers at a height of a few hundred metres; *Cassiope tetragona* was flowering much more richly up here than farther down. The cold mist, which often settles on the lowland, assuredly acts highly cowing and hindering upon the vegetation down here along the coast. On one of the days while we were staying here the temperature of the air in the lowland, where the fog reigned and a cold wind blew, was ÷ 2° C., while a few hundred metres further up, above the fogbank, it showed + 10° C.; up here the weather was calm, and the sun was shining while the fog was still enveloping the lowland.

While the vegetation was extremely poor in the lowland it was surprisingly luxuriant when you got a few hundred m mountainwards. On moist, mould-covered, partly densely moss-grown, terrace-shaped ledges in abt. 200 m height above the level of the sea were noted: Numerous vigorous tufts of *Sedum Rhodiola* (all pure male or female plants, no herma-

Fig. 1. The large basaltwall at Cape Dalton. In the fore-ground the stony bare strand-wall outside the lagoon. (From photo. by Chr. Kruuse).

phroditic plants), *Thalictrum, Potentilla maculata, Draba crassifolia, Oxyria, Erigeron uniflorus, Salix arctica, Carex rigida* (in great numbers). A great many winter-nests and other traces of lemmings were found.

Abt. 250 m above sea level: Large *Cassiope hypnoides* and *C. tetragona* in full flower. The air smelt sweet from the white corollas of *Cassiope tetragona*, which were industriously visited by humble-bees.

Abt. 330 m above sea level: On the solid basalt *Usnea melaxantha* was very common. Here a rich insect-life had developped: *Argynnis*, wasps and *Syrphidae*, besides numerous dancing gnatworms.

Large, dense cushions of *Arctostaphylos alpina* covered the field, which here consisted of débris of basalt; this species was not seen farther down the mountain.

At this height were noted besides: *Potentilla nivea, Saxifraga tricuspidata* and *S. oppositifolia, Dryas octopetala, Carex nardina, Pedicularis hirsuta, Cerastium alpinum, Polygonum viviparum, Ranunculus arcticus* with its var. *Wilanderi, Arnica alpina.*

This latter evidently turned its big yellow flowers after the sun; all its flowers stood clearly oriented after the direction of the sun.

Cape Dalton (Chr. Kruuse).

The lowland surrounding the lagoon, as well as the littoral region, was totally devoid of vegetation. The north side of the valley is formed by a steep basaltwall, which out in the bay ducks its foot directly in the sea, whereas landwards it is covered by débris consisting of coarse, sharp-edged blocks. In many places the snowcoating is still thick, and the débris is devoid of vegetation except in the few places where a little basalt-rock sticks out and thus forces the water to the surface. Here were noted tufts of *Cassiope tetragona,* some crumpled individuals of *Salix arctica, Polygonum,* an isolated *Ranunculus* *glacialis*, and some small tufts of *Tortula ruralis*; but no coherent vegetation. Above the débris the mountain ascends in broad steps towards the east. On the lower steps the snow still lies in most places metrehigh, and wherever it has melted the bottom is a mire of clay, upon which is rarely seen a *Grimmia*-tuft, and still more seldom, only in the lee of stones, some few specimens of *Luzula confusa*, *Saxifraga stellaris* v. *comosa*, *S. nivalis* v. *tenuior*, *Ranunculus glacialis* and *Oxyria*. All here is still thaw and early spring, but even later in the year this cold bottom will house but a very sparse vegetation.

Higher up the steps become more snowless and are covered by moorland-soil, and here the steep slopes between them, wherever is abundant, equally distributed moisture, become densely covered, and if anywhere in the localities a small depression is found, the sides of which protect against wind and weather, one may meet with a veritable herby slope with dense, complete and fresh-green cover of a height of 10—15 cm, formed by:

Sibbaldia, Silene acaulis, Alsine biflora, Cerastium alpinum, C. trigynum, Melandrium apetalum, Draba alpina, D. crassifolia, D. Fladnizensis, Cardamine bellidifolia, Arabis alpina, Thalictrum alpinum, Saxifraga nivalis, S. rivularis, Sedum Rhodiola, Veronica alpina, Taraxacum croceum, Antennaria alpina v. glabrata, Salix herbacea, S. glauca, S. arctica, Polygonum, Oxyria, Koenigia, Luzula spicata, Carex rariflora, C. scirpoidea, C. rigida, Trisetum, Poa pratensis, P. cenisia, Cystopteris and *Equisetum arvense.*

The horizontal flats upon the steps, especially when facing the steeply descending margin, were very moist and covered with extensive flat moss-bogs formed by:

Polytrichum strictum, Sphaerocephalus turgidus, Bartramia crispa, Bryum capillare, Pohlia gracilis, P. cruda, Tortula ruralis, Dicranoweissia crispula, Ceratodon purpureus, Dorcadion Killiasii, Amblystegium polygamum, A. cordifolium, A. sarmen-

tosum, Stereodon revolutus, Cephalozia bicuspidata v. cavifolia, C. divaricata, Blepharostoma trichophyllum, Jungermannia quinquedentata, J. alpestris, J. Kunzeana, Cesia concinnata and *Sphagnum fimbriatum* f. *orthoclada.*

Widely distributed in the moss-cover grew: *Ranunculus pygmæus, R. nivalis, R. hyperboreus, Saxifraga stellaris* v. *comosa*, *Salix arctica, Koenigia, Luzula confusa, Eriophorum Scheuchzeri, Carex rariflora, C. scirpoidea, Poa pratensis* and *Phippsia algida.*

On the inner parts of the step-flats, and in spots where the margin was convex the humidity was present in far lesser quantities and localized in brooks. Here was found luxuriant heather-moor consisting of:

Cassiope tetragona, Vaccinium, Empetrum, Stellaria longipes, Draba hirta, D. nivalis, Saxifraga tricuspidata, Pedicularis hirsuta, Pyrola grandiflora, Campanula rotundifolia, Antennaria alpina, Carex nardina, C. rupestris and *Woodsia ilvensis.*

Between the high-mountain of Cape Dalton and the mountains behind is found a low mountain range, which the weathering has covered with sand and gravel and strown with broken stones and concretions. It was very dry, without snow and water-courses, and bore a very sparse rocky-flat formation consisting of *Dryas octopetala* v. *minor*, *Alsine biflora*, *Silene acaulis, Erigeron uniflorus, Luzula confusa*, *Carex nardina, Trisetum* and *Poa glauca.* At one place, where some small, weathered crags protruded, a little above the gravel was one, abt. 1 metre long, bush of *Arctostaphylos alpina,* and at another spot one half as big specimen of *Saxifraga tricuspidata,* but elsewhere coherent plant-cover was wanting totally, and there were several metres between the separate tufts.

Up the side of the mountain to the west of this area, the vegetation was a far more luxuriant rocky-flat formation formed by: *Potentilla maculata, P. nivea, Silene*, *Alsine verna*, *Cerastium alpinum, Arenaria ciliata*, *Pedicularis lapponica, P.*

flammea, P. hirsuta, Papaver radicatum, Arctostaphylos, alpina Campanula rotundifolia, Saxifraga decipiens, Arnica alpina, Luzula confusa, L. spicata, Poa glauca, Trisetum, Festuca ovina, Equisetum variegatum and *Cystopteris.*

Turner Sund.

22—28 July. Owing to the ship's taking the ground in Turner Sund, as mentioned by Hartz in his account of the voyage (Medd. om Grønland, XXVII, p. 160) our stay in this place was somewhat longer than intended. Our investigations were all conducted in the Turner Island, at the narrowest spot of the straits, or in the neighbourhood of the island.

A quantity of drift-timber lay washed ashore, partly tall, slim conifers, partly foliage-trees (birch?). A number of loose bits of bark of pine and birch were also seen. One of the trunks of the conifers bore plain marks of the axe. Also a quantity of *Fucus* had drifted ashore; but the sublittoral region and the shallows vere totally bare of algae; on deeper water the algal vegetation was, on the contrary, rich.

A special strand-vegetation was almost totally wanting here; it was represented solely by isolated specimens of *Glyceria vilfoidea, Stellaria humifusa* and *Cochlearia officinalis v. groenlandica* f. *minor.*

On shore were seen traces of reindeer and wolf, numerous lemmings, some ermines; a number of bears were killed under our sojourn here [1]).

Turner Sund (Chr. Kruuse).

The surface of the cape was slightly undulating, covered by coarse gravel and strown with large erratic boulders. The

[1]) The stomach contents of a shot bear appeared to consist largely of leaves of *Oxyria digyna*, evidently the food which the bear has sought ashore; casual ingredients of the stomach contents: a little grass, a few leaves of *Polygonum viviparum, Saxifraga cernua, Sax. cæspitosa, Polytrichum* sp.

Fig. 2. *Ranunculus glacialis*, 2/3 nat. size, phot. Chr. Kruuse.
Gravelly bottom, Turner Sund, the cape. 27. 7. 00. *R. glacialis* was one of the few bigger phanerogams which rose above the gravel here; but this too sought shelter behind rocks (see these to the left in the figure).

depressions were almost bare of vegetation on account of the long standing snow-covering and the too great humidity. The low, flat summits of the elevated lines were covered by a scanty carpet of *Anthelia* together with scattered tufts of *Grimmia ericoides* and, at large intervals, some single phanerogams more or less influenced by the north wind, which is predominant here. More conspicuous was *Ranunculus glacialis*, which was in full bloom (Fig. 2). The flowers are marked sunflowers turning their corollas after the place of the sun in the sky. The flowers were white, as a rule; we saw, however, several reddish corols. Together with *Ranunculus glacialis* were found a few dwarf specimens of *Cochlearia officinalis v. groenlandica* f. *minor, Sagina nivalis, Silene acaulis, Potentilla maculata, Polygonum viviparum, Salix herbacea, S. arctica, Phippsia, Luzula confusa, Saxifraga decipiens* and *S. rivularis.*

A little more to the westward, by the points of a little bay opposite to the cape, I ascended a 700 m high mountain (exposition SSE.). The beach and the low foreland consisted of basalt gravel, was ploughed by wild brooks, and was covered by very poor rocky-flat formation, chiefly formed by mosses, especially *Anthelia julacea*, which covered large moist patches. Of other mosses were collected here:

Polytrichum strictum, Philonotis fontana, Bartramia crispa, Conostomum tetragonum, Bryum cirratum, B. archangelicum, Pohlia commutata, P. proligera, P. nutans and *v. sphagnetorum, Sphaerocephalus turgidus, P. cruda, Tortula ruralis, Dicranum neglectum, Swartzia montana, Ditrichum flexicaule, Grimmia ericoides, Amblystegium aduncum, A. sarmentosum, Campylium hispidulum, Stereodon revolutus, Isopterygium nitidum v. pulchellum, Cephalozia albescens v. islandica, C. bicuspidata* and *v. cavifolia, C. divaricata f. elongata, C. striatula, Blepharostoma trichophyllum, Jungermannia socia, J. ventricosa, J. minuta, Cesia concinnata* and *Prasanthus suecicus.*

Between the mosses were, here and there, single specimens of *Silene, Polygonum, Oxyria, Salix arctica, Saxifraga oppositifolia f. reptans, Cassiope tetragona, Luzula confusa, Trisetum, Poa alpina* and *Festuca ovina.* All were low and far behind in development; *Oxyria* f. inst. was here 6 cm high, whereas at an altitude of 250 metres above the level of the sea it reached 31 cm.

This tract reached up to abt. 100 metres above the sea-level. Here began the talus proper, which is considerably steeper, strown with big down-slidden boulders, and has numerous dry brooklet beds with considerable gravel walls on the sides. It stretches from 100 to abt. 250 metres' height. It was covered by spare heather-moor which, on the gravelly walls merged into rocky-flat formation of a somewhat drier description than the above-named. Here were noted down:

Dryas octopetala f. *minor, Chamænerium latifolium, Silene, Alsine biflora, Cerastium alpinum, Draba alpina, D. Fladnizensis, D. hirta, Arabis alpina, Ranunculus pygmæus, Saxifraga cernua, S. decipiens, S. tricuspidata, S. oppositifolia, Vaccinium, Cassiope hypnoides, C. tetragona, Rhododendron, Arctostaphylos, Pedicularis hirsuta, Oxyria, Polygonum, Salix glauca, Luzula confusa, Carex nardina, C. rigida, Trisetum, Poa alpina, Festuca ovina, Equisetum arvense* and *E. variegatum.*

At a height of abt. 250 m the firm rock protruded as vertical walls "Hamre", highly intersected by clefts and with minute weathering products at the base. Here were found coherent plant covers, the fresh green colour of which is in contrast to the brownish gray heather-moor below. The cover consisted of: *Potentilla maculata, Sibbaldia, Melandrium apetalum, Alsine verna v. propinqua, Arenaria ciliata, Cerastium trigynum, Saxifraga nivalis, Sedum Rhodiola, Veronica alpina, Cassiope hypnoides, Phyllodoce coerulea, Campanula rotundifolia, Antennaria alpina f. glabrata, Erigeron uniflorus, Arnica, Taraxacum croceum, Hieracium alpinum, Betula nana, Salix arctica, S. herbacea, Luzula spicata, Juncus trifidus, Carex scirpoidea* (♂ and ♀), *Poa pratensis, P. glauca, Calamagrostis arundinacea* and *Cystopteris fragilis.* In crevices in the rocks were found: *Potentilla nivea, P. maculata, Arabis alpina, A. Holboelli, Alsine verna v. hirta, Cerastium alpinum, Draba nivalis, Saxifraga tricuspidata, Veronica saxatilis, Campanula rotundifolia, Salix glauca, Carex capillaris, C. pedata, Trisetum, Poa glauca* and *Woodsia ilvensis.*

This vegetation reached up to a height of 600 metres; the top of the mountain, 600—720 metres, was very sparely covered by lichens (*Cetraria nivalis* and *islandica, Stereocaulon, Lecanora*-species and others) together with mosses, among which especially *Grimmia hypnoides* made large tufts, whereof were collected: *Polytrichum sexangulare, Sphaerocephalus turgidus, S. palustris, Pohlia gracilis, Dicranum congestum, Plagiothecium denticulatum, Cephalozia pleniceps* and *Jungermannia quinquedentata.* Between the moss-tufts were found very few vascular plants, all dry and in fruit or in a far advanced state of flowering. I noted: *Cerastium alpinum* f. *lanatum, Draba hirta, Luzula confusa, Carex nardina* and *Poa glauca.*

The cause of this poverty of species was not the height above the sea, for the distance from the above named luxuriant vegetation was but slight, but is to be sought in the scarce supply of water at the top. Here were no perennial snow drifts, altogether no sign of snow-covering such as farther down and no depressions where the water might collect and stagnate; on the contrary, the rock was so cracked through all over, that all downpour must disappear immediately after the fall so as to benefit the vegetation farther below on the side of the mountain.

That the height does not interfere with the occurrence of the plants is seen by the following list of plants collected by Koch on Henry Land, abt. 940 m up to ab. 1000 m:

Chamænerium latifolium.	*Alsine verna.*
Silene acaulis.	*Melandrium apetalum.*
Alsine biflora.	*Cerastium alpinum v. lanatum.*

Draba alpina.
Papaver radicatum.
Ranunculus glacialis.
Saxifraga decipiens.
— *cernua.*
— *tricuspidata.*
Pedicularis hirsuta.
Vaccinium uliginosum.
Cassiope tetragona.
Rhododendron lapponicum.
Campanula rotundifolia.
Arnica alpina.
Salix glauca.
Oxyria digyna.
Polygonum viviparum.
Luzula confusa f. subspicata.
Poa pratensis.
— *glauca.*
Phippsia algida.
Cystopteris fragilis.
Woodsia ilvensis.
Polytrichum sexangulare.
Sphaerocephalus palustris.
— *turgidus.*
Dicranum congestum.
Grimmia hypnoides.
Plagiothecium denticulatum.
Odontoschisma Macounii.
Cephalozia pleniceps.
Martinella Bartlingii.
Jungermannia quinquedentata.
Nardia minor.

These plants were gathered on the mountain side from a height of 940 m up to the 1000 ms. high top partly on herby slopes, partly on the rocks near the top. It is easily seen, that the top has had the same spare flora, while the herby slopes, although 250—300 metres higher than the mountain top ascended by me, have had a character corresponding to the herby slopes in a height of 500—600 metres.

Turner Sund (N. Hartz).

The vegetation is as a rule very poor upon the mountain-slopes and on the narrow foreland by Turner Sund. The lack of stability of the soil is probably an essential cause for the poverty. The weathering of the basalt is very considerable out here at the coast; the melting-water and the avalanches in spring, mountain-slides in the summer-time tear up the steep slopes with a prodigious force; huge holes and deep furrows are often seen in the cones of débris and in the gravel, even away in the narrow lowland between the mountain slopes and the sound. The remnants of the destroyed

Fig. 3. *Salix arctica*, 1/2 nat. size, phot. Chr. Kruuse.
Gravelly bottom, Turner Sund, The cape, 27. 7. 00. Completely decumbent bush; the rugged branches wind between the gravel, no branch and no leaf rises 1 cm above the gravel (a few small specimens of *Stereocaulon* in the gravel round the *Salix*-bush).

and killed vegetation are often seen in the midst of the destroying, down-rolled masses of stones.

The plants often completely change their aspects in these exposed places. *Silene acaulis* evidently can endure a good deal; it is often seen with the strangest of shapes; the normal thick tuft with a circular outline is destroyed and torn up, and the single shoots are isolated; but so long as the long, obliquely lying (originally vertical) tap root is well anchored amongst the stones the plant keeps in life and sets flowers and fruits (Fig. 4). *Arenaria ciliata* too is a plant which can live surprisingly long and well upon slides. On normal, tranquil ground it most often forms dense semi-globular tufts; but often did I see it on the sliding slopes with stretched joints and fibrous, yet flowering and fructiferous; also this plant has a long, powerful tap root reaching far into the ground.

Rarely have I seen a so marked «striate land» as in the basalt-tracts here at Turner's Sund, especially on the flat or gently sloping foreland between the mountain slope and the sound (mentioned and figured by O. Nordenskjöld in "Medd. om Grønl." XXXVIII, p. 274).

If one follows the direction of the basalt ridges and the coast line at a right angle to the «striae» one alternately passes walls of big, sharp edged blocks and grooves between the walls made up of finer material, gravel and sand, rushing torrents of melting-water and avalanches having torn open the surface, now here now there, at different times.

In the grooves is found an exceedingly poor — yet if the groove has been for some time preserved of more considerable devastations — tolerably continuous, cover forming vegetation, chiefly formed by the little *Anthelia julacea,* which is often completely blackened by old, dried-up membranes of algae (doubtless *Cyanophyceae*).

In the spring time these localities are exceedingly moist; then this vegetation does live; during our stay the proper melting period was over and the topmost part of the grooves, nearest the foot of the mountain, was as a rule dry. Together with *Anthelia* are found some *Stereocaulon* and *Cetraria islandica* and a few phanerogams, but greatly scattered: *Oxyria digyna, Ranunculus pygmaeus, Ranunc. glacialis. Luzula confusa, Salix arctica* in small decumbent specimens (Fig. 3), rarely *Salix herbacea* (which is strangely scarce in this region), *Saxifraga cernua, stellaris, decipiens* and *oppositifolia, Polygonum viviparum, Cerastium alpinum, Chamænerium latifolium, Draba alpina, Silene acaulis, Cardamine bellidifolia. Alsine biflora.*

Whenever the groove is broad and has been left tranquil for a longer period *Dryas, Cassiope tetragona, Carex nardina, Papaver* and more species occur.

The *Anthelia*-crust cracks in the drought into little polygonal fields of a size of 2—5 cm^2; in the fissures between the fields (checks) there soon appears a small, fine, crisp form of *Cetraria islandica.* In proportion as one gets from the beach farther up towards the base of the mountain *Cetraria islandica* spreads more and more widely in the *Anthelia*-cover, *Cassiope tetragona, Vaccinium uliginosum* and other heath plants begin to occur; among others I noted in such places *Dryas, Pedicularis hirsuta* and *Grimmia* (*hypnoides*?).

While down at the beach, where in many places there still lay an enormous ice-foot and large snowdrifts, we still had the first spring with small, undeveloped flower buds and humidity in the *Anthelia*-cover; but according as we withdrew from the beach, we advanced into a more and more complete summer with flovering herbs and bone dry bottom; the difference in temperature was felt quite immediately.

The most luxuriant vegetation was found here as by Cape Dalton at an elevation of from 250—500 m above the sea level, where one is above the frequent cold fogs. During nearly the whole of our stay the fog kept covering the lowest part of the mountains.

Viewed from a long distance here as there are seen green bands stretching horizontally across the mountain, evidently corresponding to the beds of the basalt. In below the «hammers» (rock ledges) there is always a narrow relatively quiet belt, where humus may collect and fine dust from the mountain slides settle down, while the big stones rolling downwards skip over; and here is found the most luxuriant vegetation, the greenest green in these tracts.

On the 25th of July I made a trip to the other side of the sound, chiefly in order to investigate some large whitish-yellow spots which could be discerned by the telescope from up the mountain side north of the sound; they were found to consist of white-burned schist (abt. 550 m above the level of the sea).

While the lowland was barren and desolate, cross furrowed by melting-water and avalanches, torn open by downs lidden blocks, in short as mentioned above, the vegetation got richer and more luxuriant in proportion as one came up the mountain.

Abt. 250 m above the level of the sea were seen large continuous carpets of decumbent *Betula nana* and *Vaccinium uliginosum*, at the edges bordered by *Empetrum*. Here were also noted the following species all in flower: *Pedicularis flammea*, *Sedum Rhodiola*, *Silene acaulis*, *Juncus trifidus*, *Cerastium alpinum*, *Taraxacum croceum*, *Antennaria alpina*, *Polygonum viviparum*, *Sibbaldia*, *Veronica saxatilis*, *Carex scirpoidea*, *Potentilla maculata*. Here was found a humble-bees' nest dug out by some animal (fox?) and lemmings. Abt. 450 m above sea level were only quite little dwarfspecimens of *Euphrasia latifolia* on gravel.

In the basalt-débris abt. 550 m above the sea-level: *Equisetum variegatum*, *Salix arctica* and *glauca*, *Campanula rotundifolia* (very low stalk, but large, deep blue flowers), *Arenaria ciliata* with a great many flowers (☿, ♀), *Poa glauca*, *Saxifraga nivalis*, *oppositifolia* and *tricuspidata*; the latter

Fig. 4. *Silene acaulis*, 1/3 nat. size, phot. Chr. Kruuse.
Gravelly bottom, Turner Sund, The cape. 27. 7. 00. The south side of the tuft is covered with flowers and flower buds, whereas its northside is killed by the wind (a few leaves of *Polygonum viviparum*).

was very conspicuous with its deep red leaves; besides the small-leaved form of *Dryas octopetala.*

Vascular plants from Cape Dalton and Turner Sund.

Dryas octopetala and *f. minor.*
Potentilla maculata f. hirta.
— *pulchella.*
— *emarginata.*
— *nivea.*
Sibbaldia procumbens.
Chamænerium latifolium.
Empetrum nigrum.
Silene acaulis.
Melandrium apetalum.
— *triflorum.*
Sagina nivalis.
Alsine biflora.
— *verna.*
Arenaria ciliata v. humifusa.
Stellaria humifusa.
— *longipes.*
Cerastium alpinum.
— *trigynum.*
Cochlearia officinalis var.
Draba alpina.
— *crassifolia.*
— *nivalis.*
— *Fladnizensis.*
— *hirta.*
— *arctica.*
Cardamine bellidifolia.
Arabis alpina.
Arabis Holboellii.
Papaver radicatum.
Thalictrum alpinum.
Ranunculus glacialis.
— *pygmæus.*
— *hyperboreus.*
— *altaicus.*
— *nivalis.*
— *arcticus.*
Saxifraga nivalis.
— *stellaris v. comosa.*
— *cernua.*
— *rivularis.*
— *decipiens.*
— *tricuspidata.*
— *oppositifolia.*
Sedum Rhodiola.
Veronica alpina.
— *saxatilis.*
Pedicularis hirsuta.
— *lapponica.*
— *flammea.*
Euphrasia latifolia.
Pyrola grandiflora.
Arctostaphylos alpina.
Phyllodoce coerulea.
Cassiope hypnoides.
— *tetragona.*
Rhododendron lapponicum.
Vaccinium uliginosum.
Campanula uniflora.
— *rotundifolia.*

Taraxacum croceum.
Hieracium alpinum.
Antennaria alpina.
Erigeron uniflorus.
Arnica alpina.
Koenigia islandica.
Polygonum viviparum.
Oxyria digyna.
Salix herbacea.
— *glauca.*
— *arctica.*
Betula nana.
Juncus biglumis.
— *triglumis var.*
— *trifidus.*
Luzula spicata.
— *confusa.*
— *spicata.*
Eriophorum Scheuchzeri.
Carex nardina.
— *ursina.*
— *scirpoidea.*
Carex glareosa.
— *rupestris.*
— *rigida.*
— *salina v. subspathacea.*
— *capillaris.*
— *pedata.*
Alopecurus alpinus.
Trisetum subspicatum.
Phippsia algida.
Glyceria vilfoidea.
Poa glauca.
— *alpina.*
— *cenisia.*
— *pratensis.*
Festuca ovina.
Calamagrostis arundinacea.
Lycopodium Selago f. appressa.
Cystopteris fragilis.
Woodsia ilvensis.
Equisetum variegatum.
— *arvense.*

Dunholm (N. Hartz).

On July 30th we went on shore for a couple of hours on this small island, a low split basalt islet, the highest summit of which lies abt. 30 m above the level of the sea. Over a large part of the island is a white covering of salt. Sun lit as it lay during our stay, in the midst of the dense sea of fog, surrounded by the crackling ice and made a kind and smiling impression upon all of us.

The vegetation is a pure strand vegetation; but 7 species of phanerogams were found: *Glyceria vilfoidea, Phippsia algida, Carex glareosa, C. salina v. subspathacea* and *C. ursina, Cochlearia officinalis v. groenlandica,* and *Stellaria humifusa.*

In the reddish coloured carpet of the *Glyceria* shone thousands of little white starflowers (*Stellaria humifusa*); here and there low, dense, yellowish-green tufts of *Carex ursina* rose above the carpet, the inflorescenses quite hidden in the tufts. *Carex subspathacea*, this tiny inconspicuous *Carex*-species, which has no doubt been often overlooked in Greenland, was rather frequently intermingled between the *Glyceria*-cover, especially in the immediate vicinity of the beach.

In dry crevices in the basalt the *Cochlearia* grew very tall and vigorous and displayed a surprising abundance of flowers; down in salt marsh it kept lower (3—5 cm).

Around a small pool filled with algae and gnat worms — abt. 25 m above the level of the sea — stood as mentioned in the account of the voyage p. 164, a group of Esquimaux houses; on the ruins of the houses grew the same strandvegetation as everywhere else upon the island, only more luxuriantly on the manured ground. *Alopecurus alpinus*, ordinarily the faithful follower of Esquimaux houses could not be found here; it frequently grows on the slopes towards the open sea; but probably the saltness of the ground has been too much for it here.

On the low rocks brood a great many eider ducks, and between the nests grew *Glyceria vilfoidea* and *Stellaria* particularly high and luxuriantly between big bush-shaped lichens and *Grimmia*-tufts. — In rock crevices, where there was shelter, shade and manure, were found 20 cm high, etiolated *Cochlearia* with very thick fleshy leaves and ripe fruit.

On the west side of the island was a very low tract of land which was partly covered by brackish water, partly above water, yet so low that it is flooded at springflood, protected from the sea by a strandwall. The water was filled with algae, and the drained part of it covered either by dried up algal membranes or by a dense carpet of *Carex salina* v. *subspathacea* together with *Glyceria vilfoidea* (Fig. 5).

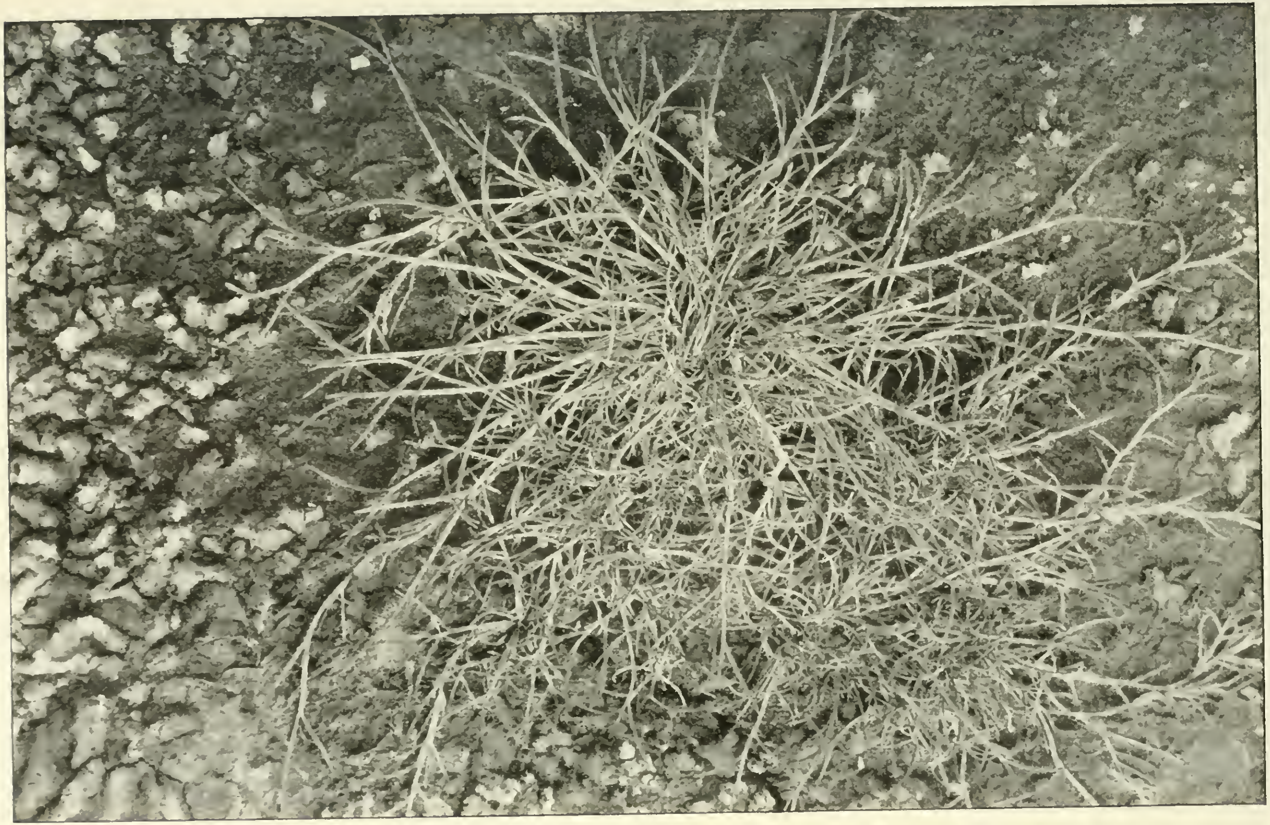

Fig. 5. Isolated tuft of *Glyceria vilfoidea* upon cover of dried up algal membranes. Dunholm. (From photo. by Chr. Kruuse).

Scoresby Sund.

Jameson Land, Dinosaur Cleft (Chr. Kruuse).

On July 31th we landed, as mentioned in the account of the voyage p. 167, about 5 miles north of Cape Stewart by the Dinosaur Cleft. The stream which runs through it is very abundant in water, fills up the whole bottom of the cleft, and seeks its way between and over numerous loose blocks. The cleft is narrow, and its steep sides are covered with débris of sandstone, which slip away under foot. Here and there a bit of solid rock, sandstone or basalt, sticks out and gives shelter to a little vegetation. At the top the cleft widens to a kettle-shaped valley, from which 3 more even, V-shaped river-valleys rise towards the plateau above Neills Klipper. I principally followed the north side of the cleft, where the vegetation was comparatively luxuriant and very abundant in species in contradistinction to the shady side, where snow-drifts and bare gravel alternate with little moss-grown patches.

Up to about 100 metres' elevation above the level of the sea the vegetation was rocky-flat formation, an open growth with the bare soil between the singly placed individuals; but these were tall, powerful, and in full blow, and the reason why they did not form a cover was evidently partly scarcity of water, partly the slipping, rather unstable ground. Wherever solid rock or large blocks hindered the gravel from gliding down were little covers, and especially where a little of the loose soil went right down to the bank of the stream, these were luxuriant. I noticed on this stretch of land the following species all in bloom:

Potentilla maculata, *Cerastium alpinum*, *C. trigynum*, *Draba hirta*, *D. Fladnizensis*, *Arabis alpina*, *Papaver radicatum*, *Chamænerium latifolium*, *Silene acaulis*, *Alsine biflora*, *Saxifraga cernua*, *S. oppositifolia*, *Rhodiola*, *Veronica alpina*, *Pedicularis hirsuta*, *Antennaria alpina* with *f. glabrata*, *Erigeron uniflorus*, *Arnica alpina*, *Taraxacum phymatocarpum*, *Oxyria digyna*, *Polygonum viviparum*, *Salix arctica v. groenlandica*, *Luzula spicata*, *Trisetum*, *Poa alpina*, *Festuca ovina*, and *Equisetum arvense*.

At an elevation of about 100 metres above the level of the sea there was some solid rock, at the foot of which a small strip of grassy slope had found shelter. Its plants were: *Poa glauca*, *P. pratensis*, *P. cenisia*, *Saxifraga nivalis*, *S. decipiens*, *Euphrasia latifolia*, *Gentiana tenella*, *Campanula rotundifolia* and *C. uniflora*. Beneath and upon the sides of the grassy slope was a shred of heather-moor, made up nearly exclusively of *Vaccinium uliginosum* with a spare intermixture of: *Potentilla nivea*, *Empetrum*, *Stellaria longipes*, *Cerastium alpinum*, *Draba hirta*, *Saxifraga cernua*, *Phyllodoce coerulea*, *Cassiope tetragona*, *Campanula rotundifolia*, *Hieracium alpinum*, *Arnica alpina*, *Salix glauca*, *Poa glauca*, *P. pratensis* and *Festuca rubra*.

The abovementioned little valley (150—170 m above the level of the sea) has sandy bottom and sides; on its western side is a large snowdrift, and the said three little valleys are filled with snow. The melting-water has dug little riverbeds through the sand in the bottom of the valley. The soil is fresh with sufficient humidity; mould is wanting; but there is shelter against the wind and favourable exposition. The bottom of the valley is covered by an extensive grassy slope. The cover was 5—10 cm high and consisted chiefly of: *Carex rigida*, *C. lagopina*, *Poa pratensis*, *Sibbaldia procumbens*, *Cerastium alpinum*, *Veronica alpina*, *Taraxacum phymatocarpum*, *Arnica alpina*, *Oxyria digyna*, *Equisetum arvense*, and *Polytrichum juniperinum*.

As a less constituent part were found intermingled among these dominant species: *Potentilla maculata*, *Epilobium ana-*

gallidifolium, Silene acaulis, Arenaria ciliata, Alsine biflora, A. verna v. rubella, Draba hirta, D. Fladnizensis, D. arctica, D. alpina, Arabis alpina, Thalictrum alpinum, Ranunculus pygmæus (partly *f. Langeana*), *Saxifraga nivalis, S. stellaris v. comosa, S. decipiens, Rhodiola, Cassiope hypnoides, Antennaria alpina, Erigeron uniflorus, Polygonum viviparum, Juncus biglumis, Luzula confusa, Carex lagopina, Alopecurus alpina, Hierochloa alpina, Trisetum,* and *Arctagrostis latifolia.*

Higher up, between 170 and 250 m above the level of the sea, upon the slopes surrounding the valley the loose layers of soil consisted of gravel with numerous much weathered blocks. They were incompletely covered by low heathermoor with large open patches where the gravel slips down. Here were noted: *Empetrum, Vaccinium, Cassiope tetragona, Dryas octopetala, Arctostaphylos alpina, Betula nana, Salix herbacea, Pedicularis lapponica, Carex nardina, C. rupestris, C. misandra, Hierochloa alpina, Pyrola grandiflora* and *Draba alpina.*

Finally the open tableland above Neills Klipper was covered by rocky-flat formation, the most conspicuous plant of which was *Salix groenlandica.* It did not rise 3 cm above the ground, the boughs were at most 5 mm thick and not exceeding 40 cm in length with very few leaves. After the willow *Dryas octopetala f. minor* and *Papaver radicatum* were the most prominent plants, and the vegetation is exactly congruent with the description given by HARTZ in "Medd. om Grl." XVIII, p. 135. This vegetation stretches, as far as we have been able to ascertain, over the whole east side of Jameson Land along Neills Klipper, and is succeded only in valleys and beds of brooks by heath or pools. It certainly is dependent on the wind-open nature of the tableland; here the snow can only make a very thin cover in winter; it melts quickly away, and the place is soon as dry as a bone. No perennial plant can rise considerably above the ground, as in that case it would be dessicated or worn off here where no shelter is to be had and the blocks themselves scarcely rise 5 cm above the bottom. The more wonderful then it is to find in this naked rocky-flat formation so many musk-oxen as was the case. I saw myself two flocks; others of the landing party saw two other flocks and some single bulls, and in the neighbourhood of this place Deichmann later on killed 14 of these animals. It is, however, an unquestionable fact that the musk-ox chiefly feeds on the leaves and young shoots of *Salix arctica*, and this is just the place where it is likely to find them in the greatest extent, and I am apt to think that it takes to the rocky-flats in winter also, because the snow-coating is thin up here and accordingly easily broken through. In summer it is not found in the lowlands of Klitdalen, and even the luxuriant grass-meadows around the ponds upon the Liverpool Land were only sparely grazed. The clipping of the grass we saw here was irregular, was found closest to the water, always accompanied by great quantities of excrements of geese. and therefore surely due to these animals. On the contrary, great quantities of the manure of musk-oxen together with plain vestiges of grazing were found upon the flat abunding in *Salix* and *Dryas* at Jameson Land east of Nathorst Fjæld, and in the brook-valley north of this were seen some lone animals.

From the Dinosaur Cleft the voyage was carried on to the Fame Islands, where we lay at anchor from the 1st to the 10th of August.

Fame Islands (Chr. Kruuse).

The Fame Islands are a small group of little islets with low rocks, among which are low, nearly horizontal flats consisting of clay and gravel. The single rocks have evidently been separate islets at a time when the height of the water was greater, and then a considerable precipitation has taken place in the little tranquil sounds. Now the flats lie 2—5 m above the surface of the water somewhat inclined towards the beach, which is reached in rather narrow interstices between the rocks. Here the surface gets a litle more curved downwards and ends in a small bluff, where the sea is at present eroding. Their surfaces are strown with small flat stones (up to

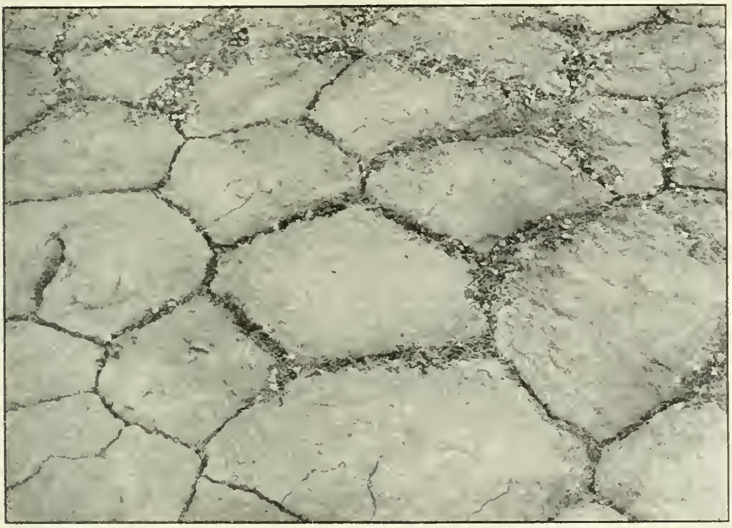

Fig. 6. Young "Rudemark" with *Stellaria humifusa* in the crevices. Fame Islands. (From photo. by Chr. Kruuse).

10 cm in diameter) covered with a rather scarce growth, especially towards the centres; but thus the condition of the bottom shows the plainer. During our stay the bottom was completely dry, stonehard and cracked into irregular, polygonal checks with 5 or 6 sides and greatest diameter at a right angle with the slope ("Rudemark", fig. 6—8). The cracks separating them are up to 6 cm broad, and one may introduce into them a 17 cm long straw; but they are doubtless often much deeper. I saw them in all developmental stages, now one year old filled

with *Stellaria humifusa* (see fig. 6), *Cochlearia officinalis* f. *minor* with numerous cotyledonous plants, *Glyceria vilfoidea* or *Dryas*, now new ones, which are still standing with sharp edges without any vegetation, or beginning ones, which are as yet represented only by fine scratches.

It was not until I saw the outmost, arched parts of the check-field that I had a clear understanding of the formation

Fig. 7. Sliding clay ("Rudemark") with semi-covered *Silene*-tufts. Fame Islands. (From photo. by Chr. Kruuse).

of this net of cracks. Here the clay was evidently in movement in the wet season. In the spring the whole mass, soaked and plastic, will slide gently downwards to the beach, where the breakers successively lick it away. The bottom is here naked, at the most covered with flat pebbles, but here and there, with long intervals stand tufts of *Silene acaulis*, *Armeria sibirica*, *Arenaria ciliata*, *Taraxacum phymatocarpum*, *Stereocaulon denudatum v. pulvinatum*, *Cetraria* *nivalis.* These are all of them densely tufted plants with a powerful, deepstriking main-root anchoring them solidly. The individuals are vigorous — the biggest *Silene*-tuft that I saw was 8 cm in diameter — but on all sides surrounded by the clay which rises 8—14 mm above the borders of the tufts (see fig. 7); here and there are tufts, which are inundated barring the inmost shoots, and dead tufts, which have evidently once been buried, but have been bared again by abra-

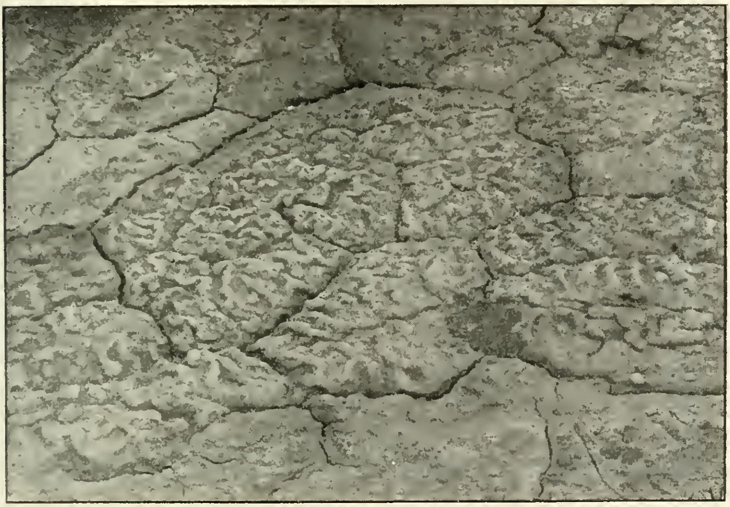

Fig. 8. Young "Rudemark". A gently inclined flat of clay covered with algæ and Hepaticæ with new crevices. Fame Islands. (From photo by Chr. Kruuse).

sion, are also seen. Here the crack-systems go across the flat (at right angles to the inclination) but are little arched, so that a series of corresponding checks make an arch with the convexity towards the sea. It is evident that the extremes of the clayey flats "trail" against the rocks, so that the movement is strongest in the middle.

Wherever the humidity has kept a little longer in the summer the surface is covered by a blue-gray, abt. 5 mm thick layer of algae with a spare admixture of *Anthelia ju-*

lacea, which in the checks lies in irregular folds of abt. 7 mm height (see fig. 8).

The inmost part of the flats, which is highest located, is very much washed out, and here the loose layers of soil consist of sand and gravel, which is nearly bare and drifts a little; here are only found a few decumbent, highly windworn individuals of *Salix groenlandica* (with *Melampsora arctica*) *Silene* and *Elyna Bellardi*.

In crevices and upon ledges as well as upon the rocks is found a powerful vegetation consisting of:

Dryas octopetala, *Potentilla pulchella f. elatior, P. nivea*, *Empetrum*, *Silene, Melandrium triflorum*, *Stellaria longipes*, *Cerastium alpinum*, *Arenaria ciliata*, *Lesquerella arctica*, *Saxifraga oppositifolia f. pulvinata*, *Rhodiola*, *Arctostaphylos alpina*, *Pedicularis hirsuta*, *Taraxacum phymatocarpum*, *Erigeron uniflorus*, *Arnica alpina*, *Polygonum*[1]), *Salix glauca*, *Betula nana*, *Luzula spicata*, *Carex incurva*, *Poa alpina*, *P. glauca f. elatior*, *P. pratensis*, and *Cystopteris fragilis*.

Finally *Glyceria vilfoidea*, *G. angustata*, *Stellaria humifusa*, *Cochlearia officinalis v. groenlandica*, and *Carex ursina* grow near the sea.

Jameson Land of Fame Islands (Chr. Kruuse).

From Vargodden towards Nathorst Fjæld extends a low sandy flat crossfurrowed by the delta arms of the streams and by dry, abandoned ditches; it is evidently a marine terrace, the building up of which is still being continued, an extensive flat with 15 cm of water (and more), which is partly dry at low water, stretching outside the present, feebly marked coastline. Its demarkation towards the deep water is distinctly marked

[1]) Very much injured by *Puccinia septentrionalis* and *Sphaerella hydropiperis*.

by a steep fall. The coastline is indicated by a very low (20—40 cm high) strand-wall of sand with sticks, leaves and, although very sparely, algae. It is thinly covered with *Glyceria distans.* Within, the sandy flat is low (hardly 10 cm above the level of the sea at high water), nearly plane, moist (groundwater in 7 cm depth), with many empty watercourses. It has a very scarce growth of *Glyceria vilfoidea, Potentilla pulchella, Stellaria humifusa* and *Cochlearia groenlandica.* There are abt. 2 metres or more between the respective tufts. Inside this extensive flat is found an old beach-line where the land rises to a flat 40—60 cm above the present height of the water. On this flat, where the groundwater is only found in 30—35 cm depth, grows *Glyceria distans, Carex ursina* and *Potentilla pulchella,* and also, in smaller numbers, *Salix arctica* and *Taraxacum phymatocarpum.* There is, on an average, 2—3 metres between the tufts, and the sand is elsewhere completely bare with the exception of some small flat depressions, viz. sanded-up watercourses, where the sand is namely slightly greenish from algae *(Confervae* and *Desmidiaceae).*

The individuals are strongly tuftshaped *Carices* and tunicate *Glyceriae,* and leaves and stalks are covered by clay and sand-dust. The surface of the sand is hard, sand drift is not seen, no more are dunes; the whole surface is full of little fissures and gives one the impression of being inundated in winter and during the period of melting.

Within this flat the land rises gently to abt. 1 m's height above the level of the sea; only here and there are seen the half obliterated vestiges of an old terrace-border. It is covered with *Salix groenlandica* in great specimens together with some few *Alopecurus alpinus*; here also are great open intervals between the tufts.

This *Salix*-flat rises evenly inwards till a height of abt. 2 m above the level of the sea and becomes more dry. The surface of the sand is now loose, it drifts.

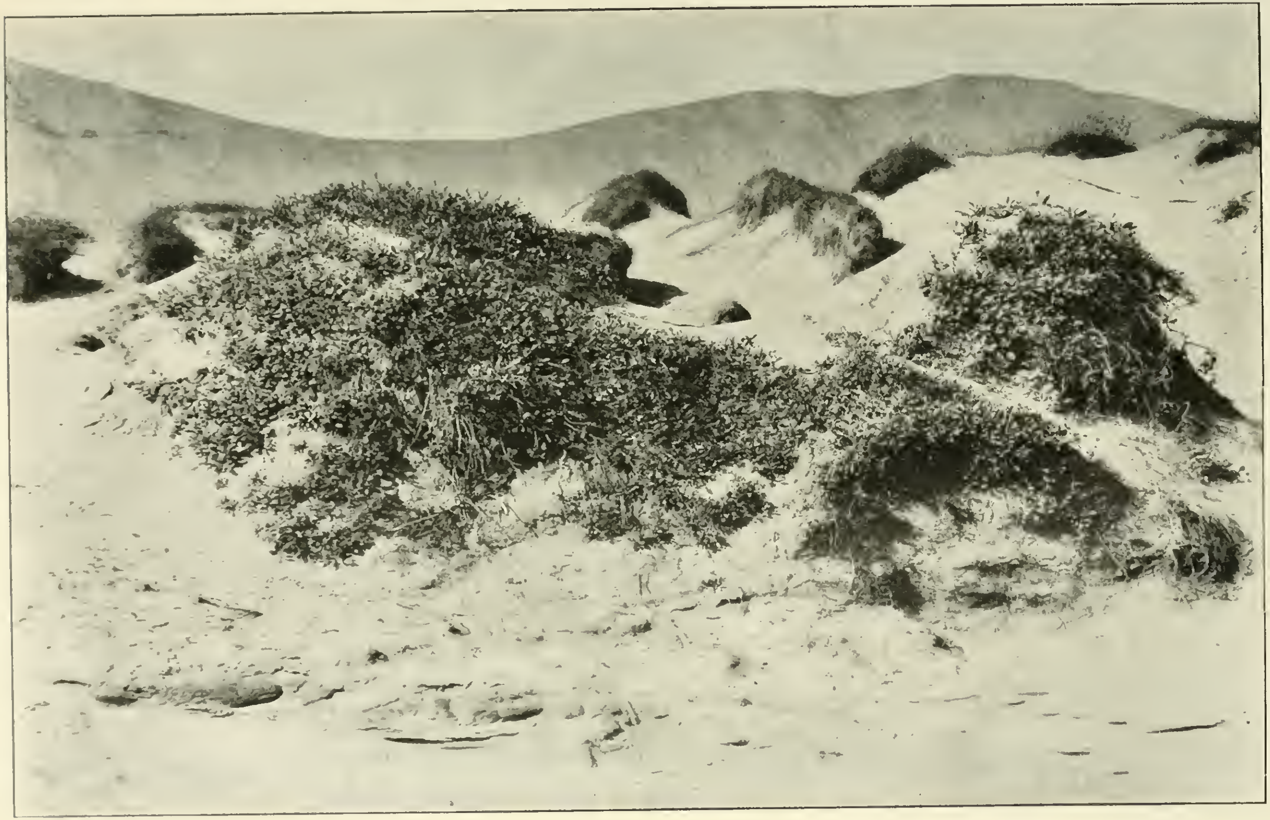

Fig. 9. Drift-sand with *Salix* and *Festuca rubra*. In the fore-ground the dune is broken down showing dark streaks of former vegetation-cover. Jameson Land of Fame Islands. (From photo. by Chr. Kruuse).

On the flat is a narrow, 2—3 (sometimes 4) m high sandy area, extending lengthwise from north to south, the surface of which is loose sand covered with *Festuca rubra* and *Poa pratensis,* standing with intervals of abt. 5 cm between the straws. Towards N. and N. E. the sand-area has nearly vertical walls (fig. 9) in which are seen undulating, irregular, wedging out, humous dark layers of a thickness of up to 6 cm and varying in extension. Besides sand these dark layers contain clay and some roots, both fresh and mouldered, but no remnants of leaves and stems.

The slopes have evidently been formed by the wind which has broken up the sand and carried it towards south; thus, there is in front (north of them), a flat with numerous little hillocks of sand (30—60 cm in diameter and 20—40 cm high) formed around or, at any rate, covered whith *Carex incurva;* it is evidently the abrasion-flat where the sand has formely been located. At the south end of the sandy area the sand settles again in loose, softly undulating heaps with windstreaking in the direction E.—W. In and upon the sand grows *Salix arctica* f. *groenlandica* (possibly also *S. glauca* f. *subarctica*) and *Carex incurva*, a more secondary constituent being formed by *Chamænerium latifolium* and *Poa pratensis. Salix* forms metrehigh, on the leeside (S) freshgreen tufts, the interiors of which are filled with sand, and which are covered on the windside (N or NNW) by the white micaceous sand, which has only a slight inclination.

The willows evidently thrive exceedingly well under these conditions, the individuals are bigger and more vigorous than usually, boughs and stems certainly are seldom more than 1 cm thick but, in return, rank, and the ramification is richer than usual. The leaves are large and close-sitting, and fructifications are very common. The year-shoots are, on an average, 7 cm long and erect or at right angles with the surface of the sand. The willow is best characterized as espalier on the sunny side and lee-side of the sand (these terms being identical here). That no vigorous main trunk is found, as generally with the espaliers, is probably due to the travelling of the sand.

The sand-drift surely takes place principally during the summer halfyear, as the sand the other time must be frozen and covered by snow and snow-crust; were the contrary the case one would be sure to see also traces of sand-wear upon the older, 2—3 years old shoots; but such are not seen. On the other hand the young 1—2 year old shoots forming the windward side of the bush are, as a rule, eroded and either killed or dying, and the destruction is slowly advancing towards the leeside, while at the same time its shoots are being covered by sand. Sometimes the wind gets the upper hand, and the bush is totally killed, and the sandhillock is demolished; the remnants of it are then seen as an irregular, one metre high cone, loosely covered by free-hanging branches and roots of willows and showing the above mentioned stratification.

Between the *Salix*-tufts are also seen the peculiar sand-formations which we named "coffins" (cpr. p. 399 and fig. 24). They are longish, narrow elevations with steep sides, which have here the direction E—W, i. e. from Nathorst Fjæld towards Hurry Inlet, and are here covered whith *Festuca rubra* v. *arenaria, Carex incurva* and *Poa pratensis.*

Festuca, which is the most frequent one, has horizontally creeping rhizomes and 15—20 cm high single straws, which at the ground are encircled by old straws and sheaths. Viewed from a distance it forms a rather dense, undulating covering. *Poa pratensis* is found much less frequently, but has a similar growth, still its lateral shoots are not so long as those of the former. *Carex incurva* forms here little tufts of abt. 10 cm height with closely placed leaves and straws encircled by remnants of old leaves; it can, however, also form a very open, abt. 5 cm high cover. It sticks more firmly to the sand than *Festuca,* and can endure considerably more erosion; it is therefore also this latter which remains, when the sand is torn up by the wind. The bottom between these gramineous plants is, both upon the "coffins" and upon the sandy flat, quite bare; neither mosses nor lichens are found.

Within this sandy area the sandflat was continued somewhat farther with an elevation of abt. 1 m above the level of the sea, but sank again to a height of abt. 70 cm in a very broad, flat depression. This is evidently an old bed of the stream which comes from the northern side of Nathorst Fjæld, whereas the above-mentioned sandy area represents a delta-island.

The depression was cross-furrowed by ditches, which had at some places, in a depth of 50—60 cm, a little stagnant water. These are beds of brooks, which in this spring have been dug out by the melting water from Nathorst Fjæld, but are now on the point of drying up. Their direction is indicative hereof, as they follow the line of gravitation from the mountain, but later on incline towards south and are lost in the large flat of the old riverbed. I suppose that the latter is flooded in the snowmelting period.

On the edges and sides of these ditches grew a hydrophilous vegetation made up of: *Equisetum variegatum* f. *anceps*, *Juncus biglumis, J. castaneus, Alopecurus alpinus* and, here and there, little specimens of *Salix arctica.* Between these the sand was coherent and greenish-coloured by algae, and in very moist spots grew little specimens of *Marchantia polymorpha.*

From within the depression the land rises evenly and is covered by a rather dense, abt. 5 cm high heath, formed by:

Dryas octopetala, Salix groenlandica, Pedicularis hirsuta, Stellaria longipes, Polygonum viviparum, Elyna Bellardi and *Alopecurus alpinus.* All these plants were greatly clipped by grazing, and frequent excrements bore witness that the musk-oxen had been here recently. Besides the bottom was undermined by lemmings so densely, that there was nearly one hole per one m^2, and many of the plants, yet chiefly *Polygonum* and *Salix*, were distinctly marked by the jaws of this small animal. Nevertheless I did not see during my stay here one single lemming above the ground; nor did the musk-oxen show up here during the whole of our long sojourn at the anchorage. On the contrary the ground was in many places covered with the footprints of wolves, and a few wolves that we saw at Vargodden were making for this place.

In the heath were dominant: *Dryas octopetala* f. *minor, Betula nana, Vaccinium uliginosum f. microphyllum* and *Arctostaphylos alpina.* Among these were found in lesser numbers: *Chamaenerium latifolium, Papaver radicatum, Draba alpina, D. hirta, Lesquerella arctica, Arabis alpina, Saxifraga oppositifolia, Pyrola grandiflora, Pedicularis hirsuta, Arnica alpina, Polygonum viviparum, Oxyria digyna, Salix glauca* v. *subarctica, Elyna Bellardi, Carex lagopina* and *Trisetum subspicatum.*

In the rocky-flat formation above *Chamænerium latifolium* and *Arnica alpina* especially attracted notice by their numbers and the size of the flowers. The mountain-side itself was very poor in vegetation, cross-furrowed as it was by clefts of wild brooks, whose stony ranges and ditches also extended over the foot of the mountain, where they appear, however, with less force.

Liverpool Land of Fame Islands (Chr. Kruuse).

The coast of Liverpool Land stands, at the head of the inlet, with a steep bluff, while the more southern coast slopes down gently; on Jameson Land it is the reverse. Here the head of the inlet is flat, whereas Neills Klipper farther south descend abruptly to the sea with a step talus. This is surely due to the condition of the currents in Hurry Inlet. Along Liverpool Land the current runs in-shore at flowing tide, and as there is here no stream of any importance, there is no deposition of layers, but a demolition is going on of formerly deposited sediment. Along Jameson Land the current runs at ebbing tides off-shore (southwards), carries along the enormous sand masses from the streams of Klitdalen, and deposits them northernmost along the western side as big sand flats.

Just opposite to the Fame Islands the coast bluff of Liverpool Land is 20—25 m high and inclines abt. 30° towards the horizon. It consists of sand, sandy clay, and gravel with boulders of up to the size of a hand. At the top, and in the nearest vicinity of the sea, it is completely vertical; it is evidently an old marine terrace (which is also suggested by spare shell-fragments) formed by materials from névé-brooks at a time when the Liverpool Land was covered by the inland-ice. Outside the beach a new terrace is forming all the way towards the Fame Islands; there is from 20 to 50 cm water upon it.

The bluff towards the sea is sparely covered with *Chamaenerium latifolium, Braya purpurascens, Lesquerella arctica,* and down-slidden parts of the vegetation of the surface.

The surface of the terrace is a stony plain, densely paved with little flat boulders and with a thin clayey coating between the stones. Sand drift is not found. It is sparely covered with low specimens of: *Dryas octopetala* f. *minor* and **integrifolia, Erigeron uniflorus, Polygonum viviparum* f. *alpina, Salix arctica* f. *groenlandica, Elyna Bellardi, Carex nardina, Poa glauca,* together with the following lichens: *Cetraria nivalis, C. islandica* v. *crispa, Parmelia saxatilis, Psora atrorufa, Stereocaulon denudatum* v. *pulvinatum, Xanthoria vitellina, Urceolaria scruposa* etc.

The distinctly tuftshaped individuals are much eroded, it being not, however, possible to show any precisely marked direction of the wind. Two *Erigeron uniflorus*-tufts, which grew hardly 25 cm apart from each other, were injuriously affected, one from the south, the other from the north, and the case is much the same with the *Dryas*-specimens (Fig. 10). The ground between the phanerogams is mainly naked, and even the lichens are greatly cowed and worn. The scantiness of the vegetation is, however, due chiefly to scarcity of water and, secondly, to want of shelter.

Fig. 10. *Dryas octopetala*. Liverpool Land. A highly windworn specimen. del. H. OLRIK.

At a somewhat greater distance from the bluff the surface descends to flat depressions partly without outlets, partly with outlets in narrow clefts, which cut through the terrace and are formed by brooks, now partly dried up or nearly waterless. Here is found a somewhat richer and, above all, higher vegetation, which is, however, only exceptionally able to cover the bottom. I noted:

Melandrium apetalum, Stellaria longipes, Saxifraga oppositifolia, S. nivalis v. *tenuis, Armeria sibirica, Pedicularis hirsuta, P. flammea, Rhododendron lapponicum, Vaccinium, Arnica alpina, Salix groenlandica, Polygonum, Juncus biglumis, J. arcticus, J. castaneus, Eriophorum Scheuchzeri, E. polystachium, Carex nardina, C. rigida, C. rariflora, C. rupestris, C. lagopina, C. ursina, C. capillaris, Glyceria Vahliana* and *Equisetum arvense.*

Farther inward, towards the east, this vegetation, which in the most humid localities had the appearance of pools without continuous cover, is continued in a luxuriant *Cassiope*-heath with a dense, 10—15 cm high cover. The few herbs were quite secundary. I noted here:

Potentilla maculata, Cerastium alpinum v. *lanatum, Draba alpina, Saxifraga oppositifolia, Pedicularis hirsuta, Erigeron* *uniflorus, Luzula confusa, Carex nardina, Hierochloa alpina* and *Poa alpina*.

Through the heath-flat stretched some winding 5—15 metres high gravelly (clay and sand with boulders) walls; their sides were rather steep (20—25°), the surfaces slightly arched or flat, from 2—10 m broad. They were covered with a rather open vegetation consisting of:

Potentilla nivea, P. maculata, Sibbaldia, Cerastium alpinum, Alsine biflora, A. verna, Melandrium triflorum, Rumex acetocella, Draba alpina, D. hirta, Arabis alpina, Saxifraga cernua, S. decipiens, Armeria[1]), *Pedicularis flammea, Campanula uniflora.*

On the plain between the walls are found numerous shallow ponds surrounded by meadows or bogs, which are evidently flooded in the spring time. The meadows, which are smaller in extent, are chiefly made up of *Carex pulla* (with *Leptosphaeria epicareta), C. scirpoidea, Poa pratensis, Arctagrostis latifolia, Phippsia algida, Juncus castaneus, Koenigia islandica, Cardamine pratensis, Ranunculus altaicus* and, nearest the margin and in the water, *Pleuropogon Sabinei* (fig. 11). It stands lonely or, at most, two or three specimens together without covering the bottom, which consists of sand with a 1—2 cm thick layer of mud, preferring seemingly little sheltered bays between blocks of stone. It is by no means rare here, but blooms sparely, and is when sterile difficult to recognize, for which reason it is easily overlooked, the more so because its habitat is one of the most disagreeable places in the country on account of the countless hosts of gnats hovering round the water. They were to the highest degree hampering during the work, so much that e. g. I was hardly able to keep the lens of the apparatus free of them while photographing.

The water in the ponds is greatly filled with gnat-worms, but I did not see other insects or crustacea. In the water it-

[1]) Attacked by *Pleospora platyspora*.

self stood a very thin-stemmed form of *Equisetum arvense*, *Hippuris vulgaris*, and *Ranunculus hyperboreus* in small numbers, so that they were nowhere able to cover the bottom or even import to it a green colour; in somewhat greater quantities were found *Amblystegia*, and along the border *Spaerocephalus turgidus* and *Pohlia albicans* v. *glacialis*.

The tufts of the bogs were covered by *Carex scirpoidea*, *C. pulla*, *Arctagrostis latifolia*, *Ranunculus pygmaeus*, *Cassiope*

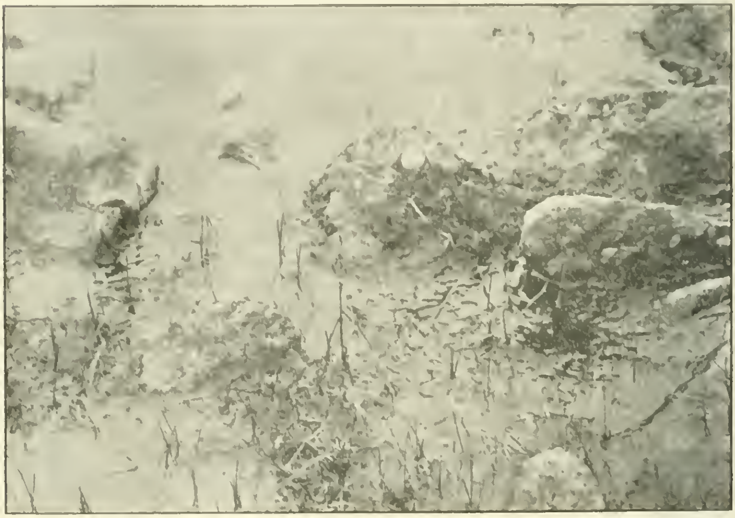

Fig. 11. *Pleuropogon Sabinei* in the margin of a pond. Liverpool Land, Hurry Inlet (From photo by CHR. KRUUSE).

hypnoides, *Pedicularis flammea*, *Equisetum arvense* and *Marchantia polymorpha*, *Russula* sp., *Boletus scaber* and *Lycoperdon favosum*.

The tufts were abt. 30 cm high and their shady sides completely covered by the dark green thallus of *Marchantia*; the checks were quite bare of any vegetation.

Both the meadows and the pools were highly clipped by the grazing of geese, the excrements of which were found in abundant quantities on the banks; also the musk-oxen seek the ponds, although, probably, only in order to drink. In the soft bottom I often saw their traces, on the other hand no regular grazing was found nor any of their manure.

Inside the low country the archæan rocks rise in gentle, iceground slopes, and here the vegetation changes completely in character. The rather meagre *Cassiope*-heath is succeeded by a luxuriant *Vaccinium*-heath with a dense cover of from 15 to 20 cm height (Fig. 12). The bushes are up to 36 m^2, fresh green or red in the top from *Exobasidium* and sometimes spotted by *Lophodermium maculare* and have abundant ripe fruit. The formation is a nearly pure Vaccinietum, and merely secondarily was found here and there a specimen of *Empetrum* or *Cassiope tetragona;* on the contrary, there were large patches with *Betula nana,* especially at the steepest spots with southern exposition; the branches rose here to 25 cm above the ground, and the cover was completely dense. The leaves had, however, already begun to assume their orange-tawny, autumnal hue, and the fruit was ripe. With regard to herbs the only ones found here were *Cerastium alpinum, Pyrola grandiflora, Arnica alpina*, and *Polygonum viviparum* f. *vulgare* (Fig. 12).

About where the *Vaccinium*-heath borders on the lowland was found a semicircular wall of gravel and stones with its concave side facing the mountain side. Into it ran a small brook, whose water collected to a pool in the middle and disappeared into the ground, to reappear as springs farther down the slope. An arm of the brook turned the southern side of the wall. The inward hollow was covered, between glacial blocks, with *Vaccinium,* only the pool in the middle was devoid of vegetation. Towards the summit of the wall *Vaccinium* became more small-leaved (f. *microphyllum*), low and adpressed to the ground, and on the upper side very leafless, so that the lichen-covered ground was seen everywhere. On the arched upper-side of the wall, and only here, were found some dead, greatly

Fig. 12. Luxuriant *Vaccinium*-heath with *Cerastium alpinum* and *Salix*. Liverpool Land in Hurry Inlet. (From photo. by CHR. KRUUSE).

dried up, weathered individuals of a *Salix* (species indeterminable) lying closely adpressed to the ground. The stems had a very irregular section, by the ground they are 6,8 cm in compass and have abt. 100 year-rings. The biggest among them may have covered abt. 2 m^2 when in life, most were still so firmly rooted that it required some exertion to lift them from the ground. The root was not decayed. The highly bilateral arrangement of the stems, without considerable upright branches or rests of such, suggests that they have been decumbent individuals which have lifted their year-shoots only 15—25 cm above the ground. The most remarkable feature about these *Salices* is that we did not find anywhere on the localities living *Salix*-individuals of a corresponding size. The only place where I did note such a one is at the North-eastern bay, where an espalier reached 1 m in height and 1,5 m in length up an erratic boulder.

Southwards, the mountains of the Liverpool Land rise to a rather even, slightly undulating table-land ending at last in Cape Tobin and Cape Hope. Its surface is, as mentioned by Koch (Med. o. Grl. XXVII, p. 293), snowless and covered with boulders, the surface being very frost-blasted as well. The vegetation is exceedingly scarce. I followed the coast, in a distance of abt. 1 mile, from the middle of Hurry Inlet till Rosenvinge Bugt when, on the 11th of August, I was ashore to search for musk-oxen, but only noted down the following species:

Vaccinium uliginosum, Salix arctica, Cassiope tetragona, C. hypnoides, Saxifraga oppositifolia, Cardamine bellidifolia, Luzula confusa, Amblystegium exannulatum, A. turgescens, A. Sendtneri, Cephalozia bicuspidata v. *cavifolia, Anthelia nivalis, Jungermannia alpestris, Cetraria islandica, Stereocaulon, Cladoniae* with more lichens.

Along the sea-coast, which I followed when returning, were found here and there sandy or clayey flats covered with *Calamagrostis arundinacea* and *neglecta, Trisetum, Poa pratensis* and

Festuca rubra, which towards the sea changed to salt-marsh vegetation, with *Carex glareosa, C. salina* v. *subspathacea, Glyceria Vahliana, G. vilfoidea, Stellaria humifusa* and *Arenaria ciliata.*

Klitdalen (Chr. Kruuse).

While referring to the following remarks of Hartz on the stony plains by Bielven I shall here mention those by me, partly in the company of Hartz, visited parts of the valley.

On the 2nd. 5th and 8th of August we undertook an investigation of the nearest parts of Klitdalen. Landing is effected with no difficulty on the eastern side as far as to the low range of hills (see Koch, Med. o. Grl. XXVII, p. 288). At Vargodden is water enough, but farther west large tracts become dry at low water. The stream was unnavigable, even to our flatbottomed steel pram.

The hill-range divides the valley in two different parts, a western pervaded by Ryders Elv and filled with deposits of sand and gravel, the materials of which are, for the greater part, derived from the sedimentary formations of the Jameson Land, and the eastern, which is a marine terrace, a continuation of the formations, described on p. 377, whose materials originate in the archaic mountains of the Liverpool Land and is, to a great extent, stamped by the glaciers formerly issued from its névé.

The hill-range itself belongs to the archaic side and ends this towards the west; it consists of solid rock, but this is, for the greater part, hidden under loose soils. Its southern end consisted of clayey sand sparely strown with boulders; closer to the stream was clean sand. The ground was rich in water, especially wherewer the clay was dominant, small springs were soaking the soil without, however, forming pools or brooks.

On dry spots the surface was cracked or forming small hillocks separated by a net of ditches, the bottoms of which lay 4—12 cm lower than the middles of the hillocks. The vegetation was found in the ditches, while the hillocks were, as a rule, bare.

On the humid clayey bottom the vegetation was heath made up of: *Cassiope tetragona, Vaccinium uliginosum, Silene acaulis*, *Pedicularis hirsuta* and *Papaver radicatum.* Less frequently were found: *Dryas octopetala*, *Cerastium alpinum v.*

Fig. 13. The border between *Casssiope-* and *Dryas*-heath. Klitdalen. (From photo. by CHR. KRUUSE).

lanatum, *Stellaria humifusa*, *Draba alpina*, *D. nivalis*, *D. arctica*, *Saxifraga oppositifolia*, *Pyrola grandiflora*, *Polygonum viviparum*, *Betula nana* and *Salix arctica* v. *groenlandica.* On the moist spots the vegetation was highly tuft-shaped, and among the heath-bushes were found:

Potentilla maculata, *Ranunculus pygmæus*, *Saxifraga stellaris* v. *comosa*, *S. aizoides*, *Rhododendron lapponicum*, *Pedicularis flammea*, *Juncus biglumis*, *Eriophorum Scheuchzeri*, *E.*

Fig. 14. Eroded *Dryas*-tuft. In the windworn part the borders between each separate year's wear are plainly visible. Klitdalen. (From photo by Chr. Kruuse).

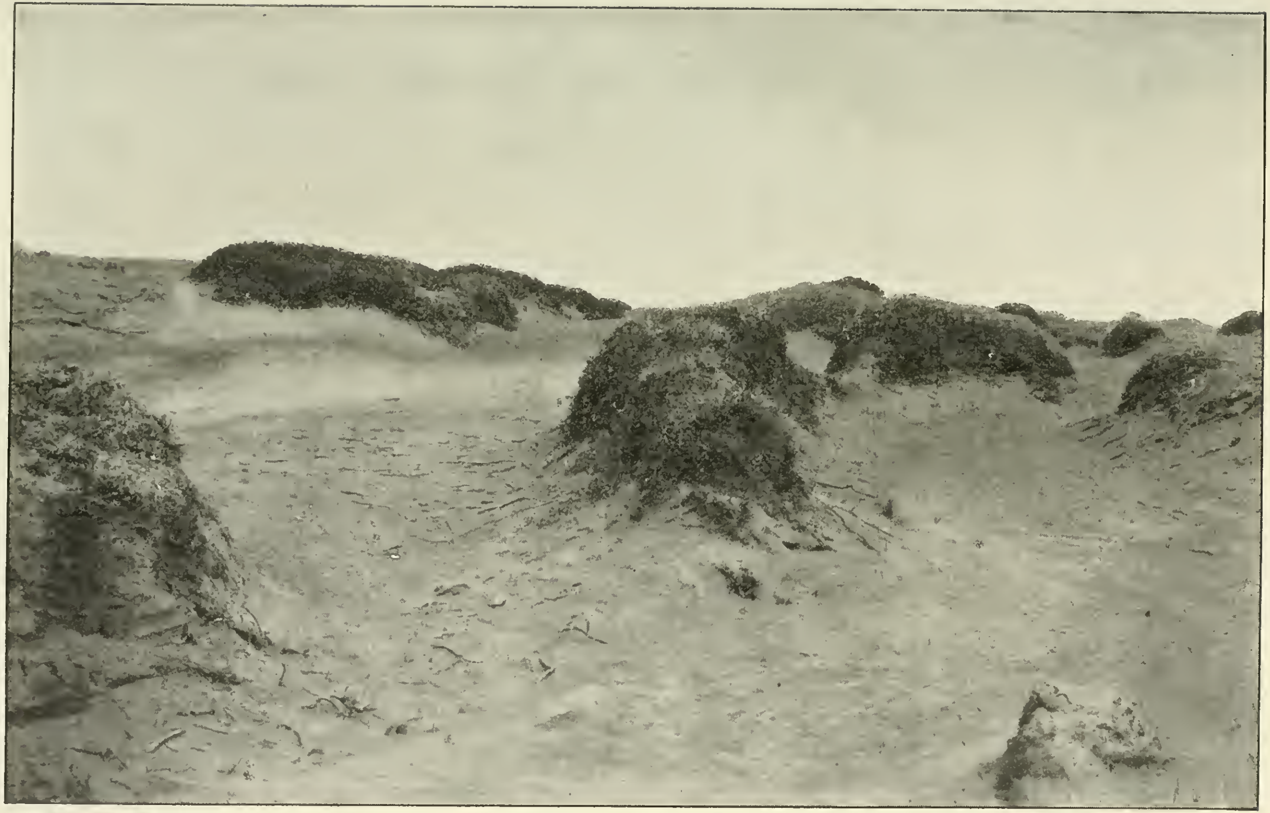

Fig. 15. Sand walls covered by *Salix* and *Chamaenerium*. In the grooves are seen roots and bits of stems denuded by erosion. Klitdalen. (From photo by Chr. Kruuse).

polystachium, *Carex rigida*, *C. rariflora* and *Equisetum arvense.*

The sandy part was covered with *Dryas*-heath or rocky-flat formation with *Salix groenlandica* and *Pedicularis lapponica.* The boundary line between the *Cassiope*- and *Dryas*-heath was very sharp and went as a zigzag line upwards to the south-western corner of the range of hills (fig. 13).

The *Dryas*-heath becomes, towards north, more scarce and is folloved by a rocky-flat formation with widely separated individuals, which are often very windworn (fig. 14).

Close east of the mouth of Ryders Elv on the bare, by the sea partly flooded, flat we found a very peculiar vegetation. There was here a gently arched, somewhat longish hill running parallel with the stream consisting of fine, dazzling white, almost clean quartz-sand. Its surface was furrowed by crevices of a depth of 1—2 m, and of a breadth of 2—3 m, which following the same main-direction as the stream were turning and winding, now widely and distinctly separate, now united into broad channels or round places. Between these, and separating them widely, were numerous, more or less parallel, continuous ranges of fine sand with rather steep sides. Their surfaces were covered with *Salix arctica* and *Chamænerium latifolium*, and at places, as a lesser constituent part, *Polygonum viviparum f. vulgaris* together with single tufts of *Poa pratensis* and *Festuca rubra* (fig. 15.) The willow was in fruit, whereas *Chamænerium* was still in rich flowering bestowing on the whole of the localities a magnificent. reddish-purple colour, especially on the southern part of the area, where the walls were highest and most pronounced. The sides of the walls were closely permeated with roots, and in many places these formed a protecting covering; they were, as a rule, fresh with all their bark, whereas at the ends of the walls, the roots were often stripped of the bark, and remnants of bark-bared branches were sticking out from the sand, while this part of the willow bushes were often dying. There was also some difference between the east side of the walls, which was, as a rule, green, and the western side, which was largely naked and eroded. Farther up the country were found similar sandy areas with *Salix*; but here the walls were not always parallel with Ryders Elv, nor did they always follow the direction of the fall of the slope; the fact is that they were always found on sloping ground, but were apparently diagonally placed.

To the north of this high sandy area the land, which is now covered by a *Dryas* rocky-flat formation, sinks down to a broad hollow by the stream, and is here, to a great extent, sparely covered with *Festuca rubra.* The lowest part formed a nearly circular spot of abt. 30 m in diameter, densely covered by *Calamagrostis neglecta* of a heigh of 25—30 cm Separate from this meadow was found along the banks of the stream and raised no more than abt. 20 cm above the surface of the latter a hydrophilous meadow, which habitually resembled a marshy meadow, the small, sharp-edged, deep, of such a meadow characteristic pools ("Lo'er", cpr. E. Wärming: Dansk Plantevækst, I, p. 262. A. Mentz in Rambusch: Studier over Ringkøbing Fjord, p. 90) being found in great numbers. Nevertheless I should not think, although I did not take my levels, that the sea-water can force its way so far up the stream and expel the freshwater. The vegetation here consisted of a dense *Carex incurva*-cover with *Eriophorum Scheuchzeri, Arctagrostis latifolia, Hierochloa alpina, Stellaria humifusa* and mosses: *Polytrichum alpinum, Sphaerocephalus palustris, Meesea trichodes, Bryum neodamense, B. ventricosum, B. archangelicum, Pohlia commutata, P. crassidens, Tortula ruralis, Dicranum congestum, D. neglectum, Swartzia montana, Ceratodon purpureus, Amblystegium brevifolium, A. turgescens, A. Sendtneri, Hypnum plumosum, Myurella julacea, Isopterygium nitidum v. pulchellum, Odontoschisma Macounii, Cephalozia pleniceps, C. divaricata v. grimsulana, C. striatula, C. asperifolia, Ble-*

pharostoma trichophyllum, Anthelia julacea, Martinella Bartlingii, Aplozia sphaerocarpa v. lurida, Jungermannia quinquedentata, J. ventricosa and *J. inflata.*

North of this hollow was found a considerably higher area where the sand had been blown together to downs of up to 10 m height in lee of solid rocks; how much of them was sand and how much rock could not be decided with certainty, but the rocks protuding at several places in the northern and north-western sides surely occupy the greater part. The surface of the down is completely smooth, has an inclination of 10—12° towards south and is wholly bare of vegetation. The sand is loose and fine. The sun heats the surface greatly; but the warmth does not penetrate very deeply, which is shown by the under-noted observation taken on the 5th of August at noon.

	On the down	In a *Salix*-bush [1]
Black ball	24°,5	24°
Green ball	25°,5	21°
5 cm deep	15°	13°,3
55 cm deep	0°	—
The air	11°	11

Here some observations by Hartz of the temperature in a south-exposed sandy slope with loose drift sand in Klitdalen may be added; the slope was abt. 1,5 m high., and the sand was dry and warm; the moisture was reached in a depth of 15 cm, the slope was totally bare of any vegetation.

	Aug. 5th 1,20 p. m.	Aug. 5th 4 p. m.	Aug. 8th 7 p. m.
Temperature of the air	+ 8° C	—	—
Temperature of sand, 25 cm depth	+ 8°,6 C.	9°,1 C.	9°,6 C.
— - — 35 — —	+ 8°,4 C.	8°,1 C.	8°,7 C.
Thermometer with blank ball, just covered by loose sand	+ 35° C.	—	—
In *moist* sand in small cleft at foot of sandy slope, in 4 cm depth	+ 8° C.	—	—

[1]) The bush was not very distant and had the same exposition.

The sand was frozen in a depth of 64 cm and in a profile on the eastside, formed by a half dried up river-bed, ice was seen in a depth of 50 cm below the surface. I suppose the dune receives its increase in the autumn in the shape of a mixture of snow and sand, which thaws during the summer and dries up until the stated depth where the melting-water freezes together to solid ice. (A similar snow-and sanddrift I noticed in 1898 at Tasiusarsik kidtlek near Angmagsalik). At the base of the kiln was found, by the above-named little, somewhat mossgrown, river-bed, a small humid sandy flat covered with *Equisetum arvense* f. *decumbens, Lachnea scutellata* and, at the margin, little tufts of *Eriophorum Scheuchzeri* together with, on a small elevation, a single *Salix arctica* v. *groenlandica* bush.

To the east of the little river-bed were extensive, almost horizontal flats, which, in my journal, I call "Graa Klit"; the soil consists of stoneless, very fine argillaceous sand, which cracks in the summer drought.

They were covered with *Arctostaphylos alpina, Dryas octopetala* f. *minor, Salix arctica* f., *Elyna Bellardi* and *Carex nardina*. None of these plants rises 5 cm above the ground, most often they are covered so strongly that only a few short stem-joints together with their leaves are free; in many cases, indeed, the petioles themselves are covered. None was seen in flower, nor were there any traces of fruit-setting from previous years. They evidently wage a hard war against the dust covering and erosions of winter, all parts above ground being, as I believe, eaten away every year (fig. 16).

Near these flats are others, which I designate by the name of "Stensletter" ("stony plains", see A. Jessen in "Danmarks Geologiske Undersøgelse" I R., Nr. 3, p. 263).

These are plane or slightly undulating, almost horizontal, flats made up of sand, argillaceous sand, in spots, gravel with shells of sea mollusca, accordingly parts of a marine terrace.

They are strown with a great number of pebbles, partly angular, flat bits of sand stone, partly water-ground, flatly oval or ovally ball-shaped blocs of archaic rocks or basalt. Some of the blocks have worn, sand-polished corners and edges, and a few have the characteristic shapes of the "triangles".

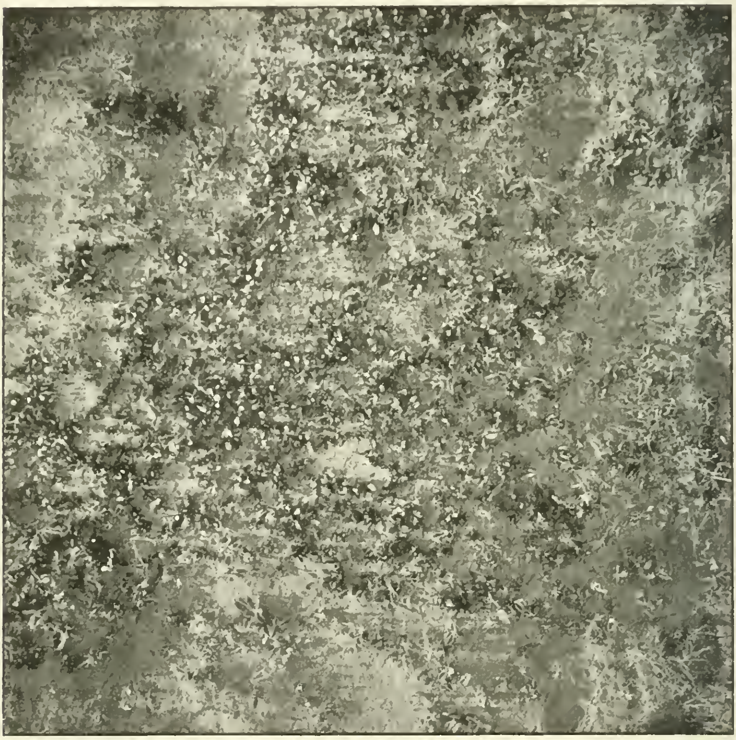

Fig. 16. *Arctostaphylos alpina* on sandy flat; only the new shoots protrude. Klitdalen. (From photo. by CHR. KRUUSE).

They most often have a thin coat of clay or ooze.

In the spring time some of the "Stensletter" are doubtless flooded for a shorter period and form extensive shallow ponds with from 10—50 cm water upon them. This period can but be of short duration; for did the flood last but a couple of months mud must be forming and rests be found of a Limnae-bogvegetation; but of such I have not seen any vestige. That the „Stensletter" have had water over them is, however, plainly seen in the adjacent, somewhat higher tracts of sand-drift, which towards the "Stensletter" have 10—30 cm high bluffs with distinct marks of water-erosion. The water, being so shallow, can quickly evaporate or sink into the sand, when the supply ceases. The existence of outlets with distinct watermarks I could not establish.

The vegetation on the "Stensletter" is exceedingly scarce. I noted:

Dryas octopetala f. minor and *argentea, Potentilla nivea, Chamænerium latifolium, Silene acaulis, Melandrium triflorum, Cerastium alpinum f. lanatum, Arenaria ciliata v. humifusa, Braya purpurascens, Lesquerella arctica, Arabis arenicola, Papaver radicatum, Armeria vulgaris v. sibirica, Polygonum viviparum f. alpina, Salix arctica v. groenlandica, Elyna Bellardi, Carex nardina, Trisetum subspicatum, Poa pratensis, Poa glauca v. arenaria* and *Festuca rubra.*

These are plants with a vigorous taproot and closely adpressed tuft-shaped growth or, with regard to the monocotyledons, tunicate growth. It is clear that the wind has only a limited time of display, for the hemicryptophytes (Raunkiær: Planterigets Livsformer og deres Betydning for Geografien) such as *Braya*, *Lesquerella* (fig. 17) and *Arabis arenicola* form round, hemispherical individuals showing no wind-wear whatever, although sometimes some covering with gravel. On the other hand, those which have wintering, epiterranean organs are highly injured on the north side. The monocotyledons, as a rule, manage best; they become, no doubt, rather crumpled, but they have an excellent defence in their old leaf-sheaths, which long resist the sand-wear. The dicotyledons, on the other hand, get very much injured on the north side; any stem, branch or root protruding is stripped of bark, dried up, weathered, bleached and killed. The northern side of a tuft is often an entangled web of branches and roots lying several cm above the worn-off soil.

The plants stand, as a rule, singly, but the bigger ligneous plants, such a *Dryas* and *Salix* yet give shelter and lee to the smaller, which, for this same reason, accompany them; thus *Chamaenerium* and *Cerastium* are hardly ever seen except

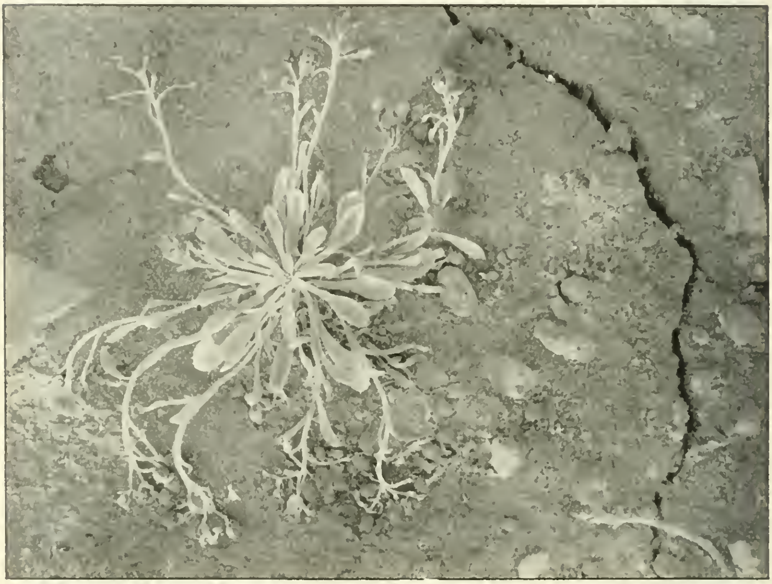

Fig. 17. *Lesquerella arctica* on stony plain. The flowering shoots erect; those fructifying decumbent. Klitdalen. (From photo. by CHR. KRUUSE).

sheltered by the willows. Yet it need not be but a small stone, arising only a few cm above the ground, which constitutes the condition of growth for an individual; indeed, I saw in one place *Arenaria ciliata* making shelter for *Potentilla nivea* (fig. 18).

In lee of each plant-tuft a small sand drift has gathered; It need not be more than 1—2 cm thick, but may very well be 15 cm in breadth and 40 cm long (the numbers corres-

Fig. 18. *Arenaria ciliata*, in front of which a small dune with protruding *Potentilla nivea*. (From photo. by Chr. Kruuse).

pond to a *Carex nardina* tuft); they may, however, measure 10—15 cm in height and upwards of 1 m in length; several are not from this year, as they have clearly been covered by water, are sometimes a little water-eroded and now and then intersected by drought cracks. The biggest sand drifts are formed by *Salix* and *Dryas*.

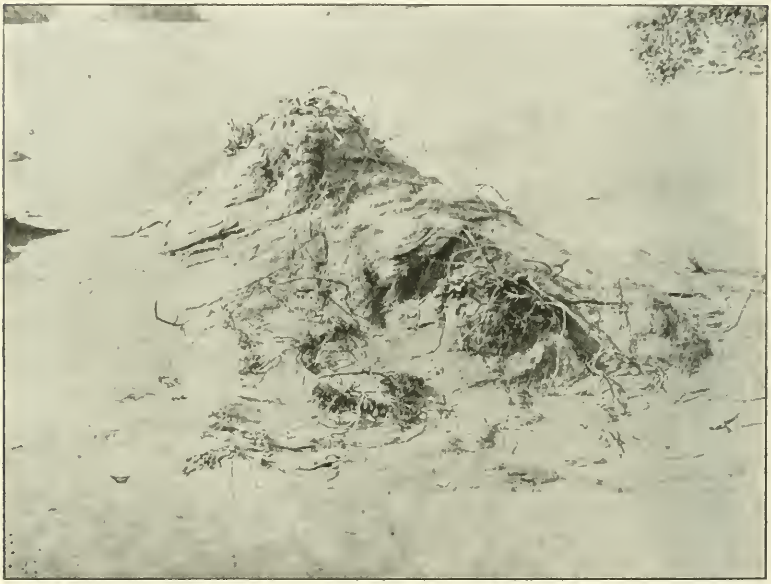

Fig. 19. Greatly demolished *Salix*-dune in front of a new sand-drift. Klitdalen. (From photo. by CHR. KRUUSE).

On the somewhat higher land environing the "Stensletter" are rather high (up to 1 m) dunes (fig. 19) around *Salix groenlandica* tufts in all stages of building up and demolition; the intervening ground is of the nature of "Stensletten", but the sand in the drifts is fine, stonefree drift sand. This is no question of any washing-out phenomenon, as there neither is any running water nor can be any considerable supply thereof.

At a still higher level are smaller flats of "living" dune sand

Here is neither stone nor solid rock in any known depth, no more is any clay found here. The surface is uneven from little undulations and hillocks, and the sand is so loose that the foot sinks into it. It is thinly, but evenly, covered by *Festuca rubra v. arenaria, Carex incurva, Chamaenerium latifolium* and *Salix glauca*. The three firstnamed plants commonly grow

Fig. 20. Windworn *Dryas* on stony plain. Klitdalen. (From photo. by Chr. Kruuse).

in rows of a length of up to 2 m after the direction of the rhizomes, which lie in a depth of from 5 to 10 cm. The covering with sand is great, *Chamaenerium* and *Salix* only rise 2—6 cm above the sand, hardly anything but leaves is seen, seldom flower and fruit, never parts of stems. *Carex incurva* is 5—7 cm high, has curved leaves and, here and there, sheaves. *Festuca* is 10—15 cm high and has many sheaves. The whole is decidedly a purely æolian formation.

In the angle between Ryder's River and its big tributary from the east („Bielven") the following notes were made (N. Hartz):

The stony plains ("Stensletter"). Here the sand has been blown and washed away, in such a way that the stones in the old sea-bottom form an almost complete cover on top of the under-

Fig. 21. *Dryas octopetala* with erect branches. Sand-drift grounds in Klitdalen. Del. H. Olrik.

lying sand layers. The stones themselves are more or less rounded, often highly sand-polished and shining; scattered among the stones are numerous white subfossile shells (*Saxicava, Mya, Astarte*). The chief direction of the wind in this valley is evidently N—S; in the shelter of each separate larger stone or plant lies a small sanddrift.

Farther down along the banks of the rivulet the stony plains have an extremely poor vegetation, so poor that the plants tone them with hardly any hue, and it consists here almost exclusively of Gramineae and Cyperaceae: *Glyceria maritima f. vilfoidea, G. distans, G. angustata, Carex incurva, Poa pratensis,* partly *f. vivipara* and some badly torn and worn tufts of *Carex nardina.*

At a somewhat longer distance from the stream grew upon the stony plains: Some tufts of *Salix groenlandica, Papaver, Draba nivalis, Armeria, Festuca rubra, Potentilla pulchella, Dryas, Braya purpurascens* and *Arabis arenicola.* The two lastmentioned species evidently thrive well on these localities, whereas most of the other species were greatly damaged by the wind; thus for instance the *Dryas*-bushes were always badly worn, with long, white, dead branches trailing flatly over the stones and the gravel.

Fig. 22. *Dryas octopetala*; part of foregoing.

Upon the large stony plains, a little farther towards the east (south of the tributary rivulet), which were furrowed by violent northern gales and intersected by spring-streamlets (now dried-up) were found, besides the above-mentioned plants some specimens of *Ranunculus glacialis, Luzula confusa, Melandrium apetalum* and *M. triflorum, Cerastium alpinum, Oxyria, Lesquerella* and *Potentilla nivea.*

Here and there a few coffin-shaped sandhills rose above the stony plain, 1—3 m long, 1/2—1 m high, evidently remnants frome rosion, preserved by the aid of the roots from the *Salix arctica-* or *Chamaenerium*-tufts which grew upon their tops and sides. *Stellaria longipes* once in a while grew among the *Salices* on these sandhills (Fig. 24).

Sand-drift grounds. In many places were small, low downs of white drift-sand. The "living" downs were often quite devoid of any vegetation. On flats with lively sand-drift

Fig. 23. *Polygonum viviparum*, sand-drift grounds. Klitdalen. Del. H. Olrik.

were noted: very luxuriant, decumbent bushes of *Salix arctica v.*, *Chamaenerium latifolium*, *Dryas* with erect branches and with only the ends of the branches above the sand (Fig. 21—22), *Polygonum viviparum*, the rhizomas of which were, in such localities, often lengthy and erect (Fig. 23), *Festuca rubra*, very vigorous, most often a form with hairy spikelets, *Arabis arenicola*, *Arenaria ciliata* (not common). Wherever the sand was a little more moist *Equisetum arvense* (the decumbent form) was added to the former; in humid crevices light green patches of several m^2 extension could be seen, the colour of which was exclusively due to this plant.

When walking upwards in the direction of southeast from the stony plains and the sand-drift grounds to the gneiss-

Fig. 24. Coffin-shaped sand-hills, erosion-remnants covered with *Salix* and *Chamaenerium*. In the fore-ground *Festuca rubra*. Klitdalen. Del. E. Ditlevsen.

grounds one saw, as soon as the shelter of a knoll had been arrived at, *Dryas* and *Elyna* draw together and form a *Dryas*-heath, which at this time of the year (beginning of August) shone already in the motley colours of autumn: large wine-red blotches of *Arctostaphylos alpina*, dark green portions of *Cassiope tetragona*, yellowish-brown patches of *Empetrum, Vaccinium uliginosum* and *Betula nana*. In more humid heath several other herbaceous plants were added to these: *Arnica, Pedicularis hirsuta, Stellaria longipes, Armeria, Luzula spicata, Pyrola grandiflora*; mosses and lichens make out a considerable part of the *Dryas*-heath.

On the south-side of a low gneiss-knoll was a rudimental herbaceous slope. The birch rose cautiously to 1/3 m above the ground, *Taraxacum croceum* and *phymatocarpum, Alsine biflora, Draba repens* were flowering among decumbent, not yet flowering bushes of *Salix arctica v. groenlandica*, the leaves of which were not fully developed either — so lately the snow had melted away from this locality.

Point Constable (N. Hartz).

On Aug. 10th I went on a tramp across the considerable delta, which is crossfurrowed by numerous more or less considerable rivulets.

The lowest tracts were occupied by salt-marsh. The bottom here was clayey ooze, and had often a reddish tint. *Carex subspathacea* formed a dense but low "grass carpet" (4—5 cm high) with a straggling intermixture of *Stellaria humifusa* and *Glyceria vilfoidea*. Numerous irregularly shaped water-holes ("Lo'er") with steep margins 8—10 cm high, exactly as in the salt-marshes at home. Upon the bottoms of the holes, which were filled with water, lay red ochre films, below these black mud of at least 20 cm' thickness.

The surface of the salt-marsh was often slightly tufted; the small tufts were particularly vigorous specimens of *Carex subspathacea*, which would attain a height of up to 10 cm.

Inside the salt-marsh followed sand-drift grounds with a vegetation similar to the one described from Klitdalen; *Calamagrostis neglecta* and *Alopecurus alpinus*, which constituted but an unessential part of the vegetation in the sand-drift grounds of Klitdalen, were common here.

Western and southern coasts of Jameson Land (Chr. Kruuse).

On Aug. 15th Koch, Nordenskjöld and Kruuse left in the walrus boat in order to explore and map down the southern and western coasts of Jameson Land. As mentioned by Koch (Med. o. Grl. XXVII, p. 285) this coast is low and flat, formed by marine clay and sand without solid rock. The margin of the sea consists of fine sand, upon which is found washed up sea-weed mixed with sticks and leaves together with, rarely, a more considerable floating timber (see picture Koch l. c. p. 284); they form 1—3 strand lines. — A special strand vegetation is completely wanting. Inside the margin of the sea the land stands with rather steep bluffs, 2—6 metres high. Outside the margin of the sea is a broad flat (100—3000 metres), which is partially dry at low water and ends towards the inlet in a steep slope. There is 10—40 cm water upon it, the bottom is fine sand or, at places, mud; it is completely bare of vegetation.

Towards east and north-east the land rises evenly and slowly; it is nearly flat, but at rare intervals traversed by numerous brooks and streams, which have beds of 20—30 metres' depth in the loose bottom. By the coast they form river-cones; but a few of them, especially those abunding with water, ended in a little triangular lagoon, bordered towards the inlet by a convex coast-bank.

The country, by the way, corresponds well to the description which Hartz has given of its southern part (Med. o. Grl. XVIII, p. 124—132). I shall therefore only briefly mention the localities we visited, the more because bad weather and the difficulties in landing greatly limited the time we could give to the exploration.

By the landing place, on Aug. 16th close to the 71st parallel of latitude ran parallel to the coast an about 10 metres high

Fig. 25. Old "Rudemark" on Jameson Land. In the furrows *Cassiope tetragona* and *Dryas*. (From photo. by Chr. Kruuse).

wall, inside which was found a broad, flat riverbed, after which the land rose evenly as far as the eyesight reached. The coast-wall consisted of marine, stoneless, somewhat sandy clay, the surface of which was cracked in checks about 40 × 100 cm in size, with 4—8 cm deep furrows between ("Rudemark"). The middles of the checks were devoid of vegetation, somewhat arched (see fig. 25), somewhat granular with nut-sized rounded clumps of clay, the margins cracked, and rather washed out. In the furrows stood: *Cassiope tetragona*, *Vaccinium uliginosum*, *Dryas octopetala f. minor*, *Salix arctica v. groenlandica*, *Pedicularis hirsuta*, *Silene acaulis, Polygonum viviparum,* and *Carex nardina.* All of them were low, somewhat lichenized and hardly reaching above the checks.

In the flat river-bed inside the wall water was only found in a pool. but after digging I found it everywhere in a depth of 10—30 cm below the even sand-bottom, which was only very thinly covered with *Equisetum arvense f. decumbens*, whose up to 15 cm long thin stems are half buried in the sand. The bank of the riverbed up to its uppermost edge is covered with *Eriophorum Scheuchzeri,* which at the bottom, although powerful and tickly tufted, is sterile, whereas the higher placed individuals have innumerable white fruit-tassels.

Within the low grounds, on the gently rising bottom, are found wide heather-moors made up of *Cassiope tetragona* and *Salix arctica v. groenlandica. Cassiope* is dominant, is tickly tufted, and 8—10 cm high. *Salix* is more scattered, is adpressed to the ground, 4—5 cm high, and somewhat surrounded by lichens. Besides were noted in small numbers: *Saxifraga decipiens, S. hieracifolia, Polygonum viviparum, Oxyria digyna* and *Luzula confusa.*

On the heath were found a few feebly depressed hollows with moist bottoms covered with *Amblystegia* and *Cardamine pratensis, Eriophorum Scheuchzeri,* and *Equisetum arvense f.*

decumbens; but otherwise the heath stretched unaltered for several square miles.

Our next tent-place by "Vandreblokken" was not reached till after a long row in rainy weather and night-quarters in the boat, as we could not land on account of low water. The bluff towards the sea was here 2—5 m high, it consists of marine clay with numerous shells of *Mya, Astarte, Saxicava* and other arctic mussels. It is greatly intersected by clefts, formed by streamlets which, during our visit, were nearly all dried up; but their bottoms were however moist, and the ground water was found in from 5 to 10 centimetres' depth. They are covered with scattered mosses, amongst which were noted: *Pohlia cruda, Tortula ruralis, Amblystegia, Anthelia julacea, Philonotis fontana,* and *Sphagnum teres.* Of vascular plants were found *Silene acaulis, Saxifraga cernua, Oxyria digyna, Carex lagopina, Trisetum subspicatum, Poa alpina f. vivipara,* and, in great numbers, *Equisetum arvense v. boreale,* which, although decumbent, is very powerful and thick-stemmed. Up the loamy soaked slopes stood besides the above-mentioned: *Phippsia algida, Poa* sp. and *Festuca rubra.*

In the small rainclefts the vegetation was a little less scattered and richer in dicotyledons. Here stood: *Sagina nivalis, Ranunculus pygmæus, Cerastium alpinum, Saxifraga cernua, Erigeron uniflorus, Oxyria digyna, Salix arctica v. groenlandica, Poa alpina f. vivipara, Poa pratensis, Glyceria angustata, G. vilfoidea,* and *Equisetum arvense.*

The surface of the land between the clefts is more sandy owing to washing out, and here are found *Cassiope* and *Vaccinium* half covered by sand, so that only branchends from 3 to 6 cm long stick out; there are great intervals between the tufts, wherever the sand is completely bare. Farther up the country the sand-drift stops, and the heath is dense, luxuriant and 10 cm high.

The sand beach is totally devoid of vegetation as well as the shallow water without, but washed ashore upon the sand was one specimen of a narrow-leaved *Zostera marina*; notwithstanding an eager search I didn't succeed in finding any more, nor did I find the plant growing anywhere. Although the "Antarctic" passed the spot twice and we ourselves in the boat once, it is little likely that it comes from here, the more because it was not single leaves which might have been used in packing, but a specimen with parts of stems. I therefore think it probable that the plant grows somewhere in Scoresby Sund in small numbers.

Again we had, in order to come ashore close west of Cape Hooker, to pass half the night in the boat away on the shallow, which is a very disagreeable thing to do in rainy weather, and not until about 3 o'clock did we get ashore and got our tent pitched against the rain. The ground around this tent place was considerably more barren than that surrounding "Vandreblokken", and it corresponds peculiarly well to the description which Hartz has given (Med. o. Grl. XVIII, p. 126—132).

Here was found mossfield on clay, principally *Anthelia*-covering with *Peltigera aptosa, Silene acaulis, Cassiope hypnoides, Oxyria digyna, Salix herbacea, Salix arctica, Luzula confusa, Carex lagopina, Trisetum subspicatum, Poa alpina f. vivipara, Festuca ovina* and in single patches *Festuca rubra*. All were low and stunted. Alternating with these was *Cassiope*-heath of 5 cm height, stony plains without any vegetation, and sandflats with lichen covering or a thin growth of *Polytrichum juniperinum, Luzula confusa, Trisetum, Oxyria, Salix arctica v. groenlandica, Cerastium alpinum*, and *Equisetum arvense*; all dwarfed.

Wherever the heath, which besides *Cassiope* consisted of *Empetrum, Arctostaphylos alpina, Vaccinium,* and *Salix arctica v. groenlandica.* was adjacent to the stony and sandy plains it was dissolved into separate tufts with bare sand between, and beyond its margin were seen remnants of the bushes. Thus I saw in one place a *Salix* which, though yet alive, had its root naked in a length of 156 cm.

It was absolutely evident that the wind broke up the surface and destroyed the heath so that this tract of land in the course of a few years will acquire a similar appearance to that of the above-mentioned stony plains in Klitdalen. The prevalent wind here, as there, was northern, and the destruction especially advanced in the direction from west to east.

Farther up the country the heath became much more luxuriant, up to from 10 to 15 cm high, and consisted, besides the above-mentioned, of *Luzula confusa, L. spicata, Poa pratensis, P. alpina, Silene acaulis, Saxifraga oppositifolia, Pedicularis hirsuta, Erigeron uniflorus,* and *Betula nana.* The sides of the river-valleys, which were here strewn with blocks of ammonite-sandstone, were abundantly covered by *Vaccinium* and *Betula*, and the bottom of the valley with a covering of *Equisetum arvense,* amongst which were scattered *Oxyria, Cerastium trigynum,* and *Koenigia.*

List of all the vascular plants hitherto known from Scoresby Sund[1]).

Dryas octopetala.
— —* *integrifolia.*
Potentilla pulchella.
— *maculata.*
— *emarginata.*
— *nivea.*
Silbaldia procumbens.
Alchimilla glomerulans
Hippuris vulgaris.
Callitriche verna v. minima.
Epilobium anagallidifolium.
Chamænerium latifolium.
Empetrum nigrum.
Silene acaulis.
Viscaria alpina
Melandrium apetalum.
— *involucratum v.*
— *triflorum.*
Sagina Linnæi.
— *nivalis.*
Alsine biflora.
— *stricta.*

[1]) cpr. N. Hartz, Medd. om Grønland, XVIII. 1905.

Alsine verna.
Halianthus peploides v. diffusa.
Arenaria ciliata v. humifusa.
Stellaria longipes.
— *humifusa.*
Cerastium trigynum.
— *alpinum.*
Lesquerella arctica.
Cochlearia officinalis v.
Draba alpina.
— *crassifolia.*
— *aurea.*
— *repens.*
— *nivalis.*
— *Fladnizensis.*
— *hirta.*
— *arctica.*
Braya purpurascens.
— *alpina.*
Cardamine bellidifolia.
— *pratensis.*
Arabis alpina.
— *Holboellii.*
— *arenicola.*
Papaver radicatum.
Thalictrum alpinum.
Batrachium paucistamineum v. eradicata.
Ranunculus glacialis.
— *pygmæus.*
— *hyperboreus.*
— *nivalis.*
Ranunculus altaicus.
— *arcticus.*
Saxifraga hieracifolia.
— *nivalis.*
— *stellaris v. comosa.*
— *cernua.*
— *rivularis.*
— *decipiens.*
— *tricuspidata.*
— *aizoides.*
— *Aizoon f. brevifolia.*
— *oppositifolia.*
Sedum Rhodiola.
Armeria vulgaris v. sibirica.
Pinguicula vulgaris.
Veronica alpina.
— *saxatilis.*
Pedicularis lapponica.
— *flammea.*
— *hirsuta.*
Euphrasia latifolia.
Gentiana tenella.
Diapensia lapponica.
Pyrola rotundifolia v. grandiflora.
Arctostaphylos alpina.
Phyllodoce coerulea.
Cassiope tetragona.
— *hypnoides.*
Rhododendron lapponicum.
Vaccinium uliginosum.
Campanula uniflora.
— *rotundifolia.*
Taraxacum phymatocarpum.
— *croceum.*
Hieracium alpinum.

Antennaria alpina.
Erigeron compositus.
— *uniflorus.*
Arnica alpina.
Koenigia islandica.
Polygonum viviparum.
Oxyria digyna.
Rumex acetosella.
Salix herbacea.
— *arctica.*
— *glauca.*
Betula nana.
Tofieldia palustris.
— *coccinea.*
Juncus biglumis.
— *triglumis.*
— *castaneus.*
— *trifidus.*
— *arcticus.*
Luzula multiflora.
— *arcuata v. confusa.*
— *spicata.*
— *nivalis.*
Eriophorum Scheuchzeri.
— *polystachium.*
Elyna Bellardi.
Kobresia bipartita.
Carex nardina.
— *dioica v. parellela.*
— *ursina.*
— *scirpoidea.*
— *microglochin.*
— *rupestris.*
— *incurva.*
Carex Maclowiana.
— *lagopina.*
— *alpina.*
— *misandra.*
— *glareosa.*
— *bicolor.*
— *salina f. subspathacea.*
— *rigida.*
— *capillaris.*
— *rariflora.*
— *pedata.*
— *supina.*
— *rotundata.*
— *pulla.*
Alopecurus alpinus.
Hierochloa alpina.
Agrostis borealis.
Calamagrostis arundinacea.
— *neglecta.*
Trisetum subspicatum.
Pleuropogon Sabinei.
Phippsia algida.
Arctagrostis latifolia.
Glyceria distans.
— *maritima v. vilfoidea.*
— *angustata.*
— *Vahliana.*
Poa abbreviata.
— *glauca.*
— *nemoralis var.*
— *alpina.*
— *pratensis.*
— *cenisia.*
Festuca ovina.

Festuca rubra v. arenaria.
Lycopodium alpinum.
— *Selago v. appressa.*
— *annotinum v. pungens.*
Aspidium fragrans.
Cystopteris fragilis.
Woodsia ilvensis.
— *hyperborea.*
— *glabella.*
Botrychium Lunaria.
Equisetum arvense.
— *variegatum.*

On August 22nd we left Scoresby Sund; after a short visit to Cape Greg on the east coast of Liverpool Land on Aug. 23rd, and to Cape Brown in the mouth of Fleming Inlet on August 24th, we made a longer visit to Fleming Inlet, Aug. 25th—26th.

Cape Brown (Chr. Kruuse).

On August 24th we landed at Cape Brown, where the foot of the mountain consisted mostly of barren débris. Yet a little stream had cut itself a narrow and deep cleft in the rock, and through it I went up the mountain. The rocks are highly ice-ground and almost without any loose soils and, accordingly, nearly devoid of continuous higher vegetation. Here and there, however, in the cleft of the stream a little sand had formed, and thanks to the avantages of shelter and with abundant humidity the plants were thriving surprisingly well. I noted during an ascent of about 300 m:

Dryas octopetala f. minor, Chamænerium latifolium, Silene acaulis, Arenaria ciliata, Alsine biflora (partly flor. lilacinis), *A. verna v. propinqua, Melandrium involucratum v. affine, Cerastium alpinum f. lanatum, Draba alpina, D. nivalis, D. Fladnizensis, D. arctica, Papaver radicatum, Saxifraga decipiens, S. cernua, S. oppositifolia, Pedicularis flammea, Cassiope tetragona, Vaccinium uliginosum, Rhododéndron lapponicum, Campanula rotundifolia, Oxyria digyna, Salix arctica, Luzula confusa, Carex nardina, Poa glauca, P. pratensis, P. cenisia, Festuca ovina, Cystopteris fragilis* and *Woodsia ilvensis.*

In moist crevices *Philonotis fontana* formed large light green cushions, and on the rocks sat here and there *Hypnum trichodes.*

Above the cleft was at little valley-bottom thinly dotted with small tufts of *Grimmia apocarpa,* and also, more rarely, *Cetraria nivalis* and *Stereocaulon denudatum.*

Fleming Inlet.

Cape Seaforth, Ørsted's Valley (N. Hartz).

On the 25th of August I made an excursion up trough the abt. 7 km broad Ørsted's Valley, which follows the direction SW-NE, traversed by a broad and watery stream with large delta formations at the outlet. On the previous evening a strong Föhnwind kept blowing out the valley carrying along with it large quantities of dust away over the inlet; viewed from some distance it looked quite like an advancing fogbank.

On this day it was clear sunshine with a feeble breeze from SW; in spite of the advanced time of the year a few gnats and *Argynnis* were, however, seen. The valley evidently is a favoured spot for large numbers of geese; numerous excrements of geese lay scattered everywhere in the bogs: these were often filled with the undigested remnants of axillary bulbs of *Polygonum viviparum.* Away in a moist moss-bog lay close by a small pool of water a big "goose tuft" abt. 10 m^2 and 1 m high (frozen in a depth of 25 cm) formed chiefly by vigorous *Aulacomnium palustre*; amongst the mosses grew luxuriant specimens of *Festuca rubra*, *Stellaria longipes* and *Marchantia polymorpha.* A great many excrements and feathers of geese upon the tuft.

At Cape Seaforth itself was found *Saxifraga oppositifolia* var. *Nathorsti,* a very peculiar and characteristic form, conspicuous at first sight on account of the pale-redviolet or fleshycoloured hue of its corolla. You think at first that

Fig. 27. The valley at Cape Seaforth. To the left *Dryas*-heath with steep declivity towards the sandy flat where little dunes form round *Festuca rubra*. (From photo. by CHR. KRUUSE).

you have a bastard of *Saxifraga oppositifolia* and *S. aizoides* before you.

This variety has been described by P. Dusén[1]) upon the specimens found in 1899 by A. G. Nathorst and K. A. Gredin at 7 divers localities in the Frantz Joseph Fjord and Kong Oscar Fjord, and Dusén gives both good habit pictures of the form and analyses of leaves, corollas and sepals of the main species and of the variety. Dusén points out that the late flowering is striking in the variety, while the main species, as known, belongs to the earliest flowering spring plants of Greenland and altogether of the whole arctic Zone.

We found numerous specimens growing amongst *Saxifraga oppositifolia* and *S. aizoides* on a low sanded moist bottom near the beach, but did not see any ripe fruits on the plant. Specimens, brought alive to Copenhagen have later flowered every year in the Botanical Gardens of the University and have kept constant, although somewhat luxuriating.

The valley was covered by considerable alluvial layers, mostly sand, and cross-furrowed by abandoned, dry river-beds. Most likely the valley-bottom is a "postglacial" river-deposit in the former inlet, the mouth of which has been partly closed by a reef formed by a basalt-stock; remnants of this still showed projecting rocks at and close outside the beach. The river carries enormous quantities of sand along with it, and excepting only the foot of the mountain the valley-bottom was made up everywhere of fine sand without stones. Nearest the mountain-foot were stones and stony clay, moraine or weathering product. The river had such an abundance of water and the current was so strong that it could not be waded.

Farther up the valley was an excellent opportunity of studying the marked influence of the height of the underground water, which asserted itself at rather inconsiderable differences

[1]) Zur Kentnis d. Gefässpfl. Ostgrönland. Bik. t. k. sv. Vet. Akad. Handl., Bd. 27. Afd. III. Nr. 3, 1901.

of elevation of the ground, and which is illustrated by the diagrammatic section of part of the valley.

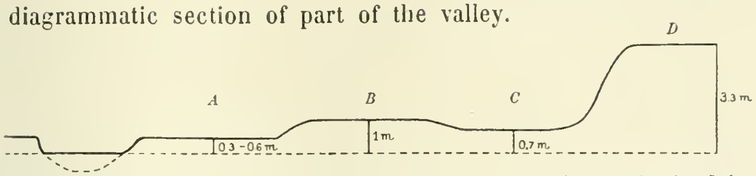

Fig. 26. Diagrammatic section of Orsted's Valley. Cape Seaforth. Fleming Inlet.

A: 0,3—0,6 m above the river. Decumbent *Salix arctica* (and *Silene acaulis*).

B: 1 m above the river. *Dryas octopetala* (and *Polygonum viviparum*).

C: 0,3 m lower than B (Dry abandoned river-bed). *Calamagrostis neglecta*-meadow with *Carex pulla, Eriophora, Equisetum arvense, Cardamine pratensis, Juncus arcticus.*

D: 2,6 m higher than C. Heath, formed by *Cassiope tetragona* with *Dryas octopetala.*

ad C. Besides the meadow was found here a tract of loose, almost bare sand with wave-lines perpendicular to the main direction of the valley, made by the wind. Here were seen single tufts of *Festuca rubra, Eriophorum Scheuchzeri, Carex incurva* and *Juncus arcticus,* which had each collected a small abt. 5—10 cm high drift of fine sand between the straws and sheltered on the eastside.

Here and there were small downs covered with *Carex incurva* and *Juncus arcticus*; on the north-side of the valley were seen considerably bigger downs, which were not reached. When later in the day a strong breeze set in from the sea large dustclouds were seen on the northside of the valley.

The divers vegetations gave different hues to the different localities, the localities covered by decumbent *Salix arctica* displaying a deep green shade (A), the *Dryas*-heath a reddish brown (B) and the *Cassiope*-heath a dark brown (D).

In the *Calamagrostis*-meadow was found *Cardamine pratensis* in flower.

Ørsted's Valley (Chr. Kruuse).

Close inside the beach was a low flat, which had evidently been covered by water at an earlier time of the year. It was covered with a dense carpet of mosses, liverworts and algae, amongst which *Chomocarpon commutatus, Sauteria alpina* and, chiefly, *Marchantia polymorpha v. alpestris* were prevalent. In the mosscover stood with abt. 30 cm' interval a great many 1—5 cm tall, hemispherical tufts of phanerogams, which were made to stand out greatly by the dark, one-coloured bottom. Here were noted:

Dryas octopetala f. minor, Silena acaulis, Sagina Linaei, Alsina biflora, A. verna v. rubella, Arenaria ciliata, Stellaria humifusa, Cerastium alpinum, Cochlearia officinales v. groenlandica f. minor, Draba alpina, D. Fladnizensis, Braya purpurascens, Cardamine bellidifolia, Saxifraga oppositifolia f. pulvinata, S. oppositifolia v. Nathorsti, S. aizoides, S. cernua, Ranunculus altaicus, R. nivalis, R. pygmæus, Pedicularis hirsuta, Koenigia islandica, Polygonum viviparum f. alpinum, Oxyria digyna, Salix arctica, Luzula confusa, Juncus biglumis, Poa alpina, Glyceria vilfoidea, Carex incurva, C. salina v. subspathacea, Equisetum arvense and *variegatum f. anceps.*

Pingel's Valley (N. Hartz).

Aug. 26th. In Pingel's valley, which stretches from the south-eastern corner of Fleming Inlet in about easterly direction I found a somewhat more luxuriant vegetation than in Ørsted's valley, more vigorous heath (*Cassiope tetragona*) and herby slopes, with fresh green grasses and herbs, and a thick, black mould-layer, probably abt. 6—7 km from the beach. Here were found in several small moist clefts traversed by brooks the following plants: *Botrychium lunaria, Veronica alpina, Sibbaldia procumbens, Thalictrum alpinum, Euphrasia latifolia.*

The four first-mentioned: *Botrychium, Veronica, Sibbaldia* and *Thalictrum* have here their northernmost known habitats on the east-coast.

The valley in the south-western corner of Fleming Inlet (Chr. Kruuse).

On Aug. 26th Deichmann and I landed in the broad valley which shoots inland from the head of the inlet towards north-west. Through the valley flows a goodly stream, which has cut out in the bottom of the valley a cleft of up to 7 metres' depth, and which at the spot where it enters the inlet forms an enormous river-cone of débris crossed by delta arms and strewn with rocks and waterground stones. These are found arranged in walls, 50—200 cm high, which radiate fanshape from the mouth of the river; between the walls are hollows with no vegetation, but often strewn with sticks and fragments of plants. The whole of the cone of débris is evidently relaid every spring, and only the heaviest blocks are allowed to remain undisturbed. Upon the walls *Chamænerium latifolium* formed a magnificent red 25 cm high cover, in which were noted: *Sagina nivalis*, *Cerastium alpinum*, *Arabis alpina*, *Koenigia islandica*, *Oxyria digyna*, *Poa alpina*, *Festuca rubra* and *Phippsia algida*.

The bottom of the valley lies about 30 metres above the level of the sea, and up to it leads a rather steep south-exposed slope covered with herbaceous plants, which formed a luxuriant, 5—15 cm high, fresh green cover. Here were noted: *Potentilla maculata*, *P. nivea*, *Sibbaldia procumbens*, *Silene acaulis*, *Sagina nivalis*, *Alsine biflora*, *Cerastium alpinum*, *C. trigynum*, *Draba hirta*, *D. alpina*, *Arabis alpina*, *Thalictrum alpinum*, *Saxifraga cernua*, *S. nivalis*, *S. hieracifolia*, *S. decipiens*, *S. rivularis*, *S. oppositifolia f. reptans*, *Veronica alpina*, *Antennaria alpina f. glabrata*, *Erigeron uniflorus*, *Taraxacum croceum*, *T. phymatocarpum*, *Polygonum viviparum*, *Oxyria digyna*, *Salix herbacea*, *Salix groenlandica*, *Trisetum subspicatum*, *Festuca rubra*, *Poa alpina*, *Poa cenisia*, *Luzula confusa, Carex scirpoidea, C. rigida, C. incurva, Juncus biglumis, Eriophorum Scheuchzeri, Ranunculus nivalis, R. altaicus, R. pygmæus f. Langeana, Campanula rotundifolia* and *Woodsia glabella.*

The top of the slope was covered by a high, luxuriant heather-moor made up of: *Dryas octopetala, Cassiope tetragona, Vaccinium uliginosum, Arctostaphylos alpina* and *Betula nana*, all with ripe fruit. Amongst them grew in lesser numbers: *Empetrum nigrum, Alsine biflora, Cerastium alpinum, Papaver radicatum, Saxifraga oppositifolia, Pedicularis hirsuta, Pyrola grandiflora, Arnica alpina, Luzula confusa, Carex nardina* and *Poa alpina.*

At spots where earlier in the summer had been springs were found covers of *Philonotis fontana* and small spots of *Leersia affinis, Chomocarpon commutatus, Cephalozia bicuspidata v. cavifolia, Blepharostoma trichophylla, Jungermannia quinquedentata, J. elongata* and its *f. alpestris.*

The bottom of the valley was very poor rocky-flat formation thinly covered with mosses (*Pohlia spp., Anthelia, Grimmiae*) and lichens, and with very few phanerogams, among which *Silene acaulis, Salix arctica, Luzula confusa,* and *Carex rigida* were the most prominent. It was striped by wild brooks and strewn with flat stones, among which numerous lemmings had their burrows. The hound JEANETTE indicated with certainty which holes were inhabited, and digging out 30 burrows we managed to capture 13 living animals.

Forsblads Fjord.

Polhem's Valley (N. Hartz). On the 28th of Aug. we went ashore for some few hours' stay at Polhem's Valley on the north side of the river. Here was found vigorous, now much desiccated heath of a dark-brown shade made up as usually by *Cassiope tetragona.*

On a dry southern slope, built up of hard quartzitic schists without any mould was found the xerophile coppice vegetation formerly described by me from the inmost ramifications of Scoresby Sund. All the vegetation was utterly dried up; large fine carpets of *Betula nana, Salix arctica* var. *groenlandica, Vaccinium uliginosum, Rhododendron lapponicum, Arctostaphylos alpina* and *Empetrum nigrum*. The birch-trunks were up to 1,5 cm thick, 50—100 cm long and rose up to 25 cm above the ground. Besides the common big, tuftshaped gramineæ in gigantic specimens were found: *Calamagrostis arundinacea, Festuca rubra* var. *arenaria, Poa alpina* and a great many other herbaceous plants e. g. *Campanula rotundifolia* richly flowering, *Tofieldia coccinea* (which was found already at Forsblads Fjord by Nathorst) partly with white flowers, *Lesquerella arctica, Rumex acetosella, Melandrium affine, M. triflorum, Silene acaulis, Draba alpina, Saxifraga nivalis, S. hieracifolia, Pedicularis lapponica, P. flammea, P. hirsuta, Arnica alpina, Elyna Bellardi, Carex nardina, Hierochloa alpina, Trisetum subspicatum, Poa glauca* and *Cystopteris fragilis*, fully corresponding to Duséns' description of the copses (Gebüsch or Gestrüpp) of Kjerulfs Fjord.

Here were exquisitely fine, marine, clayey and sandy terraces; on the clayey flats were often seen large spots devoid of vegetation. I wonder whether presence of sodic chloride here hinders the forthcoming of vegetation (cf. my observations on the south-coasts of Jameson Land (Medd. om Grønland, XVIII, p. 130). On a gravelly marine terrace-flat abt. 50 m above the level of the sea grew *Dryas octopetala *integrifolia*, a rare plant in these regions of Greenland.

Outside the valley was a small narrow lagune with a low clayey-sandy wall on which grew *Halianthus* and *Stellaria humifusa*. On the beach numerous specimens of *Fucus* were thrown ashore.

Further up the inlet we landed for a few hours' stay on Aug. 29th; here was a low *Betula nana* coppice (or perhaps rather *Betula nana* heath) with numerous powerful specimens of *Elyna Bellardi* and other tall, graminaceous plants: *Calamagrostis arundinacea, Poa glauca, Carex nardina, Aira caespitosa f. alpina, Trisetum subspicatum, Festuca rubra* and fruitbearing *Vaccinium uliginosum*, a rather luxuriant, but very uniform vegetation.

At Kingua in Forsblads Fjord we stayed from the evening of August 29th to the next day at noon; we had our tent-place for the night at the very head of the inlet. The temperature of the air at nine o'clock in the evening was still 9° C. The vegetation here was powerful and well developed, but very little peculiar, namely *Cassiope*-heath and *Carex*-bog.

Here were found *Pedicularis lapponica* and *Tofieldia palustris*. Considerable ice-free land was found between the inland-ice and Kingua of the inlet.

Canning Land (Chr. Kruuse).

On Sept. 1st we landed on Canning Land in the vicinity of Cape Fletcher. The mountains are steep and, in long tracts of land, descend vertically into the ocean without any mountain foot, but outside a pass were found huge cones of débris. Weathering and frost-bursting are quick, and the light cruptive rocks which formed the pass and the mountains to the east of this were greatly corroded. The bottom is not very stabile, and is at present lacking moisture. The sea margin is made up of rolled blocks the size of a human head; there was no strand-vegetation except in the shelter of a couple of mighty blocks, where *Halianthus peploides* and *Stellaria humifusa* had found needful space.

On the débris-heaps were found only here and there spots of 1—2 m^2 with continuous vegetation, or a single individual sticking out between the blocks. I collected the species enume-

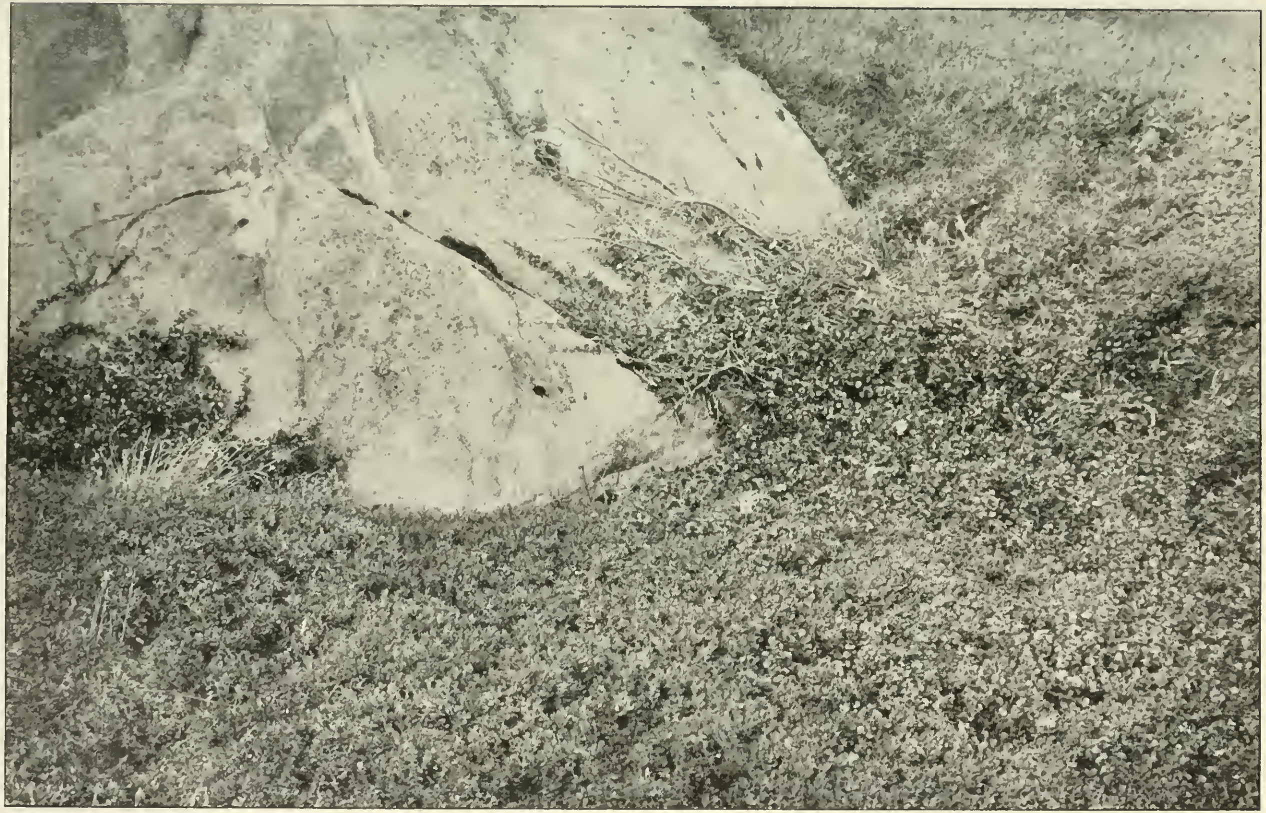

Fig. 28. *Betula nana*-espalier in *Vaccinium*-heath with *Calamagrostis arundinacea*. Forsblads Fjord. (From photo. by Chr. Kruuse).

rated below; I saw altogether only 1—3 individuals of each species with the exception of *Vaccinium* and *Salix*, of which I noticed about 20.

Dryas octopetala f. minor, Alsine biflora, Cerastium alpinum v. lanatum, Draba hirta, Saxifraga decipiens, S. cernua, S. oppositifolia, Vaccinium uliginosum f. microphyllum, Oxyria digyna, Salix arctica v. groenlandica, Luzula confusa and *Festuca ovina.*

In the pass and up the sides of the mountains up to about 700 metres above the level of the sea were noted:

Dryas octopetala f. hirsuta, Arenaria ciliata v. humifusa, Cerastium alpinum f. lanatum, Papaver radicatum, Saxifraga aizoides, S. oppositifolia, Salix arctica v. groenlandica, Carex nardina and *Poa glauca.*

The walls of the pass were, owing to quick weather-crumbling, totally bare of plants, not even a lichen could be found upon them. The north side of the mountain seen from above was also bare. I went down it 200 metres without finding other than the following mosses: *Timmia austriaca, Plagiobryum Zierrii, Onchophorus polycarpon, Grimmia apocarpa,* and *Jungermania Baueriana.*

The valley below, as seen from the heights, was completely bare of vegetation upon the coarse gravel. Indeed, this place was one of the most desolate and most devoid of vegetation ever seen by me in Greenland. On the other hand the landscape was exceedingly beautiful as from the far projecting Canning Land one had a wide view of large tracts of the coasts with lowlands and picturesque mountain-sceneries.

Angmagsalik.

The observations and collections made during our stay in the days from the 11^{th}—17^{th} Septbr. will be mentioned by Kruuse in connection with his studies conducted in 1898—99 and in 1902.

List of Plants known from the northern Fjords.

Dryas octopetala.
— — **integrifolia.*
Potentilla maculata.
— *emarginata.*
— *nivea.*
Sibbaldia procumbens.
Chamœnerium latifolium.
Empetrum nigrum.
Silene acaulis.
Melandrium apetalum.
— *involucratum v. affine.*
— *triflorum.*
Sagina Linnæi.
Alsine biflora.
— *verna.*
Halianthus peploides v. diffusa.
Arenaria ciliata v. humifusa.
Stellaria humifusa.
— *longipes.*
Cerastium trigynum.
— *alpinum.*
Lesquerella arctica.
Cochlearia officinalis f. minor.
Draba alpina.
— *nivalis.*
— *Fladnizensis.*
— *hirta.*
— *arctica.*
Braya purpurascens.
— *alpina.*
Arabis alpina.
Cardamine bellidifolia.
— *pratensis.*
Papaver radicatum.
Thalictrum alpinum.
Ranunculus glacialis.
— *pygmæus.*
— *hyperboreus.*
— *nivalis.*
— *altaicus.*
— *arcticus.*
Saxifraga hieracifolia.
— *nivalis.*
— *stellaris v. comosa.*
— *cernua.*
— *rivularis.*
— *decipiens.*
— *aizoides.*
— *oppositifolia.*
Sedum Rhodiola.
Armeria vulgaris v. sibirica.
Veronica alpina.
Pedicularis lapponica.
— *flammea.*
— *hirsuta.*
Euphrasia latifolia.
Pyrola rotundifolia var. grandiflora.
Arctostaphylos alpina.
Cassiope tetragona.
Rhododendron lapponicum.

Vaccinium uliginosum.
Campanula uniflora.
— *rotundifolia.*
Taraxacum phymatocarpum.
— *croceum.*
Antennaria alpina.
Erigeron uniflorus.
Arnica alpina.
Matricaria inodora v. phæocephala.
Koenigia islandica.
Polygonum viviparum.
Oxyria digyna.
Rumex acetosella.
Salix herbacea.
— *arctica.*
Betula nana.
Tofieldia palustris.
— *coccinea.*
Juncus biglumis.
— *triglumis.*
— *castaneus.*
— *arcticus.*
Luzula arcuata v. confusa.
— *spicata.*
Eriophorum Scheuchzeri.
— *polystachium.*
Elyna Bellardi.
Kobresia bipartita.
Carex nardina.
— *ursina.*
— *scirpoidea.*
— *rupestris.*
— *incurva.*
Carex lagopina.
— *misandra.*
— *salina v. subspathacea.*
— *rigida.*
— *capillaris.*
— *supina.*
— *pulla.*
Alopecurus alpinus.
Hierochloa alpina.
Calamagrostis arundinacea.
— *neglecta.*
Trisetum subspicatum.
Pleuropogon Sabinei.
Phippsia algida.
Arctagrostis latifolia.
Glyceria distans.
— *maritima v. vilfoidea.*
— *angustata.*
Poa abbreviata.
— *glauca.*
— *alpina.*
— *pratensis.*
— *cenisia.*
Festuca ovina.
— *rubra.*
Lycopodium Selago v. appressa.
Cystopteris fragilis.
Woodsia ilvensis.
— *hyperborea.*
— *glabella.*
Botrychium Lunaria.
Equisetum arvense.
— *variegatum.*

Flower-pollination (N. Hartz).

While referring to my observations from 1891—92 over this question (Medd. om Grønland, XVIII, p. 300) I cite below the isolated observations from 1900:

Sabine Island. 12.—14. VII.

Papaver radicatum — *Ramphomyia* (*nigrita?*).
Silene acaulis ♀ — *Agrotis* sp. (hawk-moth).
Potentilla nivea — flies.
Polemonium humile — flies.
Stellaria humifusa — flies.

Cape Dalton. 20. VII.

Rhodiola rosea ♂ — fly.
Dryas octopetala — numerous flies.
Cassiope tetragona — numerous humble bees.

Hurry Inlet.

Chamænerium latifolium — humble bees, 31. VII and 4. VIII
Cerastium alpinum — flies, 11. VIII.
Silene acaulis ♀ — *Colias*, 15. VIII.

Polhems Valley. 28. VIII.

Saxifraga aizoides — two humble bees (H. Deichmann).

Distribution of the species and some varieties in East Greenland (Chr. Kruuse).

	Northern coast part 75°–73°30'	Northern inlet part 73°30'–71°20'	Scoresby Sund 71°30'–70°	Cape Dalton part 70°–69°25'
Dryas octopetala				
— — *f. minor*				
— — *f. hirsuta*				
— — *f. argentea*				
— — **integrifolia*				
— — *f. intermedia*				
Potentilla pulchella f. humilis				
— — *f. elatior*				
— *maculata*				
— *emarginata*				
— *nivea*				
Sibbaldia procumbens				
Alchimilla glomerulans				
Hippuris vulgaris				
— — *v. maritima*				
Callitriche verna v. minima				
Epilobium anagallidifolium				
Chamænerium latifolium				
Empetrum nigrum				
Silene acaulis				
Viscaria alpina				
Melandrium apetalum				
— *involucratum v. affine*				
— *triflorum*				
Sagina Linnaei				
— *nivalis*				
— *cæspitosa*				
Alsine biflora				
— *stricta*				
— *verna v. rubella*				
— — *hirta*				
— — *propinqua*				
Halianthus peploides v. diffusa				
Arenaria ciliata v. humifusa				
Stellaria humifusa				

	Northern coast part 75°–73°30′	Northern inlet part 73°30′–71°20′	Scoresby Sund 71°30′–70°	Cape Dalton part 70°–69°25′
Stellaria longipes	....	....	....	....
Cerastium [1]) *trigynum*			....	....
— *alpinum*		....	....	....
Lesquerella arctica		....	....	
Cochlearia officinalis v. groenlandica		....	....	....
— — *v. oblongifolia*	....	....	....	....
Draba alpina	....		....	....
— — *v. glacialis*	....		....	
— — *v. oblongata*	....			
— *glacialis*	....			
— *crassifolia*	....		....	....
— *aurea*			....	
— *repens*			....	
— *nivalis*	....	....	....	....
— *Fladnizensis*	....	....	....	....
— *hirta*	....	....	....	....
— *arctica*	....	....	....	....
Braya purpurascens	....	....	....	
— *alpina* [1])		....	....	
Eutrema Edwardsii		....		
Cardamine bellidifolia	....	....	....	....
— *pratensis*		....	....	
Arabis alpina		....	....	....
— *Holboellii*			....	....
— *arenicola* [1])			....	
Papaver radicatum	....	....	....	....
Thalictrum alpinum		....	....	....

[1]) According to kind communication from Mr. C. H. Ostenfeld, Ph. D., inspector of the Botanical museum of Copenhagen, the following emendations ought to be made in Kruuse's above-mentioned list of phanerogams etc. (Medd om Grønland, XXX, S. 143—208):

P. 159. *Cerastium Edmonstonii* (Watson) var. *cæspitosa* (Malmgr.) is: *C. alpinum* L. f. *pulvinata* Simm.

P. 164. The specimens of *Braya alpina* Sternb. & Hoppe cited from Klitdalen in Scoresby Sund (Hurry Inlet, Ryder's Dal, in stony plains and in downs) are: *Arabis arenicola*.

P. 199. *Dupontia Fisheri* from Hurry Inlet, the (Dinosaur-)cleft, is *Poa* (*glauca?*).

	Northern coast part 75°—73°30′	Northern inlet part 73°30′—71°20′	Scoresby Sund 71°30′—70°	Cape Dalton part 70°—69°25′
Batrachium paucistamineum v. eradicata				
Ranunculus glacialis				
— *pygmaeus*				
— *hyperboreus*				
— *nivalis*				
— *altaicus*				
— *arcticus*				
Saxifraga hieraciifolia				
— *nivalis*				
— *stellaris v. comosa*				
— *cernua*				
— *rivularis*				
— *decipiens*				
— *tricuspidata*				
— *hirculus*				
— *aizoides*				
— *flagellaris v. setigera*				
— *Aizoon v. brevifolia*				
— *oppositifolia*				
— — *v. Nathorsti*				
Sedum Rhodiola				
Armeria vulgaris v. sibirica				
Pinguicula vulgaris				
Veronica alpina				
— *saxatilis*				
Pedicularis lapponica				
— *flammea*				
— *hirsuta*				
Euphrasia latifolia				
Polemonium humile				
Gentiana tenella				
Diapensia lapponica				
Pyrola rotundifolia v. grandiflora				
Arctostaphylos alpina				
Phyllodoce coerulea				
Cassiope tetragona				
— *hypnoides*				
Rhododendron lapponicum				
Vaccinium uliginosum				

	Northern coast part 75°–73°30′	Northern inlet part 73°30′–71°20′	Scoresby Sund 71°30′–70°	Cape Dalton part 70°–69°25′
Campanula uniflora	.....	.....	.....	.....
— *rotundifolia*	.....	.....	.....	.....
Taraxacum phymatocarpum et aff.	.....	.....	.....	
— *croceum et aff.*		.....	.....	.....
Hieracium alpinum			.....	.....
Antennaria alpina		.....	.....	.....
— — *v. glabrata*		.....	.....	.....
Erigeron compositus	.....		.....	
— *uniflorus*	.....	.....	.....	.....
Arnica alpina	.....	.....	.....	.....
Matricaria inodora v. phæocephala		.....		
Koenigia islandica	.....	.....	.....	.....
Polygonum viviparum	.....	.....	.....	.....
Oxyria digyna	.....	.....	.....	.....
Rumex acetosella		.....	.....	
Salix herbacea	.....	.....	.....	.....
— *arctica*	.....	.....	.....	.....
— — *v. groenlandica*	.....	.....	.....	.....
— *glauca*			.....	.....
Betula nana		.....	.....	.....
Tofieldia palustris		.....	.....	.....
— *coccinea*		.....	.....	
Juncus biglumis	.....	.....	.....	.....
— *triglumis*	.....	.....	.....	
— *castaneus*	.....	.....	.....	
— *trifidus*			.....	.....
— *arcticus*		.....	.....	
Luzula multiflora			.....	
— *arcuata v. confusa*	.....	.....	.....	.....
— *nivalis*	.....		.....	
— *spicata*			.....	.....
Eriophorum Scheuchzeri	.....	.....	.....	.....
— *polystachium*	.....	.....	.....	.....
Elyna Bellardi	.....	.....	.....	
Kobresia bipartita		.....	.....	
Carex nardina	.....	.....	.....	.....
— *dioica v. parallela*			.....	
— *ursina*	.....	.....	.....	.....
— *scirpoidea*		.....	.....	.....

	Northern coast part 75°—73°30'	Northern inlet part 73°30'—71°20'	Scoresby Sund 71°30'—70°	Cape Dalton part 70°—69°25'
Carex microglochin				
— *rupestris*				
— *incurva*				
— *Macloriana*				
— *lagopina*				
— *alpina*				
— *misandra*				
— *glareosa*				
— *bicolor*				
— *salina f. subspathacea*				
— *rigida*				
— *capillaris*				
— *ustulata*				
— *rariflora*				
— *pedata*				
— *supina*				
— *rotundata*				
— *pulla*				
Alopecurus alpinus				
Hierochloa alpina				
Agrostis borealis				
Calamagrostis arundinacea				
— *neglecta*				
Aira cæspitosa f. arctica				
Trisetum subspicatum				
Pleuropogon Sabinei				
Dupontia Fisheri				
Phippsia algida				
Arctagrostis latifolia				
Glyceria distans				
— *maritima v. vilfoidea*				
— *angustata*				
— *Vahliana*				
Poa abbreviata				
— *glauca*				
— *nemoralis v. pallida*				
— *alpina*				
— *pratensis*				

[1]) See note p. 427.

	Northern coast part 75°—73°30'	Northern inlet part 73°30'—71°20'	Scoresby Sund 71°30'—70°	Cape Dalton part 70° 69°25'
Poa cenisia	....	. . ..	......	.....
Festuca ovina	......	....	......	
— *rubra v. arenaria*	...	.	. ....	
Lycopodium Selago f. appressa	. . ...		.....	
— *annotinum f. pungens*			. . ..	
— *alpinum*			...	
Aspidium fragrans			. .	
Cystopteris fragilis	. . .	...	. . . .	. .
Woodsia ilvensis v. rufidula	.	.	....	. . . .
— — *v. alpina*		...	. .	
— — *v. glabella*	..	. . .	. . .	
Botrychium Lunaria		.	.	
Equisetum variegatum	......	....	. . . .	. . .
— — *f. anceps*	. . . . . .	. .		...
— *arvense f. borealis*			. . .	. . . . .
— — *f. decumbens*	......	......	...	. .....

Note. The numbers and positions of the points in the list correspond to the extension of the species within each district, full dotting indicating that it is found everywhere, whereas points to the left in the column signifies that it is found only in the northern part, points to right that it is found only in the southern part of the district.

12—6—1911.

The

Structure and Biology

of

Arctic Flowering Plants.

I.

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Copenhagen.
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Hitherto, the following papers have been published:

6.

Ranunculaceæ.

By

Knud Jessen.

1911.

The subject-matter of the present paper has been worked out in the Botanical Laboratory in Copenhagen and my thanks are due to Professor WARMING for his great kindness in giving me advice and help. I have used his notes of his Arctic journeys, and I am indebted to him for most of the flower-biology drawings and some others. As regards the remaining figures, the anatomical ones have been drawn by me and most of the morphological ones have been drawn under my supervision. The spirit-collection of *Ranunculaceæ* belonging to the museums of Copenhagen and Stockholm, in which most of the species are richly represented, were freely placed at my disposal and for this I wish to express my gratitude to the Directors of the museums, Professor WARMING and Professor LINDMAN. I have also been kindly permitted to use the Arctic herbarium belonging to the Botanical Museum in Copenhagen. In addition I wish to express my thanks to the Inspector of the Museum, Dr. phil. C. H. OSTENFELD, for the kind help I have several times received from him.

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Ranunculus glacialis L.

Wydler, 1859, p. 263. Lindman, 1887, pp. 19, 25, 39, 99, tab. I, fig. 6. Wagner, 1892, p. 55. Norman, 1895, pp. 1—4. Kerner, II. 1898, pp. 162, 272, 276. Andersson & Hesselman, 1900, p, 42. Resvoll, 1900, figs. 1, 6, 10, 16, 17. Cleve, Astrid, 1901, p. 50. Dusén, 1901, p. 29. Freidenfelt, 1904, p. 54. Sylvén, N., 1905, pp. 134—40, fig. Hollstein, 1907, pp. 84—85, 88.

Alcohol material from Fløjfjæld (Tromsø), 23. 7. 1885; Knudshø (Dovre), 7. 1891; Jan Mayen, 22. 7. 1896.

The rhizome is vertical or oblique and remains alive for several years; the length of the longest I measured was about 5 cm. The primary root dies early, and afterwards only adventitious roots occur. The latter arise without apparent order from the entire surface of the rhizome; withered leaf-fragments and a few short hairs occur between the roots.

Hollstein records that the rhizome is exceedingly short and that it dies at the same time as the floral-axis produced by it; consequently upon this point there appears to be a difference between the Arctic individuals of the species examined by me and those from Central Europe.

When flowering begins, the rhizome becomes sympodial with, usually, only one branch from the uppermost of the leaf-axils at the base of the stem; but specimens often occur with 2-several growing-points on the rhizomes, consequent upon the fact that other leaves of the rosette, besides the uppermost, may subtend buds. The flowering-axis usually bears only a few leaves at the base, viz. on the outside 1—3 scale-leaves with large sheaths and rudimentary laminæ, and then, 1—2 (according to Wydler as many as 4) long-stalked foliage-leaves; the leaf-spiral is $^{2}/_{5}$. In the majority of the specimens examined by me these foliage-leaves were wanting and the principal bud was therefore situated in the axil of the uppermost scale-leaf (Fig. 1). Sometimes forms transitional between scale-and foliage-leaves occur. In the spring the principal bud develops into a leaf-rosette consisting entirely of stalked foliage-leaves, of which the first two (or according to Wydler the first 2—4) stand transversely with regard to the subtending leaf and the parent-axis, while the others succeed in a 2/5 spiral; later in the year the scale-leaves must be developed, and the plant probably passes the winter with a winter-bud covered by the scale-leaves.

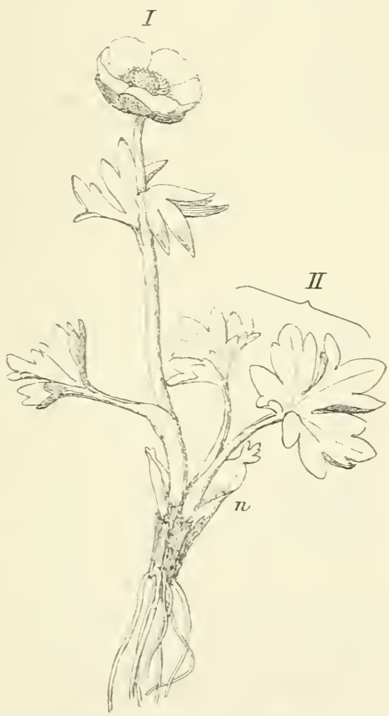

Fig. 1. *R. glacialis.* (Trömsö; about nat. size). I, Main axis; II, principal bud, *n* its subtending leaf.

The more-or-less erect, rounded and almost glabrous flower-stem bears 1—4 leaves of which the lower are stalked and the upper are sessile. The radical leaves and the stalked stem-leaves are almost similar in form, somewhat reniform, and palmatipartite, with broad primary segments; the sessile stem-leaves are divided in a similar manner; but the segments are lanceolate-elliptical. All the leaves are somewhat fleshy and are slightly hairy upon their lower surface.

The lower stem-leaf may subtend a vegetative bud which, like the principal bud, bears first two transversely-placed leaves. According to Wydler, this bud may effect vegetative propagation because the parent-stem lies prostrate upon the ground, while the bud strikes adventitious roots and becomes fixed thereby.

The herbarium-specimens in the Museum of Copenhagen confirmed this only in so far as that several stems appeared to have been prostrate to a greater or lesser degree. The 2—3 upper stem-leaves may subtend floral-axes, which each bear from one to two lateral green bracteoles. Between the principal axis and the lateral axes there is sometimes antidromy, sometimes homodromy. — The principal bud, in each of the few Greenland plants preserved in spirit, was only about 2 mm. long while, in the specimens from the other localities it always had several fully-developed leaves; all were gathered at the same time, the middle of July.

Fig. 2. *R. glacialis.* Almost ripe fruit from the Færöes, 21. 8. 1897 (about 5/1). Herbarium-material); *sem.*, seed.

The non-flowering specimens grow monopodially and have a terminal rosette; the latter, as in the flowering specimens, has externally a few scale-leaves.

The flower has five perigone-leaves densely covered with reddish-brown hairs, and five nectary-leaves[1] which are white in the first part of the flowering period, and are about twice as long as the sepals. Both the perigone-leaves and the nectary-leaves persist until the ripening of the fruits and the former become somewhat dull crimson in colour (Lindman). Norman states that the flower with ripe fruits has almost the same appearance as has the young flower. The fruit is somewhat flattened and has a rather long beak (Fig. 2).

Lindman records that the flower is protandrous in Scandinavia; my material, which was scanty in reference to this question, indicated the same. The anthers of the numerous stamens are extrorse; the filaments are short previous to flowering; the outer ones elongate first, and their anthers open after the nectary-leaves have expanded. The numerous carpels (120—150) which are closely placed in the bud do not spread out until but one or two of the numerous whorls of stamens

[1] The German "Honigblätter"; cf. Prantl.: Beiträge z. Morph. und. System. d. Ranunculaceen. Engler, Bot. Jahr., 1888.

are still in the bud-condition (Lindman). Towards the end of the flowering period the flower is homogamous, or it may be entirely pistillate (Lindman). In Central Europe *R. glacialis* is homogamous or slightly protandrous (H. Müller, Ricca). In the Alps Müller observed two flies and two small beetles visiting *R. glacialis.*

According to Kerner (l. c. pp. 162 and 276) there are three kinds of flowers in *R. glacialis*, some hermaphrodite and some pollen-bearing flowers with function-less carpels ("scheinzwittrige Pollenblüten"); the hermaphrodite are of two kinds, some with large carpels and a few small stamens, and others with small ovaries and many longer stamens; the former have cross-pollination, the latter autogamy.

Fig. 3. *R. glacialis.*

A. Nectary-leaf seen from the dorsal side; *B*, *C*, *D*, *E*, bases of nectary-leaves showing nectar-pits and the scale above with some of its variations of form. (*A*, 5/2; *B*, *C*, *D*, 5/1, from Areskutan, 25. 7. 1884; *E*, 5/1, from Piteå Lappmark, 17. 7. 1883; Drawn by E. W.).

The nectary-leaves have upon the upper side of the claws with their yellow bases a pocket-shaped nectary. Above the latter is seated a scale (Fig. 3) which varies extremely, both in regard to form and size; even the scales from the same flower may differ greatly. The scale encloses with the nectary-leaves an angle of 40°—50° and touches the outwardly-turned ripe or open stamens with its free edges. Only an insect which can bend the stamens apart from the scales will be able to reach the honey (Kerner).

The diameter of the flower is rather variable; Norman mentions the limits of size as 2·3, and 3·1 cm. with regard to specimens from Arctic Norway; Lindman gives them as 1·5 and 2·5 cm.

The earliest flowering periods, as far as I know, are the middle of May in the Færöes (Ostenfeld, Plantevæksten paa Færoerne. Kbhv., 1906, p. 39) and the beginning and middle of June in Jan Mayen and Iceland (Herbarium-material and Dusén, Beitr. z. Fl. d. I. Jan Mayen. Bih. Kgl. Sv. Vet. Akad. Handl. Bd. 26, Afd. III, 1900, p. 5). Plants in flower have been observed on the 7th of September in Arctic Norway (Norman) and on the 16th of September, 1892, at Angmasalik in East Greenland (Herbarium-material).

As regards the dispersal of the fruit I may mention Norman's well-known hypothesis regarding its dispersal by reindeer. As far as I know it has not yet been investigated whether the dung of the reindeer contains fruits of *R. glacialis* capable of germinating; but Norman rests his hypothesis on the fact that the reindeer eat by preference the tops of this plant, even when it has ripe fruit (as has been mentioned the perianth persists) and also on the fact that the plant occurs especially in the localities in Arctic Norway in which the reindeer wander, and with a few exceptions, occurs only in those regions on the earth where that animal now lives or has lived in former times.

Germination. In the literature upon the subject there are several notes on the germinating plants of *R. glacialis*; by Lamarck in "Flore Francaise," and by L. u. A. Bravais in "Die geomet. Anordnung der Blätter und Blütenstände," Breslau, 1839, note on p. 129; and information concerning the germination may be found in several papers by Winkler in Verh. d. bot. Vereins d. Prov. Brandenburg, vols. XVIII—XXVI—XXXVI. Sylvén (l. c.) has figured and described the germinating plant from material from Lapland. Germination takes place during the spring, and there is only one cotyledon; the first leaf on the epicotyl is a scale-leaf, then comes a foliage-leaf with an entire, triangular lamina. The second year only a few foliage-leaves are developed. The third-year's leaves are distinctly tripartite; the primary root is by that time dead.

The plant grows by preference in soil poor in humus. In Arctic Norway it usually is not found below a height of 200—300 m. above tree-limit; NORMAN regards it also as a decidedly continental plant that is not common upon the islands. In contradistinction to this, is the fact recorded by DUSÉN from East Greenland, 74°—75° N. lat. that it is found there growing at shore-level and is never found at the head of fjords.

Geographical Distribution. Arctic Russia, Lapland, Finmark, Norway, Sweden, Beeren Eiland, Spitzbergen, Jan Mayen, Iceland, the Færøes, the Alps, the Pyrenees, East Greenland from 65 1/2 ° N. L. northwards (LANGE, DUSÉN, see p. 342).

Anatomy. Adventitious roots of the first order. Epidermis is thin-walled, and collapsed in older roots. Exodermis is distinctly marked; the cells are somewhat radially elongated, the radial walls undulating. The epidermis and the exodermis have suberized walls, but the inner layer of the inner wall of the exodermis is of cellulose. The two outermost layers of cells of the cortex have somewhat collenchymatously thickened walls (Fig. 4). The rest of the about 15-layered cortex consists of thin-walled cells which are circular in transverse section, and of large, usually 4—5 angled, intercellular spaces. Large lysigenous lacunæ can often be seen. Next to the central cylinder there are usually a few layers of smaller and more closely-placed cells. All the cells of the cortex contained a quantity of starch (middle of July). The endodermis is slightly thickened and suberized; CASPARY's dots are indistinct; the cells are somewhat tangentially elongated. Pericycle is one-layered, and the cells are isodiametric in transverse section. The vas-

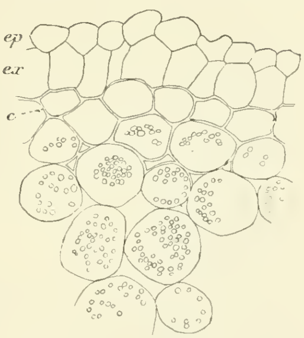

Fig. 4. *R. glacialis.* The outer layers of a root of the first order (Jan Mayen). *ep*, Epidermis; *ex*, exodermis. (215/1).

cular rays number from 3 to 5, usually 4; they may meet in the centre of the root. The sieve-tissue, as is also the case in many other species of *Ranunculus*, has in its outer part a large pentagonal sieve-tube wedged in between adjacent cells of the pericycle. Upon the inner side of the leptome-mass a few cambial divisions may be observed. The diameter of the root is from 1·5 to 2 mm. In the present species no essential differences were observed in the roots from the different localities.

The roots of the second order are very slender; 250—300 μ in diameter. The epidermis is collapsed and the exodermis well-marked. The cortex is very lacunose with about five layers of cells. Endodermis is thin-walled; the central cylinder diarch. No thickened part occurred within the exodermis. Mycorrhizas were absent; but it should be noted that in the material at hand there were only a few roots of the second order, and it is especially in the latter that mycorrhizas are found in the other species.

The rhizome. The outermost layer of the cortex together with the epidermis, is often collapsed and suberized. The cells of the cortex are elongated in a tangential direction; they contained much starch (middle of July). Hollstein records that in the interior of the cortex a continuous phellogen is developed which usually produces a layer of cork which separates off about $^1/_4$ of the cortex. I have not been able to observe anything of that kind in the rhizomes which I investigated. The vascular bundles are placed in a circle and vary in number from 5 to 10, and are of different sizes; some are circular in form, others are elongated tangentially (Fig. 5, *A*). Their course may be very irregular, usually they anastomose. Each bundle has its own endodermis, which may be slightly lignified; the cells of it also are tangentially divided; Caspary's dots are often distinct (Fig. 5, *B*). There is a cambium capable of division and the greater part of the vessels in the strands and of the wood-parenchyma is of secondary origin (Fig, 5, *B*). The cells of the pith are arranged concentrically in relation to the vascular bundles which are near them; starch was present (middle of July).

The a b o v e - g r o u n d s t e m. The outer wall of the epidermis is thickened, and the cuticle is distinct; the latter is dentate in transverse section. There are a few, somewhat projecting stomata. Hairs are scanty. Within the epidermis there is a layer of cells which, in the lower part of the stem, are angular and placed closely together; higher up they are

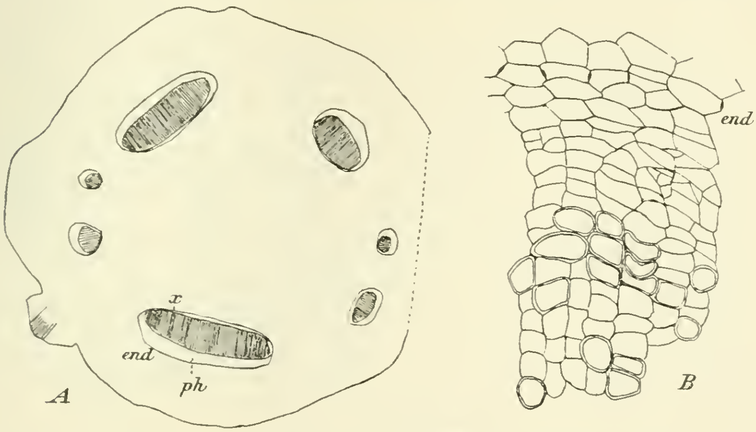

Fig. 5. *R. glacialis.*

A, Transverse section of rhizome (Tromsö; about 15/1). *end*, Endodermis; *ph*, leptome; *x*, xylem. *B*, Secondary wood and sieve-tissue with endodermis; from the rhizome (about 260/1).

more rounded in transverse section, and more loosely connected to the epidermis and with each other. The cortex consists of lamellæ which are one cell-layer thick and surround large lacunæ (Fig. 6, *B*). These plates are often collapsed and thereby large, irregular gaps may occur, which are largest in the lower part of the stem. The epidermis, and especially the outer part of the cortex, contains chlorophyll. The vascular bundles are placed in a circle and number from 9 to 11, and are all of about the same size; there are fewer in the peduncle than in the stem. The cells are placed closely together around the bundles, but I did not observe any lignified stereom; on the outer side of the sieve-tissue in some of the bundles, from one to two layers of slightly collenchymatously thickened tissue can be seen. The endodermis is not distinct. Within the V-shaped mass of wood some small-celled parenchyma often occurs. Between the wood and the cambium there is in this species, as in the others, some wood-parenchyma. The cambium is but slightly developed. Interfascicular, lignified stereom is also absent, but the cells

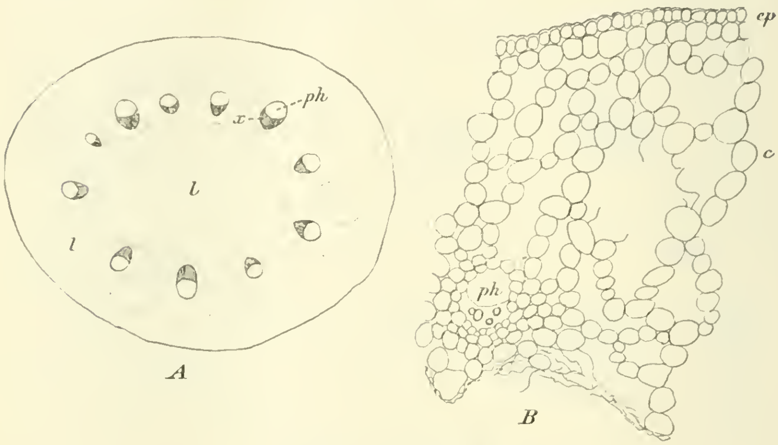

Fig. 6. *R. glacialis.*

Transverse section of stem (Jan Mayen). *A*, An entire section from near the base. *B*, Portion of section from the middle of the stem. *ep*, Epidermis; *c*, cortex; *ph*, leptome; *x*, xylem; *l*, lacuna. (*A*, about $^{20}/_{1}$; *B*, $^{75}/_{1}$).

of the medullary rays are smaller and more closely placed than are those of the cortex. The pith is more or less broken down in the stem, while in the peduncle it resembles the cortex in structure, but the lacunæ are still larger.

Such a loosely-woven stem is able to retain its erect position probably only by reason of its thickness (3—4 mm.) in combination with the pressure of the sap; and the fact mentioned above as recorded by Wydler, that the stem may lie upon the ground with its lower part prostrate, is easy to understand when reference is made to its structure.

The leaf is somewhat succulent; the upper surface is glabrous and the lower somewhat hairy with long (as much as 2 mm.), flaccid hairs. The structure of the leaf is decidedly dorsiventral; in the majority of the leaves three distinct palisade-layers (Fig. 7, *A*) were found, the height of the cells of which was about three times the breadth: the palisade-cells were slightly inclined towards the leaf-apices. There is an abrupt transition from the palisade to the spongy parenchyma which is extremely loose in structure and consists of abundantly branching cells.

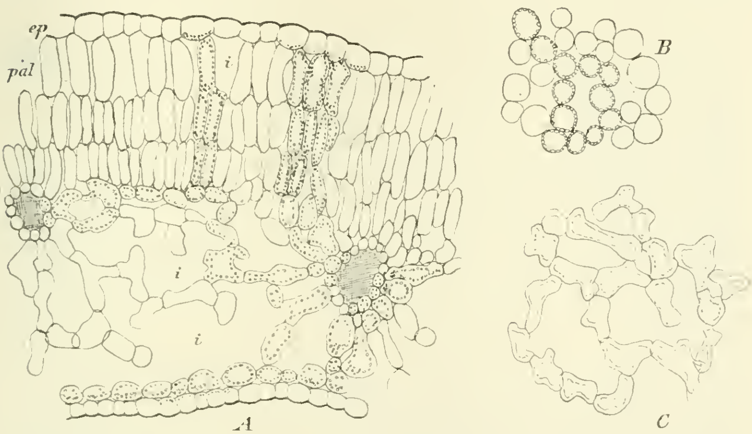

Fig. 7. *R. glacialis.*

A, Transverse section of leaf (Jan Mayen). *B*. Surface section of the uppermost layer of the palisade-tissue (Tromsö). *C*, Surface section of spongy tissue (Tromsö). *ep*. Epidermis *pal*, palisade-cells, *i*, intercellular spaces (*A*, about $^{80}/_{1}$; *B*, *C*, $^{100}/_{1}$).

The vascular bundles are surrounded by a sheath containing chlorophyll, and are entirely enclosed by the mesophyll; even above the principal vein three palisade-layers occur. The epidermis of both the upper and lower surface contains chlorophyll; the outer walls are slightly thickened. The stomata are situated on a level with the epidermis (Fig. 8, *D*). The cells of the upper epidermis have almost straight walls while those of the lower epidermis are somewhat undulating (Fig. 8, *A*, *B*). There are about three times as many stomata upon the upper as upon the lower surface. Th. Resvoll found 78 per sq. mm. upon the upper surface and 28 per sq. mm. upon the lower surface; my computations gave 100 and 33; in the Alpine *R. glacialis* Wagner found the numbers to be 163 and 54.

At the apex of each leaf-lobe there is a hydathode with its opening in a small depression almost at the apex of the lobe (Fig. 8, C). The cells of the epithema nearest to the tracheids are somewhat elongated and have undulating walls, towards the apex of the leaf they become shorter, but are undulating there also.

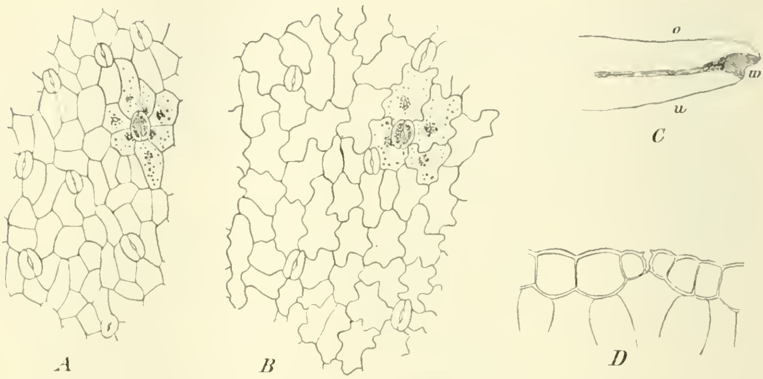

Fig. 8. *R. glacialis.*

A, Epidermis of the upper surface of the leaf (Tromsö). *B*. Epidermis of the lower surface of the leaf (Tromsö). *C*, Longitudinal section of leaf-apex, the cross-hatched part is the epithema; *o*, upper surface; *u*, lower surface; *w*, stands opposite to the hollow in which the water-pore occurs (Tromsö). *D*, Stoma from the lower surface of the leaf (Knudsho). (*A*, *B*, 100/1; *C*, 15/1; *D*, 220/1).

In the epidermis of both the upper and lower surface sphaero-crystals of different forms occur.

The stalks of the basal leaves are almost round. The epidermis is more thin-walled than that of the stem, and contains chlorophyll. The structure of the cortex and pith is like that of those of the stem, only the lacunæ are even larger. There are about four vascular bundles without accompanying stereom. In the middle of the stalk there is a lacuna of larger or smaller size.

Ranunculus affinis R. Br.
and
R. affinis* Wilanderi Nath.

(Syn. R. arcticus Richard., R. amoenus Led. p. p., see Simmons, 1906).

Lit. HOOKER, 1833, p. 12, fig., tab. VI. NATHORST, 1883, p. 23. BØRGESEN, 1895, pp. 225, 236—37. HARTZ, (II), 1895, p. 288. NESTLER, 1895. RESVOLL, 1900. ANDERSSON & HESSELMAN, 1901, pp. 49—54, figs. 25—26. DUSÉN, 1901, p. 31. SIMMONS, 1906, pp. 101—08; 1909, p. 74.

Alcohol material from Spitzbergen (Middelhook in Belsund, 30. 6. 1882; Cape Thordsen, 6. 8. 1882; Gåselandet, 11. 7. 1892).

R. affinis is a perennial herb with a vertical rhizome; the latter may reach a length of as much as 5 cm., and adventitious roots arise from the whole of its surface. The rosette-leaves are long-stalked, and the laminæ somewhat reniform, always more or less deeply palmately-cleft, often into five principal lobes. I did not find scale-leaves. In most of the plants a principal bud occurred in the uppermost leaf-axil at the base of the stem, but the other leaves of the rosette may also subtend buds, and the rhizome is often found to be branched. The new shoot begins with at least two transversely-placed, long-stalked foliage-leaves; the others succeed in a $^2/_5$ spiral. The lateral shoots develop rosettes during the same year as that in which the parent-axis flowers, and when the fruit ripens some of the rosette-leaves of the parent-axis are still alive. I have noticed no instance of the principal bud flowering the same year as the parent-axis. There are 3—4 stem-leaves; the lowermost is often stalked and resembles the basal leaves, the others are sessile and pedately cleft into 5—9 oblong-linear lobes. The stem-leaves often subtend floral axes. In var. *Wilanderi*, which is altogether of lower growth than the principal form, the upper interfoliar parts of the stem in the 2—3 flowering specimens are very short so that all the floral axes appear to proceed from about the same point (Nath.). The leaves are slightly hairy; the leaf-stalk, stem and especially the peduncle are covered with short adpressed hairs; the peduncle is furrowed.

The five perigone-leaves are hairy and somewhat violet in colour; they are outwardly or downwardly directed in the open flower and fall off early. The nectary-leaves are somewhat longer than the perigone-leaves, and are pale yellow with violet veins on the under side (Simmons, 1906); the nectary is simple and pocket-shaped (Fig. 9, *B*). The stamens are rather few in number and are situated close to the lower part of the large gynaeceum (A. & H.); the head of carpels is ovate in the young flower, but elongates somewhat and becomes cylindrical during fruit-setting; in var. *Wilanderi* it remains ovate. According to my computations the diameter of the flower was about 2—5 cm. (according to Anders. & Hesselm. it is 1·5—2 cm.)

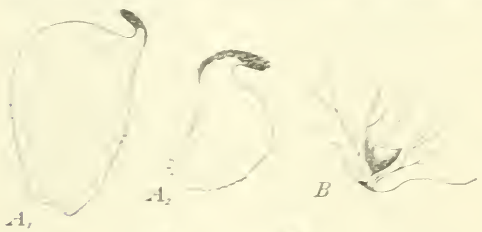

Fig. 9. *R. affinis.*

Carpels: A_1 ripe; A_2 during flowering (Cape Thordsen: [illegible]). *B*. Base of nectary-leaf (Spitzbergen: [illegible]).

and the corolla is almost flat when it is fully expanded (A. & H.). The flowers which have been investigated from Gåselandet appear to be protogynous-homogamous. The stamens had not yet opened, nor had they elongated, but the carpels had fully-developed papillæ upon the stigmas. The plant begins to flower in the early part of July at Scoresby Sound, in East Greenland (Hartz, Dusén) and in Spitzbergen; in August it has ripe fruit (Herbarium-specimen).

Lange records that it grows in damp localities. Simmons (1906) found it in well-manured soil under a nesting-place for sea-gulls.

Geographical Distribution. West Greenland (rare). N. E. Greenland, Spitzbergen, Nova Zembla, Arctic Siberia.

Altai, Arctic America with the Archipelago, and the Rocky Mountains (Simmons, 1906).

Anatomy. The adventitious roots of the first order are triarch-tetrarch, and those of the second order diarch. Both the epidermis and the exodermis are suberized; in several specimens the former is found to have collapsed, the latter has undulating radial walls. The two outer layers of the cortex within the exodermis are slightly collenchymatously thickened; the rest of the cortex has large intercellular spaces and, in older roots, large lysigenous lacunæ. The cells of the endodermis had become slightly thickened and suberized, and several had divided tangentially. This species, as is also the case in the other species of Ranunculus which have been investigated, has a large pentagonal tube in the outer part of the sieve-tissue wedged in between adjacent cells of the pericycle. Mycorrhizas have been found, both in the principal form and in var. *Wilanderi*; it was always only roots of the second order that contained hyphæ which were often rolled together into balls.

The structure of the rhizome is similar on the whole to that of the other species with erect axes which have been investigated (Fig. 10, *A*). Stereom is absent. The epidermis and the outermost layer of the cortex are often suberized and collapsed; the cortex is lysigenously lacunose.

The cuticle upon that part of the stem which has elongated internodes, is striped. The tangential walls of the epidermis are somewhat thickened, the radial walls are furnished with pores; the epidermis contains chlorophyll. Upon the upper part of the stem the stomata are fairly numerous and they project slightly. Large intercellular spaces occur in the cortex (the sub-epidermal layer not included), but no lacunæ. The stereom, as usual, is most strongly developed in the fruit-bearing axis. The fibrous tissue outside the leptome may reach a thickness of seven layers and the lignified cells of the medullary rays towards the circumference have somewhat thickened walls. The bundles number between 10 and 15; some wood-parenchyma occurs between the sieve-tissue and the vascular woody part from which non-lignified parenchyma was wanting, and, as was the case in several other species, some small-celled, somewhat collenchymatous parenchyma occurs on the inner side of the bundles (Fig. 10, *B*). In the peduncle there is no distinct sheath between the conducting tissue and that around it. The young flower-stalk has almost no stereom. In the older stem there is a large central lacuna.

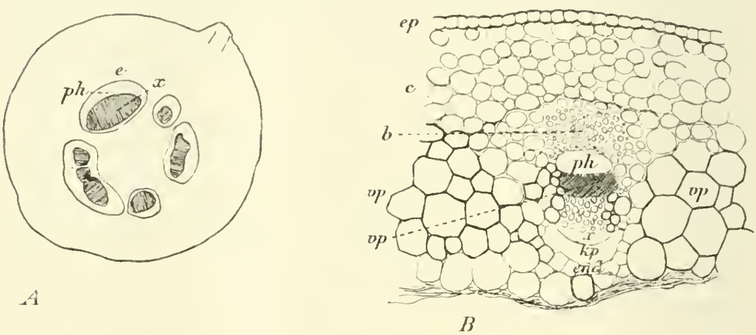

Fig. 10. *R. affinis.*

A, Transverse section of rhizome (Gåselandet; $^{17}/_{1}$). *e*, Endodermis; *ph*, leptome; *x*, xylem. *B*, Portion of transverse section of stem (Cape Thordsen; $^{90}/_{1}$). *ep*, Epidermis; *c*, cortex; *b*, bast; *ph*, leptome; *vp*, lignified parenchyma; *x*, xylem; *kp*, collenchymatous parenchyma; *end*, endodermis.

Var. *Wilanderi* was somewhat more compact in structure than was the principal form.

The thickness of the leaf varies from 210 to 250 μ, and the specimens investigated show greater differences among themselves in the structure of their leaves than is the case in any other species. The epidermis however is nearly alike in all the specimens; it contains chlorophyll, and the radial walls are more or less acutely-undulating, those of the lower surface somewhat more strongly so than are those of the upper surface (Fig. 11, *A*, *B*); the radial walls are also often perforated and are often thickened on one side in the angles; the lateral walls of the guard-cells of the stomata often have horn-shaped thickenings which project into the lumen of the neighbouring cell like incomplete walls, (see *R. acer*, Fig. 16, *C*). The stomata are on

Fig. 11. *R. affinis* Wilanderi.*
A, Epidermis of the upper surface of the leaf. *B*, Epidermis of the lower surface of the leaf. *C*, Surface section of spongy parenchyma (*A*, *B* and *C*, $^{120}/_{1}$).

a level with the surface; according to Resvoll their number averages 29 per sq. mm. upon the upper surface, and 76 per sq. mm. upon the lower surface; my computation gave a similar numerical result. Nestler (l. c., p. 294) found 38 per sq. mm. upon the

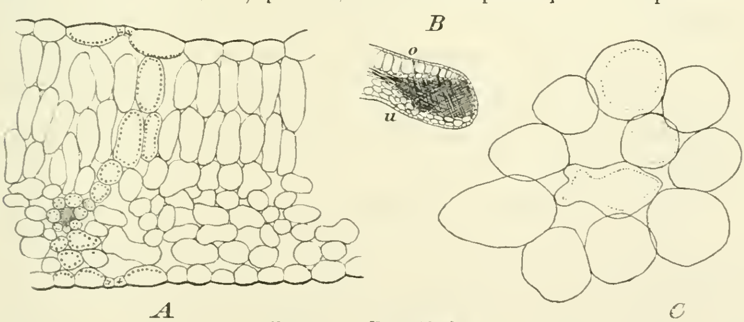

Fig. 12. *R. affinis.*
A, Transverse section of leaf (Cape Thordsen; $^{110}/_{1}$). *B*, Longitudinal section of leaf-apex (Gåselandet; $^{24}/_{1}$): tracheids are scattered in the epithema; *o*, upper surface; *u*, lower surface. *C*, Surface section of palisade-tissue ($^{250}/_{1}$).

upper, and 69 per sq. mm. upon the lower surface. They are fairly evenly distributed, but they are absent from the larger veins where the cells of the epidermis are elongated and more or less straight-walled. The above-mentioned differences appeared in the palisade-tissue; some of the investigated specimens from Cape Thordsen (Fig. 12, *A*) had two palisade-layers constituting about one-half of the mesophyll. the quota between breadth and length of the cells is $^1/_2$—$^1/_3$; the other specimens, including var. *Wilanderi* had only one palisade-layer which constituted $^1/_3$—$^1/_4$ of the mesophyll; the single palisade-cells were less regular in form than are those of the first-named specimens and their quota was on an average somewhat larger than $^1/_2$. The spongy parenchyma in these leaves was considerably looser than that in the former leaves with two palisade-layers, and consisted of more abundantly branching cells (Fig. 11, *C*).

The large bundles are accompanied by some weak stereom. Nestler (l. c., p. 301) records that he found a complete sclerenchymatous sheath; the specimens which I investigated had bast only upon the upper and under side of the bundles and in greater quantity on the lower surface. Nestler does not mention from whence his specimens originated.

Fig. 12, *B* is a somewhat diagrammatic representation of a longitudinal section through the apex of a leaf; the slanting part is the epithema in which the vessels of the bundle spread out and which opens almost at the margin. The cells of the epithema, as was the case in the other species, have strongly undulating walls.

The leaf-stalk is cordate in transverse section; its cuticle is striped and there is chlorophyll in its epidermis. Five bundles occur of which the median, outwardly-turned one is the largest. The fibrous tissue outside the leptome is fairly strong and on the sides it abuts upon the V-shaped woody parts; the endodermis is slightly lignified on the inwardly-turned part of the bundle, on the outer side it touches the fibrous tissue outside the leptome. There is a large central lacuna.

R. acer L.

Lit. Wydler, 1859. p. 267. A. Berlin, 1883, pp. 19—21. Hj. Nilsson, 1884, p. 203. Marié, 1885, p. 82. Holm, 1885, p.

41. Lindman, 1887, pp. 25, 29, 40, 42. Leist, 1889, p. 16. Schlicht, 1889, pp. 14—17, figs. 9, 10. Lubbock, 1892, p. 87, fig. 126. Rosenvinge, (I), 1892, pp. 676—77. Hartz, 1894, p. 18 Nestler, 1895, figs. 9, 18. Norman, 1895, pp. 20—23. Rosenvinge, (III), 1896, pp. 109, 127, 144, 161, 168. Ekstam, 1897, p. 147. Kerner, 1898, pp. 109, 194, 311, 699. Goffart, 1900, p. 107, figs. 340—47. Cleve, 1901, p. 51. Freidenfelt, 1904, p. 62. Sylvén, 1906, pp. 275—76.

Alcohol material from Greenland (Julianehaab, 19. 6. 1883 and Igdlorsuatsiak), Iceland (Helgavatn 7. 8. 1889), the Færöes, Denmark (several places).

The rhizome is short and vertical; it bears a rosette of long-stalked foliage-leaves with large sheaths; scales are absent. In Denmark the rosette-leaves pass the winter in a green condition (see also Sylvén), and their large sheaths densely surround the apices of the shoots. The principal bud is situated in the uppermost leaf-axil at the base of the stem; the first leaves (according to Wydler it may be the first six leaves) are often arranged in two rows: the others follow in a $^2/_5$ spiral. In Denmark it is more usual for the principal bud to flower the same year as the main axis, than it is in Greenland, Iceland and the Færöes. Other rosette-leaves may also subtend shoots. From the bases of the shoots strong adventitious roots arise, and individual shoots are fairly quickly isolated, and become independent.

The leaves of the rosette, and often the lowermost leaf upon the elongated stem, are stalked and palmately cleft into deeply-serrate or lobed segments; forma *multifidus* D. C., however, which is almost as common in Greenland as is the principal form, has the five leaf-lobes deeply tripartite with linear lobes. The upper stem-leaves are sessile.

In the leaf-axils of the elongated stems of well-developed individuals, floral branch-systems occur branching in a sympodial manner in the bracteoles, the lower branches being the most vigorous. In Greenland the plant may attain a height of at least 53 cm. and in the Norwegian willow-bogs, as much as 176 cm. (NORMAN). On the other hand, individuals from exposed localities, are found which measure only 4 cm., and of which the solitary flower scarcely reaches above the rosette-leaves (f. *pumilus* Whbg.). The density of the hair-covering varies also greatly and is no doubt partly dependent upon the habitat of the plant; plants which have been growing in copses are often almost entirely glabrous, while those from exposed localities may be covered with a dense covering of white or yellowish-brown hairs (var. *Lindholmiana* Berl.).

Fig. 13. *R. acer.*

A, Base of nectary-leaf (Denmark; [illegible]/1). *B*1, Carpel from a hermaphrodite flower at time of flowering. *B*2, Carpel from a staminate flower; both from Denmark (15/1); see text.

In Greenland a form has been found with double flowers (f. *flore pleno*) in which all the stamens are petaloid (ROSENV., I); but the flower usually has five yellowish-green perigone-leaves and five nectary-leaves, glistening as if with oil; these latter have pocket-shaped nectaries the free edge of which varies greatly in form (Fig. 13, *A*). The numerous, extrorse anthers overtop the head of carpels, which is low in growth before pollination. The diameter of the flower is between 1·5 and 2·5 cm.; in Nova Zembla the diameter of that of *R. acer* f. *borealis* TRAUTV. is as much as 3·0 cm. (EKSTAM). In Denmark the flower is eagerly visited by small beetles (*Meligethus æneus*) and flies; LINDMAN found, besides several species of flies, a few *Macrolepidoptera*; EKSTAM noticed flies.

In the flower-bud the stamens overtop the carpels; but before the flower expands the outermost stamens elongate and they open before the glistening papillæ can be observed upon the stigmas. The homogamous stage is the longer. Spontaneous self-pollination may take place at night when the flowers are closed (cf. Lindman, p. 30). In Nova Zembla Ekstam found protogynous-homogamous, homogamous, and protandrous-homogamous flowers. In Denmark I have found besides the common hermaphrodite flowers, others with carpels not fully developed; Fig. 13 B_1, B_2, shows two carpels, both from flowers of which the stamens had shed almost all their pollen; B_1 is fertile, B_2, together with the other carpels in the same flower, is without papillæ. When the flowering is over, plants are commonly found bearing, only barren, shrivelled-up carpels.

The pollen is protected from rain by the peduncle bending, during wet weather, so that the flower-cup is turned downwards.

The flowering begins in May-June, somewhat earlier in Denmark than in the Arctic regions, and may be continued into September. (Norman, Rosenvinge, II).

The fruit, like the fruits of the majority of the species of *Ranunculus*, does not appear to be especially adapted to any particular dispersal-agency. Examples of wind-dispersal are however known (Ekstam), and it may be presumed that some are dispersed by the agency of water. Of 200 fruits, which lay in quiet water, the last sunk after 3 days, while of 100 fruits, which lay in water which was frequently stirred, all sank before the expiration of 24 hours. Norman believes that synzoic dispersal by means of cattle takes place, and mentions having found germinating plants in cow-dung. I fed a heifer, in May, 1910, with fruits of the previous year, and 36 hours after, 80 apparently unhurt specimens of these were washed out of the dung; they were immediately sown and seven (8·8 %) germinated.

Sylvén is of opinion that *R. acer* usually germinates in spring, but under cultivation the fruits will germinate immediately after maturation, and in Denmark I have observed young germinating plants in August. In the plants which germinate in spring the primary root of the seedling and also the hypocotyl live only the first summer, and adventitious roots are developed early from the base of the epicotyl. The sheaths of the cotyledons are slightly coherent (Sylvén, Lubbock, 1892).

In Arctic Norway the frequency of occurrence of this species is similar from sea-level to high up in the mountains, with local accumulations in the cultivated home-fields and on the snow-line: in the latter place it often occurs as f. *pumilus*, (Norman). In Iceland also it is common in cultivated meadows, a fact which is perhaps to be connected with its above-mentioned dispersal by cattle. In South Greenland it is common on grass-land, grassy slopes and in willow-copses in the exterior of the country (Rosenv., III). In northern Sweden it grows on damp ground (Cleve), and in Nova Zembla it occurs on the tundra on dry, stony ground (f. *borealis* Trautv.) (Holm).

Geographical Distribution. Arctic America, Greenland, Iceland, the Færöes, northern and central Europe, the Alps, Caucasus, Arctic Russia, the Urals, north-east Siberia and Nova Zembla.

Anatomy. In the roots of the first order the outer walls of the epidermis are somewhat thickened, the exodermis is distinctly marked, the cells are radially elongated and the radial walls undulating. Both the epidermis and exodermis are suberized. The cortex is 15—17 layers thick and contains starch; the starch-grains are compound. The two subexodermal layers of the cortex are somewhat collenchymatously thickened, the others are thin-walled and collapse more or less according as to whether the plant grows in damp or in dry ground. (Freidenfelt). The endodermis of the mature root is thickened and lignified, with thin-walled passage-cells opposite to the 4—5 radial masses of wood of the central cylinder. According to Freidenfelt the cambium can develop in older roots some secondary wood. The leptome-mass has the usual large pentagonal tube which is wedged in between adjacent cells of the pericycle.

The roots of the second order have an exodermis and endodermis like those mentioned above; all the layers of the cortex (about 4) are thin-walled, also the endodermis, which is corky. The central cylinder is diarch. Schlicht has found endotrophic mycorrhizas in the lower part of the primary root and in roots of the second order. The specimens from Denmark, the Færöes and Iceland which I investigated also had mycorrhizas in the above-mentioned parts of the roots. The hyphæ were often rolled together into compact balls in the inner layers of the cortex. Roots from Greenland have not been investigated.

The rhizome. (Compare Hj. Nilsson). In the specimens investigated, the epidermis was, for the most part, collapsed, together with the outer layer of the cortex, and was corky like the latter. The slightly irrregular cells of the cortex were somewhat tangentially elongated; the outermost living cells had rather thick walls. The bundles were often grouped irregularly around the pith; they anastomosed, and in the thicker rhizomes they were not placed in any one circle. The Danish specimens had a few-layered fibrous tissue outside the leptome and a sheath of strong wood-parenchyma on the inner side of the woody part. The Færöese specimen which has been investigated also had this inner arch of stereom, but in the Iceland specimens all lignified stereom was wanting. The endodermis was fairly distinct, and was lignified; it had tangentially elongated cells. The cells of the pith were irregular; in an old, Danish specimen there were many scattered sclerenchyma-cells in the pith. The cortex and the pith contained starch. Rhizomes from Greenland have not been investigated.

What has been said above with regard to the rhizome applies also to the structure of the stems, viz. that the specimens from Iceland which have been investigated have a smaller amount of lignified stereom than those from Denmark. The Greenland specimens were similar on the whole to those from Iceland. The epidermis also was stronger in the Danish specimens (outer walls about 6 μ thick) than in the others. The cuticle was striped; the stomata were situated on a level with the surface. The Greenland and Iceland specimens had much

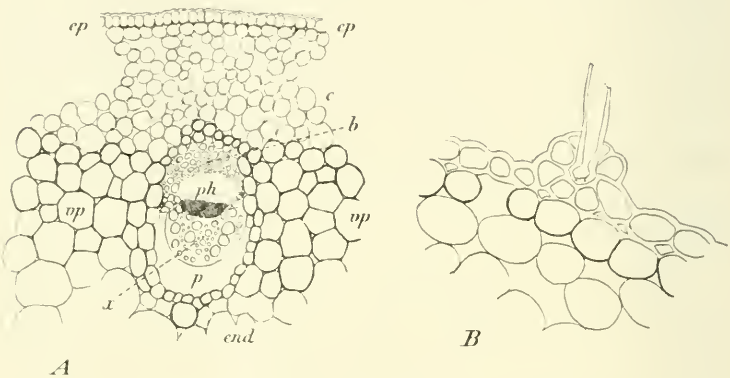

Fig. 14. *R. acer.*

A. Portion of transverse section of stem (Greenland; about 80/1). *p*, Non-lignified parenchyma; between leptome and xylem there is some wood-parenchyma; the letters as in Fig. 10, *B*. *B*, Base of hair with the epidermis and the outermost layer of cortex of peduncle (Greenland; 250/1).

chlorophyll in the epidermis, the Danish had none at all or but little.

Of the 6—10 layers of the cortex the outer are richer in large intercellular spaces than are the inner; but none are present between the epidermis and the subepidermal layer. The bundles (Fig. 14, *A*) range in number from ten to many and are unequal in size. In the Danish specimens the fibrous tissue outside the leptome attains a thickness of as many as nine layers and is very strong; the thickness of the interfascicular lignified parenchyma is as great as six layers and it has, in some parts, somewhat thickened walls. A few layers of somewhat thickened and often also lignified parenchyma including the endodermis formed the stereom on the inner side of the strand; the endodermis on the outer side of the fibrous tissue outside the leptome is much thickened and lignified. Between the rudimentary cambium and the vessels which lie scattered in the wood-parenchyma there occurs a mass of wood-paren-

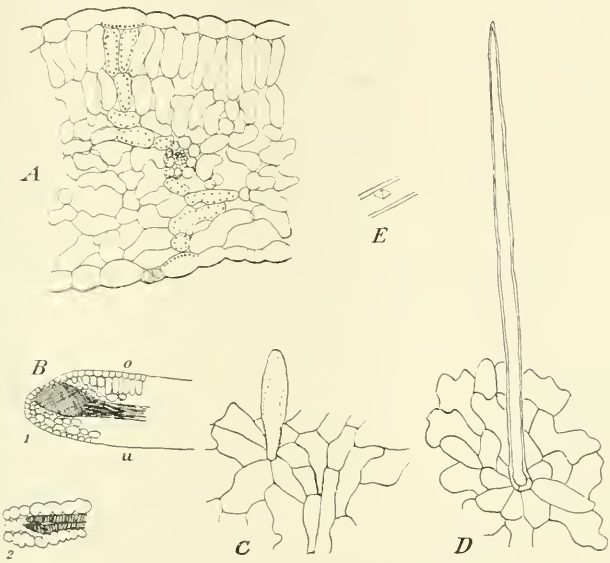

Fig. 15. *R. acer.*

A, Transverse section of leaf (Greenland; $^{100}/_{1}$). *B, 1,* Longitudinal section through leaf-apex with epithema (cross-hatched). *o*, Upper surface; *u*, lowers urface ($^{25}/_{1}$). *2*, Tracheids with epithema-cells (Greenland; $^{120}/_{1}$). *C*, Club-shaped hair from the upper surface of the leaf. *D*, Small ordinary form of hair from leaf (Denmark; $^{85}/_{1}$). *E*, Octahedral crystal lying in a hair from leaf (Denmark; $^{220}/_{1}$).

chyma; and between the vessels and the endodermis, a larger or smaller portion of non-lignified parenchyma is found. Lignified stereom is quite absent from the young peduncle and not until after flowering does it develop. The pith is almost entirely broken down quite early. The hairs are unicellular, fairly thick-walled and slightly lignified.

The Greenland and Iceland specimens, with the exception of the above mentioned modifications, resemble those from Denmark.

The thickness of the leaf in Danish and Greenland specimens was 300—340 μ, in those from Iceland 160—225 μ.

Two kinds of hairs occur upon the leaves; the more common (Fig. 15, *D*) are like those of the stem, and some of them contain crystals of a substance, of which the base is calcium-hydrate; the others (Fig. 15, *C*) only occur along the veins of the upper side and are club-shaped, thin-walled, and rich in contents (compare NESTLER, p. 291, Fig. 18).

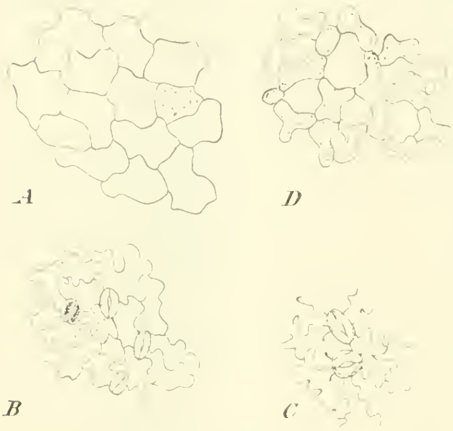

Fig. 16. *R. acer.*

A, Epidermis of the upper surface of the leaf (Iceland). *B*, Epidermis of the lower surface of the leaf (Iceland). *C*, Epidermis of the lower surface of the leaf (Denmark). *D*, Surface section of spongy parenchyma of leaf from Greenland, (A, B, C and D $^{100}/_{1}$).

The epidermis of the leaves from northern localities, but Denmark can scarcely be included, contains chlorophyll; otherwise it is nearly alike in the Danish and Icelandic specimens. In the latter the radial walls of the cells of the upper surface are less undulating than those of the lower surface, which has strongly undulating walls especially in the Danish specimens. In these latter incomplete walls often proceed from the radial walls, especially from the guard-cells of the stomata (cf. *R. affinis*; and see Fig. 16, *C*); there are found only mere indications of such a condition in the leaves from other localities. In the Greenland specimens the radial walls of the epidermis of the lower surface are almost similar to those of the upper surface in the Iceland specimens, while those of the upper surface are slightly curved. The stomata are situated on a level with the surface, are fairly evenly distributed and their longitudinal axes have no fixed direction. NESTLER found 15 stomata per sq. mm. upon the upper surface and 98 per sq. mm. upon the lower surface (l. c. p. 294); he does not give localities for his specimens. The specimens from Denmark, Iceland and Greenland which have been investigated have per sq. mm. upon the upper and lower surface, from 0 to about 85, from 0 to about 90, and from about 30 to about 150, respectively. There is great variability in the number of the stomata in the leaves from Iceland and also in those from Greenland.

The Danish and Icelandic specimens have one palisade-layer those from Greenland have generally two layers (Fig. 15, *A*); everywhere the palisade-layers constitute from $^1/_3$ to $^1/_2$ of the thickness of the mesophyll, and the quota of the individual cell is generally from $^1/_3$ to $^1/_2$. The spongy parenchyma in the upper part is distinctly more compact than in the lower, and in the Danish and Icelandic specimens it consists of longer and more abundantly branching cells than in those from Greenland (Fig. 16, *D*).

Upon the upper surface the lamina is depressed like a gutter over the larger veins, and the latter are accompanied upon the upper and lower surface by stereom, which reaches to the epidermis. The smaller veins are surrounded only by a sheath which contains chlorophyll.

At the leaf-apices there is an epithema the pores of which open upon an oblique plane. The cells are often branched in several planes and the walls are undulating, as in *R. nivalis* (Fig. 15, *B*).

The leaf-stalk is cordate in transverse section. The bundles number 5—15, alternately large and small; in structure they are similar to those of the stem from the same place, but no inner arch of stereom occurs. Interfascicular stereom is absent. The structure of the cortex and epidermis is similar to that of those of the stem. The epidermis contains chlorophyll. The pith is broken down gradually.

Ranunculus sulphureus Sol.

Syn. *R. altaicus Laxm.*

Lit. Hartz, (II), 1895, p. 288; (III), 1895, p. 332. Norman, 1895, p. 17. Ekstam, 1897, p. 147; 1899, p. 23. Abromeit, 1899, p. 31. Th. Resvoll, 1900, fig. 3. Andersson & Hesselman, 1901, p. 19. Dusén, 1901, p. 30. Simmons, 1906, p. 108; 1909, p. 74.

Alcohol material from Greenland (Scoresby Sound, 18. 7. 1892); Norway (Lyngen, 7. 8. 1884); Spitzbergen (Hornesund, 25. 6. 1882, Belsund, 1. 7. 1882, Rendalen in Sassenbay, 15. 7. 1882, Tampetberg, 17. 7. 1882, King Charles Land, 4. 8. 1898, Advent Bay, 8. 8. 1910); Nova Zembla.

Malmgren (Spetsb. Fan. Fl. K. Sv. Vet. Akad. Översigt, 1862) writes that *R. altaicus* has longer styles than *R. sulphureus* and that its nectary-leaves are obcordate (quoted in Simmons, 1906, p. 108). Simmons finds no reason to consider these two as distinct species, as the characters mentioned are not constant; he will go no further than to call *R. altaicus* a variety of *R. sulphureus.* One of the individuals in the material from Scoresby Sound had nectary-leaves some of which were slightly emarginate at the apex and the others rounded. As far as I have been able to see, there is no difference in the anatomy of the two forms.

The rhizome is either slanting or vertical and may live several years. The longest which I measured had a length of about 3 cm. The adventitious roots arise especially from the nodes (Fig. 17). Rhizomes are often found with rather numerous ascending branches. Each such branch bears a rosette consisting only of foliage-leaves, in number rarely exceeding five; very often there is but one or two. In flowering specimens the rhizome is continued into a stem with elongated internodes which bears as many as four foliage-leaves; the lowermost of these is stalked, the upper are sessile. The arrangement of the leaves is $^2/_5$, with the exception of the first two leaves of the shoot which are probably transversely-placed. Usually only the main axis flowers, but the stem-leaves may subtend floral axes; these axes bear from one to two green bracts. The stalked stem-leaf probably rarely subtends flowers, but upon vigorous specimens a shoot is fairly frequently developed in this axil, which however can scarcely produce more than two transversely-placed, stalked foliage-leaves. The principal bud is situated in the uppermost leaf-axil at the base of the stem (Fig. 17); frequently the leaf below also subtends a bud. Consequently, the shoot almost resembles in appearance that of *R. glacialis,* only, in *R. sulphureus,* the scale-leaves are absent. The plant probably passes the winter as does *R. nivalis* (see figure in Kjellman l. c., p. 493): the sheaths of the fully-developed leaves of the rosette surrounded the shoots of the next year, the leaves and terminal flowers of which are formed even during autumn.

Fig. 17. *R. sulphureus.*
(Scoresby Sound; 18. 7. 1892; $^5/_4$).
I, Main axis; II, the two-leaved principal bud; *b*, the subtending leaf.

The height of the flowering plant is usually from 6 to

16 cm. (NORMAN l. c.). I have measured herbarium specimens from Nordfjord in Disco which were about 35 cm. in length. A dwarf specimen is shown in Fig. 18.

Fig. 18. *R. sulphureus.* (King Charles Land). Dwarf-plant which had been growing on sand near the shore.

There are five reddish-brown, hairy perigone-leaves and five yellow nectary-leaves about twice as long as the perigone-leaves. The receptacle is almost globular in form but elongates somewhat during fruit-setting, not so much, however, as in *R. nivalis.* These two plants, *R. sulphureus* and *R. nivalis* agree very closely but are distinguished from each other especially by the fact of *R. sulph.* having short, reddish-brown hairs upon the torus, while they are absent from *R. nivalis* (SIMMONS l. c.). The nectary occurs upon the claw of the nectary-leaf (Fig. 19) and consists of a simple pocket. EKSTAM (1899, l. c.) records that in Spitzbergen the flowers have a slight perfume, and that they are proterogynous-homogamous; but self-pollination is rendered difficult by the fact of the gynoecium overtopping the stamens considerably even when the latter have opened. The anthers are partially extrorse. In Arctic Siberia and in Nova Zembla the diameter of the flower is about 16 mm. (EKSTAM, 1897); in Scandinavia the maximum is

Fig. 19. *R. sulphureus.*
A, Base of nectary-leaf with nectary (7/1). *B,* Almost ripe fruit; about 7/1 (Spitzbergen: 8. S. 1910).

30 mm. (Ekstam. 1897). Several species of flies have been noticed upon the flowers in Spitzbergen (Ekstam). In the middle of June the plant appears to be in full flower everywhere and ripe fruit is found at the middle and end of August (Andersson & Hesselman; Ekstam), but the flowering period may continue as long as into September (Sept. 9; Norman l. c.). Fruit is set abundantly.

The nuts are smooth and somewhat flattened, and the beaks are rather long (Fig. 19); they are dispersed by the agency of the wind (Ekstam 1897).

According to Norman, in Arctic Norway this species is not so particular in its requirements regarding habitat as *R. glacialis*; it occurs both at the shore and in the interior of the country; in the lowlands and in the highlands (willow-zone). In N.E. Greenland it is no doubt most frequent in the coastal districts (Dusén l. c.). In Arctic Norway it appears to grow by preference in rather damp ground or in gravel, and is also found in marshy localities. Hartz found it growing in a bog in Scoresby Sound.

The species is circumpolar but does not occur exclusively in Arctic regions as it is also found in North America in the Rocky Mountains, and in Asia it extends towards the south as far as to the Baikal-Mountain regions and to Altai. In Europe it occurs only in Finmark (Simmons l. c.).

Anatomy. I am not prepared to say anything regarding the main root; it probably dies early as is commonly the case in the genus *Ranunculus*; the adult plant bears only adventitious roots. The anatomy of the latter does not differ in any essential points from the root-structure described for *R. glacialis*. which may very well be regarded as a type, at least as far as the Arctic species of *Ranunculus* are concerned.

The epidermis in the adventitious roots of the first order has perhaps less tendency to collapse and the exodermis is not so distinct as in *R. glacialis*; both the layers are suberized. A somewhat thickened, subexodermal layer occurs and the cortex has larger or smaller lacunæ. The endodermis is somewhat thickened and the central cylinder is diarch to tetrarch.

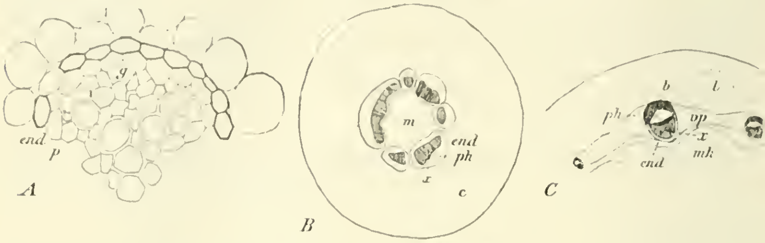

Fig. 20. *R. sulphureus.*

A, Portion of section of central cylinder of adventitious root of the first order (Scoresby, Sound; 165/1). *B*. Transverse section of rhizome (Spitzbergen; 8/1). *C*, Portion of transverse section of stem (Spitzbergen; about 20/1); *b*, bast; *c*, cortex; *end*, endodermis; *g* the large pentagonal sieve-tube; *l*, lacuna; *m*, pith; *mh*, pith-cavity; *p*, pericycle; *ph*, leptome; *vp*, lignified parenchyma; *x*, xylem.

There is a large sieve-tube on the outside of each group; cambium is absent (Fig. 20, *A*).

The root of the second order consists of epidermis, about five layers of cortical cells and a diarch central cylinder. The epidermis as well as large parts of the cortex are collapsed; a thickened subexodermal layer does not occur. The epidermis and the indistinct exodermis are suberized. Here also a large sieve-tube occurs on the outside of each group of sieve-tissue.

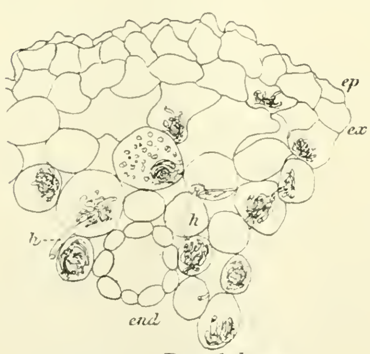

Fig. 21. *R. sulphureus.*

Portion of transverse section of root of the second order showing mycorrhizas (Nova Zembla; 220/1): *ep*, epidermis; *ex*, exodermis; *end*, endodermis; *h*, hyphæ.

Mycorrhizas have been found in specimens from all the habitats and the hyphæ often occur in large quantities in the lower, slender parts of the roots of the first order and in the roots of the second order. Balls of hyphæ, whenever such occur, are most frequently found in the inner cells of the cortex (Fig. 21).

The starch-grains are compound.

The rhizome (Fig. 20, *B*), also, resembles in the essentials of its structure that of *R. glacialis.* The outer walls of the cells of the epidermis are somewhat thickened, but often the epidermis is dead, in which case the cells lying within become somewhat collenchymatously thickened; often the outer layers of the latter also die. The cortex contains abundance of starch (June), the grains are compound; the cortical cells are slightly tangentially elongated, and there are fairly large intercellular spaces, I have not been able to find any phellogen in the rhizome either in this species or in any of the other in my material; as mentioned on p. 344 Hollstein notes that it occurs in *R. glacialis.* The vascular bundles vary in number, and are arranged in a circle, each of them surrounded by an endodermis with Caspary's dots. They often anatomose, which causes the form, size and number to vary in different sections of the same rhizome. The cambium is capable of division, and the greater part of the wood (vessels + parenchyma) and the sieve-tissue is of secondary formation. The endodermis is often somewhat lignified. The pith is like that in *R. glacialis.*

The Stem is stiffly erect in contradistinction to *R. nivalis* in which the stem bends sideways (Simmons); it is rounded and thinly covered with hairs; the flower-stalk is more hairy than the stem. In herbarium-specimens the lower part of the stems of the preceding year are often found to arise from the rhizome below the rosette.

The structure is essentially like that of the stem of *R. nivalis.* The cuticle is grooved and the epidermis which contains chlorophyll has fairly thick tangential walls. The stomata are on a level with the surface. The cortical tissue is often found to be dead in scattered patches. A great part of the pith in the flowering stem is broken down, leaving a large hollow space in the centre. The vascular bundles (Fig. 20, *C*) occur in numbers varying from 10 to 15 and are of different sizes, large and small alternating almost regularly; upon their outer side there is fibrous tissue, from 3 to 5 layers thick, consisting of lignified cells with thick walls. This layer of tissue abuts directly upon the sieve-tissue and is continued to the sides as an interfascicular portion of lignified parenchyma forming a boundary between the pith and the cortex. This strengthening-ring (A. MEIER's "Festigungsring") consists of from 2 to 4 layers of cells, the walls of which are slightly, or else not at all, thickened. Around each vascular bundle is a lignified endodermis, which is most easily seen upon the inner side of the bundle; externally its cells resemble those of the fibrous tissue. Between the cambium and the vessels there is some wood-parenchyma, and between the vessels and the endodermis non-lignified parenchyma occurs.

The flower-stalk is slightly furrowed and is more densely hairy than the stem. The hairs are unicellular and rather long. The vascular bundles are fewer in number than in the stem, and during flowering, stereom is almost absent, but it develops afterwards during fruit-setting and becomes stronger than that in the stem. The outermost part of the cortex has larger intercellular spaces than has the inner. There was no special endodermis around each single vascular bundle and a common one was not distinct in the specimens examined.

The stem contains but a small amount of starch (middle of July), the grains are compound.

The Leaf. The rosette-leaves and often the lowermost stem-leaf are stalked; in form they are short and broadly ovate and often with a somewhat wedge-shaped base; the margin is divided into a varying number of shallow, short, broad lobes. The sessile stem-leaves are more or less deeply 5—7 lobed. Hairs occur along the margin, but otherwise the leaves are glabrous. No difference has been found between the anatomy of the basal leaves and that of the stem-leaves. The outer walls of the epidermal cells are slightly thickened; the radial walls are somewhat undulating and almost alike in the epidermis of both surfaces (Fig. 22, *C*, *D*); but above the larger bundles

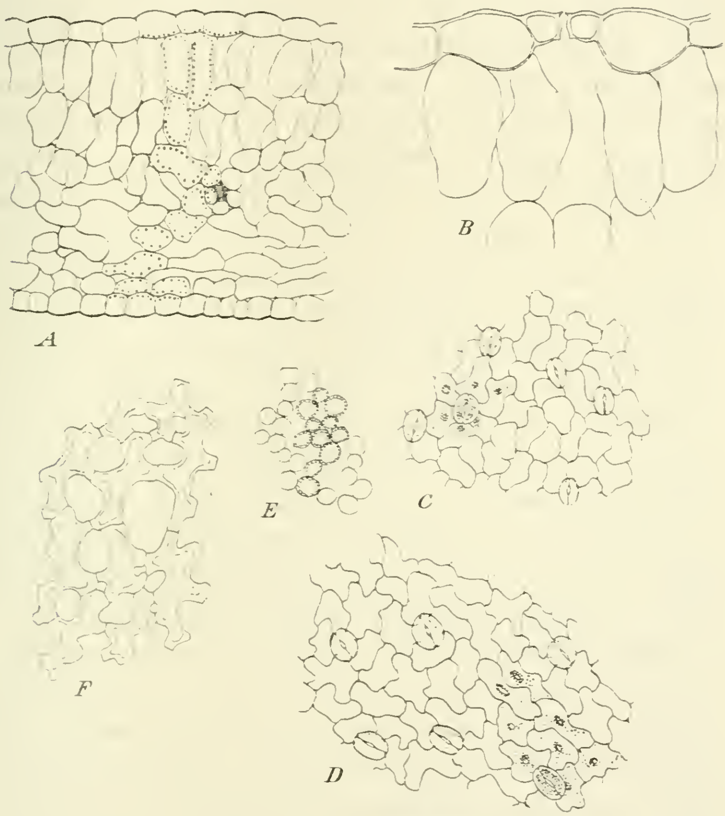

Fig. 22. *R. sulphureus.*

A, Transverse section of leaf (Scoresby Sound). *B*, Stoma from the upper surface of the leaf. *C*, Epidermis of the upper surface of the leaf. *D*, Epidermis of the lower surface of the leaf. *E*, Surface section of uppermost palisade-layer. *F*, Surface section of spongy parenchyma (*B*, *C*, *D*, *E*, *F* are from Spitzbergen; *A*, *C*, *D*, *E*, *F*, $^{160}/_{1}$; *B*, $^{220}/_{1}$).

the epidermal cells are nearly straight-walled and are elongated parallel with the bundles. The epidermis contains chlorophyll, and sphæro-crystals are found in many cells. The stomata are either on a level with the surface or project slightly, and here as in other species of *Ranunculus* the outer, lateral walls of the guard-cells in transverse section are convergent inwards (Fig. 22, *B*). In the lobes the stomata are arranged more or less parallel with the main bundle, otherwise they are without any fixed order. According to my computation about the same number of stomata occur per sq. mm. upon both surfaces of the leaf, viz. about 70. Th. Resvoll found 67 per sq. mm. upon the upper and 83 per sq. mm. upon the lower surface. Th. Resvoll records 2—3 palisade-layers. The leaves I investigated had two layers which taken collectively constituted $^1/_2$—$^1/_3$ of the thickness of the mesophyll. The individual cells of the palisade-layers are usually barrel-shaped; the uppermost layer is often higher than the lower ones, and in some places the palisade may be said to occur in but one layer, the cells of which are then more strongly differentiated as palisade-cells. The palisade-cells are slightly inclined towards the leaf-apex. Usually there is a rather distinct passage from the palisade to the spongy parenchyma; the latter is very lacunose in structure and is composed of branched, often somewhat stellate cells (Fig. 22, *F*). Long slit-like lacunæ often occur within the subepidermal layer upon the lower surface.

Along the main bundles of the leaf, upon both the upper and lower surface, run elongated elements which in transverse section are circular, close-set, and non-prosenchymatous; they touch the epidermis of both surfaces; along the somewhat weaker bundles such cells occur only upon the lower surface, while the palisade-layers upon the upper surface are not invaded; the smaller bundles are surrounded only by a sheath containing chlorophyll (Fig. 22, *A*). Here as in other species, each lobe terminates in a hydathode in which the mesophyll is transformed into an e p i t h e m a the intercellular spaces of which open out in water-pores, in exactly the same manner as in *R. nivalis* (see Fig. 27, *A*).

The dwarf-plant from King Charles Land (Fig. 18) had leaves which were somewhat looser in structure than were those in the other specimens which were investigated. It was found growing upon a sandy shore and had a very vigorously developed root-system.

The leaf-stalk is reniform in transverse section. There are three vascular bundles and they are certainly not accompanied by stereom; the endodermis is only slightly evident. The pith has a tendency to collapse so that a larger or smaller lacuna is formed. The cortex nearly resembles that of the stem in structure. The epidermis contains chlorophyll; it, also, resembles that of the stem.

No differences have been found in the structure of the individuals investigated from the different localities, with the exception of the dwarf-plant from King Charles Land.

Ranunculus nivalis L.

Lit.: Buchenau & Focke, 1872, p. 28. Kjellman, 1883, p. 493. Holm, 1885, p. 50, tab. XI, figs. 6—7. Lindman, 1887, p. 42, tab. 1, fig. 10. Børgesen, 1895, pp. 225, 231, 236, fig. 48, resumé: Journal de bot., IX, 1895. Hartz, II, 1895, p. 288; III, 1895, p. 331. Norman, 1895, p. 14. Ekstam, 1897, p. 146. Abromeit, 1899, p. 30. Ekstam, 1899, p. 23. Andersson & Hesselman, 1900, p. 48. Resvoll, 1900, figs. 2, 8, 9, 12, 31. Cleve, 1901, pp. 51, 103. Dusén, 1901, p. 30. Freidenfelt, 1904, p. 53. Simmons, 1906, p. 110. Sylvén, 1906, p. 274, tab., XXV, fig. 2.

Alcohol material from Disco in Greenland, 20. 7. 1884; Kaafjord in northern Norway, 16. 7. 1885; Spitzbergen, 6. 8. 1910.

The rhizome is either vertical or oblique and may attain a length of as much as 5 cm. The primary root dies early, but adventitious roots arise especially from the nodes of the rhizome; a sympodium is formed when flowering begins. The stem is erect and ribbed, especially the fruit-stalk, and it is hairy with reddish-brown hairs which are most dense upon the peduncle. Some dwarf individuals from Hudson Strait which I measured were 2 cm. high, but the usual height is

8—10 cm. at the beginning of the flowering period and 15—25 cm. towards the time for the ripening of the fruit. The stem is, at that time, not rigidly erect as in *Ran. sulphureus* but "spreads then outwards, and becomes assurgent" (SIMMONS l. c.). The full-grown plant bears only foliage-leaves (KJELLMAN l. c.), but before it attains the flowering stage, according to SYLVÉN (l. c.) it has developed even in October a winter-bud protected by scale-leaves. The rosette-leaves are usually few in number, and long-stalked; they are cordate at the base and are deeply three-cleft. There are 2—3 stem-leaves; the lower one is stalked and is similar in form to the rosette-leaves, the others are sessile and simpler in form (Fig. 23). The principal bud occurs in the axil of the uppermost basal leaf, but the other leaves of the rosette may also subtend buds and the rhizome is often found to be branched. The two lowermost stem-leaves may subtend floral-axes which are usually much more slender than the main axis; they bear one or two green bracts. In the specimens from Spitzbergen (leg. 6. 8. 1910) the principal bud had an almost fully-developed flower, with fully-developed hairy perigone-leaves and nectary-leaves and far advanced stamens and carpels. The young stem-leaves

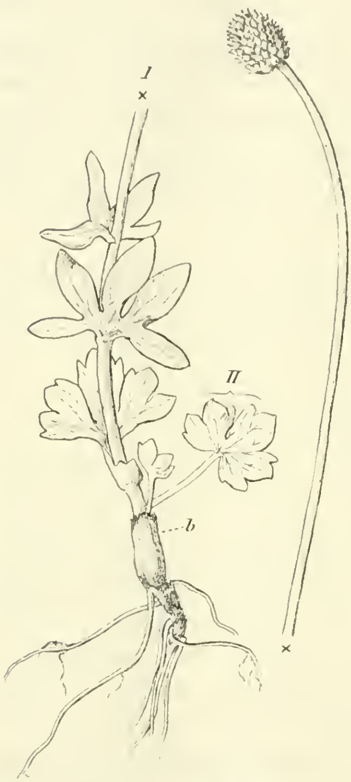

Fig. 23. *R. nivalis.*
(Advent Bay in Spitzbergen: 6. 8. 1910; 5/6). *I*, Main axis; *II*, principal bud subtended by *b* which is the dead sheath of the uppermost rosette-leaf upon axis I.

surrounded the flower and apparently formed its chief protection; there were, in addition, two unexpanded basal foliage-leaves with large sheaths, and below two fully-developed leaves, the thin, translucent sheaths of which encompassed the bud. The leaves of the parent-axis had withered (cf. Kjellman, l. c. Fig.). The other buds of the rosette may attain the flowering stage in the same year as the principal bud; but probably, as a rule, this is delayed until they have become stronger. The dead flower-axes often persist on the rhizome throughout the winter.

The flower has five perigone-leaves which are densely covered with reddish-brown hairs and are half the length of the oval nectary-leaves; they are bright yellow in colour. The cluster of fruits is oblong; it grows considerably in length after fertilization and becomes as much as 14 mm. high. The fruits are somewhat flattened and have a rather long and straight beak (Fig. 24, *B*).

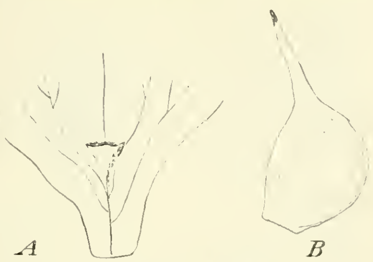

Fig. 24. *R. nivalis.*

A, Base of nectary-leaf with nectary (Kaafjord; $^{8}/_{1}$).
B, Almost ripe fruit (Spitzbergen; 6. 8 1910; $^{8}/_{1}$).

The nectary-leaves have at their base an open pocket-shaped nectary (Fig. 24, *A*). The flower differs in structure from such as that of *R. acer*, in which the flower is flat and the stamens longer than the carpels; in the present species the flower is deep and narrow, the stamens short and the head of carpels is high and convex (Lindman l. c. Tab. I, Fig. 10). In Spitzbergen the diameter of the flower is 10—12 mm. (Ekstam) and in Greenland 15—23 mm. (Warming, notebook). Both Lindman and Ekstam record that it is proterogynous-homogamous, and the latter thinks that self-pollination cannot easily take place, as the pistil and stigma grow considerably after pollination. In Spitzbergen the flower has a slight perfume, it is visited by

Diptera (Ekstam). Lindman has proved by experiment that it sets ripe fruit after self-pollination. The flowering begins in the middle of June, and the fruit ripens in August. Ekstam (1897) did not find ripe fruit in Nova Zembla, but records such from Arctic Siberia. He states that the fruit is dispersed by the agency of the wind. Norman thinks that reindeer are concerned in Arctic Norway with the dispersal of the fruit.

According to A. Cleve (l. c.) *R. nivalis* germinates during autumn (December), but seeds which had been sown by Sylvén in flower-pots germinated during the following spring. In the first stages of its development *R. nivalis* resembles *R. pygmæus*, but is distinguished from the latter by less decided heterophylly. The two cotyledons are long-stalked, the lamina is oval-lanceolate, and the sheaths are coherent at their base. The primordial leaf is tripartitely lobed in front (Sylvén).

During the first weeks of the period of vegetation in spring, *R. nivalis* appears to require a cold soil, wetted by melting snow, but afterwards the soil may become dry without injury (Cleve, Norman). In Spitzbergen the plant grows both upon grassy slopes and also in marshy ground, and at Scoresby Sound in East Greenland in damp clay. In Norway it is a markedly continental plant that may extend very high up into the mountains (1550 m. above sea-level); in East Greenland it is not very probable that it will be found at the heads of the of the fjords (Norman, Hartz, Dusén).

Geographical Distribution. (Holm). Arctic America, Greenland, Spitzbergen, Scandinavia, Arctic Russia, Nova Zembla, North Siberia.

Anatomy. The structure of the root (Fig. 25, *A*, *B*) was similar in specimens investigated from all the regions from which I had material, and did not differ in any essential points from that of the root of *R. glacialis*. The epidermis has a tendency to collapse, both it and the exodermis are suberized. From one to two of the outermost layers of the cortex are collenchymatously thickened, but only in roots of the first order. The cortex acquires at an early stage large, lysigenous lacunæ. The endodermis is suberized, but the walls are not thickened. The central cylinder is di- or triarch in roots of the first order and diarch in roots of the second order. The latter contain hyphæ which are usually found rolled together into balls in the inner layers of the cortex (Fig. 25, *C*); such mycorrhizas have been found in specimens from Disco, Kaafjord and Spitzbergen.

The rhizome is similar to that of *R. glacialis.*

The stem above ground nearly resembles in structure

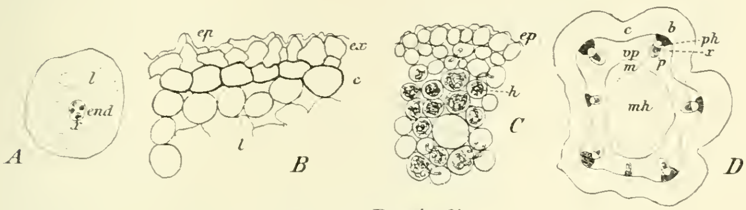

Fig. 25. *R. nivalis.*

A, Transverse section of adventitious root of the first order (Disco; about $^{20}/_1$). *B*, Portion of A (about $^{110}/_1$). *C*, Mycorrhiza of root of the second order (Kaafjord; $^{60}/_1$). *D*, Transverse section of peduncle (Spitzbergen; 6. 8. 1910; about $^{18}/_1$). *b*, Bast; *c*, cortex; *end*, endodermis; *ep*, epidermis; *ex*, exodermis; *h*, hyphæ; *l*, lacuna; *m*, pith; *mh*, pith-cavity; *p*, non-lignified parenchyma; *ph*, leptome; *vp*, lignified parenchyma; *x*, xylem.

that of *R. sulphureus.* The cuticle is more slightly striped than in the latter. The stomata are on a level with the surface. The epidermis contains chlorophyll and is attached to the outermost layer of the cortex; the rest of the lacunose cortex, extending inwards to the ring of stereom, is about five layers thick. The development of the stereom is about equal to that in *R. sulphureus*; this applies also to the fibrous tissue outside the leptome. The peduncle, as usual, is considerably stronger towards the time for the ripening of the fruit than at an ealier stage (Fig. 25, *D*), and it is somewhat stronger in *R. nivalis* than in *R. sulphureus*; in the former it is also more strongly furrowed. Consequently, judging from my material, the difference, recorded by Simmons (l. c.), in the direction of the ripe stems in the two species in question apparently cannot be explained by the anatomical features. The pith was broken down throughout the entire stems.

The leaf is almost or quite glabrous. The radial walls

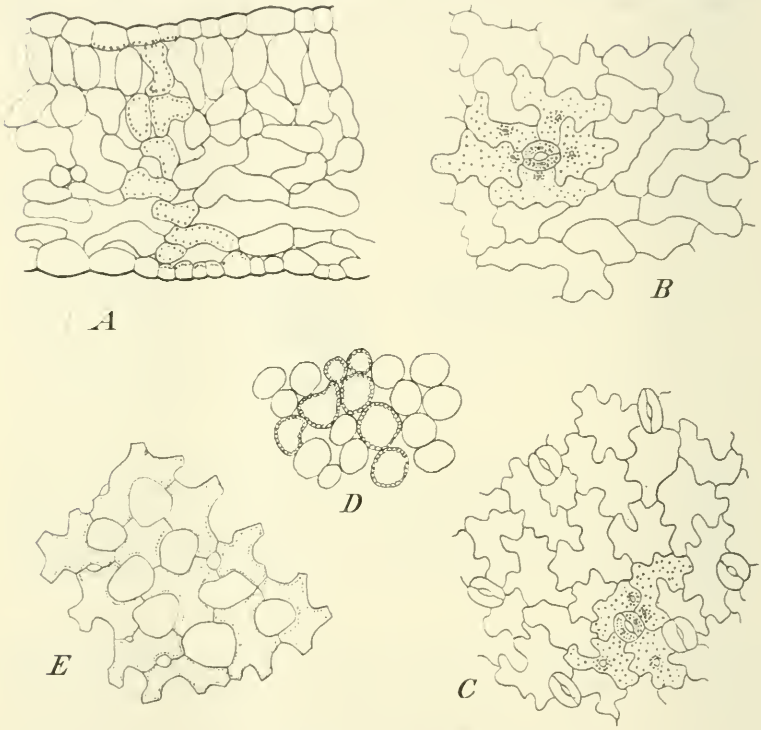

Fig 26. *R. nivalis.*

A, Transverse section of leaf. *B*, Epidermis of the upper surface. *C*, Epidermis of the lower surface. *D*, Surface section of uppermost palisade-layer. *E*, Surface section of spongy parenchyma. (*A*, *B*, *C*, *D*, *E* are from Kaafjord, Norway; $^{115}/_1$).

of the epidermal cells of the upper surface are somewhat undulating but less so than those of the lower surface (Fig. 26, *B*, *C*). The stomata are on a level with the surface and occur in greater numbers upon the lower surface. The relations between the numbers upon the upper and lower surface is somewhat uncertain; Börgesen (l. c. p. 229) found 4 and 11 respectively per unit of surface, Resvoll (l. c. p, 357) 25 per sq. mm. upon the upper surface as against 58 per sq. mm. upon the lower surface; according to my computation there are three times as many upon the lower, as upon the upper surface. The stomata are distributed fairly evenly over the whole surface, but they are less numerous above the veins and just at the margin of the leaf; their direction on the leaf-lobes is almost parallel with that of the main vein, but less regularly so upon the rest of the surface. The bundles are without stereom, only the larger ones upon the upper and lower surface are accompanied by a few elongated, cylindrical cells without thickened walls: each bundle is accompanied by a sheath in which the chlorophyll appears especially to lie against the outer wall.

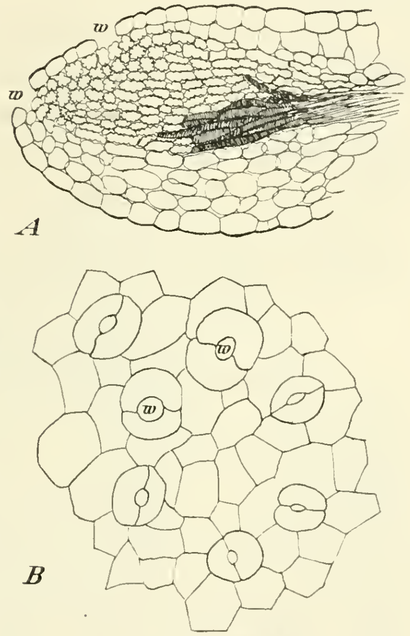

Fig. 27. *R. nivalis.*

A, Longitudinal section of leaf-apex with epithema (Spitzbergen; $^{100}/_{1}$); *w*, openings in the epidermis probably answering to the collapsed guard-cells of the water-stomata. *B*, Portion of the area with water-stomata (Disco; $^{220}/_{1}$); *w*, the apertures of the water-stomata.

From one to two palisade-layers occur which are slightly inclined towards the leaf-apex; the individual cells are about twice as long as they are thick and are often barrel-shaped and somewhat irregular; the palisade-layers constitute about one-half of the mesophyll. There is a gradual transition from the palisade-to the spongy tissue with numerous large intercellular spaces (Fig. 26, *A*); the cells are branched, which is best seen in surface section (Fig. 26 *E*). There often occurs a slit-like lacuna between the subepidermal layer of the lower surface and the rest of the mesophyll.

In Fig. 27, *A* the epithema of the leaf-apex is shown; it is peculiar owing to the highly undulating cell-walls. The water-pores occur upon the slanting, upturned terminal surface (Fig. 27, *B*).

I found no essential differences in leaves from the different regions. It is an interesting fact which is pointed out by Börgesen, namely that the structure of the leaf becomes looser with increase of the geographical latitude (Dovre—Kaafjord (70° N. lat.) — Nova Zembla).

The leaf-stalk is reniform in transverse section. There are three vascular bundles and a large central lacuna.

R. pygmæus Wahlenb.

Lit. Buchenau & Focke, 1872, p. 28. Lange, 1880, p. 55; 1887, p. 254. Nathorst, 1884, p. 46, tab. 1. Lindman, 1887, pp. 25, 41, 100, tab. 1, fig. 7 A. B. Rosenvinge, 1892, p. 675. Wagner, 1892, pp. 8, 20. Hartz, 1894, p. 52; 1895, II, p. 288. Børgesen, 1895, pp. 235, 236. Norman, 1895, p. 11. Ekstam, 1897, p. 145. Abromeit, 1899, p. 30. Ekstam, 1899, pp. 22, 32, 37. Resvoll, 1900, figs. 11, 26. Andersson & Hesselmann, 1901, p. 48. Cleve, A., 1901, pp. 51, 78, 88, 103. Dusén, 1901, p. 30. Freidenfelt, 1904, p. 53. Sylvén, 1906, p. 272.

Alcohol material from Greenland (Danmarks Ø, Aug. 1891; Godhavn in Disco, 20. 7. 1884; Kutdlisat in Disco, 9. 8. 1890 [var. *Langeana*]; Norge (Trondfjældet Jemtland, 19. 6. 1880); Spitzbergen (Advent Bay, 3. 8. 1810; Middelhook in Belsund, 1. 7. 1882).

R. pygmæus is a perennial herb. The rhizome is vertical; roots arise from the whole of its surface and it is covered with a dense matting of the vascular strands of dead leaves. Though the rhizome does not become long yet some are commonly found measuring as much as 2 cm. in length. The plant often grows in dense tufts which are produced by the rhizomes branching freely and the individual shoots readily become detached by dying away at their base. Branching takes place from the upper leaf-axils in the rosette; the principal bud occurs in the uppermost. The shoot bears first two transversely placed long-stalked foliage-leaves, then similar leaves succeed in a $^2/_5$ spiral. The principal bud frequently flowers the same year as the parent-axis, and in that case the bud which lives through the winter is seated in the uppermost leaf-axil at the base of axis II. Usually there are two stem-leaves, of which the lower is short-stalked and sometimes subtends a floral axis. Antidromy is no doubt the most common condition. (Fig. 28, *A*).

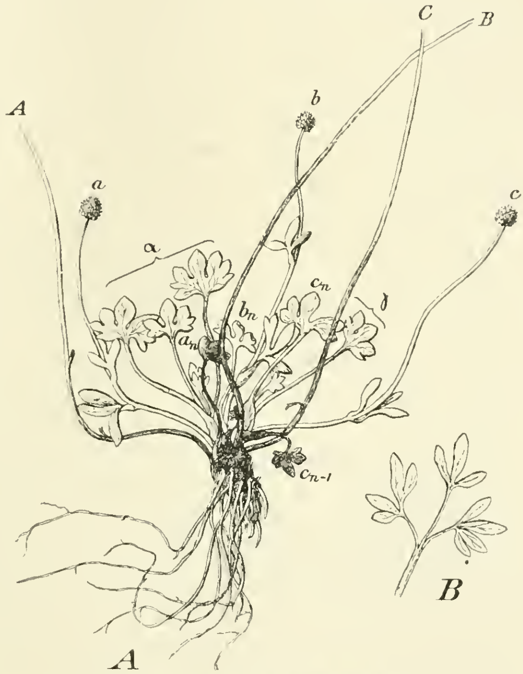

Fig. 28, *A*. *Ran. pygmæus.*
(Trondfjæld in Norway; 2. 8. 1883, about nat. size).
B. *Ran. pygmæus* var. *Langeana Nath.*
(Disco: Unartok; 14. 8. 1890; about nat. size).
A, *B*, *C*, Old axes from 1882; *a*, *b*, *c*, axes that have flowered, 1883; *an*, *bn*, *cn*, their uppermost basal leaves; *α*, *γ*, shoots in the axils of *an* and *cn*.

I have observed only foliage-leaves on mature shoots; but a section through the principal bud from a specimen from Disco, gathered in August, showed a leaf which no doubt was a scale-leaf (Fig. 29, *A*), and Sylvén found scale-leaves upon his cultivated plants. The large leaf-sheaths of the rosette must protect the young apex of the shoot with its delicate organs during winter, and the dense growth of the plant may also be useful in this respect.

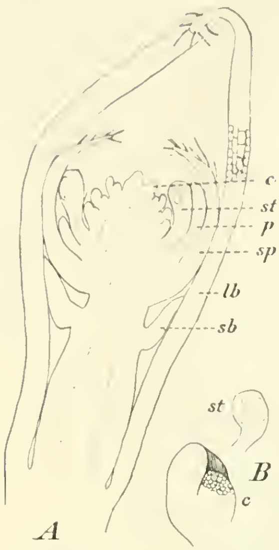

Fig. 29. *R. pygmæus.*

A, Longitudinal section through a principal bud (Danmarks Ø; Aug. 1891; $^{20}/_1$). *c*, Carpel; *st*, stamen; *p*, nectary-leaf; *sp*, perigone-leaf; *lb*, scale-leaf; *sb*, stem-leaf. *B*, Stamen ($^{25}/_1$) and carpel ($^{72}/_1$) from the same bud.

It is not uncommon to find plants with dead stems from the preceding year upon them (Fig. 28, *A*), which proves that at least these specimens live longer than one year (compare the statement ♃ (⊙?) in Neuman, "Sverriges flora," Lund, 1901).

The rosette-leaves, and also the lowermost stem-leaf, are stalked, somewhat reniform in shape, and deeply tripartite with either entire or shallowly 2—3 lobed elliptical segments. The 1—2 upper leaves are sessile and tripartite with oblong lobes. The leaves are glabrous or also slightly hairy at the margin.

The stem is ascending: before and just after flowering it is short, in dwarf specimens from Advent Bay in Spitzbergen about 0·5 cm.; afterwards it elongates greatly and becomes as much as 16 cm.

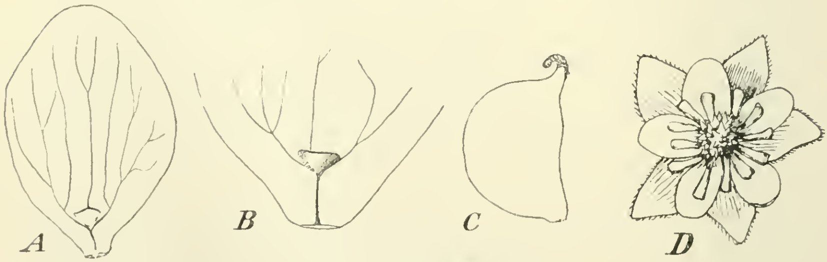

Fig. 30. *R. pygmæus.*

A, Nectary-leaf ($^9/_1$). *B*, Nectary ($^{15}/_1$). *C*, Fruit (Danmarks Ø; Aug. 1891; $^{15}/_1$). *D*, Flower of *R. pygmæus* (Holstensborg in Greenland; D, drawn by E. W.; $^7/_2$).

high. The peduncle differs from the stem in being more densely hairy and more deeply furrowed.

The flower has five slightly hairy perigone-leaves and five lustreless nectary-leaves; the anthers are extrorse or slightly turned sideways; the stamens are few in number, (Fig. 30, *D*). Ekstam found homogamy and spontaneous self-pollination to occur in Spitzbergen. Lindman also records homogamy and figures two kinds of flowers: large ones measuring about 7 mm. in diameter in which the head of carpels is so high that only the lowermost stigmas may be reached by the stamens, and small ones about 4 mm. in diameter in which the stamens stand at the same level as the head of carpels. In Spitzbergen the diameter of the flower is 5—8 mm. (Ekstam); in Nova Zembla 5—10 mm. (Ekstam). The nectaries are simple and pocket-shaped (Fig. 30, *B*). Lindman and Ekstam did not notice any perfume.

Flowering takes place in the beginning and middle of summer. In Arctic Norway the plant grows by preference at the snow-line, and the time for the coming out of the leaves may differ greatly even in the case of plants standing close to each other, according as to whether they stand nearer or further from the snow (Norman). The fruit ripens in August.

The fruit (Fig. 30, *C*) is dispersed by the agency of the wind, which may be connected with the fact of the peduncle elongating greatly during fruit-setting; but the dispersal is not very effectual and the plant is often found growing in colonies (Ekstam; 1897).

Sylvén described the germination, which takes place during spring (Cleve). Heterophylly is more decided than in *R. nivalis,* not until during the second year do the leaves attain the fully-developed form.

Nathorst has established a var. *Langeana* which is characterized by the leaf-segments of the basal leaves, and sometimes of the lower stem-leaf, being stalked. The middle lobe is 3—4 partite, and the lateral lobes are more or less symmetrically 2—4 partite (Fig. 28, *B*). The stem-leaves are almost sessile and divided to the base into 3—5 lanceolate-oblong segments. This variety grows in mossy bogs and often together with the principal form. HARTZ found numerous transitional forms between the variety and the principal form (I, p. 52). NATHORST found this variety on Disco, where HARTZ also found it as he also did on Arveprinsens Island.

In var. *Langeana* it often happens that the internodes of the rosettes are elongated, in correspondence to its life in quickly-growing moss.

Geographical Distribution. West and East Greenland, Iceland, Scandinavia, Beeren Eiland, Spitzbergen, Nova Zembla, Arctic Russia, North Siberia, Arctic North America, the Rocky Mountains (LANGE, TH. HOLM).

Anatomy. The root of the first order was diarch or triarch. The epidermis was more or less collapsed especially in roots of the second order. The exodermis was distinct, the latter and the epidermis were suberized. The outermost layers of the cortex were either not at all collenchymatously thickened or but very slightly; its intercellular spaces were fairly large; lysigenous lacunæ often occur, especially in roots of the second order. The endodermis was suberized but not thickened.

Mycorrhizas have been found in specimens from Advent Bay, Trondfjældet and Disco. The hyphæ often form balls in the inner cortical layers, especially in roots of the second order.

The greater part of the epidermis of the rhizome had fallen off in the specimens investigated; the outer cortical layers were suberized and slightly thickened. Lacunæ were absent from the cortex. 5—8 vascular bundles which anastomosed freely were present; and also, in different sections of the same root, isolated bundles were seen with a special endodermis; also groups of bundles, each group with its own endodermis; or else all the bundles were fused together so that there was an outer and an inner endodermis, between which the bundles occurred (Fig. 31, *A*). The cambium was rudimentary. The vessels were scattered among non-lignified parenchyma. The pith was not broken down. The starch-grains were highly compound.

The stereom in the stem is weak during flowering but afterwards — when the peduncle elongates greatly — it becomes much stronger: it is about four layers thick between the bundles which, upon their inner sides, are often surrounded by lignified parenchyma and upon their outer sides by strong fibrous tissue. Between the woody part and the inner arch there occurs in the larger bundles a quantity of small-celled, non-lignified parenchyma (p) as in the majority of the other species; and between the vessels and the cambium occurs some wood-parenchyma.

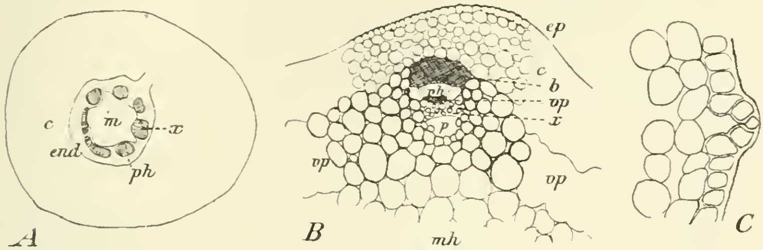

Fig. 31. *R. pygmæus.*

A, Transverse section of rhizome (Spitzbergen; $^{23}/_{1}$). *B*, Portion of transverse section of stem (Spitzbergen; $^{72}/_{1}$). *C*, Stoma from the stem (Danmarks Ø; $^{220}/_{1}$). *ep*, Epidermis; *c*, cortex; *end*, endodermis; *b*, bast; *ph*, leptome: *vd*, lignified parenchyma; *x*, xylem; *p*, parenchyma; *m*, pith.

chyma. The vessels were but slightly developed in the specimens investigated, their diameter is small, and they are few in number. The cambium is rudimentary. The bundles number 5—8. The pith breaks down gradually but entirely (Fig. 31, *B*).

The cortex consists of cylindrical cells and has large intercellular spaces. The stomata are on a level with the surface or project slightly (Fig. 31, *C*); the cuticle is slightly striped; chlorophyll is present in the epidermis.

The leaf nearly resembles in structure that of *R. nivalis;* the thickness varies from 270 to 300 μ. The radial walls of the cells of the upper and lower epidermis are somewhat undulating, those of the lower somewhat more so than those of the upper

(Fig. 32, *B*, *C*). The stomata are either on a level with the surface or project slightly. Borgesen and Wagner record the number to be equal upon both surfaces, Resvoll records 44 per sq. mm. upon the upper as against 62 per sq. mm. upon the lower surface. Chlorophyll is present in the epidermis. From one to two layers of palisade-cells occur which are scarcely twice as high as they are broad and are somewhat barrel-shaped;

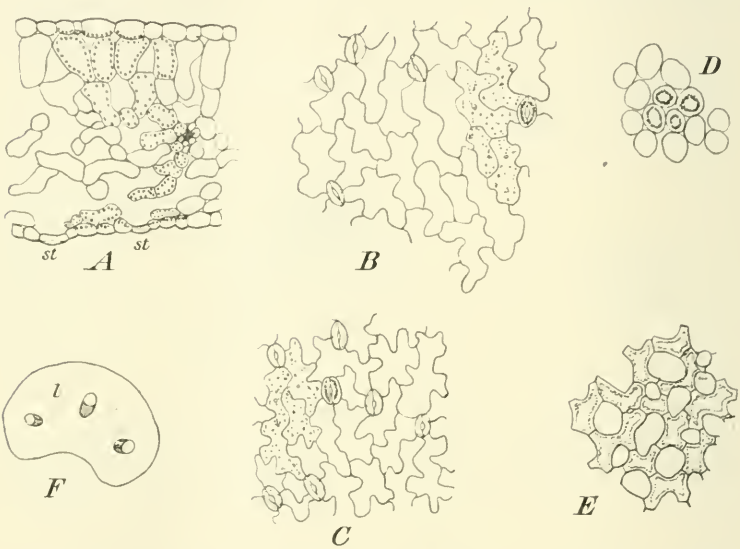

Fig. 32. *R. pygmæus.*

A, Transverse section of leaf (Danmarks Ö; 100/1). *B*, Epidermis of the upper surface of the leaf (ibid; 110/1). *C*, Epidermis of the lower surface of the leaf (ibid; 110/1). *D*, Surface section of palisade-layers (ibid.; 110/1). *E*, Surface section of spongy parenchyma (ibid.; 110/1). *F*, Transverse section of leaf-stalk (22/1).

they constitute from 1/3 to 1/4 of the thickness of the mesophyll. The spongy parenchyma consists of branched cells and is very loose in structure especially in its lower part where large slit-like lacunæ are often seen between the subepidermal layer and the rest of the mesophyll; (Fig. 32, *A, D, E*). The bundles are not accompanied by stereom and are surrounded by a sheath containing chlorophyll.

Each leaf-apex terminates in an epithema the structure of which is similar to that of *R. nivalis* and, as in the latter, the area with the water-pores occurs almost at the margin; stomata are absent from the under side of the leaf-apex.

The leaf-stalk is reniform in transverse section. There are three vascular bundles; they are without stereom. The cortex often has lacunæ, but otherwise resembles that of the stem (Fig. 32, *F.*).

R. reptans L.

Lit. Lange, 1887. Hartz, 1894, p. 34. Norman, 1895, p. 6. Rosenvinge, III, 1896, p. 240.

Alcohol material from Greenland (Sophiehamn, 6. 8. 1883; Monekordhiak, 19. 7. 1883); Denmark (Fure Sø, 2. 9. 1910).

R. reptans from a morphological point of view, is a transitional form between the preceding species and the *R. lapponicus*-type. In the flowering plant there is a short, erect rhizome which bears a rosette consisting of a few, stalked, linear to linear-lanceolate foliage-leaves, the uppermost of which subtends a principal bud which may develop a floral-stem with elongated internodes the same year as the parent-axis flowers, but which no doubt usually develops only a rosette. I am not prepared to say whether the latter may remain green during winter in Arctic countries; in Denmark it passes the winter in a green condition.

The more or less filiform ærial stem becomes horizontal with the formation of the first elongated internode. The internodes are highly curved as in *R. hyperboreus*. The two-rowed leaves are very similar in form to the rosette-leaves and, like the latter, they have a large sheath; the uppermost ones are very small, the number of leaves on the straight stem differs much, I have in arctic specimens often found 3—5 but 14 also occurs; the creeping stem may reach the length of about 50 cm. When the axis flowers it becomes ascending, usually just above the uppermost leaf; the peduncle however often bears a bract. The uppermost leaf upon the horizontal stem may subtend a shoot with elongated internodes, which continues the main axis sympodially until that also produces a flower, and so on. But in Greenland and Iceland, judging from herbarium-material, it seems probable that rarely more than two generations of axes attain the flowering stage. In the other axillary-shoots of the stem the internodes either remain short or the axillary shoots develop like the parent-axis and flower; their axillary shoots are rosettes; this is also frequently the case with the main shoot.

The more vigorous shoots occur in the lower axils of the straight stem, and from their bases and from the nodes of the parent-axis vigorous adventitious roots arise late in summer. They are of two kinds: some slender, hyaline and abundantly branching, and others which are white and almost unbranched and begin with a somewhat thickened base, becoming thinner downwards; these roots may be regarded as storehouses of food-material for the axillary-shoots which become independent during autumn by the death of the parent-axis.

The flower has five somewhat prominent perigone-leaves and five yellow nectary-leaves which do not overlap and are somewhat longer than the perigone-leaves (from 2·5 to 6 mm.). The nectaries are simple and pocket-shaped (Fig. 33).

Fig. 33. *R. reptans.* Nectary-leaf (Greenland; 6/1).

The anthers are turned sideways. The cluster of ovaries is almost globular and does not overtop the stamens. In the material, both from Greenland and Denmark, the flowers were somewhat protandrous-homogamous. The diameter of the flower in Arctic Norway is about 9 mm. (Norman), in Greenland and in Denmark about 5 mm. The time of flowering in Arctic Norway is from the middle of July to September, and in Denmark from the middle of June to the middle of September.

The ripe fruits have a more or less curved beak, and if they are not wetted, can float for a long time (from one to two weeks), but the majority of them sink within 48 hours if the surface gets wet (according to my experiments, made with Danish fruits[1]). I can make no statement about the germination, but the fruits of the nearly allied *R. Flammula* are capable of germinating immediately after maturation.

R. reptans grows on the pebbly shores of lakes, where it often forms a dense mat; it may also occur among moss (Hartz); it is often submerged and the leaves are then linear and it is sterile; Norman records that in Arctic Norway it may be found in large expanses of water at a depth of as much as one metre. According to Norman it is a decidedly continental plant in Arctic Norway in the greatest contrast to *R. Flammula*.

Geographical Distribution. North America, from Canada and Newfoundland to 69° N. lat.; West Greenland; Iceland; the Færoes; Central Europe; Scandinavia, as far as Finmark; Finland and Arctic Russia. (Lange).

Anatomy. The root resembles in structure that of other species of *Ranunculus*. Roots containing reserve food-material (of which only Danish specimens have been investigated) have a still entire epidermis; the exodermis is of somewhat radially elongated cells with undulating walls; both the layers are suberized. The cortex has no thickened outer layers; its cells are full of starch (the grains are compound). The endodermis is suberized but the walls are not thickened. The central cylinder is diarch, the vessels are slightly developed. The slender roots have a more or less collapsed epidermis and the cortex is for the greater part broken down. The central cylinder is also diarch in these roots. The diameter of the central cylinder relative to that of the root is only slightly smaller in the roots containing reserve food-material than it is in the slender ones.

Mycorrhizas have not been found.

The nodes and the internodes of the stem differ some-

[1] See also Kolpin Ravn: Om Flydeevnen hos Froene af vore Vand- og Sumpplanter. Bot. Tidsskrift, Bd. 19, København, p. 146.

what in structure, the former having become rhizome-like by the anastomosing bundles coming closer to each other, so that the cortex is thicker than in the internodes. The cortex and the pith are not broken down and lignification often occurs in the latter in the Danish specimens. The bundles are without stereom. The internodes are somewhat different in structure in the Danish specimens, according as to whether the land-or the submerged form is in question. The bundles in the latter are not accompanied by stereom, while the former has an external weak, and an internal stronger arch of bast and of lignified parenchyma respectively (Fig. 34, *b* and *vp*). The specimens from Greenland were similar in structure to the Danish land-form. The bundles number from three to seven. The vessels are few in number, but large. Some small-celled parenchyma occurs between the vessels and the inner arch, and some wood-parenchyma between the vessels and the sieve-tissue. No interfascicular lignified parenchyma occurs. The endodermis is indistinct. The pith is broken down in all the specimens which have been investigated from all localities. The epidermal cells have only slightly thickened walls, but they are thicker in the land-form than in the submerged form, and the former has also a more distinctly striped cuticle than has the latter. The living cortex consists everywhere of but 2—4 layers.

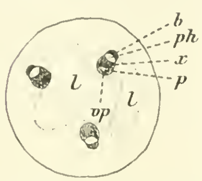

Fig. 34. *R. reptans.* Transverse section of an internode of the stem of the land-form (Denmark $^{20}/_{1}$): *b*, bast; *ph*, leptome; *x*, xylem.; *p*, parenchyma, *vp*, wood-parenchyma; *l*, lacuna.

The structure of the leaf varies greatly according to external conditions. As there is a gradual transition from the submerged, linear leaf to the linear-lanceolate leaf of the land-form, so there is also from the nearly radial to the dorsiventral. The dorsiventral leaf (Fig. 35, *A*) has one palisade-layer the cells of which are barrel-shaped and somewhat irregular; they form about one-half of the thickness of the leaf. There is a gradual transition to the spongy cells, which are slightly branched. The epidermal cells have undulating radial walls. The stomata are more numerous upon the upper surface, but the number varies somewhat in the different leaves. In the specimens from Denmark I found from 57 to 83 per sq. mm. upon the upper surface, and about 50 per sq. mm. upon the lower, and the specimens from Greenland have about the same number.

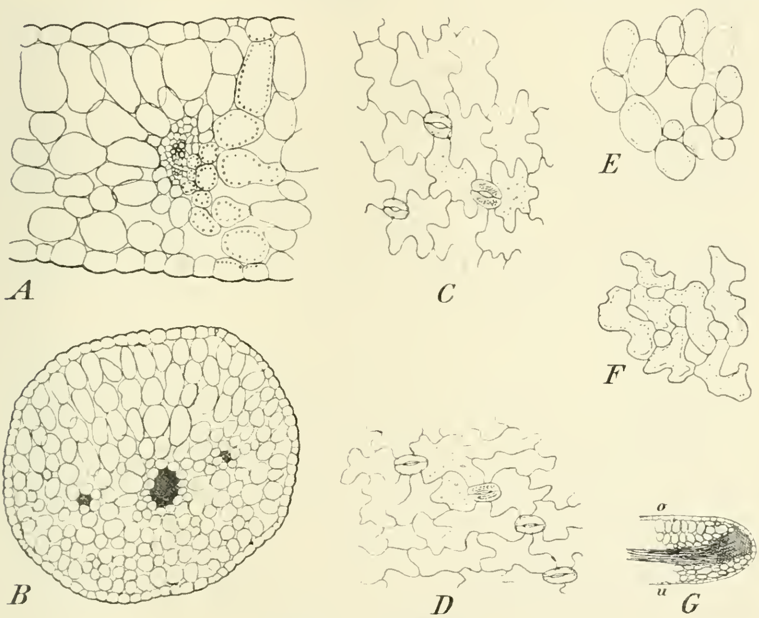

Fig. 35. *R. reptans.*

A, Fragment of transverse section of leaf of land-form (Denmark; $^{110}/_1$). *B*, Transverse section of leaf of submerged form (Denmark; $^{110}/_1$). *C*, Epidermis of the upper surface of leaf of land-form (Denmark; $^{94}/_1$). *D*, Epidermis of the lower surface of leaf of land-form (Denmark; $^{94}/_1$). *E*, Surface section of palisade-cells of land-form (Denmark; $^{94}/_1$), *F*. Surface section of spongy parenchyma of land-form (Denmark; $^{94}/_1$). *G*, Longitudinal section through the leaf-apex of land-form (Denmark; $^{26}/_1$).

In the Danish specimens there is also some chlorophyll in the epidermis; (Fig. 35, *C*, *D*). A few thick-walled hairs of the usual type occur. The bundles are without stereom. The radial leaf is rounded and has an axile bundle. The mesophyll and the epidermis consist of elongated cylindrical cells; stomata are present, but in no great number. This leaf resembles that of *Batrachium*, but has larger intercellular spaces. Fig. 35, *B* shows a leaf transitional between the two types; the mesophyll of the upper surface is palisade-like, and there are three bundles. The bundles are without stereom, but have a more or less distinct sheath containing chlorophyll.

Each leaf-apex has an epithema which opens at the margin (Fig. 35, *G*). The cells have highly undulating walls, similar on the whole to those in *R. nivalis*.

R. hyperboreus Rottb.

Lit. Hooker, 1833. Lindman, 1887, p. 41, fig. 8 a, b, tab. I. Hartz, 1894, pp. 6, 34; 1895, (II), p. 289. Norman, 1895, p. 8. Rosenvinge, I, 1892, p. 675; III, 1896, p. 108. Kruuse, 1897, p. 385. Abromeit, 1899, p. 30. Andersson & Hesselman, 1900, p. 47. Resvoll, 1900, figs., 4, 5, 13, 20, 22, 23, 25, 27, 28, 30, 33. Dusén, 1901, p. 30. Porsild, 1902, pp. 170, 196, 205. Simmons, 1906, p. 115.

Alcohol material from Greenland (Friedrichsthal, 29. 8. 1883, Jacobshavn, 25. 7. 1884, Sermilik, 3. 7. 1885, Kingigtortadlit, 1. 7. 1887, Uperniviarsuk, 9. 7. 1887, Niodluisuk-Øen, 21. 8. 1888). Iceland (Thingvellir, 13. 6. 1895). Lapmark (Bosekob, 3. 7. 1884). Spitzbergen (Gåseöen 28. 7. 1882).

R. hyperboreus bears a great resemblance to *R. lapponicus* but is distinguished from the latter *inter alia* by the form of its leaf, by its more abundant branching, and by its much shorter flower-stalks. The leaf is deeply tripartite, the lobes are narrower than in *R. lapponicus,* the middle one is entire and the lateral lobes are often shallowly 2-lobed (Fig. 36). The leaves are placed in two rows upon the slender stem the internodes of which are curved. The internodes may reach a length of 10 cm. Usually every leaf subtends a lateral shoot which is antidromous to the main axis. The first leaf of the shoot is situated dorsally and somewhat sideways, and its internode is elongated. It is no doubt usual for 3—4 generations of axes to attain the flowering-stage during the same year; the first ones produce both leaves and flowers, the higher ones are often purely floral, with sessile bracts and short internodes.

Roots arise from the nodes of the stem; they may attain a great length (20 cm.) and are usually unbranched.

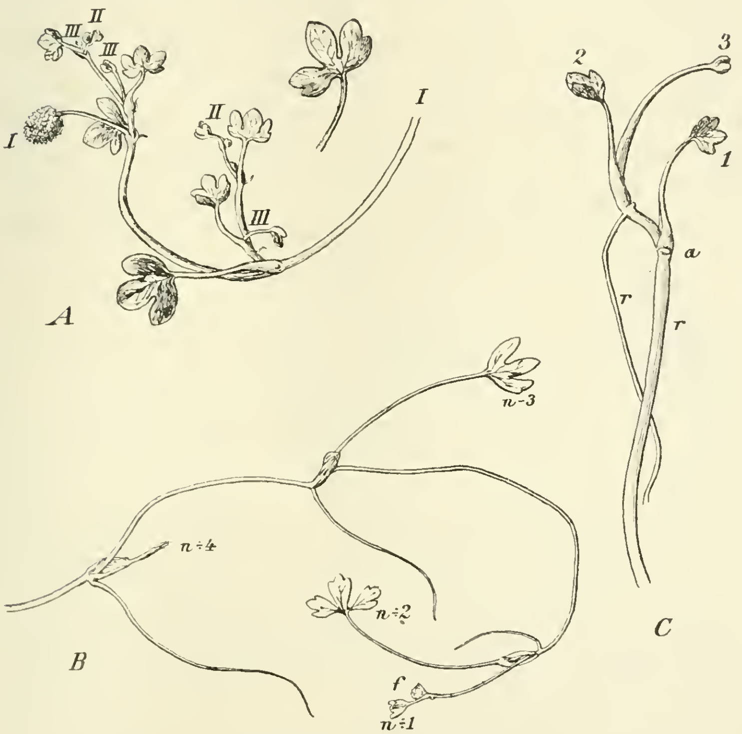

Fig. 36. *Ran. hyperboreus.*

A, A specimen from Friedrichsthal; about nat. size. *I* is the main axis which has flowered, the two last leaves subtend lateral axes (*II*) which bear flower-buds. Axes of the third order have begun to develop. A leaf is seen above. *B*, A somewhat etiolated plant which has probably just quitted the winter condition; leaf $n \div 4$ is dead, as also the leafy axis which occurs behind it; the leaves $n \div 5$ and $n \div 6$ (omitted from the figure) subtended lateral axes which now are independent. (Kingigtortadlit 1. 7. 1887; about nat. size). *C*, Gemmule (Spitzbergen: Gåseö; $^4/_1$); *r*, root; *a*, scar, answering to the point of attachment to the parent-axis.

R. hyperboreus passes the winter without visible means of protection. Plants which have just begun to grow in spring, have long, slender, and apparently etiolated shoots from the dead stem of the preceding year (Fig. 36, *B*).

The flowers are small and short-stalked and the leaves project above them (Abromeit). The perigone-and the nectary-leaves are usually trimerous (Fig. 37); but the pentamerous condition may also occur; the perigone-leaves are yellowish and highly arched, the nectary-leaves are yellow; the nectar-pocket is simple (Fig. 38, *A*). The stamens number from a few to about 20; they are short and can reach only the lowest carpels (Lindman). In Norway the homogamy of the flower is preceded by a short staminate stage (Lindman); Warming (note-book) found it to be homogamous in Greenland. In Ellesmereland Simmons searched in vain for expanded flowers; the flower-buds, as also the fruit-clusters, were always submerged,

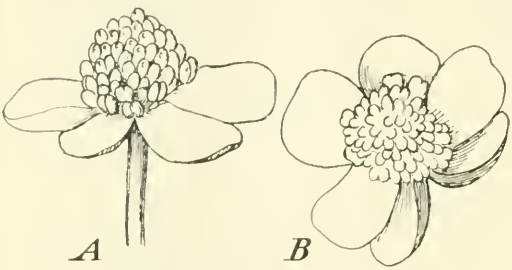

Fig. 37. *Ran. hyperboreus.*
A, B, Flowers from Greenland; (drawn by E. W.; 4/1).

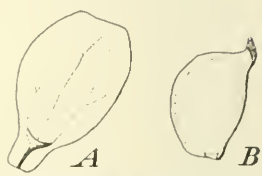

Fig. 38. *Ran. hyperboreus.*
A, Nectary-leaf (8/1). *B*, Fruit (8/1).

therefore he thinks that the flowers are cleistogamous and that self-pollination takes place below the surface of the water. The flower is often sterile (Kruuse, Anders. & Hesselm.); the time of flowering is July and August.

Vegetative propagation is the more usual method: new individuals are formed by the lateral shoots becoming independent upon the decay of the parent-axis. Perhaps gemmules also are important to the process. Fig. 36, *C* shows a gemmule from Gåseøen (Spitzbergen). At the point of transition between the stem and the large root an oval scar is seen, the place of connection with the parent-axis. I saw only this one, but it is possible that axillary shoots are normally set free from the parent-axis before they develop further.

Geographical Distribution. East and West Greenland, Arctic North America with the Archipelago, Labrador, the Rocky Mountains, Arctic Siberia, the Himalayas, Arctic Russia, Nova Zembla, Spitzbergen, Northern Scandinavia, Iceland (Simmons).

Anatomy. The epidermis of the roots is thin-walled and the walls are collapsed; the exodermis has undulating radial walls; both layers are suberized. The cortex is almost entirely broken down even in roots picked during the early part of summer, only a few layers remaining within the exodermis and around the suberized, thin-walled endodermis. The central cylinder is diarch. Root-hairs are present but few in number; I have not found mycorrhiza.

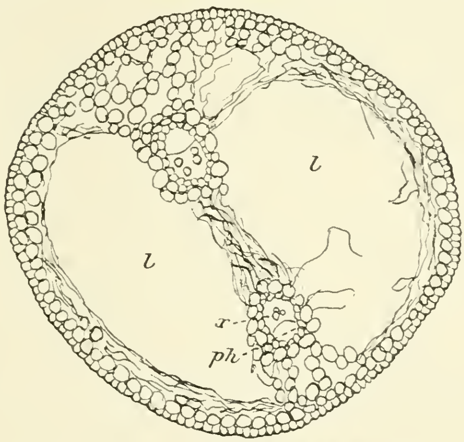

Fig. 39. *Ran. hyperboreus.*
Transverse section of the prostrate stem (Uperniviarsuk. *ph.* Leptome; *x*, xylem; *l*, lacuna.

The stem is rounded and smooth, the cuticle is slightly striped, and the outer walls of the epidermal cells are thin; the stomata are on a level with the surface or project slightly; the epidermis contains chlorophyll. Anatomically the stem may be divided into two parts, viz. the nodes which have the usual structure of the rhizome (see *R. lapponicus* p. 401) and the internodes. The latter are exceedingly loose in structure with large intercellular spaces; the greater part of the cortex and the pith is broken down at an early stage (Fig. 39), but the extent of disorganisation is no doubt somewhat dependent upon the locality. The 2—4 bundles are either quite devoid of stereom or else they have fibrous tissue outside the leptome consisting of some weak strands of bast. The structure of the peduncle is not, in any essential degree, stronger than that of the prostrate stem, only there is a larger amount of close-set parenchyma, which becomes lignified around the bundles during fruit-setting; also in the peduncle the pith and the cortex are usually broken down; the subepidermal layer is placed close to the epidermis.

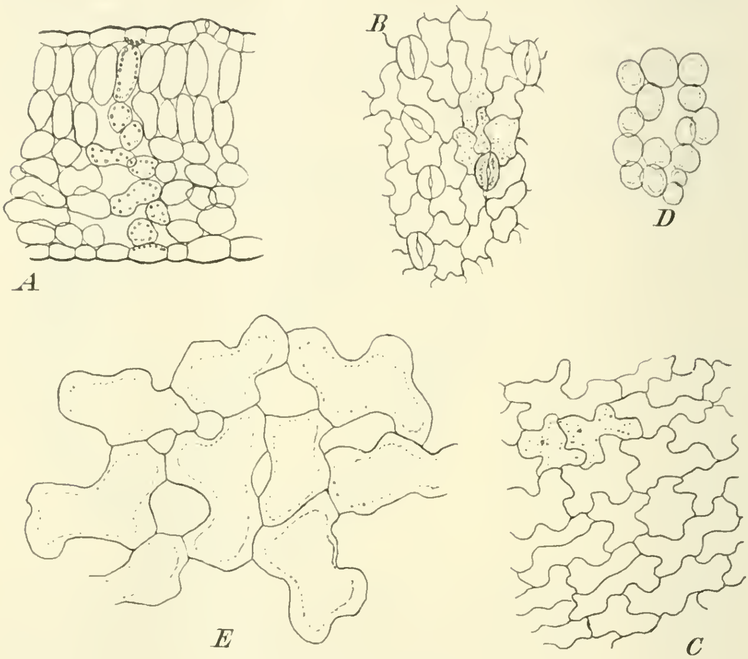

Fig. 40. *Ran. hyperboreus.*

A, Transverse section of leaf (Thingvellir; $^{146}/_1$). *B*, The epidermis of the upper surface (Greenland; $^{130}/_1$). *C*, The epidermis of the lower surface (Spitzbergen; $^{154}/_1$). *D*, Surface section of palisade-cells (Greenland; $^{130}/_1$). *E*, Surface section of spongy parenchyma (Greenland; $^{339}/_1$).

The leaf is glabrous; the thickness varies from 180 to 270 μ. The cells of the epidermis have undulating anticlinal walls, those of the upper surface often somewhat more so than those of the lower; chlorophyll is present. The stomata are on a level with the surface; they vary greatly in number, but are always most numerous upon the upper side. In specimens from Nidluitsukøen and Gåseøen (Spitzbergen) they were almost entirely absent from the lower surface, but occurred to the number of about 100 per sq. mm. upon the upper surface. Resvoll records concerning specimens from Jacobshavn in Greenland that they have none upon the lower and 126 per sq. mm. upon the upper surface; and in those from an unnamed locality in East Greenland, 27 upon the lower as against 235 upon each sq. mm. of the upper surface; and in specimens from Bosekob, 34 on the lower surface as against 63 per sq. mm. of the upper surface. Two palisade-layers usually occur, constituting about one-half of the mesophyll; the individual cells are about twice as long as they are thick, are barrel-shaped and somewhat irregular. There is a gradual transition from the palisade-layers to the spongy parenchyma which consists of slightly branching cells and has numerous intercellular spaces (Fig. 40, *A*). The sub-epidermal layer which is placed close to the epidermis has cells which often branch more abundantly than those of the rest of the spongy parenchyma. The bundles are not accompanied by stereom.

The area with the water-pores is situated almost at the margin. The structure of the epithema is as in *R. lapponicus.*

The specimen from Thingvellier was somewhat more compact in structure and had slightly longer palisade-cells than the rest of the specimens investigated.

The leaf-stalk was like that of *R. lapponicus.*

Ranunculus lapponicus L.

Lit. Hooker, 1833, I, p. 16. Hartz, 1894, p. 36. Norman, 1895, p. 10. Borgesen, 1895, pp. 236, 37. Ekstam, 1897, p. 145. Abromeit, 1899, p. 31. Ekstam, 1899, p. 22. Resvoll, 1900, figs. 7, 15, 19, 21, 24, 29, 34. Andersson & Hesselman, 1901, p. 47.

Alcohol material from Spitzbergen (Rendalen in Sassenbay, 15. 7. 1882); Greenland (Kororsuak, 19. 6. 1879; Sarfanguak (Holstenborg), 21. 7. 1884; Kappinilik, 5. 9. 1885; Christianshaab, 2. 7. 1888).

Ranunculus lapponicus is a perennial, creeping herb. The pale, horizontal stem which creeps in the moss dies away at the hinder end but keeps on growing sympodially by means of the principal bud situated in either the uppermost leaf-axil or the one below it. Above the principal bud the main axis becomes negatively geotropic, bends upwards, and produces a flower.

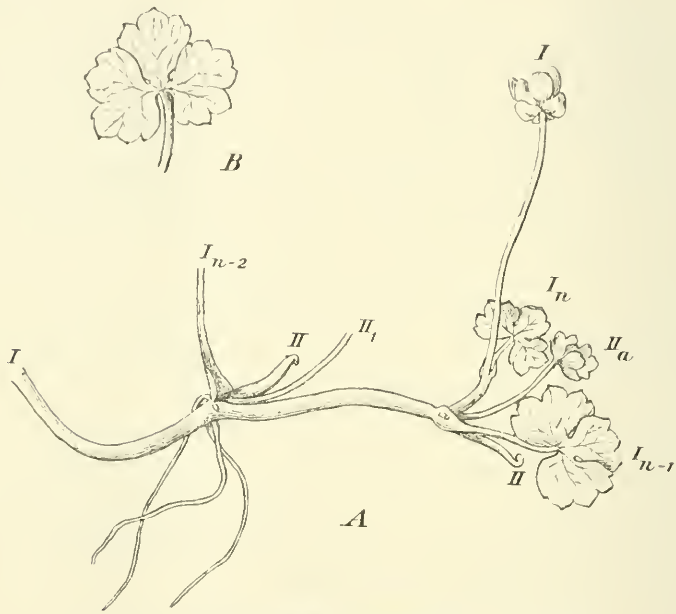

Fig. 41. *R. lapponicus.* (Spitzbergen; 15.7.1882).
A, (1/1). The flowering axis bears the leaves *In*, *In*-1, *In*-2; the last two subtend vegetative buds which bear the leaves *II*1 and *IIa*; the uppermost lateral axis may be regarded as a principal bud. *B*, A foliage-leaf (1/1).

The first stage of the plant is probably similar to that of *R. reptans*: a rosette of leaves upon a short vertical rhizome and a prostrate main axis which gives off roots from the nodes. This main axis no doubt soon becomes independent as the rosette dies, and then it continues its growth as described above. The filiform roots which arise from the nodes are usually unbranched and may be very long, as much as about

20 cm.; they are developed during the same year as the rhizome upon which they occur. The arrangement of the leaves is two-rowed; they are long-stalked, reniform and tripartite with 3—5 broad shallowly-lobed segments.

Usually only the principal bud develops. The first internode of the shoot is quite short, and the first leaf is dorso-lateral; the following internodes are elongated. The end of the shoot terminates in a hook formed by an unexpanded revolute leaf, the sheath of which surrounds the apex of the stem. This apex, in herbarium-specimens, is often seen directed obliquely downward. The horizontal rhizome may attain a length of as much as about 22 cm. In many of the individuals which I have had for examination the erect or ascending main and flowering axis bore a barren leaf (Fig. 41); Hooker (l. c.), records that in America this is the case only in specimens from the coast: this leaf is placed either high up upon the axis and is then bract-like, or else lower down and has then the form of the leaves upon the rhizome. The internode of this leaf is usually ascending and its anatomical structure is then similar to that of the flower-stalk; more rarely it is prostrate and similar in structure to the rhizome, roots being produced at the node. During fruit-setting the vertical axis elongates greatly (and reaches as much as about 16 cm.).

The flower has three green perigone-leaves which are somewhat downwardly bent in older flowers, and about seven nectary-leaves which are *Ficaria*-yellow in colour and glisten as with varnish and are only slightly longer than the perigone-leaves. The stamens are turned partly laterally and partly outwards. The ovaries are oval and somewhat flattened with a long hooked beak. The nectaries are simple and pocket-shaped (Fig. 42).

According to Warming's notes (Sarfanguak, 14. 7. 84) the carpels and the stamens ripen simultaneously, and as the latter stand closely against the former, self-pollination must easily take place. By bending inwards the anthers touch the stigmas and are often thrust entirely in between them, and the apices of the stigmas are often bent down outside the anthers. Ekstam found proterogyny-homogamy both in Nova Zembla and in Spitzbergen; he writes in 1897 that self-pollination is apparently impossible as the carpels are always higher than the stamens; but he finds (1899) that in Spitzbergen self-pollination easily takes place by the stigmas becoming bent spirally backwards at the time that the stamens open and bend inwards. In Greenland

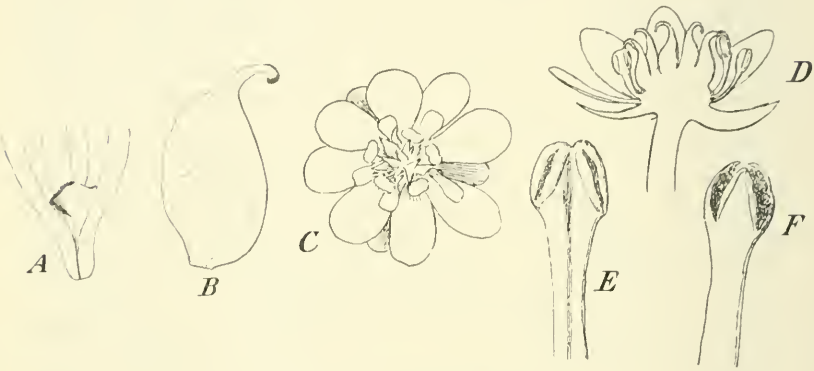

Fig. 42. *R. lapponicus.*

A, Base of nectary-leaf with nectary (Greenland; 6/1). *B*, Almost ripe carpel (Sarfanguak; 6/1). *C*, Flower seen from above (Sarfanguak; 12. 7. 1884; 5/2). *D*, Longitudinal section through flower (ibid.; 5/2); the anthers stand close to the stigmas. *E*, *F*, Stamens (10/1) seen from the outer side. (*C*, *D*, *E* and *F* were drawn by E. W.).

the diameter of the flower is 10—12 mm. (Warming); in Spitzbergen 8—10, sometimes 13 mm.; in Nova Zembla 5—8 mm., and in Arctic Siberia usually 12 mm. (Ekstam, 1897 and 1899). Ekstam found that the flowers had a strong perfume in Spitzbergen, but were scentless in Nova Zembla. Hartz (l. c.) records fragrant flowers from Egedesminde. No insect-visitors have been noticed. The plant flowers July-August; ripe fruit has not been found in Spitzbergen, but it is probably formed (Ekstam, 1899; Andersson & Hesselman l. c.). Ekstam did not find ripe fruit in Nova Zembla (1897).

The fruit may be dispersed perhaps partly by the agency of animals (epizoically) and partly by the agency of the wind.

I am not prepared to state anything regarding the germination. Hooker (l. c.) records that the species reproduces itself by gemmules; my material gave no information regarding this point. Vegetative propagation takes place by the separation of lateral axes.

R. lapponicus grows in marshy localities among moss (*Sphagnum*); it appears to be rather rare wherever it occurs.

Geographical Distribution: Arctic America and Labrador, West Greenland, Spitzbergen, northern Scandinavia, Arctic Russia, Nova Zembla and northern Siberia (Nathorst l. c.).

Anatomy. The roots are usually unbranched, long and filiform. Their internal structure is exceedingly loose. There are no differences in the roots of plants from the different localities. Both the epidermis and the exodermis are suberized; towards the apex of the roots the former has thin outer walls which have a tendency to collapse, but towards the base the outer wall is of the same thickness as the rest of the walls; the latter has slightly folded radial walls. No thickened outer portion of the cortex occurs; it is often entirely broken down with the exception of a few layers of the inner and the outer cortex and the trabeculæ which connect the two last and stand opposite to the woody parts of the central cylinder. The endodermis is suberized, at any rate in the upper part of the root. There are three wood masses which, in the older root, meet in the middle. No mycorrhiza has been found. The starch-grains are compound.

The stem consists anatomically of three parts: the internodes, the nodes and the flower-stalk. The first-mentioned are characterized by the vascular bundles (3—6) not anastomosing and being almost without stereom, and by the pith and cortical tissue being very much broken down by age, as in *R. hyperboreus.* The nodes are similar in structure to those of the rhizomes of the species with erect stems; the bundles anastomose and form a more or less complete ring around the pith; the latter and the cortex are less lacunose; the cells of the latter are somewhat tangentially elongated and there are more cortical layers than in the internodes. Roots arise from the nodes.

The flower-stalk, especially towards the time for the ripening of the fruit, is rather rich in stereom (Fig. 43). It is somewhat polygonal in transverse section. The cuticle is decidedly striped, and the stomata project above the surface. The cortex has large intercellular spaces. Each bundle (3—6) is surrounded by a sheath of stereom; there is strong fibrous tissue outside the leptome. Between the wood and the cambium there is a several-layered mass of wood-parenchyma with highly thickened walls, and between the vessels and the endodermis there is some non-lignified parenchyma. The interfascicular, lignified parenchyma is 5—6 layers thick and its walls are rather highly thickened. The pith in the peduncle is found partly broken down; its cells were slightly lignified. — The epidermal cells contain chlorophyll.

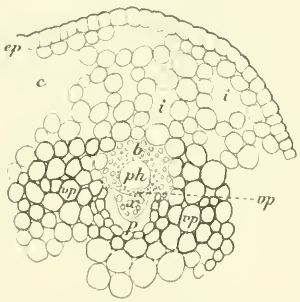

Fig. 43. *R. lapponicus.* Portion of transverse section of peduncle (Spitzbergen; $^{75}/_1$). *ep*, Epidermis; *c*, cortex; *i*, intercellular space; *b*, bast; *ph*, leptome; *x*, xylem; *p*, non-lignified parenchyma; *vp*, lignified parenchyma.

The leaf. The epidermal cells as usual, have only slightly thickened outer walls. The cells contain chlorophyll. Seen with the naked eye the leaf shows brown spots upon both surfaces: many of the cells of the epidermis being filled with brown juice, probably tannin (it did not, however, give the reaction with the iron-salts). The walls of the upper epidermis are slightly undulating and stomata are almost entirely absent; the walls of the lower epidermal cells are highly undulating (Fig.

44, *B, C*) and stomata occur in great numbers; Resvoll found 136 per sq. mm. The stomata are on a level with the surface. The epidermal cells above the larger nerves are elongated and have less undulating walls. The palisade-cells usually occur in two layers or else in only one, and are at most twice as long as they are thick; the layers, taken as a whole, constitute scarcely one-half of the thickness of the mesophyll. The individual cells are often irregular. The spongy parenchyma is loose in structure,

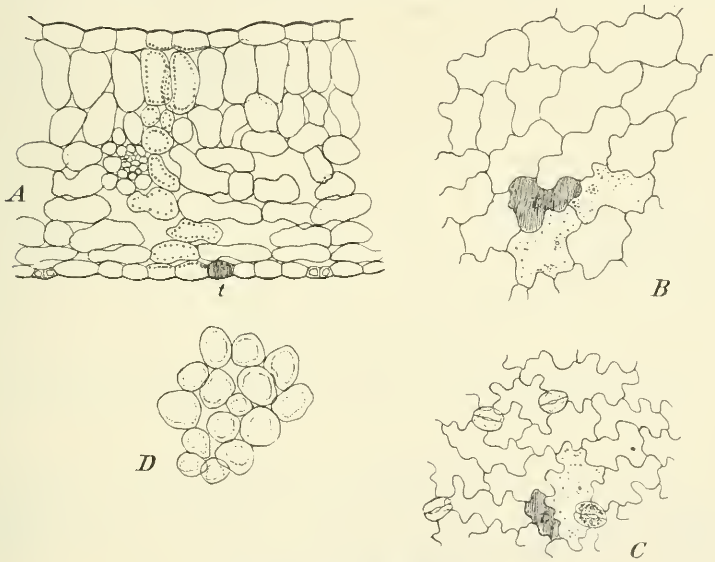

Fig. 44. *R. lapponicus.*

A, Transverse section of leaf (Sassenbay in Spitzbergen; $^{130}/_1$); *t*, brown-coloured cells probably containing tannin. *B*, The epidermis of the upper surface (Greenland; $^{96}/_1$); *t*, as in *A*. *C*, The epidermis of the lower surface (Greenland; $^{96}/_1$); *t*, as in *A*. *D*, Surface section of palisade-cells (Greenland; $^{130}/_1$).

its cells are slightly branched or polygonal (Fig 45, *A*), but the subepidermal layer consists of abundantly branching cells. There is a gradual transition from the form of the tissue of the upper to that of the tissue of the lower surface. The bundles are without stereom, but the larger ones among them upon the upper and lower surface are accompanied by elongated cells. Around each bundle there is a sheath containing chlorophyll.

In each leaf-apex there is an epithema which opens out almost at the margin, upon a slanting, upwardly-directed surface. The tracheids terminate in intercellular spaces and the cells of the epithema have short branches and undulating walls as in the other species (Fig. 45, *B*).

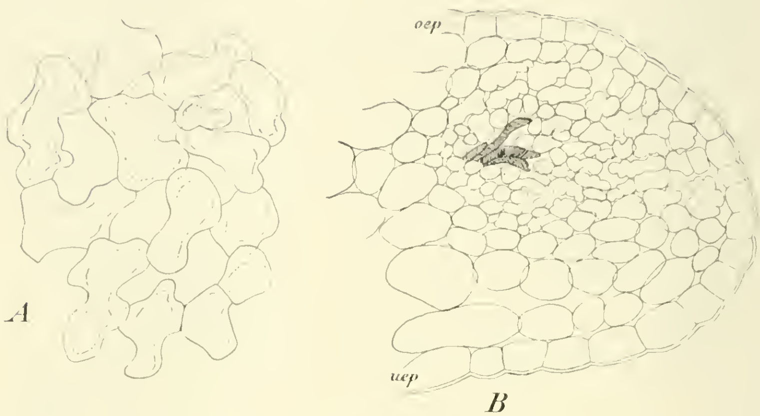

Fig. 45. *Ran. lapponicus.*

A, Surface section of spongy parenchyma (Spitzbergen; 183/1). *B*, Longitudinal section of a leaf-apex (Greenland; 180/1) showing the epithema and some tracheids.

The leaf-stalk has three vascular bundles, which are almost like those of the fruit-stalk in structure, but are somewhat weaker; the pith and the cortex are lacunose. The epidermis contains chlorophyll; the cuticle is furrowed.

R. Pallasii Schlecht.

and

R. lapponicus L. × *R. Pallasii* Schlecht.

Lit. Hooker, 1833. Nathorst, 1883, p. 21. Ekstam, 1899, p. 21. Andersson & Hesselman, 1901, pp. 42—47 (Figs. of leaf, leaf-anatomy, etc.).

Alcohol material from Spitzbergen. *R. Pallasii:* Advent Bay, 11. 8. 1882; the hybrid: Rendalen in Sassenbay, 15. 7. 1882.

The stem of *R. Pallasii* essentially agrees in structure with that described for *R. lapponicus.* The stem is rounded and somewhat inflated; in the horizontal portion stolons arise from the axils of the two-rowed, distant leaves; the first leaf of the shoot has often only a short internode. I do not think there is any true principal shoot. The uppermost leaf, which is smaller than the others upon the main axis, often subtends a horizontal stolon or, as in the herbarium-specimen, one with

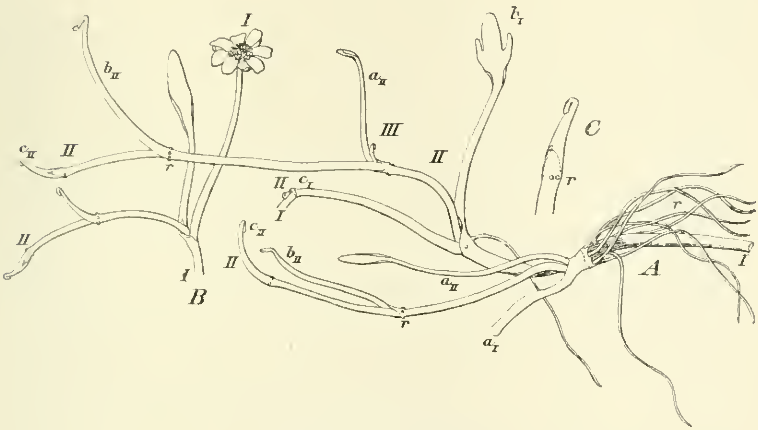

Fig. 46. *R. Pallasii.*

A. A specimen about $^2/_1$. The axes are indicated by Roman numerals *I, II, III*; the leaves by a_I, b_I, etc. a_{II}, b_{II}, etc.; C_I has been cut off. *B.* The upper part of a plant with a flower (about $^2/_1$). *C,* shows a young nutating leaf the sheath of which surrounds the apex of the shoot (about $^1/_1$).

a somewhat downward tendency, always shorter than those which proceeded from the lower leaves. The uppermost leaf may also subtend a floral-axis which bears a leaf without axillary flower. Adventitious roots arise within the nodes of the shoot during the first summer but as a rule they probably do not emerge until the next summer, when the shoot flowers (Fig. 46). It is not probable that the individual shoot-generations live more than two summers. The plant probably passes the winter in a similar manner to *R. hyperboreus.*

The different parts of the plant are often very long; thus the internodes, fruit-stalks and leaf-stalks measured as much as 14 cm.

Andersson & Hessselman (l. c.) have proved that the var. *Spitzbergensis,* established by Nathorst (l. c.), is a hybrid between *R. lapponicus* and the present species; it is the only hybrid known from Spitzbergen. In regard to the majority of the characters of this variety it is intermediate between the two parents, and Andersson & Hesselman have a long series of statements concerning such characters, as, for example, comparisons of the leaves, the lower ones of which in *R. Pallasii* are usually tripartite and the upper ones entire and lanceolate, while in the hybrid they are relatively broader and 5 or 3-partite. Again in *R. Pall.* the lamina almost continues the direction of the stalk; in *R. lapp.* it stands at an angle with the stalk; while the hybrid is intermediate in this respect.

The flower has three perigone-leaves; in *R. Pallasii* it has 7, or sometimes 6—8 white nectary-leaves, but in the hybrid there are usually 6 greenish-yellow nectary-leaves. The nectary-leaves are somewhat longer than the perigone-leaves. The diameter of the flower is usually 15 mm. in *R. Pallasii* and somewhat smaller in the hybrid. The nectaries are simple and pocket-shaped (Fig. 47, *A*). The flower in both has a strong perfume, according to Nathorst that of *R. Pallasii* is reminiscent of *Platanthera*. The flowers are proterogynous-homogamous in *R. Pallasii* according to Ekstam who has observed the visit of small Diptera. The carpels in *R. Pallasii* have an almost straight beak, the hybrid is intermediate in this respect between *R. Pallasii* and *R. lapponicus* with its markedly bent beak.

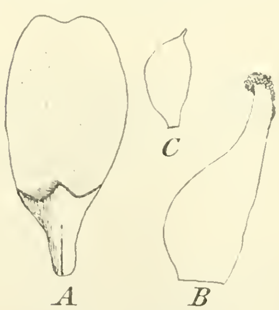

Fig. 47. *R. Pallasii.*

A Nectary-leaf (4/1). *B.* Carpel (11. 8. 1882; 3/1). *C.* Almost ripe fruit (Siberia; 18. 6. 1876; Herbarium-material; 1/1).

Flowering takes place in the middle and the end of summer; in Spitzbergen ripe fruit has not been observed (Ekstam, Nathorst); but it can certainly be developed in Siberia (Fig. 47, *C*). — *R. Pallasii* and the hybrid both grow in moss.

Geographical Distribution. The hybrid has been found in Spitzbergen only; *R. Pallasii* in Arctic America and Labrador, Spitzbergen, Arctic Finland, Arctic Russia, Nova Zembla and North Siberia (Nathorst).

Anatomy. The roots are often very long, filiform, and usually unbranched. Their structure is of the common type and the texture is exceedingly loose. The epidermis and the exodermis were suberized, the latter had undulating walls. A few layers of the cortex remained within the exodermis and a few outside the endodermis, also some slender, radiating trabeculæ. The endodermis was suberized, the walls were not thickened. The central cylinder was diarch. A few thin-walled root-hairs occurred. The starch-grains are compound, especially in the inner layers of the cortex. — I did not find hyphæ in the roots.

In *R. Pallasii* the internodes of the horizontal stem and the peduncle (in the flowering period) had a similar structure. The cortex was few-layered and had numerous large intercellular spaces (Fig. 48, *C*). The epidermis showed a slightly striped and indistinct cuticle, and the outer walls of its cells were thin; the latter contained some chlorophyll. The stomata were on a level with the surface. From seven to eight vascular bundles occurred; in the peduncle they were surrounded by a somewhat greater amount of close-set parenchyma than in the internodes of the stolon. The specimens examined contained neither bast nor lignified parenchyma, but perhaps these are developed in the peduncle during the ripening of the fruit when it stands stiffly erect (herbarium-material). The bundles are arranged very excentrically in the thick stem, and the whole of the pith is broken down (Fig. 48, *B*).

The nodes of the stem resemble in structure those of *R. lapponicus*. The roots no doubt remain a long time within the epidermis of the parent-rhizome; they showed distinctly plerome, periblem and dermocalyptrogen. (Fig. 48, *A*).

R. Pallasii and *R. lapponicus* differ in the structure of their peduncles (see Fig. 43); also in this point the hybrid is intermediate; the young plant in the flowering stage which I investigated had no interfascicular stereom, but a weak fibrous tissue outside the leptome; upon the inner side of the bundles the endodermis was lignified.

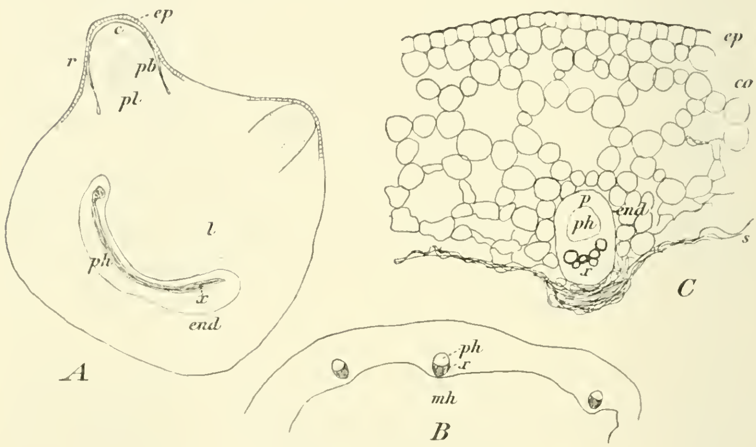

Fig. 48. *R. Pallasii.*

A. Transverse section of a node of a stolon (17/1). *B*. Portion of transverse section of stolon (17/1). *C*. Piece of the same (75/1); *ep*, epidermis; *c*, calyptra; *co*, cortex; *r*, young root; *pb*, periblem; *pl*, plerome; *ph*, leptome; *x*, xylem; *l*, lacuna; *p*, non-lignified parenchyma; *s*, collapsed tissue; *mh*, pith-cavity.

The leaf is glabrous in *R. Pallasii* and somewhat fleshy; the thickness varied between 340 and 510 μ. It has brown spots especially upon the upper surface, as the epidermal cells probably contain tannin as in *R. lapponicus* (see p. 403); the epidermis also contained chlorophyll and the outer walls of its cells were about 3 μ thick; the radial walls were somewhat undulating, almost equally upon both surfaces. The stomata were on a level with the surface or projected slightly, about

50 were found per sq. mm. upon both surfaces; they were somewhat unevenly distributed. Cells containing tannin occurred to the number of about 35 per sq. mm. upon the upper surface, and were also unevenly distributed; upon the lower surface only a few occurred.

The leaves of *R. Pallasii* which were investigated had two

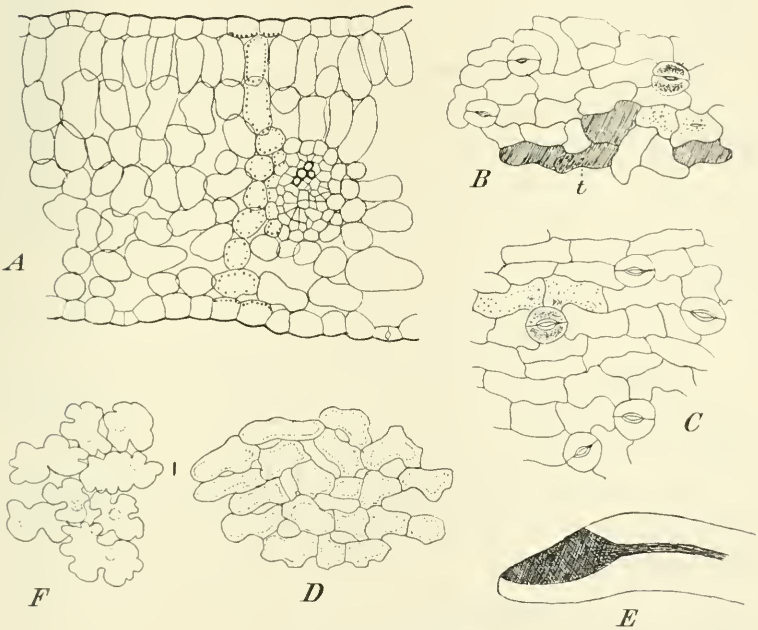

Fig. 49. *R. Pallasii.*

A, Transverse section of leaf ($^{100}/_1$). *B*, Epidermis of the upper surface of the leaf ($^{85}/_1$); *t*, cells the contents of which are probably tannin. *C*, Epidermis of the lower surface of the leaf ($^{85}/_1$). *D*, Surface section of spongy tissue ($^{85}/_1$). *E*, Longitudinal section through the leaf-apex, showing the position of the epithema ($^{17}/_1$). *F*, Cells of the epithema with *nuclei* ($^{220}/_1$).

palisade-layers which constituted from $^1/_2$ to $^1/_3$ of the thickness of the mesophyll; the individual palisade-cells were irregular, about twice as long as they were thick, and only slightly inclined towards the leaf-apex. There was a gradual transition to the spongy parenchyma; the cells of the latter were shortly branched or stellate, and as usual, those of the subepidermal layer more strongly so than the rest. (Fig. 49). The bundles were found to be surrounded by a sheath containing chlorophyll; stereom was absent; the palisade-layers continued unaltered across them.

At the leaf-apices an extensive epithema was found, consisting, as in the other species, of shortly branched cells with undulating walls. The water-pores open upon an oblique, upwardly-directed surface upon the leaf-apex (Fig. 49, *E*, *F*).

The transverse section of the leaf of the hybrid is figured by Andersson & Hesselman together with that of the leaf of the parents; also in this point the hybrid is intermediate.

The leaf-stalk of *R. Pallasii* closely resembles the stem in structure and the transverse section is almost circular in outline.

Batrachium confervoides Fr.

Synonyms: *B. paucistamineum δ. eradicatum* (Læst.). *R. aquatilis* v. *eradicata* (Læst.). *R.* paucistam. δ. confervoides* Tullb. *R. paucistam.* v. *borealis* Beurl.

Lit. Gelert, 1894, p. 28. Norman, 1895, p. 33. Rosenvinge, (III), 1896, p. 240. Kruuse, 1897, p. 385. Dusén, 1901, p. 29. Porsild, 1902, p. 206.

Alcohol material from Greenland (Sophiehavn 5. 6. 8. 1883), Iceland, (Nallanes, 10. 1. 1894).

This species is like the majority of the species of *Batrachium* a perennial, herbaceous water-plant with branching stems which creep upon the mud at the bottom of the water and send up to the surface in the spring long, filiform, branching shoots. *Batr. confervoides* has only finely-divided, stalked leaves, arranged in a $^2/_5$ spiral; the shoot becomes sympodial when flowering begins. The peduncles are of the same length as the leaves; they bend backwards during fruit-setting. Long, slender, adventitious roots, unbranched in places, arise from the nodes of the erect shoots.

The flower has five perigone-leaves and five white nectary-leaves which are about twice as long as the perigone-leaves; the nectary-leaves have a yellow claw, and bear a tubular cornet-shaped nectary (Fig. 50, *A*). There are 6—10 stamens, which are longer than the head of carpels. The fruits are wrinkled and hairy, and almost without a beak. Of the flower-buds, in the material from Iceland (Jan. 10) which has been investigated, the lower and older ones had partially-barren stamens, while no such stamens were observed in the upper buds. The diameter of the flower is 3—5 mm. (Greenland). As far as I know, no observations on the flower-biology of the species have been published, but as other species in the genus it is probably homogamous.

The flowering period in Arctic Norway is from the beginning of July to the middle of September, and ripe fruit was observed in the middle of August (Norman).

The fruit is probably dispersed by the agency of the water (cf. Kolpin Ravn, Bot. Tidsskr., XIX).

The fruits of other species of *Batrachium* are capable of germinating during the year in which they ripen (Gelert, Sylvén, 1906, p. 279), and in Scandinavia the seedlings pass the winter in a green condition.

Batr. confervoides grows, by preference, in small pools and in rills, no doubt usually in shallow water; but Kruuse (l. c.) found it at Egedesminde in West Greenland growing in a depth of as much as 3 m., and found that it sets fruit but rarely in water shallower than 1·5 m. Porsild (l. c.) saw it in Disco in water not shallower than 30 cm. and especially in the neighbourhood of large boulders and then always upon the side most exposed to wind and water. In Arctic Norway it does not appear to regard the temperature of the water, as it sets ripe fruit both in streams with affluents from snowy mountains and also in water with a relatively high temperature (Norman).

It can survive getting dry during summer (Rosenvinge, Norman); in such cases its leaf-segments become oval in transverse section.

This species appears to occur especially frequently in Greenland, Iceland, northern Scandinavia and Finland (Gelert).

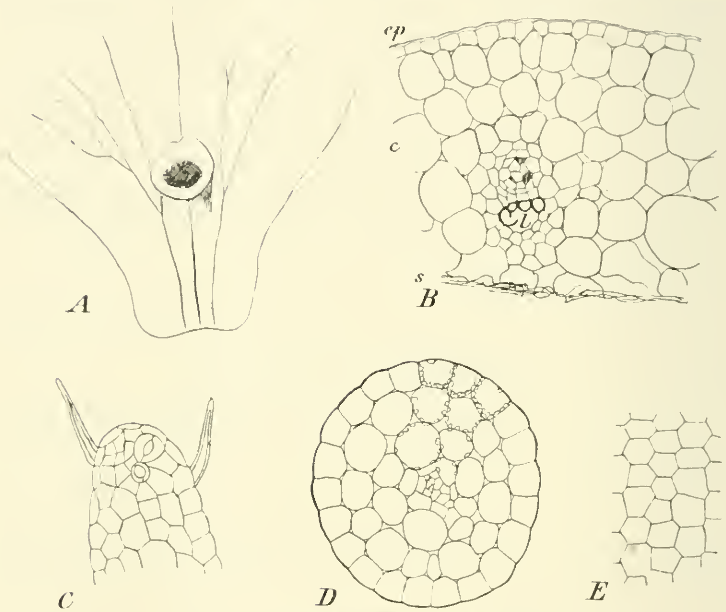

Fig 50. *Batrachium confervoides.*

A, Base of nectary-leaf with nectary (Greenland; $^{12}/_{1}$). *B*, Portion of the transverse section of a stem (Iceland; $^{120}/_{1}$). *ep*, Epidermis; *c*, cortex; *l*, lacuna; *s*, collapsed tissue. *C*, Apex of leaf with hair and water-stomata (Iceland; $^{140}/_{1}$). *D*, Transverse section of segment of an aquatic leaf (Iceland; $^{170}/_{1}$). *E*, The epidermis of an aquatic leaf (Iceland; $^{120}/_{1}$).

Anatomy. The adventitious roots which arise upon the ascending stems resemble in structure those of the examined species of *Ranunculus*. The epidermis and the exodermis are suberized; the former shows a tendency to collapse, the latter has slightly-undulating radial walls. The greater part of the coxtex breaks down at an early stage. The endodermis is suberized. The central cylinder is diarch; the woody masses are not in contact with each other. — Mycorrhiza was absent.

I have only had material of ascending stems for investigation. With the exception of some small modifications their structure resembles that of the examined species of *Ranunculus*. The cells of the epidermis are much smaller than those of the cortex; as many as seven layers of the latter occur and they are somewhat more closely placed than are the cortical cells in those species of *Ranunculus* which have been investigated (Fig. 50, *B*). The 3—5 bundles are each surrounded by an endodermis which is slightly lignified in the older stems. As is also the case in other species of *Batrachium* the woody mass in the bundle frequently encloses a large air-space, produced by the breaking down of young vessels; remnants of the walls are often seen projecting into the space. In the material from Iceland (January) these canals had just begun to develop in a young internode which was nearly one cm. long. The continuous pith-cavity which occurs in full-grown stems had not yet begun to develop in the internode in question.

The leaves resemble in structure the divided leaves of other species of *Batrachium*; the segments of the aquatic leaves are cylindrical with an axial bundle surrounded on all sides by a few layers of homogeneous, elongated non-prosenchymatous cells (Fig. 50, *D*). The epidermis contains a larger quantity of chlorophyll than the inner layers; the radial walls of its cells are straight. Only one or two stomata occur at the apex of the segments (Fig. 50, *C*); they resemble in form the water-stomata figured for *R. nivalis.* The apex of the leaf usually bears 1—4 hairs; but sometimes these are absent.

When the plant becomes dry during summer (cf. Rosenvinge) it develops, in common with other species of *Batrachium*, leaves which in form and certainly in internal structure differ from those of the aquatic form (cf. Askenasy, Bot. Zeitung, 1870). Such leaves were not found upon the Arctic specimens which I have had for investigation; but a land-form of the nearly-related *Batr. paucistamineum* (Tausch) Gelert, from Denmark, exhibited the following structure: The leaf-segments had become oval in transverse section; there was only one bundle, but the tissue on its upper side and partly also beside it had developed into 1—2 palisade-layers, of which some individual cells were about twice as long as they were thick; upon the under side of the bundle the cells were more like those of the aquatic leaf. Moreover, intercellular spaces were more abundantly present in the mesophyll than in that of the aquatic leaves. The radial walls of the epidermis were undulating and the upper surface had as many as 80 stomata per sq. mm. while many fewer (about 10 per sq. mm.) occurred upon the lower surface. The Danish land-form had retained some chlorophyll in its epidermis. The land-form had retained the water-pores at the apex of the leaves.

Anemone Richardsoni Hook.

Lit. Hooker, 1833. Lange, 1887. Janczewski, 1898, p. 507.

Alcohol material from Præstefjæld (Holstenborg), West Greenland, 1884, and 4.8.1886.

This species, like *A. nemorosa*, is a perennial herb with a horizontally elongated rhizome which becomes sympodial when flowering begins. The principal bud is subtended by the last leaf (Fig. 51, *A*). The rhizome may become very long (20 cm.), and the length of the internodes is usually 1—3 cm.; they are about 1·5 mm. thick. The present species differs from *A. nemorosa* not only in regard to the rhizome but also as regards the leaves, the majority of them being foliage-leaves; Janczewski writes "all" but a specimen in the herbarium shows one scale-leaf distinctly. The rhizome can produce at least four foliage-leaves during one summer; they are long-stalked and the lamina is deeply 3-lobed with ovate, deeply-indented segments.

The principal bud may produce leaves during the first year, but I do not think it does so always, the first leaf is placed laterally in reference to the subtending leaf; the bud in question may attain the flowering stage the same year as the parent-axis. In the herbarium-specimens, the second flowering

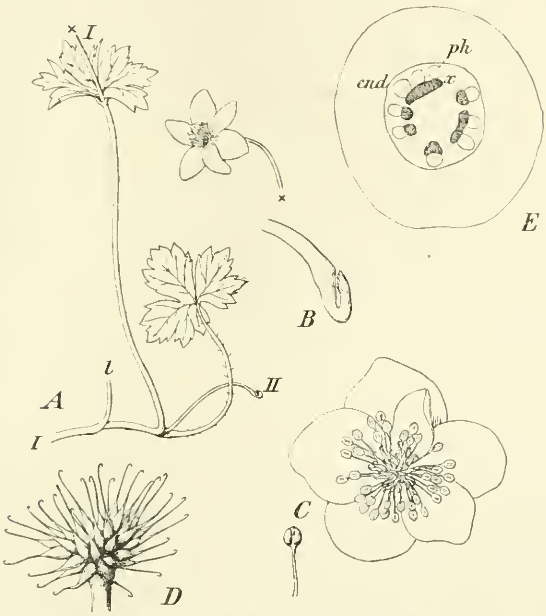

Fig. 51. *Anemone Richardsoni.*

A, A fragment of a plant from Præstefjæld; 16. 7. 1884; 1/2. The flower has been cut off and placed by the side. The upper foliage-leaf subtends the principal bud of which the growth begins with an elongated internode; *l*, basal part of the stalk of a foliage-leaf. *B*, The apex of a rhizome with a nutating leaf, the sheath of which surrounds the tip of the shoot (5/2). *C*, Flower seen from above (3/2). The perianth leaves are of unequal size; a stamen is placed by the side of the flower (5/2). The anthers are turned inwards. *D*, Cluster of fruits, almost ripe (2/1). *E*, Transverse section of rhizome (17/1); *end*, endodermis; *ph*, leptome; *x*, xylem (*A*, *B*, *C*, *D* were drawn by E. Warming).

axis on such individuals had a foliage-leaf which subtended the rejuvenating shoot. Also other leaves than the uppermost one may subtend shoots which are very similar to the principal bud. — The slender, branched, adventitious roots arise from the rhizome a short distance below each node.

The erect peduncle attains a height of from 5 to 20 cm. and bears a tripartite involucre which, when flowering begins, is seated above the middle of the peduncle, but is considerably below that point when the fruits are ripe, the upper part of the axis having elongated greatly. The peduncle is somewhat hairy, the hairs being most dense upon the upper part.

The flower has 3 + 3 yellow perianth-leaves, sometimes 4 + 4, and the leaves in the whorl are of unequal size (Fig. 51, *C*). In the expanded flower the filaments are bent outwards towards the perianth-leaves, the anthers are introrse. At first the long backwardly-turned styles are erect, but afterwards, they probably become so far turned outwards that they can reach the anthers. The diameter of the flower is 19—22 mm. Honey is absent. (Warming, notebook).

Flowering begins at the end of June and is continued into August. The fruits may certainly be dispersed epizoically, as the styles of the carpels are long (about 4 mm.) and hooked at the apex (Fig. 51, *D*).

In Greenland it has been found only at Holstensborg and Sukkertoppen; it grows there in damp places in willow copses. It is morever found in arctic and subarctic America from Hudson's Bay to Alaska, Rocky Mountains, Unalaschka, East Siberia (Lange).

Anatomy. The roots are slender and branching; they remain in the primary condition. In their anatomy they greatly resemble those of *A. nemorosa*. The epidermis is suberized; its outer wall is fairly thick, and highly convex. The cortex is 5-layered and compact in structure with very small intercellular spaces, the walls of the cells are fairly thick. The starch-grains in the cells are both single and compound. The cells of the endodermis are tangentially elongated, the walls are somewhat thickened and are corky: the pericycle is one-layered. The central cylinder is diarch, in the larger roots the woody parts meet in the middle. In the more slender roots the epidermis is collapsed.

Mycorrhizas are present; the hyphæ form balls in the inner cortical cells.

The rhizome (Fig. 51, *E*) is rounded, and in its anatomy bears resemblance to that of *A. nemorosa*, but it is not so decidedly modified to contain reserve food-material. The epidermis is not especially thick-walled; the cortex is compact in structure, the intercellular spaces are not large. Concentric with the epidermis and about midway between it and the centre of the rhizome is an endodermis which when young shows Caspary's dots. From five to ten bundles are arranged in a ring; the woody parts which have large vessels are often more or less fused together. Their number then may be ascertained from the leptome-groups, which occur isolated from each other. The pith is not broken down. The starch-grains are highly compound.

The peduncle has about 12 bundles which in the young stalk are devoid of stereom, but in the older fruit-stalk, have about four layers of fibrous tissue outside the leptome and a fairly definite, interfascicular lignified ring of about five layers with somewhat thickened walls. Between the vessels and the sieve-tissue a little wood-parenchyma is found and on the inner side of vessels occurs a considerable amount of small-celled, slightly collenchymatously thickened parenchyma, which is bounded internally by an endodermis-like layer which abuts upon the somewhat large-celled and more or less broken-down pith. — The cortex consists of 6—7 layers and is looser in structure than that of the rhizome; in the outer part there are tangential schizogenous lacunæ. The cells of the epidermis have but slightly thickened outer walls and a smooth cuticle; they contain some chlorophyll. The stomata are on a level with the surface or else project slightly; the hairs are unicellular, slightly suberized and often excentrically thickened.

The leaf is slightly hairy along the margin and bears, scattered on both surfaces, pointed hairs the walls of which are thickened; there occur in addition small club-shaped, thin-walled hairs, rich in contents, but far fewer in number (compare *R. acer*) (Fig. 52, *B*). The cells of the epidermis contain some chlorophyll and have undulating radial walls, which are however more or less straight above the larger nerves. Only very few stomata occur upon the upper surface, but upon the lower surface there are, on an average, about 40 per sq. mm., either

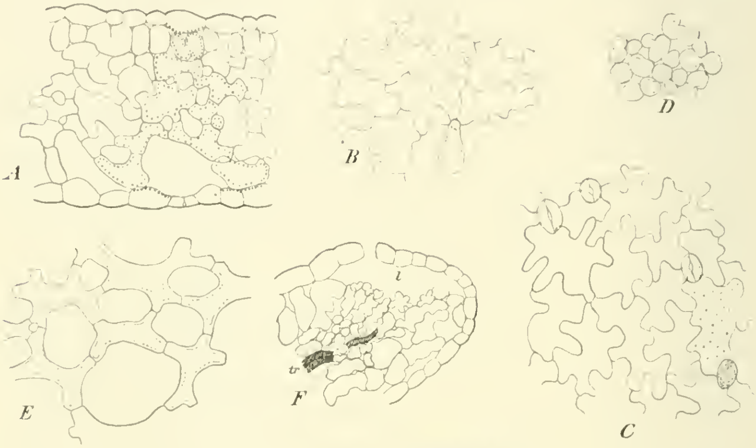

Fig. 52. *Anemone Richardsoni.*

A, Transverse section of leaf. *B*, The epidermis of the upper surface with a club-shaped hair. *C*, The epidermis of the lower surface. *D*, Surface section of palisade-cells. *E*, Surface section of spongy parenchyma. *F*, Longitudinal section through the apex of a leaf; *l*, a lacuna between the epidermis and the epithema; some tracheids are seen, *tr*. (*A*, *B*, *C*, *D*, *E*, $^{105}/_{1}$; *F* $^{90}/_{1}$).

on a level with the surface or slightly projecting; they are not evenly distributed and the apertures do not lie in any fixed direction. The palisade-layers constitute only a small part of the mesophyll, the majority of their cells have incomplete walls (Fig. 52, *A*). The spongy parenchyma consists of abundantly branching cells and is very loose in structure. The bundles are surrounded by a sheath containing chlorophyll, and the larger ones have conducting-parenchyma upon their upper and lower surface.

The larger teeth of the leaf contain an epithema which opens almost at the margin and of which the cells have undulating walls (Fig 52, *F*).

The leaf-stalk is hairy like the peduncle. The epidermis contains chlorophyll and is thin-walled. The cortex has numerous tangential schizogenous lacunæ. There are three bundles which upon the outer side have about three layers of fibrous tissue; their structure is otherwise almost entirely like that of the bundles of the flower-stalk. Interfascicular stereom is absent. The pith is more or less broken down.

Thalictrum alpinum L.

Lit. Lecoyer, 1878, p. 9, pl. III. fig. 28. Lindman, 1887, pp. 18, 44, 101. Lange, 1888, p. 53. Rosenvinge, (I), 1892, p. 675. Borgesen. 1895, pp. 236, 37, fr. res. p. 7. Hartz, 1895, (II), p. 289. Norman, 1895, p. 37. Ekstam, 1897, p. 148. Cleve, 1901, p. 50. Dusén, 1901, p. 29. Skottsberg, 1901, p. 16. Freidenfelt, 1904, pp. 49, 50, pl. III, fig. 38.

Alcohol material from Sweden (Jemteland, 6. 8. 1881); the Færöes (Kirkebö); Iceland (Havnefjord, 4. 7. 1894, unknown loc., 15. 5.); Greenland (Kobbefjord, 29. 6. 1884, Godhavn, 26. 7. 1884).

This plant, as also *Coptis trifolia*, has a subterranean rhizome which is horizontal or somewhat slanting, is slender, has elongated internodes and bears scale-leaves in a spiral. This rhizome will afterwards bend upwards with its apex; its internodes will become short; it will pass the winter with a bud covered with scale-leaves which will next spring produce one or several long-stalked foliage-leaves. Perhaps the axis may develop further and produce an inflorescence. The flowering axis often bears halfway up a short-stalked foliage-leaf of the same nature as the basal leaves. Small oval bracts subtend the flowers in the racemose inflorescence (Fig. 53, *A*). The principal bud occurs in the axil of one of the basal leaves, and the structure of the shoots is consequently sympodial. The majority of the flowering individuals in the alcohol material examined by me had only basal leaves and short internodes in the rosette of the leaves, of these the one next below the uppermost subtended the principal bud. The subtending leaf was either a scale-leaf or a foliage-leaf with a large sheath. Upon the other flowering individuals the uppermost basal-leaf was preceded by a somewhat elongated internode. Perhaps the principal bud is really subtended by the uppermost basal leaf upon individuals whose aerial stem bears a median foliage-leaf; this leaf may subtend an inflorescence similar to that of the parent-axis.

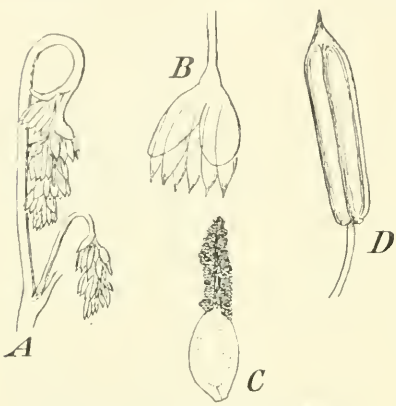

Fig. 53. *Thalictrum alpinum.*
A, Young inflorescence (Kobbefjord; 29.6.1884; about 8/1). *B*, Flower which has not yet expanded (ibidem; about 10/1). *C*, Carpel from expanded flower (Jemteland: June, 1881; about 12/1). *D*, Stamen (Kobbefjord; 29.6.1884; about 20/1). (*A*, *B* and *D* were drawn by E. Warming).

The rejuvenating shoot develops a rosette of foliage-leaves during the same year as that in which the parent-axis flowers, and produces during autumn a winter-bud protected by scale-leaves. The leaves are long-stalked and pinnate or bipinnate, with opposite, stalked primary segments, and broadly ovate, glistening, glabrous leaflets that are bluish-green upon the lower surface and of which the edges are revolute.

The vertical part of the rhizome, may, in addition to the principal bud, also produce other ascending rosette-shoots and scale-bearing rhizomes; some however are met with that bear foliage-leaves upon elongated internodes, probably due to the fact that the rhizome has been lying close to the surface. The horizontal rhizome may give off branches. From the vertical rhizome arise strong, brown, branching roots, the cortex of which is wrinkled and rough on account of the secondary growth;

from the horizontal part of the rhizome only slender roots arise.

The numerous stamens protrude far beyond the four closely placed, delicate perianth-leaves (Fig. 53, *B*), the colour of which varies somewhat from yellow to violet or greyish-red to grey-green. The stamens have usually violet filaments and brownish-yellow anthers.

Axell (1869) found *Thalictrum alpinum* to be homogamous, Lindman and Ekstam (l. c.) protogynous-homogamous. Lindman thinks that it is especially during the homogamous stage that the stigmas receive pollen, as they are covered by the far-protruding stamens and the bell-shaped perianth. Warming (notebook) found no honey in Greenland specimens. No pollinating agents have been observed; the plant is anemophilous (Lindman, Warming, notebook).

Lecoyer figures anthers of *Thalict. alp.* from the different habitats of the plant and finds great variation in their length as well as in that of the elongation of the connective of the anther; for instance, according to him, there is a great difference between the anthers from Norway and those from Lapland. In the material at my disposal they all resembled the one which I have figured from Kobbefjord in Greenland (Fig. 53, *D*); in specimens from Arctic Russia the stamens were however somewhat smaller and the connective was somewhat longer and more pointed.

Thalict. alpinum flowers in July and the fruit ripens in August. Lindman (l. c. p. 101) found fruit with seed capable of germination at a height of 900 m. — The fruit is dispersed by the agency of the wind, according to Ekstam (1897).

In Arctic Norway *Thalictrum alpinum* is found both in the lowlands and the highlands, on horizontal ground and on slopes; it is about twice as common upon the sunny side as upon the indifferent and shady sides; it can grow in pools and can live with plants which overshadow it (Norman). In Nova Zembla it grows upon dry slopes (Ekstam).

Geographical Distribution. Arctic America, East and West Greenland, Iceland, the Færöes, Scandinavia, Finland, the Alps, Caucasus, Arctic Russia, Nova Zembla, North Siberia, Altai and Asiatic coast of Bering Strait.

Anatomy. The adventitious roots of the first order. The primary cortex is thrown off or else persists as dead layers around the secondary formation. In a young root from Iceland, gathered in May, tangential lacunæ had been developed between the endodermis and the primary cortex, the outer layer of which was somewhat collenchymatously thickened, while the epidermis was thin-walled and corky. The secondary cortex resembled the primary in the fact of its outer layers being also somewhat collenchymatous; the inner layers were thin-walled and distinctly radially arranged. The thin-walled endodermis had replaced the primary epidermis; its cells were tangentially elongated. The central cylinder is triarch or tetrach or according to Marié, even pentarch or hexarch: the secondary vessels were larger than the few primary ones. The cambium was complete.

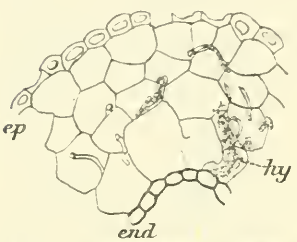

Fig. 54. *Thalictrum alpinum.* Fragment of transverse section of root of second order (Iceland: Havnefjord; 45/1). *ep*, Epidermis; *hy*, hyphæ; *end*, endodermis.

The roots of the second order remain in the primary condition and are diarch. The endodermis is slightly thickened. The cortex consists of four thin-walled layers, of which the innermost is the largest. The epidermis is remarkable owing to the fact that it is dimorphic (Fig 54); it is partly of thin-walled cells which collapse at an early period, and partly of cells of which the walls thicken at an early period (Freidenfelt). These roots contain spongy hyphæ.

The rhizome, also, has secondary growth. The youngest stage of a horizontal one which I observed had from one to a few vessels in the eight masses of wood, and an incomplete ring of sclerenchyma, no doubt outside and also including the endodermis, but the latter was not distinct. A later stage showed the ring of sclerenchyma 1—3 layers thick, in a complete condition; still later, the thin-walled primary cortex, 5—6 layers thick, was found to be collapsed, and in the full-grown stage it had been thrown off together with the sclerenchyma-layer. The epidermis is one-layered and thin-walled. The secondary cortex has on the outside some layers of dead, suberized cells, and within these a somewhat collenchymatously thickened part; the innermost part is thin-walled and the cells are arranged radially.

The wood-masses are either fused together or are separated by narrow medullary rays from which cambium is absent: otherwise the latter is complete. The cells of the pith are thin-walled and more or less collapsed in the older rhizomes. The structure of the vertical part of the rhizome was similar to that of the horizontal part, only it was thicker, the course of the bundles was irregular and thin-walled parenchyma was more abundant among the secondary vessels.

The peduncle is short and thick and pentagonal. The epidermis is fairly thick and contains chlorophyll; the cuticle is smooth, and the stomata are on a level with the surface. The cortex is 5—6 layered and consists of fairly closely placed cylindrical cells; intercellular spaces are absent between the subepidermal layer and the epidermis. In the outermost layers in the angles of the peduncle, only very little or no collenchyma occurs; such a tissue is found in other species of *Thalictrum*. Outside the 7—10 bundles there is a ring of bast which, opposite to the bundles, is as much as 7 layers thick while in the interfascicular part about three layers are found: the sieve-tissue occurs close to the bast-layer; in the adult peduncle no endodermis was to be seen; the cambium is rudimentary. On the inner side of the vessels, which are arranged as a V or in 2 lateral masses separated by thin-walled parenchyma, some small-celled parenchyma occurs, easily distinguishable from the large-celled pith; the latter was broken down in the older stems, leaving a pith-cavity.

The leaf is less hydrophilous in structure than are those of the previous species. Hairs are absent. The epidermis of the upper surface is about 28 μ thick, while that of the lower surface is about 17 μ, and it is almost entirely devoid of stomata; its radial walls are somewhat undulating, and the cells are homogeneous. The cells of the lower surface, on the other hand, vary more in form; most frequently the radial walls are undulating, almost like those of the upper surface, but they may also resemble those shown in Fig. 55. *C*, and the difference does not appear to have any connection with the number of the stomata; the number varies greatly, and numbers between 280 and 420 per sq. mm. are the most common. The stomata are on a level with the surface; their direction is not fixed; they occur only between the larger veins and not above them. The epidermis contains a little chlorophyll. The radials walls of the lower surface are furnished with pores.

The bundles are situated nearer to the lower surface, the larger ones, both upon the upper and lower surface, are accompanied by stereom which extends to the epidermis of both surfaces; the smaller bundles either have a little bast upon their under sides or are only provided with a sheath in which chlorophyll occurs, especially along the outer walls.

The palisade-cells are in 2—3 compact layers which constitute about $^1/_2$ or $^2/_3$ of the mesophyll; the quota of the palisade-cells is about $^1/_3$; there is a somewhat abrupt transition from the palisade to the spongy parenchyma, the rather small cells of which were somewhat branched and loosely connected (Fig. 55 *A*, *D*).

The specimens from Iceland differed somewhat from the others which were investigated, in that the leaves were somewhat less thick (about 210 μ against about 280 μ from Greenland and Scandinavia) and there were only two palisade-layers, while those from Greenland and Scandinavia had three layers. The leaves from the Færöes, which have been investigated, resembled those from Iceland.

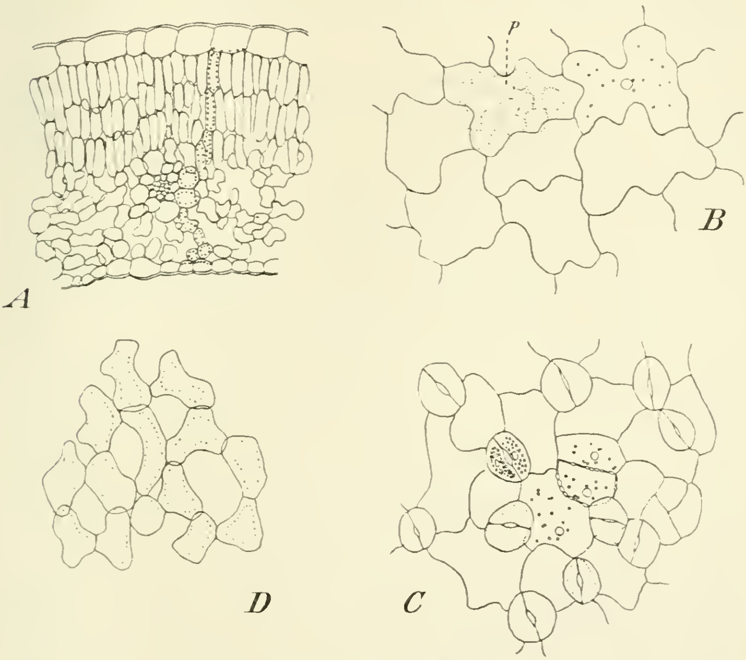

Fig. 55. *Thalictrum alpinum.*

A, Transverse section of leaf (Godhavn; $^{90}/_{1}$) *B*, Epidermis of the upper surface (Havnefjord; $^{230}/_{1}$); *p*, palisade-cells. *C*, Epidermis of the lower surface; (Godhavn; $^{230}/_{1}$); the perforation of the wall has been drawn only in one cell. *D*, Surface section of spongy parenchyma (Godhavn; $^{230}/_{1}$).

The leaf-stalk is obtusely square in transverse section. The ring of sclerenchyma and the four large and four small bundles resemble in structure the corresponding parts of the stem. The epidermis contains chlorophyll and the cuticle is slightly striped. The cortex consists of 4—6 layers. The pith is large-celled and not broken down.

All the specimens which have been investigated from the different districts, with the above-mentioned exceptions, were found similar in structure.

Coptis trifolia Salisb.

Lit. Hooker, 1833. Marié, 1885, pp. 103—105. Lange, 1887. Maxwell, 1893, p. 100. Rosenvinge, (I), 1892, p. 677; (II), 1896, p. 67.

Alcohol material from Greenland (Julianehaab, 20.6.1883, Nuluk 23.6.1883, Friedrichsthal, 29.8.1883, Kobbefjord, 28.6. 1884, Sukkertoppen, 16.8.1884, and 15.7.1895, Godthaab, 20.7.1895, Frederikshaab, 8.7.1892).

Coptis trifolia is a perennial herb with subterranean, horizontal rhizome and evergreen leaves. The horizontal rhizome is yellow and slender, has elongated internodes and bears scale-leaves arranged in a spiral. The length of an internode is about one cm., and the rhizome may attain to a considerable length (about 20 cm.). The scale-leaves often subtend lateral shoots of the same kind as the parent-axis. The slender, branched roots arise especially from the nodes. After the horizontal rhizome has developed scale-leaves for some time, it produces short internodes and foliage-leaves and the axis becomes an ascending one. After this, foliage-leaves alternate with scale-leaves so that the first leaves which the shoot develops in the summer are foliage-leaves (probably at most four) and the next scale-leaves also separated by short internodes; the scale-leaves protect the bud which remains throughout the winter, and the next spring the bud recommences the growth with foliage-leaves, etc. The usually solitary flower is terminal upon a penduncle which bears a bract; sometimes the bract subtends a flower. I have found the length of the peduncle to be from 2 to 12 cm.; it is scarcely probable that it grows much during the time of fruit-setting.

The uppermost scale-leaf subtends the principal bud

Fig. 56), but other scale-leaves may also subtend shoots. The first leaves upon the shoots are foliage-leaves, and they develop during the same year as the flower of the parent-axis; the first two are lateral, while the others (foliage-leaves and scale-leaves) follow in a spiral, those scale-leaves which develop last protecting the bud for the next year. The principal bud frequently flowers the same year as the parent-axis, and in

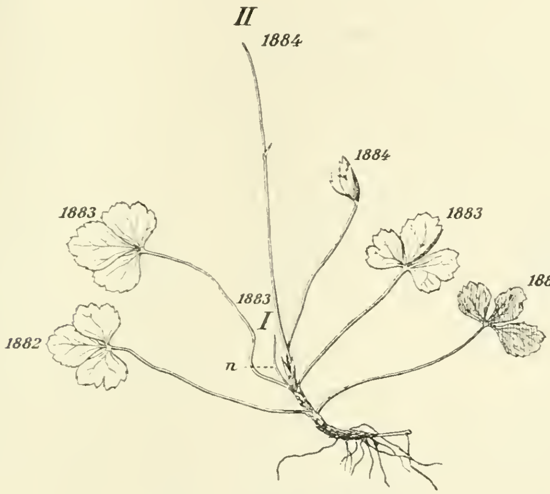

Fig. 56. *Coptis trifolia.*

(Sukkertoppen: 10. 8. 84 1/2). The two lowermost leaves were developed in 1882, after which scale-leaves were developed; the shoot I flowered in 1883; the uppermost scale-leaf on axis I subtended axis II, of which the foliage-leaves were developed in 1883; the shoot flowered in 1884, and the first leaf of the principal bud developed in the same year.

that case its uppermost scale-leaf subtends the bud which remains throughout the winter, and which by that time may have developed about three foliage-leaves.

The scale-leaves are leaf-sheaths morphologically, the upper ones often bear small, rudimentary laminæ. The foliage-leaves have a short, compact sheath, a long and slender stalk, and a tripartite lamina with broadly ovate segments that are shallowly lobed and have pointed teeth. The bracts are either lanceolate sheaths, and are in such a case no doubt colourless, or they have a small tripartite laminæ and then doubtless contain chlorophyll.

The flower has 5—7 lanceolate, stellate, expanded, white perigone-leaves and a varying, but smaller, number of spoon-like orange-coloured nectaries often thickened at the apices and sides; transitional forms between the short, spoon-like and the ordinary leaf-form are often met with (Fig. 57). The anthers are numerous with thin filaments; the carpels are 6—10 in number, are long-stalked at maturation, and the style is hooked, at any rate in the half-ripe fruit. The spoon-like nectaries according to Warming (notebook) drip with honey. The diameter of the flower is from 0·6 to 1 cm. The flowers investigated were rather markedly protogynous. In the scarcely-expanded flower the filaments are short and erect and the anthers are still closed, while the papillæ upon the tall carpels begin to develop in basipetal succession; gradually the filaments elongate and bend outwards, then the laterally-turned anthers open, but even the elongated stamens can scarcely reach the stigmas. Lastly, a homogamous stage occurs. This description is based upon the spirit material exclusively.

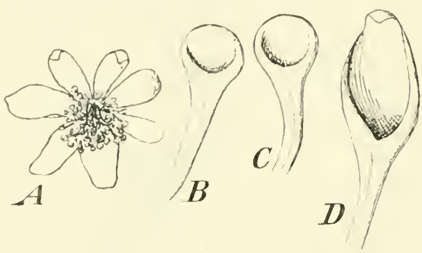

Fig. 57. *Coptis trifolia.*
A, Flower from Nuluk in Greenland, drawn at the end of the ♀ stage (about 2/1). *B*, *C*, Two common forms of nectary-leaves. *D*, Nectary-leaf with more common leaf-form. *B*. *C* and *D* from Sukkertoppen in Greenland (10/1).

The flower begins to develop in May; the fruit ripens probably in August. In South Greenland *Coptis trifolia* sets ripe fruit (Warming), and Rosenvinge (II l. c.) records it with flowers and with fruit of the previous year, at the end of July, from N. Strømfjord, which is its northern limit in Greenland (67° 32′ N. lat.). The seed is probably dispersed by the agency of the wind, or perhaps it is also epizoic.

In Greenland the habitats are grassy slopes, copses and luxuriant heaths (ROSENVINGE, (I).

Geographical Distribution. West Greenland (common south of Godthaab), Labrador, Canada, Unalaschka, Kamtchatka, Arctic Siberia (LANGE, ROSENVINGE, (I).

Anatomy. (Compare MARIÉ l. c.). The epidermis of the root of the first order is more or less collapsed and corky and bears root-hairs; the exodermis has somewhat thickened walls in which the middle lamella is suberized. The cortex is from 4 to 6 layers thick, the cells are somewhat collenchymatous and the intercellular spaces very small. The endodermis has somewhat thickened, suberized walls; the pericycle is one-layered. The central cylinder is diarch, the vessels filling up the greater part of it; the two groups of sieve-tissue are diametrically opposed to each other and are surrounded by wood-vessels upon the three sides. In the roots of the second order the cortex consists of about three layers; the innermost layer is of large, radially elongated cells, the outermost has somewhat collenchymatously thickened walls. The epidermis has a tendency to collapse, it may however bear numerous root-hairs. The groups of wood in the diarch central cylinder are not fused together. The cortical cells in these roots contain hyphæ which form balls in them.

Regarded anatomically there is a difference between the vertical and the horizontal part of the rhizome, in that the former has a phellogen which, according to MÀRIÉ, develops from 3 or 4 outer layers of the cortex. The cork is 3—5 layers thick. The horizontal rhizome, on the other hand, retains its small-celled epidermis which has arching and fairly thick outer walls. The cortex is almost similar in both parts of the rhizome and is rather compactly built of cylindrical cells which, especially in the vertical part, are rich in starch. The starch-grains are either single or compound. In the horizontal part of the rhizome there is a continuous wood-ring; the number of the bundles is indicated by the isolated groups of sieve-tissue. The cambium is no doubt always rudimentary. The endodermis which surrounds the central cylinder is fairly distinct. In the vertical part of the rhizome, on the other hand, the bundles are separated more or less from each other and leave room for the medullary rays, of which the elements are much elongated in a radial direction and are non-lignified. The cambium is capable of division but is fascicular only. In the outer part of the wood large vessels occur in fairly distinct, tangential layers separated by wood-parenchyma, an arrangement which recalls the formation of annual rings. The primary wood has smaller vessels than has the secondary. Secondary cortex is developed only to a slight extent. The pith cells are crowded with starch especially those in the vertical part of the rhizome.

The peduncle is somewhat furrowed; the epidermis consists of small cells, the outer wall, especially, is thick and is provided with a smooth cuticle. The stomata project somewhat (Fig. 58, *A*); the epidermal cells contain a small amount of chlorophyll. The cortex consists of 5—6 layers of fairly closely-placed, cylindrical cells with rather thick walls. The bundles number about seven and are closed and have on the outside a fibrous tissue, 3—4 layers thick. Upon the inner side of the wood from one to two layers of slightly developed wood-parenchyma occur; between the latter and the vessels, there is, in the larger bundles, some non-lignified parenchyma, and between the large group of sieve-tissue and the vessels some wood-parenchyma. An interfascicular, and in part fairly strong, mass of lignified-parenchyma, about four layers thick, is present; the pith is broken down in places in the fully developed axis.

Along the larger veins of the upper surface of the leaf there are a few small hairs. The outer walls of the epidermal cells of both the upper and the lower surface are fairly thick, especially those of the upper; the radial walls are markedly undulating, and almost equally so upon both sides (Fig. 58, *C, D*). Upon the upper surface there are only a few stomata, upon the lower about 350 per sq. mm.: they are fairly evenly distri-

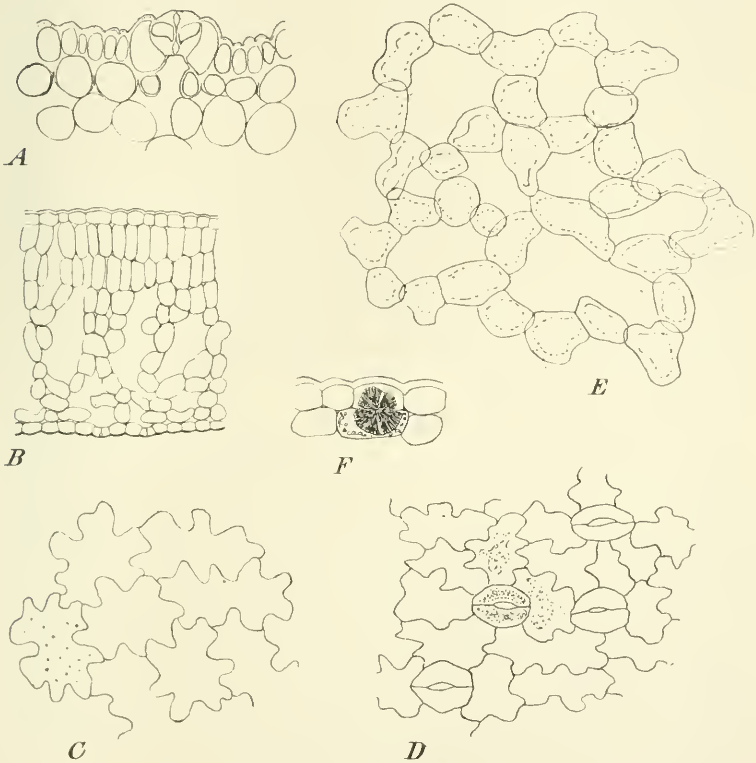

Fig. 58. *Coptis trifolia.*

A, Epidermis of the peduncle, showing a stoma (Godthaab; $^{300}/_{1}$). *B*, Transverse section of a one-year-old leaf (Godthaab; $^{130}/_{1}$). *C*, Epidermis of the upper surface of the leaf (Sukkertoppen; $^{300}/_{1}$). *D*, Epidermis of the lower surface of the leaf (Sukkertoppen; $^{300}/_{1}$). *E*, Section of spongy parenchyma, parallel to the surface, from a one-year-old leaf (Sukkertoppen; $^{300}/_{1}$). *F*, Sphæro-crystal from the cells of the lower surface ($^{300}/_{1}$).

buted, but are absent above the large veins. The direction of the stomata is almost similar to that of the principal vein of the leaf-lobe. The epidermis contains chlorophyll. In the young leaves the bundles are not accompanied by any especially well-marked stereom, but in the one-year-old leaves buttresses of strong stereom occur above and below the largest bundles; but in the case of the smaller bundles only below them; the smallest are entirely without stereom. There is in these leaves, upon the lower side of the sympodial marginal vein, an especially strong fibrous tissue extending to the epidermis, which is not the case with the other bundles.

The young partially expanded leaf is almost isobilateral in structure, and is without intercellular spaces of any size. Usually two palisade-layers are gradually differentiated and may constitute as much as one-half of the mesophyll, the cells occur close together and are about twice as long as they are thick. Large intercellular spaces are also gradually developed in the spongy parenchyma, and, as shown in the figure, are separated by vertical lamellæ. The transverse and the longitudinal sections are similar in this point.

No true epithema occurs, but the vein extends almost to the epidermis of the tooth of the leaf-apex, and upon the upper side of this tooth 2—3 stomata occur with the same appearance as that of the water-stomata in *R. nivalis*: stomata are absent from the under side of this tooth.

The leaves are rich in large, yellow sphæro-crystals (Fig. 58, *F*), especially abundant along the veins and under the epidermis; they are probably of substances which have been in solution in the living cell, but were precipitated by alcohol; their nature has not been more closely investigated.

The leaf-stalk, apart from its form, is similar in structure to the peduncle.

Summary.

I. The growth-form of the species which have been investigated may be referred to the following groups.

A. The *Primula*-type. The species referred to this group have a vertical, perennial rhizome, the primary root probably dies early in all the species, and there is a well-marked principal bud in the uppermost leaf-axil of the rosette: *Ran. sulphureus*, *acer* and *affinis* which have only foliage-leaves, and *Ran. glacialis*, *nivalis* and *pygmæus* which have also scale-leaves.

To this group also *R. reptans* may be referred but the main axis is creeping. These species are *hemicryptophytes*[1].

B. *R. hyperboreus*, *lapponicus* and *Pallasii* belong to the same type: The adult plant has no rosette, the straight stem creeps above the ground or in the moss, and in *R. lapp.* and *Pallasii* the branches often grow obliquely downward. *R. hyperboreus* and *Pallasii* are without a well-marked principal bud. In *R. lapp.* a principal bud occurs. — *Hemicryptophytes*, or perhaps *R. lapp.* and *Pallasii* may also be cryptophytes.

Batrachium confervoides is no doubt nearest to this group; but is a *hydrophyte*.

C. *Anemone Richardsoni*, *Coptis trifolia* and *Thalictrum alpinum* may be referred to the same type: There is a creeping subterranean rhizome and a principal bud which occurs in the axil of the uppermost leaf in *Anemone Richardsoni* and *Coptis trifolia* and in the axil below the uppermost in the specimens of *Thalictrum alpinum* examined by me. There is no aërial stem. The rhizome of *Anemone Richardsoni* is monomorphic and bears foliage-leaves especially. *Coptis trifolia* and *Thalictrum alpinum* have a dimorphic rhizome, the horizontal part of which bears scale-leaves, while the vertical part with short internodes bears foliage-leaves and scale-leaves in regular alternation. In *Coptis trifolia* the leaves pass the winter in a green condition. — *Hemicryptophytes*. *Anemone Richardsoni* may perhaps also be a cryptophyte.

II. Flower-biology. The flowers in probably all the species are well-developed by the latter part of the summer

[1] Raunkiær: Planterigets Livsformer og deres Betydning for Geografien. København, 1907.

which precedes that in which they expand (cf. *R. pygmæus* and *nivalis*). All the species which have been investigated are entomophilous except the anemophilous *Thalictrum alpinum*; with the exception of that plant, they all have flowers which are fairly conspicuous, partly on account of their size being often rather large and partly on account of the colour of the nectary-leaves; these are yellow in the majority of the species but white in *R. glacialis*, *R. Pallasii*, *Batrachium confervoides* and *Coptis trifolia*. The perigone-leaves are green to yellowish-green.

The majority of the species are dichogamous although not to any great extent, and in all probability self-pollination usually takes place in cases in which cross-pollination does not occur. Again, the greater part of the dichogamous species is proterogynous with a homogamous stage at the end of the flowering period, viz. *Ranunculus affinis* (?), *R. sulphureus*, *R. nivalis*, *R. lapponicus* (also recorded to be homogamous), *R. Pallasii* (also homogamous), *Thalictrum alpinum* (also recorded to be homogamous) and *Coptis trifolia* which is proterogynous to some extent.

The protandrous species are *R. glacialis*, *R. acer* and *R. reptans*; also in these species the flowers ultimately become homogamous. In Denmark *R. acer* has, besides the hermaphrodite flowers, others that are diclinous.

R. pygmæus and R. *hyperboreus* are homogamous; the latter is recorded to be also slightly protandrous.

Some of the species are recorded to have f r a g r a n t f l o w e r s: *R. acer* (perfume slight), *R. sulphureus*, *R. nivalis* and especially *R. Pallasii* and *lapponicus*.

All the entomophilous species have n e c t a r i e s except *Anemone Richardsoni*. In the majority of the species of *Ranunculus* the nectary is covered by a simple scale; in *R. acer* this is irregularly lobed at the free edge; in *R. glacialis* the nectary is naked, but a lobed scale is seated above it. In *Batrachium* the nectar-pit is naked.

Insect-visitors have frequently been observed in the species of *Ranunculus*, usually small Diptera.

III. Fruit-dispersal. The fruit is doubtless dispersed by the agency of the wind, but it appears that in some species synzoic dispersal may also occur (*R. glacialis*, *nivalis* and *acer*).

IV. The germination is known only in a few species; in some, it takes place during spring, in others during autumn. *R. glacialis* is remarkable by the fact of its having only one cotyledon.

V. The roots, in the specimens which have been investigated, fall naturally, according to their anatomy into three groups.

A. In all the species of *Ranunculus* and in *Batrachium confervoides* the primary structure is retained. The epidermis is thin-walled and has a tendency to collapse (except in *R. acer*); the exodermis is usually distinct, and the radial walls are undulating; both layers are suberized. In several species the two outermost layers of the cortex are slightly collenchymatously thickened; in this respect the species with creeping stems form an exception. The median part of the cortex is more or less broken down, often to a great extent; the degree of disintegration is probably dependent not only upon specific differences but also upon the lesser or greater degree of humidity of the locality. Around the usually thin-walled, suberized endodermis some layers of the cortex are always retained. *R. acer* has a thick-walled endodermis. The central cylinder is usually diarch to tetrach. The pericycle is one-layered; on the outside of each group of sieve-tissue there is more or less distinctly to be seen in all the species a large, pentagonal sieve-tube wedged in between adjacent cells of the pericycle.

The roots of the second order agree with the above description, only the exodermis is probably not suberized and none of the layers are collenchymatous.

The following species had endotrophic mycorrhizas, which occurred almost exclusively in roots of the second order: *Ran. sulphureus*, *acer*, *affinis*, *nivalis* and *pygmæus*. HESSELMAN, in his paper "Om Mykorhizabildningar in ark. Växter" (Bih. Kgl. Sv. Vet. Akad. Handl. Bd. 26, Afd. III), mentions no *Ranunculaceæ*. — Root-hairs were found in *R. glacialis*.

B. The roots of *Anemone Richardsoni* and of *Coptis trifolia* are very similar. The epidermis is strong; the exodermis is not very prominent and the cell-walls of it and of the rest of the cortex are fairly thick; the intercellular spaces are very small; no broken-down parts were observed. The endodermis has somewhat thickened walls which were found to be suberized. The central cylinder of *Anemone Richardsoni* was found to consist altogether of primary elements; in *Coptis trifolia* some secondary wood is developed; from two to three radial masses of wood occur. In both species spongy hyphæ occurred in roots of the second order. — Roots-hairs were found in *Coptis trifolia*.

C. The roots of the first order in *Thalictrum alp.* have vigorous secondary growth in thickness; the primary cortex is thrown off. The outermost layers both in the latter and in the secondary cortex have collenchymatously thickened walls. The primary radial masses of wood number from three to six. The secondary roots are of primary structure and are peculiar owing to the presence of a dimorphic epidermis; they were found to contain spongy hyphæ.

VI. The vertical rhizome in the species of *Ranunculus* of the *Primula*-type is very similar in structure in the different species; usually it is schizostelous. In regard to *R. acer*, a smaller amount of lignified elements was observed in the specimens from the northern localities than in those investigated from Denmark.

VII. The stem and the peduncle in all the species, were found to be on the whole similar in structure. The bundles are closed and are arranged in a ring. The strengthening tissue occurs close to the bundles; it is almost entirely absent from certain species and is fairly well developed in others; it consists of two parts — the fibrous tissue outside the leptome, and a band of lignified parenchyma uniting the bundles. Both in the stem and in the rhizome of *R. acer* a smaller amount of stereom occurred in the specimens from the northern localities than in those from Denmark. The nodes in the species of *Ranunculus* with creeping stems resembled in structure the rhizomes in the species with *Primula*-structure.

In several cases the monostelic structure mentioned by Marié could be demonstrated in the peduncle while the rest of the stem was more or less distinctly schizostelous.

The pith was often found broken down.

The cortex was very loose in structure in the majority of the species (cf. for instance *R. glacialis* and *Pallasii*) and very often great parts of it were broken down. *Anemone Richardsoni* and especially *Coptis trifolia* and *Thalictrum alpinum* had a firmer cortex than had the other species, and the epidermis in the last two had also a more xerophytic character; in the species of *Ranunculus* it was rather thin-walled; the cuticle was usually found to be thin and striped. The epidermis contained chlorophyll in all the species, often in great quantities; the stomata were either on a level with the surface or projected slightly.

VIII. The structure of the leaves. The species which have been investigated may be referred to two large groups, viz., the submerged-leaved and the aërial-leaved.

A. The typical submerged leaves in *Batrachium confervoides* and *R. reptans* are cylindrical and more or less radial; *Batrachium* has one bundle in each lobe, *R. reptans* has no doubt usually three in each leaf. When these plants grow in dry localities the leaves of both species react in a similar manner and approach the bifacial type to which the elliptical leaves of *R. reptans* may be referred entirely. The submerged leaves of these two species have no stomata and few stomata respectively; in the bifacial leaves they are more numerous upon the upper surface.

B. The aërial leaves. All the species of *Ranunculus* with the exception of *R. reptans* and *R. glacialis* may, with regard to the structure of their leaves, be referred to the same sub-group. The leaves are glabrous or slightly hairy (except in *R. acer*), the epidermis is thin-walled and the palisade-tissue and spongy parenchyma are homogeneously developed in all the species; from one to two palisade-layers occur which constitute about one-half of the thickness of the mesophyll, and the individual palisade-cells are often barrel-shaped and somewhat irregular; the spongy tissue contains numerous intercellular spaces and the cells are branched in a stellate manner. In *R. hyperboreus* the stomata were more numerous upon the upper surface, and in *R. Pallasii* their number was equal upon both surfaces, but in the other species they were more numerous upon the lower surface. The habitat of all is usually damp moss.

R. glacialis differs from the above-mentioned species in its better developed palisade-tissue and in the looser structure of its spongy parenchyma. The stomata are most numerous upon the upper surface. It grows in localities which are poorer in humus than those in which the other species of *Ranunculus* grow.

In Greenland *Anemone Richardsoni* is doubtless especially a shade-plant; in the structure of its leaf it closely resembles *Anemone nemorosa*. Stomata occur almost exclusively upon the lower surface of the leaf.

Of the species which have been examined *Thalictrum alp.* and *Coptis trifolia* are the most xerophytic. The leaves are coriaceous and the epidermis is thick, especially in *Thalictrum alp.* The palisade-cells occur in 2—3 compact layers; the spongy parenchyma consists of shortly branched cells. In both species stomata are almost absent from the upper surface, but occur very numerously upon the lower surface. *Thalictrum alp.* grows in very different localities. The fact that the leaves pass the winter in a green condition may perhaps account for *Coptis trifolia* being xerophytic.

As a peculiar feature common to all the species may be mentioned the fact that the epidermis contains chlorophyll. As is well-known this is the case in temperate regions in plants growing in scanty light, for example, in many aquatic and woodland plants; which appears to suggest that the species in question have not been exposed to intense light—at any rate not constantly. For further particulars the reader is referred to Lidforss[1] who states that a great many North-European evergreens have chlorophyll in the epidermis, especially that of the lower surface of the leaf; the epidermis there is often separated from the mesophyll by means of large lacunæ and it will then, on account of the presence of the chlorophyll, be more independent in regard to its nutrition-physiology.

Of the 14 species which have been investigated the stomata, in the majority, were most numerous upon the lower surface, viz. in *R. affinis*, *acer*, *sulphureus*, *nivalis*, *pygmæus*, *lapponicus*, *Anemone Richardsoni*, *Thalictrum alp.* and *Coptis trifolia*, nine in all. Of these *Ran. lapponicus*, *Thalictrum alpinum* and *Coptis trifolia* have probably none, as a rule, upon the upper surface. *R. Pallasii* has an almost equal number upon both surfaces, a fact which perhaps is connected with the position of its leaf, the lamina continuing the direction of the stalk. The following species have the greater number upon the upper surface: *R. glacialis, hyperboreus* (its leaves are sometimes floating-leaves), *R. reptans* and perhaps *Batrachium confervoides*, the last two in their aërial leaves. Börgesen (l. c.) states that

[1] "Die wintergrüne Flora." Lunds Universitets Årsskrift, N. F. Bd. 2, Afd. 2, No. 13, 1907.

the majority of the species which he has examined had the stomata most numerous upon the upper surface.

All the species of *Ranunculus*, *Batrachium confervoides* and *Anemone Richardsoni* were furnished with hydathodes and epithemata at their leaf-apices. It is usual for the water-pores to occur marginally upon a somewhat upwardly-directed surface, and in all these species the epithema is essentially similar in structure; the tracheids are somewhat spreading and terminate at the intercellular spaces, and the cells of the mesophyll are shortly branched and have strongly undulating walls. Chlorophyll is usually absent from the epithema and the nuclei of the cells were remarkably large.

From the consideration of the above it will be seen that the species which have been investigated are very similar in regard to the greater part of their structure; and, as is natural, the similarity is especially conspicuous in the relatively numerous species of *Ranunculus*; it has also been shown that in the material at hand no considerable differences have been able to be demonstrated in the individuals of the same species from different regions (see however *R. acer* and *R. affinis*).

27—6—1911.

The

Structure and Biology

of

Arctic Flowering Plants.

I.

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Hitherto, the following papers have been published:

7.

Lentibulariaceae.

(Pinguicula).

By

Fr. Heide.

1912

INTRODUCTION.

This paper has, like the preceding ones of the same series, a two-fold purpose: the one to contribute to a better knowledge of the relation between the arctic plants and the conditions under which they live, and the other to serve as a basis for future studies of a similar nature.

I think I have contributed towards the first-mentioned by distinguishing two types in my material: an arctic and a temperate one and by confining my representation to this main point, and as regards the second I hope to have succeeded in some measure in pointing out the future way towards a closer treatment of the question. But on the whole my paper has, more and more, attained the character of a preliminary sketch, in which also the principles of my future works on this subject are laid open to criticism. The cause of this is, among other things, that on working up my subject I found that a material, collected several years ago, could not serve one and every purpose; the new principles for botanical treatment have outgrown the principles which determined the collection of the material, and the application of this has become more limited. In regard to ecological studies it will be necessary in the future to form new principles for investigations in Nature, as I have also had occasion to mention in the text.

The material for investigation I have received partly from the Botanical Museum in Copenhagen and partly from the "Riksmuseum" in Stockholm. The latter institution has very generously placed its perfect and beautiful herbarium at my disposal. The photographs have been taken by H. E. Petersen, Mag. Sc. The illustrations were drawn mainly by Professor Eug. Warming several years ago; on some points — all concerning morphology — I have naturally found it necessary to add new ones. The determination of the *Arthropodae*, caught by the arctic species of *Pinguicula*, has been kindly undertaken by Mr. K. L. Henriksen and W. Lundbeck, Mag. Sc., Inspector at the Zoological Museum in Copenhagen. For which I tender them my best thanks. Lastly, I wish to thank Mr. R. V. Hansen for his valuable aid in translating my manuscript.

The species mentioned in the following pages are: —

Pinguicula vulgaris .... p. 447

Pinguicula alpina .... p. 469

Pinguicula villosa .... p. 470

With respect to the genus *Utricularia*, of which I have had an exceedingly scanty material for purposes of investigation, I can only confirm the facts already known.

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I. Morphology and Biology.

Pinguicula vulgaris L.

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Materials in alcohol from West-Greenland, Iceland, Norway.

Pinguicula vulgaris is nearly always confined to moist localities, though not to so great an extent as *P. villosa*. The localities are marshes with grass-covered surfaces and moist rocky walls; it is rarely found in Sphagnum. The plant grows most frequently on turfy soil, more or less mingled with sand, and on rocks with a thicker or thinner covering of earth, but it may also grow on loose detritus, and it has even been found in gravelly tracts (for instance together with *Azalea* and *Betula nana*); moreover it has been seen in places sometimes overflowed by the sea (Norman). According to the same author it is found up to 900 m. above sea-level.

It is a typical rosette-plant, perennial, and lives through the winter by means of a special hibernacle, consisting of small, solid scale-leaves, containing starch. The development from seed is as follows: The germinating plant (Fig. 1, *A*) begins with a distinct primary root, which decays however very early, and adventitious roots develop from the stem: there is but one cotyledon, furnished with stomata and more or less developed glands, probably unable to function as yet (Fig. 1, *B* & *D*). As regards morphological explanation of this cotyledon, a very eager discussion has been carried on from time to time, but so far, harmony on this point has not been attained. Concerning the different views expressed on this difficult question I refer the reader to: Gaertner, 1791; Brown, 1810; Treviranus, 1838, 1839, 1848; St. Hilaire, 1838, 1841; Walpers, 1848; Klotsch, 1848; Webb, 1853; Buchenau, 1865; Caspary, 1867; Dickson, 1869; Goebel, 1891—93; Merz, 1897; Sylvén, 1905; Velenovski, 1907.

The young plant has long internodes until it reaches the light, which probably causes the formation of the rosette. When this stage is arrived at, the plant has a short rhizome, gradually dying away at the hinder end, bearing the rosette leaves, and furnished with a few roots, an inch in length and somewhat constricted in their upper part. At first they are white and bear root-hairs, later on these decay, and the root is covered with a brown layer of cork. The size of the rosette-leaves

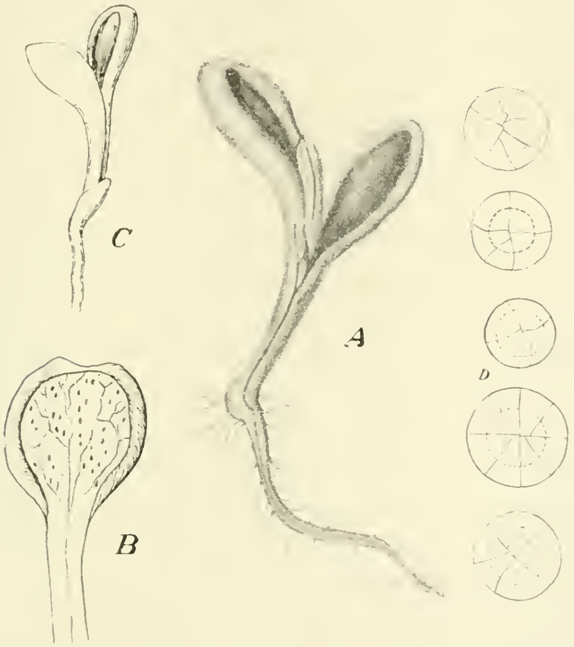


Fig. 1.

A, Seedling of *P. vulgaris* from the Færöes; this plant has been taken out from a colony of seedlings. *B*, Cotyledon of the same. *C*, Seedling of *P. alpina* from Tromsø. (E. W.; 1886) *D*, Different forms of glandular hairs from the cotyledon of *P. vulgaris*. (F. H.)

varies somewhat, but on an average seems to be a little smaller than that of those in our Danish specimens. With regard to the shoot-structure and the manner of growth some peculiarities are found in the arctic specimens of *Pinguicula*, which are not found in plants from more southern places. Therefore, I must mention the case a little more in detail.

The shoot-structure of *P. vulgaris* has been described very fully by Buchenau, later on Warming investigated the shoot-structure of the arctic species and found that it agreed with Buchenau's description. The result of my investigations, however, does not show this. According to Buchenau the shoot-structure is the following: The plant, on reaching the light, develops its first rosette, the so-called "spring-rosette" which terminates in a flower: thus the main axis ends its growth. But at the time of flowering a rejuvenating shoot is seen in the axil of the uppermost foliage-leaf; this shoot develops into the second rosette "the autumn-rosette." While developing, it forces the fruit-stalk somewhat to one side, and often before the fruit is ripe, the stalk is flaccid and almost rotten. Simultaneously, the spring-rosette and its roots usually decay, and the autumn-rosette is now nourished exclusively by its adventitious roots. Towards the winter the leaves of the autumn-rosette decay entirely, and in the middle of the latter is now found the fully developed hibernacle which next year develops into a new spring-rosette. In the case of the plant not flowering, both spring and autumn rosettes belong to the same axis.[1]

The description given here suits the shoot-structure of the "temperate" specimens of *P. vulgaris*, and in my material I have found the same to be the case in two specimens from Norway and the Færöes. That the same early decay of the fruit-stalk is found also in these plants I conclude from a peculiarity concerning the germination. I have received seedlings from Romsdalen (Norway) and the Færöes (Fig. 1, *A*), and

[1] Whether Buchenau is right in regarding the shoot-structure in *Pinguicula vulgaris* as sympodial I cannot decide at the present time. Professor C. Raunkiær has directed my attention towards the fact, that Irmisch regards the said shoot-structure as monopodial. This point naturally being of great interest I intend to investigate it more closely in the future, but in ecological respect and as regards my observations on temperate and arctic types of *P. vulgaris* the question has not any real importance, as will also be evident from the following representation. Whether the shoot-structure of *P. vulgaris* is sympodial or monopodial, the distinction between temperate and arctic types in the genus *Pinguicula* must be made nevertheless.

these are characterized by growing in small, compact tufts, resembling moss-tufts in form. The plants stand very close together and in considerable numbers in these colonies. The formation of these can only be explained by the fact, that the fruit-stalk has fallen down before the capsule had opened and that the seeds have germinated in a heap. So no real dispersal of the seeds has taken place in these two cases. Whether the colonies of seedlings mentioned here are common in temperate regions I myself have not been able to investigate, and in the literature of the subject I have never met with any notes regarding this fact.

Ecological studies on arctic plants should be based on species widely distributed both in cold and temperate regions, and then only can there be a possibility of an interesting comparison, and in this respect the genus *Pinguicula* is well qualified. It contains three species, inhabiting arctic and temperate countries, the one, *P. vulgaris,* thrives well both in the level lands of Central Europe and on rocky walls in arctic regions, another, an alpine species, and finally a purely arctic one, *P. villosa.* The most variable of these three, *P. vulgaris,* requires, however, everywhere in its wide geographical area, the same conditions, mainly with regard to water. The possibility of the arctic specimens being very differently formed in their anatomical characters from the temperate ones, must already in consequence of this be regarded as very small. On the other hand, the rather complicated shoot-structure of this species could better be thought to be subject to a reduction, produced by the conditions in arctic regions. Here, the late commencement of the summer will delay the development of the spring-rosette and, at the same time, of the flower (Hartz, Rosenvinge, Jónsson). The flowering, which takes place in Denmark usually in May—June, will for instance in Greenland not occur before June or July; in August—September the winter-bud must be developed because the night-frost comes already at this time. A reduction in the shoot-structure of *P. vulgaris* can thus be supposed, and what we find in this species as an adaptation to arctic conditions we likewise suppose will be found as a normal arrangement in the purely arctic species, *P. villosa*. My results will prove, that this supposition agrees with reality.

Already from a superficial investigation it must be remarkable, especially with Buchenau's results *in mente*, that the fruit-stalk with the wide-open capsule is always found in a stiff, erect position in the arctic specimens of *P. vulgaris*, collected in August (Fig. 5), sometimes also the fruit-stalk from the preceding year will be found. As already mentioned by Warming this is also the case with *P. villosa* (Fig. 14 *A*). From this it will first be seen, that the dispersal of the seeds is very complete in the arctic specimens of *P. vulgaris*. It is a well known fact, that the fruit-stalk of arctic plants is as a rule more inclined to remain in its place than that of plants of southern regions, and usually this circumstance is explained by the fact that the process of decay is exceedingly slow in the former regions. But this explanation does not settle the matter in regard to *Pinguicula*. Quite naturally the autumn-rosette requires space while developing, and the fruit-stalk must give way, at least it will be forced considerably away from its erect position. That this is never seen to occur in the arctic specimens of *P. vulgaris* must mainly be explained by the peculiarity that these never develop their autumn-rosette. In the material I have had for investigation I have succeeded in distinguishing two types of this species, a temperate one, agreeing wholly in its shoot-structure with Buchenau's description, and an arctic one, not previously recorded.

The latter develops as follows: In the spring the winter-bud produces a spring-rosette, the axis of which terminates in a flower; in the axil of the uppermost foliage-leaf is seen a rejuvenating bud, which does not develop into an autumn-rosette, but directly passes into its winter-rest as hibernacle (Fig. 2, *A*).

Whether a specimen belongs to the arctic or the temperate type, is not difficult to determine, provided the said specimen is collected in July or August, a time when the brown starch-filled scale-leaves of the winter-bud are fully developed. In the first case the leaves of the rosette surround the flower-stalk and

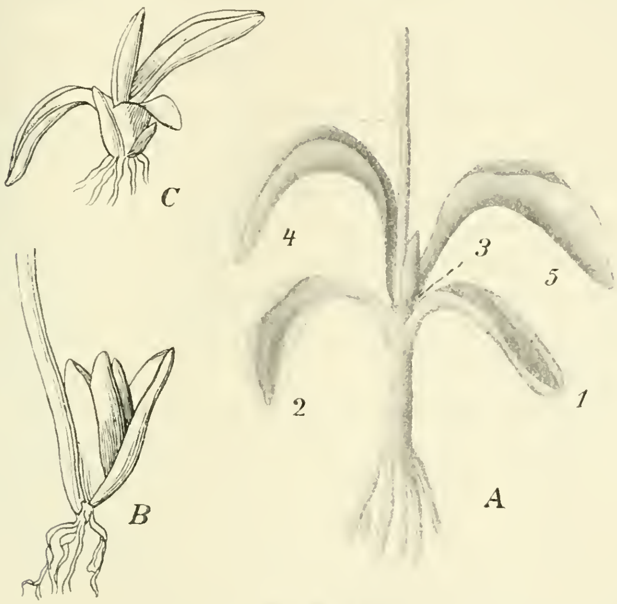


Fig. 2. *Pinguicula vulgaris*, arctic type.

A, Specimen from Kingua Kuanersok in Greenland, July 13; foliage-leaf No. 3 has been removed. (F. H.) *B*. Winterbud and fruit-stalk, Hammerfest, July 1. (E. W.) *C*. Winter-bud and half-developed spring-rosette, Kobbefjord, June 29. (E. W.); between the winter-bud and fruit-stalk foliage-leaves of the autumn-rosette are not developed. (Slightly magnified.)

the winter-bud, and the latter two stand close together without intervening rosette-leaves; this rosette therefore is a spring-rosette. But in the second case the leaves of the autumn-rosette are developed between the flower-stalk and the winter-bud, and then the latter is often forced away from its erect position. Besides, it is very easy to decide whether the rejuvenating shoot in the uppermost leaf-axil will develop into an autumn-rosette, or directly pass into its rest as hibernacle. In the first case the rejuvenating shoot develops large, true foliage-leaves, placed in the axil of the uppermost leaf of the spring-rosette, but in the second case this at once develops thick brown scale-leaves, rich in starch (Fig. 2 *A*). This latter characteristic has the advantage, that it can be used in the determination of materials also from the early summer-time, naturally, with an exact result, only if spirit-materials are concerned.

The comprehension of the position of the winter-bud in relation to the flower-stalk and the character of the rejuvenating shoot are the key to the distinction between the arctic and the temperate type of the genus *Pinguicula*.

In the arctic type of *P. vulgaris* a reduction has thus occurred, though not a very strikingly deep one, but this reduction, however, indicates a peculiar adaptation to the shorter period of growth of the arctic regions.

Whether a similar reduction of the shoot-structure can be found in other arctic plants I have not been able to investigate, but *a priori* I should not think it impossible. The morphological type, here described as specially arctic, will be found again in *P. villosa*. The phenomenon which in *P. vulgaris* represents only an adaptation to the arctic climate, represents in *P. villosa* the normal shape. An autumn-rosette is never developed, but the rejuvenating bud directly passes into its rest as hibernacle (Fig. 3, *A* & *B*). One more peculiarity of the shoot-structure will further be found in *P. villosa*, but this is exclusively occasioned by certain circumstances of the soil in which it grows, and not by the influence of climatic factors; this case will not be mentioned more closely here.

P. alpina does not differ in shoot-structure from the ordinary temperate type; everywhere in its geographical area even in northern Scandinavia, it develops its autumn-rosette.

The fruit-stalk also in this species does not seem to be subject to quick decay; by the growth of the autumn-rosette it is forced somewhat to one side (Fig. 4), but scarcely to such an extent as in the temperate type of *P. vulgaris*, probably occasioned by the circumstance that the leaves of the autumn-rosette are bent more slightly backward than are those of the spring-rosette. The tension, forcing the rosette-leaves close to the ground — a fact which will be treated later

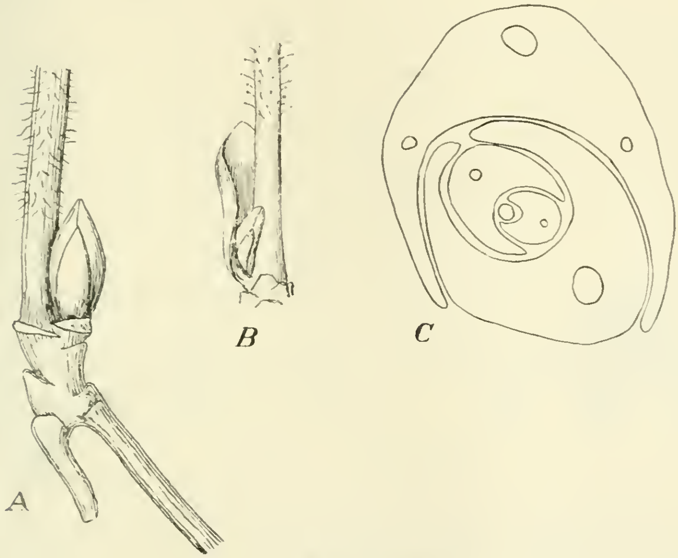


Fig. 3. *Pinguicula villosa.*

A Winter-bud and fruit-stalk; the uppermost foliage-leaf has been removed. (F. H.) *B*, Winter-bud and fruit-stalk; the uppermost foliage-leaf is present. (E. W.) *C*, Transverse section of winter-bud. (F. H.) *A—C*, Vårstien. Kongsvold, Dovre (Norway; July), autumn-rosette is not developed.

on —, can scarcely be very strong in the autumn-rosette of *P. alpina.*

In connection with this distinction between the two types two questions must naturally arise. First, it would be interesting to investigate whether the short arctic period of growth has caused the said reduction to be a constant feature in these plants, and secondly we ought to endeavour to draw a limit for the southern extension of the arctic type of *P. vulgaris.*

Concerning the first of these points, however, I cannot for the present communicate any results, in the future I hope to be able to do so. *A priori* we may venture to think that *P. villosa*, if cultivated in Denmark, will continuously retain its arctic type, being undoubtedly, of the three species in question, the oldest inhabitant of arctic countries, and in herbarium material I never, even far down in Sweden, perceived any trace of development of an autumn-rosette. With respect to *P. alpina* there is nothing interesting to state on this point, but as regards *P. vulgaris*, the result of its cultivation is subject to greater doubt, and in consequence of this, such experiments with this species have a greater value. Whether the arctic type here is constant, it is quite impossible to say, though probability tends to the contrary.

Fig. 4.
Pinguicula alpina.
Autumn-rosette is developed; the fruit-stalk is pushed somewhat to one side by the rosette. Plateau de Murnau (Haute Bavière). June. About $^{1}/_{2}$ natural size. (H.E.P. phot.)

Concerning the determination of a geographical limit, I have been more successful. *P. vulgaris* being a circumpolar species, one would with such a phyto-geographical line (a sort of Biochorus) be able to state the influence of the arctic climate upon a particular plant, and such a result would not be without interest. A line of this sort must naturally be exceedingly difficult to draw; in order to be able to arrive at a satisfactory result a great many observations in nature are required, made mainly in July or August. Only when this has been done in regard to the main points, will it be possible to proceed to the determination of the climatic factors distinguishing the two types.

If we take the opposite view and draw the geographical limit on the basis of the already existing climatological material.

one will attain more or less to the following result: The line will pass through the southern regions of British North-America, further to the east it will pass through Iceland and Western Norway, thereupon again with a southern direction through Sweden, Finland, Russia and Siberia. Further the height above sea-level will cause variations in the line in the different places.

Naturally I have not been able to draw this line even in

Fig. 5. *Pinguicula vulgaris*, arctic type.
Winter-buds and fruit-stalks. Autumn-rosette is not developed. Probably from the end of August. Ilua, Greenland. About 2/3 natural size. (H. E. P. phot.)

a tolerably correct manner on the basis of the material at my disposal. For this the difficulties have been too great. In the first place the material has not always been collected in the season most suitable for my purpose; secondly, I have often been obliged to make my investigations on herbarium-plants in which the shoot-structure sometimes is very difficult to determine; last but not least, I have had from the greater part of the regions concerned only a few or no specimens at all for observation. If in spite of these great defects I have nevertheless decided to venture an experiment, I have done it especially because I think I may be able to give some suggestions concerning the places, where future investigations on this point may be carried out with the greatest advantage. I naturally intend to investigate also this point in the future, but I am fully aware that it is impossible for me to do this thoroughly, unless others cooperate with me in the elucidation of the question.

I therefore communicate my results as quite premilinary:

Greenland.

In the fairly rich material from different places in West, East and South Greenland all the specimens seem to belong to the arctic type. (Dried and spirit material). (Fig. 2, *A* & Fig. 5.)

North America.

From this country I have had but two plants for investigation, therefore I cannot draw the line here. (1.) Labrador. specification wanting, arctic type. (2.) Quebec, Gaspé County, River St. Anne des Monts, August, temperate type. (Dried material.)

Iceland.

Eastern	Iceland.	Vallanes (Fig. 6).	arctic type.
»	»	Seydisfjordur, July	» »
Northern	»	Helgavatn. June.	» » ?
»	»	Husavik. June.	» » ?
»	»	Øfjord. Akureyri, June . . .	» » ?
North-western	Iceland.	Dyrefjord, July.	temperate »
Western	»	Reykjavik.	» »
Southern	»	Westmanna-Islands, July. .	» »
»	»	Hjørleifshøfdi, July	» »
»	»	Ulfsvatn, Tvidægra, 500 m. above sea-level. July . .	arctic »

This material is collected mainly in June or July, a season of the year, in which it is difficult to decide, whether an autumn-rosette will develop or not in this locality, the value of this material is thus somewhat dubious (Dried material.)

Eig. 6. *Pinguicula vulgaris*, arctic type.
Probably from August. Vallanes, East-Iceland (H. Jónsson).
About natural size. (H. E. P. phot.)

Norway.

File Fjæld, Nystuen, August. . . . . arctic type
Dovre, July . . . . » »

Rørstad, Nordlandene, August	arctic type.
Tromsø, July.	» »
Hammerfest, July (Fig. 2, *B*)	» »
Bosekop, July	» »

(Dried and spirit material.)

Fig. 7. *Pinguicula vulgaris.*
Vigorous specimens with long leaves and flower-stalks. Uppland. Upsala. Lassbybackar, June. About 1/3 natural size. (H. E. P. phot.)

Sweden.

Øland, Borgholm, July	temperate type.
Gotland, Visby, June	» »
Kinnekullen (Wenern), June	» »
Ornø (at Stockholm), June.	» »
Stockholm, July	» »
Vermland, Gillberga, July	» »
Uppland, Sollentuna, Svartingeäng	» »
Medelpad, Njurunda, July	arctic »
» , Sundsvall, June.	temperate »

Medelpad, Borgsjø, July	arctic type.
Jemtland, Storlien, July	temperate »
» , Åreskutan, August	arctic »
Lappmark. Quickjock, July.	» »
» , Jukkasjärvi, July	» »
Luleå Lappmark, Karasjok, July.	» »
» , Abisko, July	« »

Concerning the Swedish material, in Uppland there are circumstances, worthy of a closer investigation with respect to this point; whether a variation in the development of the autumn-rosette occurs here, I cannot say; regarded quite superficially it seems so (Fig. 7). Further the specimens from Øland and from the regions around Upsala are distinguished from the others by long, narrow leaves; long, distinct leaf-stems, and extremely long flower-stalks — in all plants grown under favourable circumstances; whether these forms, however, are produced by climatic or terrestrial influence, I am not able to decide (Fig. 8.). (Dried material.)

Finland and Russia.

Kajsana?, July	arctic type.
The peninsula of Kola (without further indication)	» »

(Dried material)

According to these investigations Greenland exclusively presents the arctic type, the same is the case with the northern and eastern coasts of Iceland; the western and southern coasts of this island, on the other hand, present the temperate one. Probably, however, very complicated circumstances are found on this island, as already suggested by my synopsis. Probably the climatic circumstances, for instance in the inner parts of the fjords, will often cause the existence of the temperate type in the region, mainly inhabited by the arctic one, and in return the latter will be found in places in the region of the temperate one. No doubt the distance from the sea, both vertically and horizontally, will also cause great variations in the course of the boundary line. Epecially from such geographical localities a large material is necessary to determine the influence of the arctic climate on the plant, and the material must, besides being of a botanical and meteorological nature, also contain more satisfactory indications as to the nature of the locality, than has hitherto been the case with the spirit-materials and herbarium-specimens in our museums. — From Iceland the line with probably go over the middle of the Scandinavian peninsula in a direction towards Sundsvall; an arctic deviation is found along Dovre and Filefjæld in Norway, and a corresponding temperate one along the west-coast of Norway; I am not able to say, how far to the north this is found. After this the line goes through Finland in a direction towards the south through Russia, Siberia and North-America. —

Fig. 8. *Pinguicula vulgaris.* Very vigorous specimen with long leaves and flower-stalks. Øland. Thorslunde. June. About 1/3 natural size. (H. E. P. phot.)

The shoot-structure in the genus *Pinguicula* evidently varies highly in the different species, found in different climates, and contains probably interesting deviations from the well-known case in *P. vulgaris.* An extensive comparison with respect to this point, will no doubt be valuable, but such a thing is naturally beyond the limits of this paper, I venture, however, in continuation of my treatment of the morphological peculiarities of the arctic species, to mention a single point concerning *P. caudata.* Taken together with this species my temperate and arctic types show a fine phytogeographical scheme. Through a single period of growth the picture will be as follows:

I. Subtropical type. *P. caudata.* Mexico. Summer-rosette of the ordinary *Pinguicula*-type, terminating in a flower. The rejuvenating shoot in the axil of the uppermost foliage-leaf forms a winter-rosette like that of *Sempervivum* with short and thick leaves, filled with amylum and furnished with a large layer of cells filled with water. The glands are not fully developed. (Nourishment by insects is thus excluded in the winter-rosette). By this peculiar winter-rosette the plant passes the unfavourable season. Hibernacle is never developed. According to Sander also the winter-rosette can develop flowers. (Literature: Schlechtendal, 1832, p. 393. De Candolle, 1844, p. 28. Sander, 1881, p. 541. Hooker, 1882, pl. 6624. Godefroy-Lebeuf, 1883, p. 387. Duchartre, 1887, p. 207).

II. Temperate type. *P. alpina* and *P. vulgaris.* Spring-rosette, terminating in a flower. The rejuvenating shoot in the axil of the uppermost foliage-leaf develops an autumn-rosette, in the middle of which the winter-bud is to be found; both rosettes are of the ordinary *Pinguicula*-type.

III. Arctic type. *P. vulgaris* (arctic specimens) and *P. villosa.* Spring-rosette, terminating in a flower. The winter-bud is directly formed from the rejuvenating shoot in the axil of the uppermost foliage-leaf. Autumn-rosette does not develop.

The three types, here mentioned, show the main characters of the forms produced in different climates; between the two first I am not able to demonstrate a transition. But I see an evident transition between the two last types in *P. vulgaris.*

Also in the rare *P. vallisneriaefolia* there seem to be circumstances, worthy of closer investigation with regard to the shoot-structure. The literature, however, gives but few and uncertain indications on this interesting point. (Webb, 1853, p. 48. Buchenau, 1865. p. 62.)

Diagram of the shoot-structure in the genus *Pinguicula.*

I. Subtropical type. *P. caudata.* II. Temperate type. *P. alpina* and *P. vulgaris.* III. Arctic type. *P. vulgaris* and *P. villosa.*

As already mentioned there exists a peculiar tension in the leaves, causing these to be always bent backward in exhumed specimens. The advantage of this is, that the middle of the rosette, and with this the young leaves, will always be forced up over the surroundings. The substratum in which this species, *P. vulgaris*, grows, being almost exclusively solid (not growing as is the case with the *Sphagnum*), and the tension always very strong, the leaves will easily be able to perform their work to perfection. This is not the case with *P. villosa*, as the following with show.

As is well known, the leaves are adapted to catch insects. The edges are incurved; according to Klein's experiments this circumstance prevents the escape of small insects. These are forced up under the incurved edge and are digested there. In a separate chapter a synopsis of insects, caught by the arctic specimens will be given collectively with respect to all three species.

Vegetable propagation usually occurs in temperate regions, the uppermost leaves in the autumn-rosette supporting small, often stalked bulbs, which, during the next year, develop into independent plants. As regards their main characters these bulbs are formed like the winter-bud, consisting of small, thick scale-leaves, characterized by a strong brown colour, probably due to their contents of tannin. Whether this kind of vegetative propagation is found at all in the arctic type of *P. vulgaris*, which never develops an autumn-rosette, I cannot say, I never observed anything in that direction, but probably this work is undertaken by the spring-rosette, in which case vegetative propagation is, however, very scanty. I have been led to this conclusion mainly by a parallel circumstance in *P. villosa*, which will be mentioned later on. It is possible, that this limitation of the vegetable propagation is balanced by the more regular dispersal of the seeds in the arctic species, but in order to be able to judge correctly on this point one must, however, also take note of the number of the seeds and their power of germination, which, for the time being, I have not been able to do.

Concerning the quantity of the flowers a statistic synopsis shows a difference between temperate and arctic types. In the former 3—4, and even 10 flowers are very commonly found on the same plant, while ordinarily only one flower occurs on the latter. In a single case I have observed traces of development of an infloresцense, the same, as will be mentioned in the following, has been observed in *P. villosa* (Fig. 16) and can perhaps give a hint regarding the true explanation of the inflorescense in the genus *Pinguicula*, a question which has however no interest in a communication regarding the special nature of the arctic plants. I only refer the reader to Buchenau's and Wydler's somewhat dubious explanations on this point.

With respect to the temperate type the biology of the flower has been investigated by many inquirers, the arctic one has been studied in the best and most detailed manner by Warming. My investigations can only confirm and, on a single point, supply Warming's results. As is well known, the case is usually as follows in *P. vulgaris*: The flower is homogamous, and self-pollination is prevented by the foremost part of the stigma being very large and stretching far beyond the anthers so that these latter are totally covered. The hindmost part of the stigma is on the other hand small and sometimes divided into two (Fig. 9, *B*). The anthers open with a longitudinal slit closely below the stigma. The proboscis of

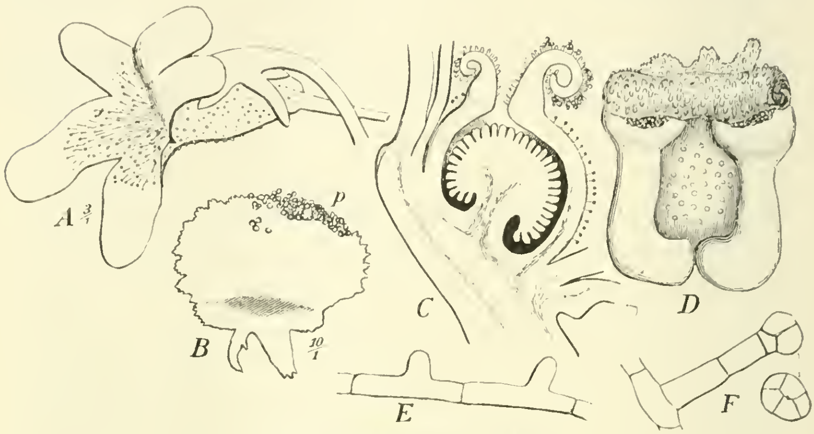


Fig. 9. *Pinguicula vulgaris.*

A, Flower; the entrance is not well-drawn; it ought to be somewhat wider. *B*, A stigma, the hindmost part of which has been divided into two lobes; p. pollen-grains. *C*, Longitudinal section through pistil; the foremost part of the stigma has rolled backwards down to the anthers. *D*, Pistil with the stigma, rolled backwards, and the two anthers, seen from front. *E*, Different forms of hairs from the spur (see also *H* in Fig. 10). *F*, A glandular hair from the inner wall of the spur; the head is seen also from above. (E. W.; 1886). *A*, From Tromsø; *B—F*, From Godhavn in Greenland.

the insect, when entering the flower, first touches the foremost part of the stigma, and when withdrawn this part of the stigma is bent aside, and the insect is furnished with pollen. After this the elastic stigma again springs back and covers the anthers. Owing to this circumstance self-pollination must be impossible, but in the arctic specimens the case is different. Warming has sometimes found the foremost part of the stigma rolled in such a manner, that its upper surface was brought into close contact with the pollen-masses (Fig. 9, D); this I have observed in the majority of the arctic flowers in my material. Whether this peculiar phenomenon is caused by a natural tension in the stigma or by the agency of an insect I cannot decide, though its frequency makes the first mentioned explanation probable. In the cases mentioned here the stigma has been

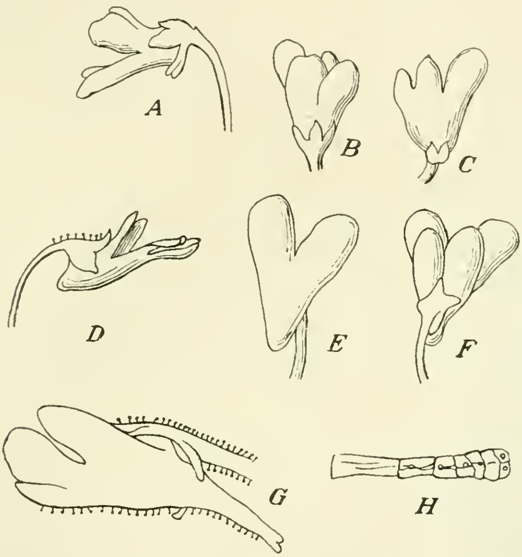


Fig. 10. *Pinguicula vulgaris.*

A—C, A flower, seen from different sides; it had two rudimentary anthers, but the pistil was normal. *D—F*, A flower with only one anther; the pistil was normal; *D*, Side-view; *E*, front-view; *F*, back-view. *G*, A flower with a spur, slightly divided into two parts. *H*, A hair from the inner side of the corolla. *A—F*, From Tromsø; *G—H*, From Godhavn in Greenland (E. W.)

thickly covered with germinating pollen (Fig. 9, *B*, *C*, *D*). According to all investigators only very few insects visit the flowers of *P. vulgaris*, and in the arctic countries, where larger insects are fewer in number than in other regions, the necessity of self-pollination must be exceedingly great. This agrees very well with the usual explanation of the biological circumstances in arctic countries: that self-pollination is, as first mentioned by Warming, very common here.

The hairs in the inner parts of the flower and their distribution has likewise been described in detail by Warming. I shall only mention the different types which occur: 1) Glandular hairs, but the glands are not sessile, as they are found to be on the foliage-leaves. Morphologically these hairs probably correspond with the long glandular hairs of the leaves (Fig. 9, *F*). 2) Fig. 10, *H*. These hairs are likewise multicellular; sometimes there is an indication of the development of a glandular head. 3) Short cylindrical papillæ, mere prolongations of the epidermis; these are found in the spur only (Fig. 9, *E*). The importance of these hairs is yet unknown, their secretum is mucilage, as far as investigated. According to Stadler their secretum serves as an alluring matter for insects, at any rate in *P. alpina*; this species being wanting in honey. It does not seem to be very wrong to use this explanation regarding all the hairs in the flower of *Pinguicula*. The flower is visited by small insects, which are however valueless to it, and are found dead in the spur. Among the small animals, found in the inner parts of the flower, Warming mentions a *Rotatoria*, a circumstance, taken by him, however, to be a mere casualty. In flowers from Denmark I have observed a great many indeterminable parts of chitin, as well as wings, parts of legs, small *Homopterae*, *Acarinae*, etc., together with some black, indeterminable masses of organic nature; in the arctic specimens I have found the latter only. The above-mentioned contents of the spur seem to support Stadler's views.

Further it must be mentioned, that deformations are often found in the flowers of the arctic specimens of *P. vulgaris*, some examples are figured in Fig. 10; whether the arctic type is different from the temperate one on this point I cannot say, but it does not seem to be probable. Other examples are mentioned by Rosenvinge (1896 a.)

In specimens from Denmark and the Færöes Rostrup has found an *Ustilago* (*U. Pinguiculae* Rostrup); this I have not observed in arctic specimens.

Pinguicula alpina L.

Doll, p. 383. Wydler, 1851, p. 420; 1857, p. 607. Hildebrand. Müller (1893) 1881, p. 352. Winter, p. 78. Klein, 1883, p. 163, tab. IX & X. Warming, p. 27. Stadler, p. 51. Loew, p. 53. Norman, p. 863. Sylvén, 1906.

Materials in alcohol from northern Scandinavia.

In arctic regions this species is found mainly in the same localities as *P. vulgaris* and often growing together with the latter; perhaps it goes a little higher above sea-level in Scandinavia, to about 1000 m (Norman). According to Klein it exists in two varieties, a yellow-green one and a more reddish one; to separate these in my Scandinavian material has been quite impossible. The shoot-structure has been mentioned under *P. vulgaris*. In a biological respect (Fig. 12) it behaves somewhat differently from *P. vulgaris*. The arrangement of the genitals however is the same as in the latter, but self-pollination is prevented by a slight protogyny. It is visited by flies, on the whole the visits of insects are much more frequent than in the two other species, both the yellow spots on the underlip and the wider entrance to the spur and to the genitals serve as honey-guides. According to Müller it is a "Fliegen-Klemfallenblume." Honey is absent, but its part is performed by the mucilage, secreted by the glandular hairs in the inner part of the flower (Stadler).

Fig. 11. *Pinguicula alpina.* Richly flowering specimen. Plateau de Murnau (Haute-Bavière). May. About 3/4 natural size. (H. E. P. phot.)

In *P. alpina* Winter found an *Ustilago*; this I have not observed in any Scandinavian specimen.

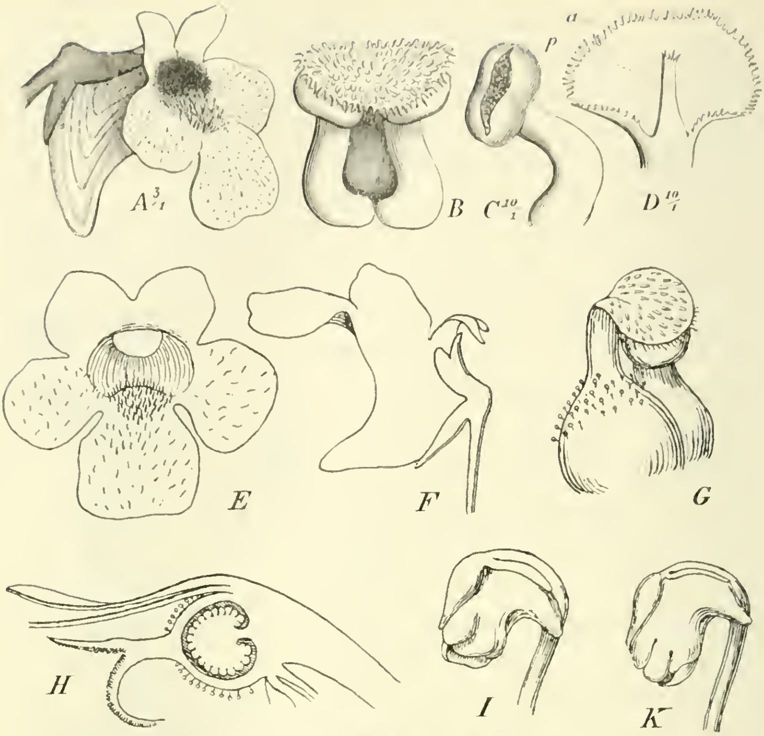


Fig. 12. *Pinguicula alpina.*

A, Flower; the entrance is drawn not wide enough (cf. *E*). *B*. The pistil and the anthers are almost covered by the stigma. *C*, An anther in act of dehiscence. *D*, The stigma, back-view. *E*, A flower, front-view (7/2). *F*, The same, side-view (5/2). *G*, The pistil and the one anther; the foremost anther has been removed (10/1). *H*, Longitudinal section through pistil (10/1). *I* and *K*, Rudimentary flowers; the anthers were open, the pollen-grains were filled with amylum (3/1). All the specimens are from Tromsø (Norway), June 28. (E. W.)

Pinguicula villosa L.

Wichura, p. 419. Axell, p. 44. Lange, 1880, p. 72. Warming, p. 27. Goebel, p. 116. Loew, pp. 89 og 116. Norman, p. 867. Sernander, p. 351. Sylvén, 1906.

Materials in alcohol from northern Scandinavia.

This species is in a higher degree than the two preceeding ones confined to moist localities, its habitat always being the water-filled substratum of the *Sphagnum*-cover. The rosette has but a few leaves, usually only two or three leaves are able to function, on the whole the plant is smaller and weaker than the two other species (Fig. 14, *A*). The main characters of its shoot-structure have already been mentioned under *P. vulgaris*, it only remains to mention a circumstance pertaining to its manner of growth, caused by the more or less rapid growth of the *Sphagnum*. As the plant is always struggling with this factor, it is compelled to develop shoots with more elongated internodes than is *P. vulgaris*, which grows on a more solid substratum.

In spring the plant grows with elongated internodes, until it gets above the *Sphagnum* and reaches the light, when it develops its rosette. The tension in the leaves of this species being undoubtedly very weak, the plant must be forced upwards during the summer almost exclusively by the *Sphagnum* pressing on its stem and leaves, until the the winter-bud develops and the foliage-leaves decay totally; then the *Sphagnum* grows forth and covers the plant for the winter. The manner of growth is here quite similar to what is known from *Drosera* (cf. Th. Nitschke: Wachsthumsverhältnissen d. rundblättrigen Sonnenthaues. Bot. Zeit, 1860, p. 57). Only when the plant does not at first reach above the *Sphagnum* during its growth by elongated internodes is the case then somewhat different (Fig. 13). The plant will then develop flowers without having formed a spring-rosette, and the rejuvenating shoot will develop with elongated internodes, instead of forming a winter-bud at once. Later on, when the growth of the *Sphagnum* diminishes, the rejuvenating shoot develops a winter-bud at its apex, at a proper distance from the surface of the *Sphagnum*. By this

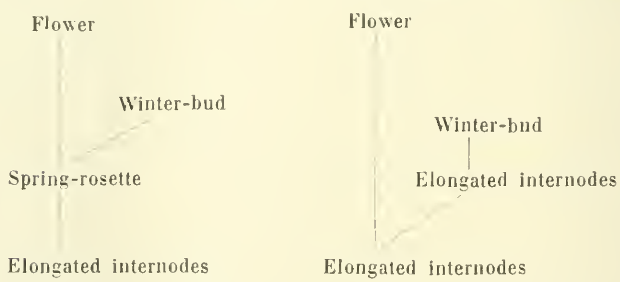
Fig. 13. *Pinguicula villosa.*

A plant, which in spring did not reach above the Sphagnum, and therefore has not developed its spring-rosette; the rejuvenating shoot has formed elongated internodes instead of forming a winter-bud. Not before the shoot reaches to a suitable depth below the Sphagnum-surface, will the winter-bud develop. The plant belongs to those which are unfitted for the struggle for existence. Luleå Lappmark, Quickjock, July. About $1^1/_2$ nat. size (F. H.)

arrangement it gains a possibility of reaching above the *Sphagnum* in the following year. That the phenomenon is not, as I at first supposed, caused by the influence of climatic factors on the plant, will be evident by the fact that it has only been observed in a very few specimens in all the collections from different places in Scandinavia, and to draw a geographical line between the two types, as I have tried to do from the mentioned supposition, and as I have done with *P. vulgaris*, is quite impossible here.

These specimens I can only regard as those which are unfitted for the struggle for existence, and this agrees very well with the fact that they are found mingled with the others, both in arctic and temperate regions.

Diagram of the manner of growth of *P. villosa.*



I. *P. villosa*, normal manner of growth.

II. *P. villosa*, constantly overgrown by the *Sphagnum*.

The leaves are very concave, often the edges are bent so closely together that the leaf is formed like a channel (Fig. 9, *A*). — As to vegetative propagation, I have, in spite of the rich material at my disposal, only observed it a very few times; from the lower parts of the rhizome, probably from the spring-rosette of the preceding year, a few shoots with elongated internodes had developed. But, as a whole, vegetative propagation is very scanty. Concerning the number of flowers, I never saw more than one flower in the same period of growth. The biology has been treated by Warming; also as regards this species I can but confirm the facts already known. *P. villosa* is distinguishable in some main characteristics from the other

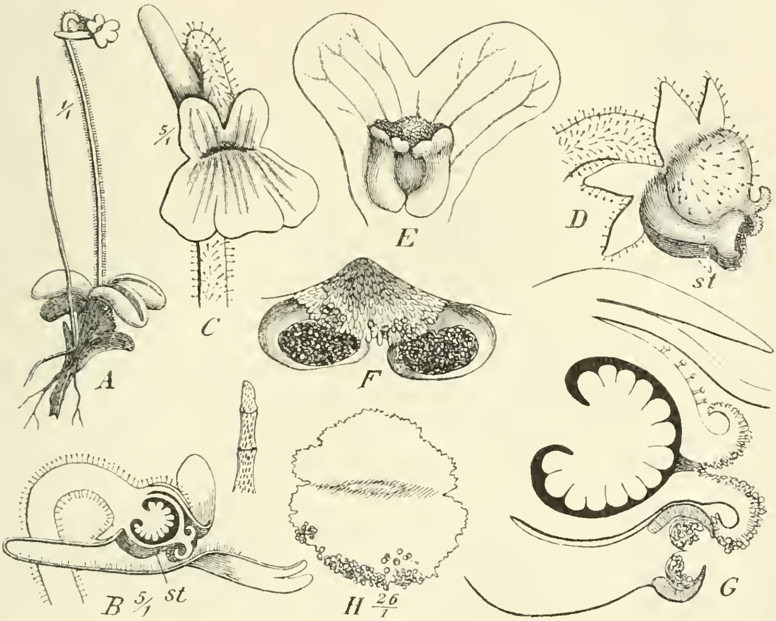


Fig. 14. *Pinguicula villosa.*

A, A plant (nat. size). *B*, Longitudinal section through flower; *st*. an anther. *C*. A flower, front view; the hairs of the lower lip are omitted. *D*, Pistil and anthers (*st*); the corolla has been removed. *E*, The upper lip with the pistil and the anthers. *F*, Within the upper lip the foremost part of the stigma and the anthers are seen from above. *G*, Longitudinal section, somewhat oblique, through a flower; the one anther is shown in section; the fibrous layer is indicated; the greater part of the pollen-grains has fallen out; the foremost part of the stigma has rolled backwards down to the anthers. *H*, The stigma, seen from above; the downward lobe is the foremost one. *I*. A hair from the middle part of the lower lip. Bosekop, July. (E. W.: 1886).

two species. The hindmost part of the stigma is always well developed, usually, however, it is smaller than the foremost one (Fig. 14, *H*.) According to Warming this fact proves that *P. villosa* represents a more primary type than the other two. Both parts of the stigma are furnished with papillæ on their upper side and are more or less bent backward (Fig. 14, *G*).

The foremost one is relatively much larger than that of *P. vulgaris* and *P. alpina*, and does not, as is the case with these species, cover the anthers (Fig. 14, *F*—*G*). The isolated upper lip with the genitals seen from the front shows the whole of the anthers,

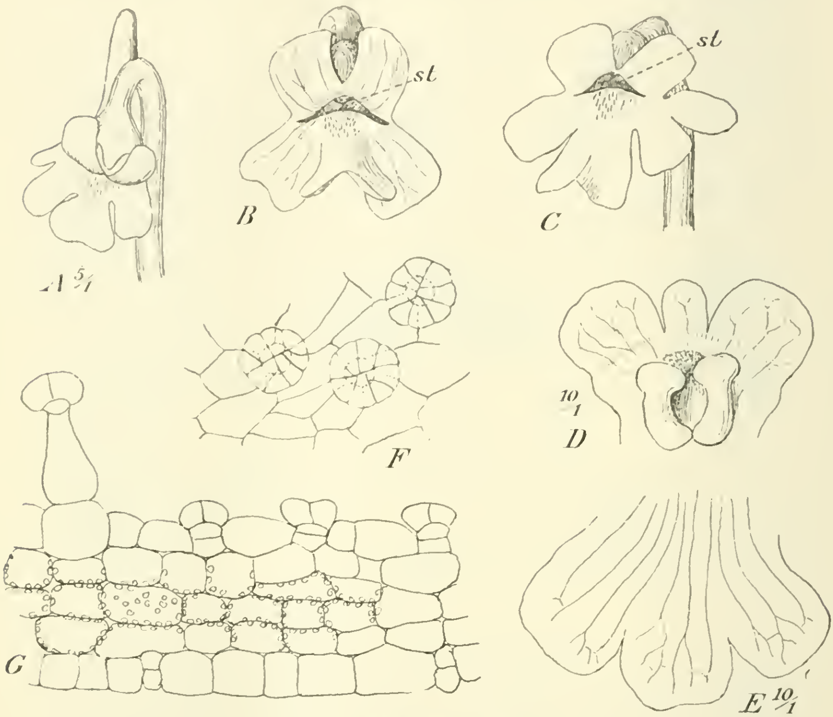


Fig. 15. *Pinguicula villosa.*

A—*E*, Different examples of deformed flowers; *st*, the anthers. *F*, Glandular hairs from the upper side of the foliage-leaf. *G*, Transverse section of a foliage-leaf. Bosekop (Norway). July. (E. W.)

and above them the stigma (Fig. 14, *F*). It has been proved that the subsidence of the foremost part of the stigma into the pollen results in the germination of the pollen-grains deposited thereon. On the whole, the pollen germinates very readily. Warming mentions his having found it germinating in different parts of the flower, and my investigations prove

Fig. 16. *Pinguicula villosa.*
Two specimens with an indication of inflorescence. Luleå Lappmark, Quickjock, Snjärrak, July. About 3/4 natural size. (H. E. P. phot.)

the same. Self-pollination seems thus to be a normal arrangement in *P. villosa.*

The hairs in the inner parts of the flower are as regards shape like those in the two other species, but as regards distribution and number they seem to be a little more scanty. As the figures show, deformations in the inflorescence as well as in the flower are found in this species (Fig. 15—16).

Summary. Finally in order to sum up in a few words the characters — both morphological and biological — which distinguish the arctic type of *Pinguicula* from the temperate one, the scheme should be as follows:

1. Reduction of the rejuvenating shoot.
2. Limitation of vegetative propagation.
3. Narrower and shorter leaves.
4. A smaller number of flowers.

5. A shorter inflorescence.

6. A greater possibility of self-pollination.

The ordinary type contains *P. alpina* and the temperate type of *P. vulgaris*, the arctic one, on the other hand, contains *P. villosa* and the polar-type of *P. vulgaris*.

As already mentioned, experimental culture alone will be able to prove whether the arctic characters are constant in the plants in question. Hypothetically, I have suggested that this will be found in *P. villosa*. In case such experiments give positive results in regard to the main points as regards *P. vulgaris*, we should be justified in classifying the arctic type, here mentioned, as a special variety, named *P. vulgaris, var. arctica*, but scarcely before this occurs.

Postscript to the chapter on Morphology and Biology. Since writing the previous chapter I have become acquainted with the following description by Alice Eastwood in "A descriptive List of the Plants collected by Dr. F. E. Blaisdell at Nome City, Alaska" (Botanical Gazette vol. XXXIII, 1902, p. 293):

"*Pinguicula arctica*, n. sp. — Leaves rosulate, glabrous, apparently fleshy, broadly ovate, sessile, obtuse, 1—2 cm. long, 5—8 mm. wide; scape purple, glabrous below, glandular-pubescent above, 1-flowered, 7 cm. high; calyx 2-lipped; upper lip of 3 deltoid divisions half as long as the lip, the sinus acute; lower lip narrower, with 3 shorter teeth and obtuse sinus one-third as long as the division; corolla purple, 11 mm. long, hairy within, with club-shaped hairs that extend to the lobes of the upper lip; lobes 3, orbicular, 4 mm. across; lower lip of 2 similar but shorter lobes; spur slender, tapering, 7 mm. long; stamens 2, with filaments dilated at base, nearly 2 mm. long, surmounted by capitate anthers; ovary orbicular, glabrous; stigma of 2 white broad plates, thin in texture.

This appears to be near *P. vulgaris*, but the corolla is of different shape and hairy within, while the spur is longer."

I cannot conclude my report on the morphology and biology of the two types of *Pinguicula* mentioned in this paper, without taking a stand as regards *P. arctica* A. Eastwood. It appears to me that the eagerness for finding new species, which is growing so rapidly in our days, may without injury to the future development of Botany be restricted considerably — at any rate we may be justified in demanding that it shall be kept within the limits of common sense. The features, in which *P. arctica* is said to distinguish itself from *P. vulgaris*, namely the shape and hairiness of the corolla and the length of the spur, are so uncertain and variable, that no careful investigator ventures to use these as a basis for the creation of a new species. The above-mentioned author does not know any of the features, which I have found peculiar to the arctic specimens of *P. vulgaris*, and in which they agree with the purely arctic species, *P. villosa*. I cannot believe that it will be possible to disregard these features totally, when a new arctic species of *Pinguicula* is to be created. Although "P. arctica" is our ultimate object, this has not yet been attained — either by Alice Eastwood or by any other investigator.

II. Physiology.

Linnæus, p. 10. Withering, p. 18. Darwin, p. 279. Morren, 1876 a; 1876 b. Pfeffer. Tischutkin, 1889, p. 346; 1891, p. 33. Goebel, p. 181. Fenner.

At first, as is well known, the genus *Pinguicula* was placed by Ch. Darwin in 1875 among the so-called insectivorous plants. Already long before this time the mucilagenous secretum of the leaves had been observed; further, it was known, that the secretum was able to cause the coagulation in milk (Linné, Withering), and the plant has moreover been used medicinally. Buchenau supposes that the glandular hairs found on the leaves of the autumn-rosette, and especially the long, non-glandular hairs of the leaf-stems. serve to protect the winter-bud against the attacks of insects. Ch. Darwin was the first to make experiments here, and later on, his eminent works on this subject were followed by those of several other authors. Among these I must content to refer the reader to Goebel's on *P. vulgaris*, Klein's on *P. alpina*, and Warming's short remarks on *P. villosa*. Differing from the others are Tischutkin's works on the micro-organisms contributing to the process of digestion in *Pinguicula*, and though his views have already been strongly disputed, there would be some reason for making experiments of digestion in the arctic countries, where the activity of the micro-organisms is known before-hand to be very small. On the whole all earlier investigators of arctic plants have strangely enough passed by in silence the question of studying the processes of life in the arctic regions; that physiological experiments in themselves will not alone contribute highly to the knowledge of the economy of the arctic plants, but should also be the basis, on which the anatomical structure of the plants in question should be studied, I shall consider in a following chapter. Experiments on assimilation, respiration, transpiration etc., together with several quantitative analyses of the different parts of the plant certainly demand other abilities than those hitherto employed in the arctic botanical investigation, but seen from a merely historical point of view it is undubitable that the study of the ecology of the arctic plants will ultimate in an unnecessary period of dormancy, if the interest for this science does not create a new basis for it on physiological experiments.

With regard to the insectivorous plants the question on the importance of the digestion of insects, and the relation between the latter and the other physiological processes will

Synopsis of *Arthropoda*, caught by the arctic species of *Pinguicula*.

Species	Locality	Diptera	Homoptera	Thysanura	Araneïna	Acarina
P. vulgaris	Greenland (Kingua-Knanersok) July, 1895	Chironomus sp. Sciara sp.		Achorutes sp. A. humicola Isotoma sp.		Erythræus sp. E. phalangioides var. gracilipes. Oribata sp. Bdella sp. Notaspis sp. Trombidium sp. Leiosoma sp. Nothrus sp.
P. vulgaris	Greenland (Ekaluit, Ameralik) July, 1895	Chironomus sp. Phytomyza?		Achorutes sp. Isotoma sp. Lipura sp.		Erythræus phalangioides var. gracilipes. Oribata sp. Bdella sp. Notaspis sp. Trombidium sp. Scutovertex sp ?
P. vulgaris	Greenland (Kingua Arpiksuit) July, 1890	Chironomus sp.		Achorutes sp. Lipura sp.	Thanatis sp.? Theridlum sp.	Oribata sp. Hypoaspis sp.?
P. vulgaris	Norway (Tromso) 1885	Mycetophilus sp.?	Deltocephalus lividella (Larva)	Isotoma sp. I. viridis		Erythræus sp. Erythræus phalangioides var. gracilipes. Trombidium sp.?
P. alpina	Norway (Tromso) July, 1883			Isotoma sp.? I. viridis		
P. villosa	Norway (Bosekop) 1885			Achorutes humicola. Isotoma viridis.		
P. villosa	Norway (Vårstien, Kongsvold Dovre) July, 1878	Chironomus sp.		Achorutes sp. Isotoma sp. I. viridis Lipura sp. Lepidocyrtus sp.		Trombidium sp.

further arise; but here we still want the necessary preliminary works from the temperate regions; the investigations hitherto made to clear up the most important question regarding the knowledge of the insectivorous plants cannot be used as a basis for arctic ecological studies. (Kellermann & v. Raumer, F. Darwin, M. Büsgen, etc.) —

A synopsis of the animals which serve as nourishment for the insectivorous plants in the different regions will perhaps be not quite without interest in the judgement of their economy; as far as I know, there has not previously been published anything save scattered and unsatisfying remarks on this point (Ch. Darwin, O. Penzig, Klinggraeff, etc.) The following synopsis is the first essay in the said direction, but naturally it is too defective to be able to afford a basis for any kind of judgement.

III. Anatomy.

Pinguicula vulgaris L. and Pinguicula alpina L.

Klein, 1880, p. 1401; 1882, p. 60; 1883, p. 167, tab. IX & X. Russow, p. 417. Van Tieghem & Douliot, p. 279. Dangeard & Barbé, 1887, p. 307. Dangeard, 1888, p. 260. Hovelacque, 1888 a, p. 262; 1888 b, pp. 641 & 713. Fenner.

The merely descriptive part of the anatomy of *P. vulgaris* has been treated so fully as regards the temperate type, that new facts can scarcely be added, and the differences between this and the arctic one seems so small, that, from a mere anatomical investigation, they appear to be alike. Also *P. alpina* and *P. villosa* (Fig. 15, *G*) do not present features which at the present time can be connected with the conditions in the arctic countries. But from this we do not venture to conclude that in the economy of the plants there are not found circumstances caused by the influence of climatical factors, and that the arctic specimens in their anatomical structure are wholly like the temperate ones. The reduction in the rejuvenating shoot, mentioned in the first chapter, makes it precarious to us to stop at such an explanation. The plant being able to adapt its shoot-structure to a short arctic period of growth, it will be unreasonable to allow that no other elements in its organisation were marked by special arctic characters. When the merely anatomical investigation is not capable of giving a direct answer to this question, it will be the most natural way to make physiological experiments and use them as a basis for the judgement of the anatomical characters.

"Numbers are the metrical feet of science" says Raunkiær, and it can hardly be doubted that the ecological studies will profit by a closer co-operation between physiology and anatomy, especially as these two sciences are not at present foreign to one another. When using in ecology exact physiological experiments as a basis, we are led to a wider view on the anatomical structure and to a greater continuity between the single facts of the latter, while it must be regarded as also quite settled, that such experiments will direct attention to several small features, to which no special value has hitherto been ascribed or which have been quite overlooked.

When I thus refrain from giving details as to the anatomical structure in the arctic species of *Pinguicula*, it is owing to the reason that for the present I can only state that they in every way agree with the temperate ones, and this I think is not in harmony with the facts; the fault is to be found, in this case, in the method, hitherto used, and the time for giving a minute judgement of adaptation to the conditions in the inner structure of these plants cannot arrive, before it can be made on a substructure of physiological experiments, performed in the regions, where the said plants are indigenous.

6 2 1912.

DANMARK-EKSPEDITIONEN TIL GRØNLANDS NORDØSTKYST 1906—1908 · BIND III · NR. 13

SÆRTRYK AF »MEDDELELSER OM GRØNLAND« XLIII

SOME NOTES

CONCERNING

THE VEGETATION OF GERMANIA LAND

NORTH-EAST GREENLAND

BY

ANDR. LUNDAGER

WITH A MAP (PL. XVII)

KØBENHAVN

BIANCO LUNOS BOGTRYKKERI

1912

I. Climatic conditions at Danmarks Havn. 1906—1908.

Temperature. The mean temperature in the first year was — 13.1°, in the second year — 12.0°, for both years — 12.6°. (According to MOHN's chart of the isotherms of the year it should be about — 12.0°; the Germania Expedition gives — 11.7° for the Island of Sabine).

The mean temperature and the extremes for the months were: —

	1906					1907						
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July
Mean....	+ 2.1	— 3.7	—14.5	—21.0	—24.6	—23.0	—26.0	—23.7	—19.4	— 8.2	+ 1.1	+ 3.3
Maximum	—	+10.2	+ 0.2	— 8.5	—12.2	— 3.4	—16.4	—12.4	— 9.1	+ 5.0	+ 7.7	+12.3
Minimum	—	—13.0	—23.8	—34.0	—34.4	—36.4	—35.9	—40.9	—30.1	—22.0	— 7.5	— 2.0
	1907					1908						
Mean....	+ 2.3	— 4.4	—14.6	—19.7	—17.2	—20.8	—28.9	—21.1	—19.6	— 6.4	+ 1.1	+ 5.4
Maximum	+12.2	+ 2.8	— 2.5	— 9.4	— 0.6	— 6.6	—20.4	— 1.4	— 3.5	+ 3.0	+11.6	+17.1
Minimum	— 6.0	—14.5	—23.3	—32.1	—33.8	—33.5	—38.3	—36.2	—33.7	—22.3	— 9.3	—

The seasons of the year: —

Autumn (Sept.—Nov.).... — 13.0
Winter (Dec.—Feb.)..... — 23.4
Spring (March—May).... — 16.4
Summer (June—Aug.)... + 2.6

Number of days on which the mean temperature was above 0°: —

Aug. 06—July 07... 89 days
Aug. 07—July 08... 76 —

Days without frost: —

Aug 06—July 07... 31 days
Aug. 07—July 08... 38 —

Days with frost (temp. usually above 0°, but minimum below or = 0°): —

Aug. 06—July 07... 73 days
Aug. 07—July 08... 69 —

Ice-days (temp. constantly below 0°): —

Aug. 06—July 07.. 261 days
Aug. 07—July 08.. 259 —

N.B. Reasonable values have been calculated and added to compensate for the first half of Aug. 1906 and for the latter half of July 1905, both of which were wanting, so that the figures, throughout, apply to complete years.

Precipitation in mm. of water (based partly upon measurements and partly upon a rough estimate).

The totals for the months and the years: —

	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Year
1906—07	0.0	6.0	10.7	13.6	20.3	27.1	23.5	23.1	4.4	2.8	10.2	1.9	143.6
1907—08	16.1	8.9	2.2	38.3	17.4	33.9	11.5	12.7	0.8	5.0	0.6	0.0	147.4
(The figures must not be regarded as strictly accurate.)													
Mean...	8.0	7.4	6.4	26.0	18.8	30.5	17.5	17.9	2.6	3.9	5.4	1.0	

Summer (April—Sept.) 28.4
Winter (Oct.—March) 117.2

Consequently, 4/5 of the total amount of precipitation must be reckoned to the winter half-year. Not even 1/10 of the precipitation of the year falls as rain.

The first rain of the year fell in { 1907 on June 25; 1908 - — 17 }

and the last rain fell in { 1906 on Sept. 25. (Very exceptional; the temp. of the air being —10°.); 1907 - Aug. 22 }

Number of days with downpour.

	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Year
1906—07...	0	9	11	9	11	14	12	13	7	7	8	6	107
1907—08...	12	2	5	15	16	21	8	9	5	10	4	0	107

According to the seasons of the year: —

	1906—07	1907—08
June—Aug.	14	16
Sept.—Nov.	29	22
Dec.—Feb.	37	45
March—May	27	24
Summer (April—Sept.)	37	33
Winter (Oct.—March)	70	74

Consequently, the winter half of the year has twice as many days with downpour as has the summer half of the year.

II. Vegetation-conditions.

When the Danmark Expedition arrived at Cape Bismarck in the middle of August 1906, it was already autumn from a floristic point of view. During the excursions to Stormkap and Hvalrosodde at the end of the month, it was only late-flowering species which were found just in the act of expanding, or else those, whose flowering-period extends over the whole of the summer according to the different localities in which they occur. Among these may be mentioned especially *Ranunculus glacialis* on damp gravelly flats beneath the melting snow-drifts (*Dryas octopetala* also, in part), as also *Pedicularis hirsuta, Ranunculus sulphureus* and *Papaver radicatum*. In damp river beds *Oxyria digyna* is usually conspicuous, with its red leaves and purple-coloured nuts.

The *Dryas*-tufts are standing quite brown upon the primitive rocks and are so dry that the leaves crumble between the fingers; at the same time — on August 24 — still luxurious mats of *Dryas* are to be found upon a slope with a southern aspect where the melted snow of drifts from higher altitudes provides sufficient moisture for the nourishment and necessities of life of these stragglers. *Cassiope tetragona*, also, has now finished flowering and is quite brown and dry. Along the large Lakseelv, on the northern side, near high-water mark, *Saxifraga oppositifolia* stood in full bloom, as also a few individuals of *Taraxacum phymatocarpum* and *Lesquerella arctica*. The *Cyperaceæ* also have finished flowering and are withering except near the water-courses. In a few damp places a flowering specimen of *Silene acaulis* may yet be seen and near the shore, *Statice armeria*; but a little higher up that also is decaying.

Upon Fuglenæbsfjæld, at an altitude of about 300 metres, *Arnica alpina, Potentilla nivea* and *Melandrium affine* were found in flower, while *Stellaria longipes* had not yet reached that stage. The locality was a rock-ledge with a humus-like substratum, south-east exposition and sheltered towards the north and west. Upon a level gravel-field percolated by melting snow, *Saxifraga oppositifolia* was found flowering; not until then, when it was released from its snow-covering, did it have its spring.

As seen from the table (p. 350), the amount of precipitation is on the whole inconsiderable, but least during spring and autumn.

On September 18, 1906, the percentage of moisture in the air was recorded to be 44′. The result of a dry autumn is thorough desiccation of the soil before the snow-covering comes, and this circumstance is of vital importance to the vegetation. Not until September 24 does snow come, and the temperature is constantly relatively high. The minimum, — 13.0° — is not reached until the end of the month; no regular snowstorm occurred until October 22nd.

At New Year there is only a thin covering of snow in the district around Danmarks Havn.

All the level areas of the rocky flat proper are nearly free from snow, and consequently the vegetation there has no protection against the wind and weather. It is of common occurrence that the winter snow is carried away by the wind and forms drifts on the leeward of rocks. From the level ground on the rocky flat the snow disappears almost entirely after the first storm of wind which closely follows the snowfall when it does not accompany it; at any rate in such places the snow does not remain long enough to confer humidity upon the soil during spring. In bogs and meadows, in so far they may be called meadows, the circumstances are somewhat different; here the snow finds shelter and is able to form a rather considerable layer, the thickness of which varies according to the character of the vegetation. In places where the latter is dense and covers the ground entirely, the uppermost dead apices of grasses and Cyperaceæ protrude above it and lie prostrate upon its surface in the direction of the prevailing wind, NW.—SE. Where the ground is uneven by erosion and has isolated boulders, the surface appears dark seen from the NW. while the snow is lying on the leeward towards the south. Everywhere along the hill-sides large snow-drifts occur, and they condition the life of the vegetation upon the more level areas lower down, *Eriophorum*-bogs (Fig. 1) being usually formed if the gradient is favourable, so that the water may find outlets. Above such bogs, areas are often found which are not laid bare by the melting of the snow until late in summer, and there a barren slush of clayey mud only is formed.

Inwards in the bay, on Hvalrosodde which I visited on January 4, 1907, the extensive area along the river is also free from snow. It consists of moraine formations with an almost level surface, of which the entirely flat areas are quite snowless; here *Statice armeria* stands quite unprotected. Only the small channels formed by melted snow afforded a shelter for the snow beneath which *Cassiope* lies

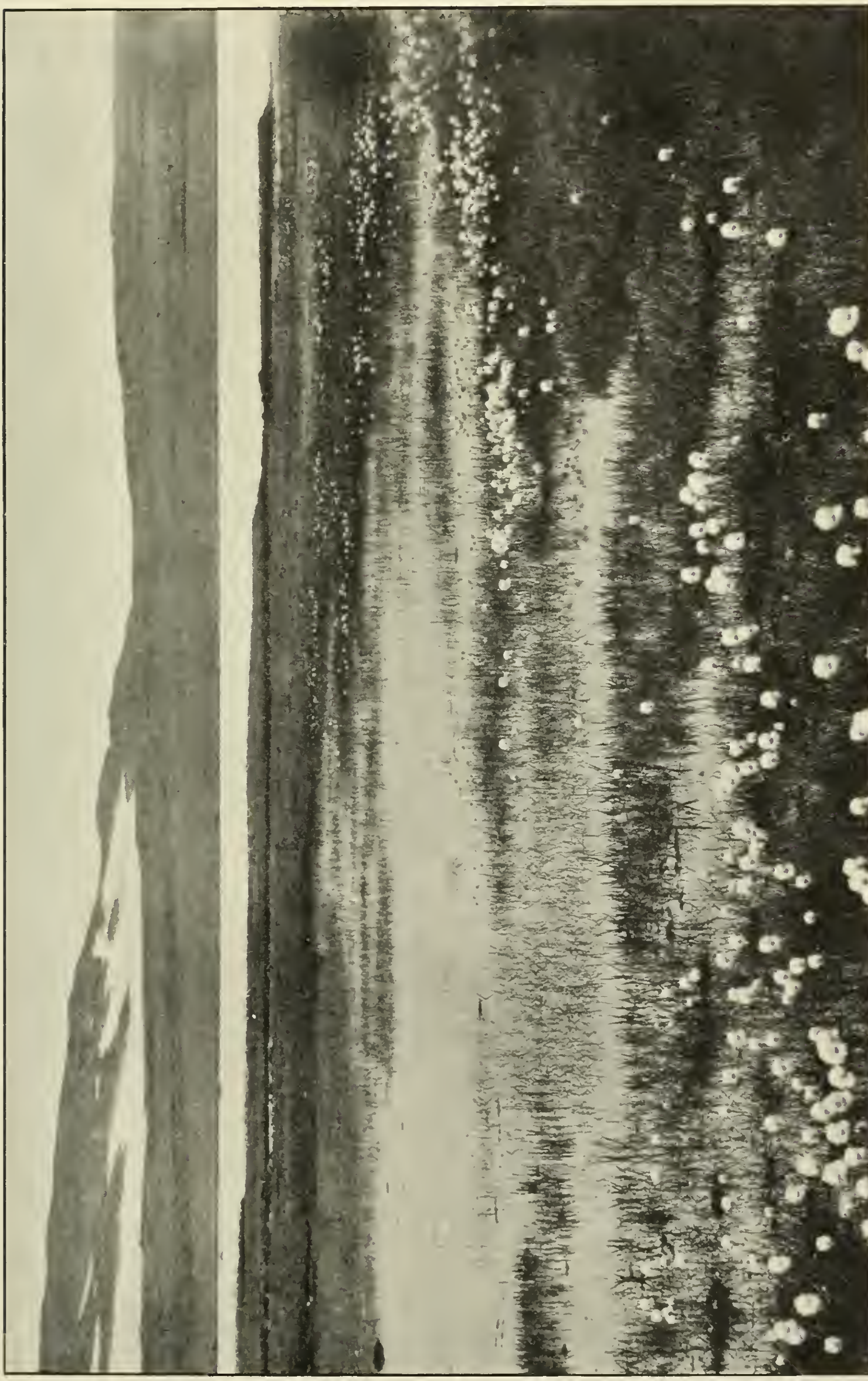


Fig. 1. Landscape to the north-west of Danmarks Havn. Varderyggen, with remains of snowdrift in shelter, is seen in the background.

in its winter-sleep. At Hvalrosodde the gravel and the sand is so dry and loose that the frost is not able to bind it.

On January 7, 1907, the ground is for the first time covered by loose snow — everywhere.

On April 5 the Snow Bunting arrived; but not until the 23rd can the weather be said to have grown milder. On that day I saw two Buffon's Skua in the bay betwen Cape Amélie and Cape Marie Valdemar. Off Isle de France there was open water.

Even now evaporation is in full activity and consequently the mountain darkens from day to day.

On May 24 we have for the first time a positive temperature; six days afterwards the thermometer records above 0° at all three readings.

At the end of May, with the commencement of the higher temperature, we have also other common spring phenomena; small gatherings of water begin to appear in Basiskær and on the 20th, *Saxifraga groenlandica* flowers on Termometerfjeld — beneath a "pane" of ice.

From Hvalrosodde open water is recorded along the shore of a lake near Lakseelv. At Danmarks Havn, before June, only a few boulders had become visible by the melting of the snow along the margin of Drikkevandssø.

On June 4 *Saxifraga oppositifolia* is in flower, but only here and there and not quite expanded. The next day it is found flowering commonly at Stormkap, and on the same day flowering individuals are also met with at Termometerfjeld.

There are now in a great many places small, open tarns, where wading birds rest in their journey.

In the night previous to the 3rd of June the large flight of birds occurred just at the point of time when the door of the cupboard was thrown wide open. As we know, these pools contain swarms of living creatures such as larvæ and other creeping things which condition the existence here of small wading birds. It is quite a peculiar experience to be out on a night when the flight of these birds takes place. The air is full of the music of their notes and of the whirr of wings. I was on my way to Stormkap in the night in question with a hand-sledge, so for several hours I had a good opportunity of hearing the winged crowds as they made towards land to their breeding places, where the flocks separate.

Out on the ice a bear was lying with its two cubs and was devouring a seal which it had caught at a breathing-hole. This meal was watched over with apparent interest by foxes and ravens, and spying gulls who, seated upon the neighbouring icebergs, waited for the moment when the lawful owner of the prey should retire.

On the 4th the minimum thermometer recorded for the first time a positive temperature; soon afterwards we had east winds which again for some days brought the thermometer down below freezing point.

On June 10 we have snow and wind with a high, almost positive, temperature the whole day.

Under such circumstances the snow which has fallen benefits the whole surface of the ground, as it is now allowed to melt where it lies. Seen from Termometerfjeld the ground down towards Skibshavn was white at noon; but before long the soil, already somewhat thawed and sun-heated absorbs the melting snow. In contradistinction to a considerable part of the winter-snow, which disappears by evaporation early in spring and leaves behind it only a dry bottom, this summer-downfall penetrates easily to the roots of the plants, which are just now in want of it.

On moss-tufts and other plant-carpets there is not the slightest indication of dampness from evaporating snow. But, on the other hand, the fresh verdure of both the moss and the lichen now show that they have benefited by the moisture from above. The boggy stretches are also now so far thawed that the plant-life there can begin to awaken; already some days ago drinking-water had been fetched from a small streamlet near Basiskæret.

The weather was also quite summer-like on June 13 when I made an excursion to Hvalrosodde. The surface was in a bad state a great part of the way and especially the last part where the melting snow had already formed large ponds upon the ice. In the bay off the mouth of Lakseelv the wind had covered the ice with a rather considerable layer of dust and sand from the lowland above and this furthers, in a high degree, the melting of the snow, so that both the number and the depth of the pools were greater here than farther from land. And the conditions grew perceptibly worse day by day. At 3 p. m. the temperature (measured by a swinging thermometer) was $+ 12.4°$. From the fore-shore (Fjæren) we had driven our sledges so far into the land, that they just touched the snowless ground; then we stopped to pitch our tents. But now the snow retired so quickly down towards the fore-shore that it was almost noticeable from hour to hour how the distance increased, and although, in the following days, we had fog and a lower temperature, yet several metres of the way to the ice was bare of snow when we left the place on the 17th.

In the lower part of the bed of the Lakseelv, which is at this point from 40 to 45 metres broad, the snow was yet lying deep, but there were a few pools here and there; higher up it appeared as if a single spot was free from ice and in this opening in the ice several swimmers (loons) lived.

In a pond formed from melted snow, the temperature of which measured + 16.4°, *Oxyria digyna* was seen with large, fresh, leafy shoots and a *Statice* with an almost fully developed flower-bud. On dry ground, on the other hand, *Oxyria* develops flower at the expense of its leaves — the reverse is found to be the case in *Statice*. In spite of the falling temperature, + 7.5° was measured at 8.30 p. m. in a larger lake. Around the tenting-place stood crowds of *Saxifraga oppositifolia* in bloom. At night the temperature went down to below 0°. The whole of the next day there was a dense fog, so dense that tent-ropes were covered with rime, and the swinging thermometer also became covered with ice during use; the following night the temperature went down to — 2.0°. Not until late in the day, on the 15th, did the fog disperse by a fresh breeze from the NW.

As it might be of great interest to see spring advance toward the head of the fjord I tried to reach Fuglenæbsfjæld, near a spot which I had visited at the end of August the previous year; but already off Rypefjeld, about 10 km. from Hvalrosodde, the sledge was stopped by a crack in the ice; and as it was not possible to proceed further by the sledge, I went ashore there. Upon sloping ground, copiously watered by melting snow, one of the usual *Eriophorum*-bogs was formed (Figs. 1, 2). Here masses of lumps of *Nostoc* were lying, and here *Eriophorum polystachyum* was found already in flower. Around Danmarks Havn the species was not seen flowering until the end of the month. Next day when I visited "Trekroner" I found *Draba arctica* (J. Vahl) in flower while it was not seen flowering at Danmarks Havn till the 22nd. As might be expected, these few features indicate an earlier spring in the interior of the fjords than down by the coast.

Unfortunately the conditions on the ice were such that they compelled me to retreat early so I had to limit my excursions to a single visit to "Trekroner" on June the 16th.

This rather formidable mass of rocks forms the eastern boundary of Sælsö; it consists of three elevations, separated by valleys, with surfaces consisting of boulders and large stones with intervening, flattened areas covered by the products of weathering. Strangely enough, I found up here *Trisetum*, which in the coastal region is only found on sheltered rock-ledges with a snow-covering of long duration. But a similar snow-covering may probably also be found

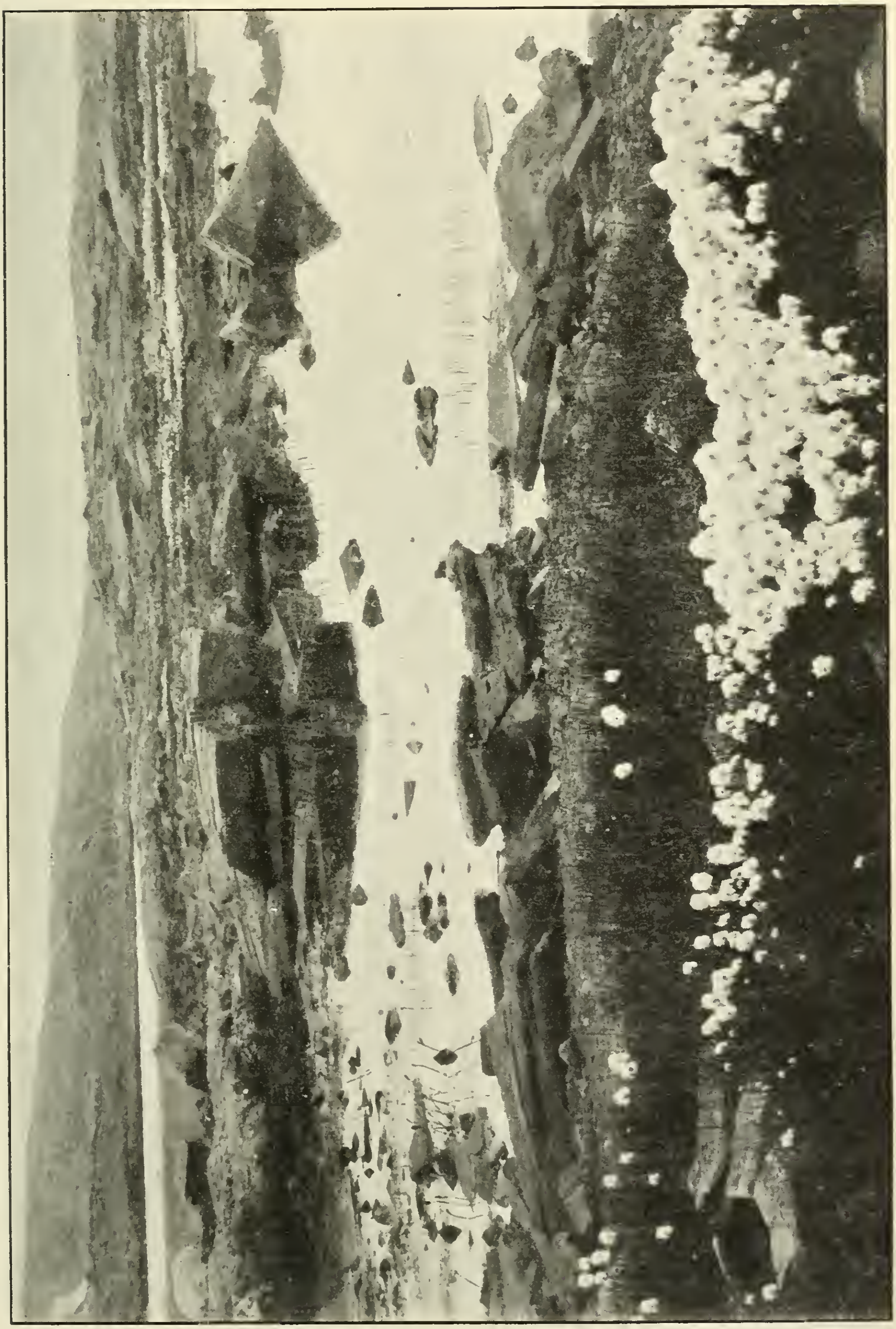


Fig. 2. View of a small lake with *Hippuris vulgaris* in the lake, to the left. In the foreground associations of *Eriophorum Scheuchzeri* and *E. polystachyum.*

here on the small patches of gravel in the shelter of larger and smaller loose stones. Upon the south-west side of the mountain, facing the lake, the most favourable conditions for the vegetation exist which can on the whole be found in the district traversed. Seen from a distance there is here in reality a vegetation which reminds one of heather-moors (cf. Warming, “Lynghede” in Meddelelser om Grønland, XII, 1887). *Cassiope* is the most dominant plant (Fig. 4); it imparts a dark tone to the rocks. At nearer approach the numerous, small rippling half-hidden streamlets from the more elevated snow-drifts are distinctly heard. Upon the rather steep rocky slope, where these tiny murmuring brooklets cut their way into the layer of moorland soil, one also meets with strips of continuous greensward, apparently consisting principally of species of *Carex* which, however, cannot be determined at this time of the year. If anywhere anything could be reminescent of “grassy slopes” (“Urteli”) it would be here where certain spots open a possibility for the formation of humus. A slight depression between the stones easily becomes filled with withered plant-remains and the dung of the hare and the ptarmigan — a fitting nursery for saprophytic fungi. When these loose materials are removed many tender young shoots, as might be expected, are found in a soil penetrated by plant-roots; but it is not the tender or the frail species which have here been permitted to occupy the best localities. So far as the contents of the spirit-jars from this locality could be determined, it was, as from the corresponding localities nearer the coast, *Campanula* and *Polygonum* which principally cover such relatively favourable small patches of the otherwise hard and poor rocky flat.

Besides the above-mentioned species, *Draba glacialis* flowered here on June 16; but already two days earlier it had been found flowering in Lambert Land (79° 8'). *Hierochloë* also stands here, broad and strong, with open anthers. In these dreary, poor surroundings its effect is very arrogant, like that of a giant of old descent who struggles for survival.

While I am busy with my collections a humble-bee buzzes noisily round me and a spider darts away frightened, being disturbed in its chase by my intrusion.

About the 20th several lakelets (Figs. 2, 3) are free from ice and spring has come to Danmarks Havn also. The small wading-birds are now nesting and in the lakes one encounters Long-taileds Ducks, Eiderfowl, Red-throated Divers and Brent Geese.

Although it may be said that *Saxifraga oppositifolia* is now in flower nearly everywhere, it is evident that it is a little behindhand in places where it is exposed to the north. *Saxifraga flagellaris* is

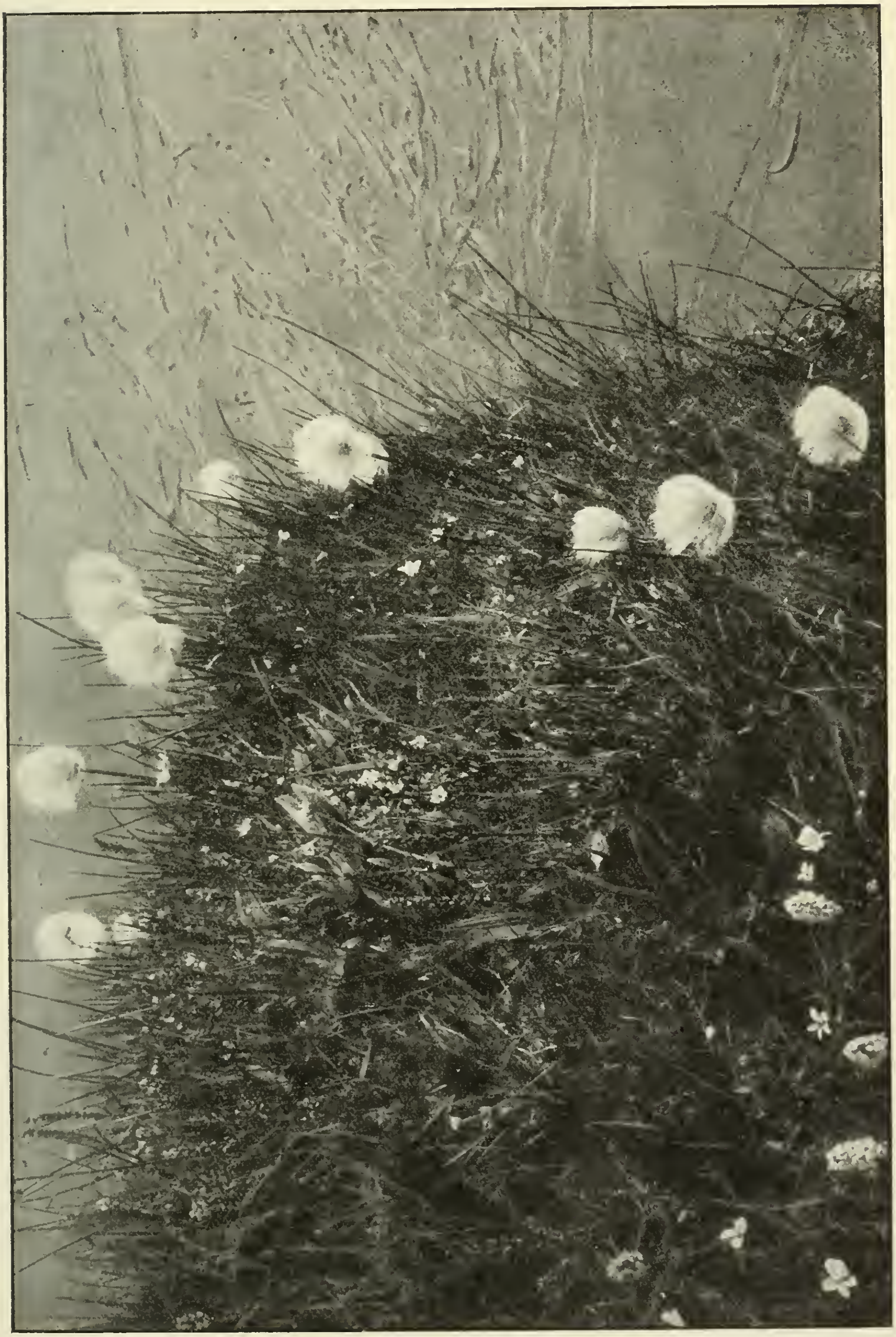


Fig. 3. *Polygonum viviparum, Eriophorum Scheuchzeri, Stellaria longipes, Alopecurus alpinus, Saxifraga cernua* and *Salix arctica* on the margin of a lakelet near Danmarks Havn.

also in flower on the 20th, and *Cerastium alpinum*. *Pedicularis hirsuta* peeps forth with its shoot-tops, woolly with white hairs, and appears to be somewhat behindhand here around Danmarks Havn, for already on the 22nd a flowering individual was gathered on Lille Koldewey, although it was not yet in flower on the main land. It was one of the few species, whose first flowering-period occurred later in the year 1908 than in the year before.

It appears as if spring comes earlier in the Island of Maroussia than around Danmarks Havn, at any rate, there are many circumstances which seem to show this; for instance, the *Melandrium triflorum* brought home, was gathered there in flower earlier than I saw the plant in flower at Danmarks Havn, although it may have been an accident that a single species should be found in flower there before it flowered in other places.

Not until the 20th did Vester Elven force its way through its upper course; before this there had only been a local draining of the melting snow of Basiskæret. To the north of the bog large masses of snow are lying on the southern slopes of the mountains; it is from here that the clayey, gravelly flat towards the stream is irrigated, and already some days ago *Ranunculus sulphureus* was found flowering here in the more elevated parts of the gravelly flat, while the more low-lying parts of it are almost exclusively covered with *Alopecurus alpinus;* but as yet the latter shows no sign of life here, while *Eriophorum polystachyum* has reached its flowering stage.

We have now advanced as far as "midsummer," which in these parts is in reality the beginning of the summer. The transition in 1907 was indicated by the first rain of the year. On June 24 5.0 mm. of rainfall were measured; even if this was not a very large quantity it was sufficient to make traffic out of doors irksome. The rain began at noon and lasted all the afternoon.

In the course of the following eight days the floral display had reached its maximum. Probably about half of the flowering species are out now, thus all the *Drabas,* several *Saxifragas* and the most prominent of the *Ranunculi;* these species are the character-plants of the country which give the stamp to the landscape by the great abundance of their individuals. In the bog, for instance, *Ranunculus sulphureus* is now in full bloom and reminds one not a little of the *marsh-marigold* on a spring day at home when, with its yellow patches, it livens up surroundings which have hardly yet become green.

It is natural that moisture should be of the greatest importance to this, the culminating period of the vegetation. Referring to the measured amount of precipitation we see that June is relatively

Fig. 4. *Cassiope tetragona* association in Germania Land.

conspicuous with 9.1 mm. spread over eight days. Until the 10th it appeared as snow, and not till the 24th as rain; but besides this measured moisture another factor is utilised-in addition to the most important of all which is, of course, moisture due to the melting process — viz. the fog; the causal connection of this is less conspicuous but certainly of no less importance both directly and indirectly. At the end of the month we often had south-easterly winds and a dense fog from the sea crept over the land, where it soaked everything, and this sometimes happened several days running. For lichens and mosses this form of moisture is undoubtedly of the greatest importance, but the whole vegetation profits by direct absorption; to this should be added its indirect significance to evaporation which is modified to a high degree when the fog lies densely upon the surface of the earth.

Under such circumstances the temperature of the ground and the water, provided currents do not supervene, is the same at night as by day and coincides very nearly with that of the air. This is proved by the following interesting measurements.

After an almost constant temperature, on the 24th of June 1907 (+ 3.4°, + 3.7°, + 3.2° at 8 a. m., 1 p. m. and 9 p. m. respectively) I measured the temperature at night at 1 a. m. in a wet moss-tuft, again in a small stream and still again in a damp *Silene*-tuft and obtained everywhere + 3.4°; the air was then + 2.9°.

In the main channel of Vester Elven, where the current is rather strong, the temperature, on the other hand, was only + 1.8°. The water on its way from the place of melting is not under the influence of the rays of the midnight sun when there is a dense cloud-covering as was the case here. In the evening of the 24th, at 9 o'clock, the wind was N. fast C. and the cloud-covering was 10^{1-2} ni.[1]

As the temperature, also, is of the greatest importance to the plant-life, not only must the supply of heat be able to be relied upon, but also it is necassary to economise that which has already been obtained; the point is to have as slight a loss of heat as possible. And here the cloud-covering also plays a great part in the condition of the plant-life.

We have above an example of the influence of the nimbus-clouds directly to impart moisture, and indirectly to retain the heat by moderating the evaporation. A dense covering of stratus-clouds also serves the latter purpose; but they are far more favourable to the vegetation when the conveyance of heat is concerned. While the fog was always coincident with low temperature, there might very well be conveyed to the ground a considerable amount of heat in

[1] Here and everywhere the figures indicate the amount of the cloud-covering, and ni., str. and fr.-str. stand for nimbus, stratus and fratus-stratus respectively.

spite of a dense layer of stratus, and under conditions when the temperature of the air was low.

Some of the measurements prove this. On June 28 we had: —

	8 a. m.	Temp. + 0.7°	Force of wind 2.3	Cloud-covering	10^1 str fr-str.
	2 p. m.	— + 1.1°	— 2.2	—	10^2 ni.
	9 p. m.	— + 3.5°	— 2.1	—	10^{1-2} str.
and on the 29th	8 a. m.	— + 2.6°	— C	—	9^{0-1} str.

Although the sun had not been out during the night yet in the morning of the 29th at 9.45 the temperature in the main channel of Vester Elven was + 7.2° and in the soil under irrigation + 13.0°, and in the air + 2.8°.

This phenomenon I can only explain by the fact that the cloud-covering had not absorbed all the rays of the sun so that in spite of the dense layer of clouds there had been no slight supply of heat simultaneously with considerable modification of evaporation.

Fogs also continued during the month of July, in which the precipitation is so very inconsiderable. But during this month southerly-easterly winds are not always coincident with fogs.

The precipitation was measured in four days, all told. The heaviest rainfall occurred on the 9th and was measured as 1.1 mm. Moreover it rained a little on the 12th, 13th and 14th. The maximum of the last 24 hours was + 8.8°, up to that time the highest temperature of the year; the following day the fog hung again over sea and land, and the temperature was low.

Not till the 22nd does the fog rise and for the remainder of the month the weather is clear, the wind principally in the north-west.

On July 4 the summer is so far advanced that the Snow Bunting has young ones; the gnats begin to appear and around Danmarks Havn *Saxifraga oppositifolia* is fast approaching the end of its flowering-period. But at Cape Bismarck a lake is found where the ice is still lying; a narrow strip of water along the shore is the only visible sign of the spring not having passed over it without leaving its traces.

On July 5 the ice round the ship was so crumbly that the passage was unsafe even for the dogs; and on the day following the ship became free. Some little time, however, elapsed before we really got some heat, and the maximum of the year, + 12.3°, is not reached till the 17th; but then, on the other hand, the minimum is as high as — 2.0° and of the 30 days with a positive mean temperature 15 are even quite frost-free.

The hottest day of the year fell on July 31 with the highest recorded temperature; the sum of the three readings of this day

(+ 5.6, + 11.1 and + 3.0, at 8, 2 and 9 o'clock respectively) is 19.7°. At 1 p. m. the black-bulb thermometer recorded + 42.0°.

The gnats occur to a degree that is most tiresome, though they are not nearly as numerous as in the corresponding swampy districts on the west coast.

In spite of the heat the summer must be said to have finished by the end of this month; all plant-life had been long before on the descent and even the late-flowering species have reached their last stage of development—fruit-setting. The high temperature during the day does not suffice to call forth and continue the development of those species and individuals which perhaps appear first at this time from beneath the melting snowdrifts. From the beginning of August we have to reckon with a fairly distinct day-period; already in the night between August the 4th and the 6th the thermometer went down to — 2.0°. Not till the 23rd did we get a negative day-temperature, but three days later we had the first 24 hours of continuous frost.

There is plenty of precipitation during the month; 16.1 mm. of which half fell on the 12th.

The melting of the snow reached its maximum, with the largest bulk of water in Vester Elven, on August 3rd.

With the setting-in of frost the cycle of the vegetation is virtually at an end for this year. Only here and there we find — in shelter and under the influence of the sun's heat in the middle of the day — a few *Ranunculi*, *Saxifragæ* and other hardy plants in bloom; but I am under the firm impression that the period of growth was considerably longer in 1906. On the other hand in 1907 more snow seems to have melted than the year before. As far as can be judged more snow was lying on the mountains then than there is now lying at the same time of the year.

The appearance of the old snowdrifts also indicates this. The more the snow melts away the darker become the surface-layers which mark the pauses between the different snowfalls of unequal thickness which, in the course of the winter, build up the snowdrift (Fig. 5). And that layer will be darkest which is the last to be melted during a summer period, especially if it lies deeper than the melting-level of one or more previous years. For every time the storms, in the course of the winter, have brought the snow to rest in a drift, loose material is brought thither from the fields above. This material continues to cover the snow in layers and helps, very much, to hasten the melting because of its dark colour.

Such a stratification can be seen in profile at lakes and other places where the drifts are undercut by water so that the outer edge appears with a vertical fracture after parts of the drift have tumbled down. At such places the latter, in its consistency, reminds one of a glacier, and the perennial snowdrifts fully justify the name of glacier, formed as they are like the land-ice by the snowfall of many years.

With September, autumn had entered upon a more austere stage than at the same time in the previous year. This applies in particular to the first third of the month; in 1906 we had then a rather high positive temperature while in 1907 we had a negative mean temperature already in the first week of the month, which was of great and fatal import to the vegetation, as it meant an abrupt termination to the life of those individuals that were belated. On September 11 the maximum temperature was the same in 1906 and 1907, namely + 2.8°. Then followed the lower temperature which in 1907 brought the summer period to an end about a fortnight earlier than in 1906.

If the mean temperature of the whole month is considered exclusively, the difference between 1906 and 1907 is but small, as we have in 1906 — 3.3° against — 4.0° in 1907. This slight difference, which is owing to the higher temperature at the end of the month in 1907 might lead to the supposition that September 1907 must in the main have presented itself nearly as did the same month the year before; but facts show, all the same, considerable discrepancy which is clearly indicated by a comparison of the means for each week.

	1st week	2nd week	3rd week	4th week
1906	+ 2.57°	— 1.72°	— 5.81°	— 7.67°
and 1907	— 0.42°	— 3.52°	— 6.72°	— 3.67°

What is decisive here is naturally the earlier appearance of the frost rather than its severity.

In 1906 passage across the ice between the ship and the shore was established on September 20; while in 1907 the sheet of ice had already formed a bridge on September the 1st. However, some days later the traffic was broken off by storm and springtide, but yet lasting communication was established some ten days earlier than in the previous year.

Vester Elven also suspended its activity somewhat earlier than in 1906 when it supplied drinking water to the dwellers on land as late as September 18, while in 1907 the river-bed was dried up already on the 9th.

On September 27 we had our first snowstorm; at two in the afternoon the storm was in full swing although the wind greatly increased in violence later on in the day with a more copious fall of snow. This, the first snowstorm, occurred exactly a month earlier than in 1906, but otherwise under similar conditions, starting from the north, whence the wind veered to NNW., attaining a velocity of about 20 metres per second. As sudden a rise of temperature as in 1906 did not take place, but yet the temperature rose to + 0.2 in the course of the night.

The percentage of the moisture in the air was low on an average, often below 50; the lowest percentage of moisture recorded is 36 on October 3, 1907. Both in 1906 and 1907, autumn — or the time when the frost arrives — was accompanied by north-westerly winds which dried up the ground and thus created better conditions for the plants which, after having finished their development, were ready to meet the advance of winter. As regards the majority of the species seeds had been set abundantly. No doubt it also holds good for the buds which have been formed, that they are much more protected in a relatively dry condition than if they had been covered with ice before the snow-covering came. Evaporation and the desiccation resulting from it are further prevented by a protective sheath of old leaves (cf. List, pp. 23 and 27: *Lesquerella* and *Potentilla pulchella*).

As will be seen from the table, the mean temperature for October appears about equal for both years. The first part of the month was much colder in 1907 than in 1906; on the other hand the conditions were reversed as regards the latter part. Otherwise there is a distinct similarity between the two months in many cases; this applies, among other things, to the direction of the wind, which is principally westerly. Between the two points of the compass W. and N., both inclusive,

1906 shows 52 readings
and 1907 — 57 — ,

next comes calm with

1906 — 30 —
and 1907 — 24 —

E. is represented by two readings both in 1906 and 1907.

The different directions of the wind cause some differences in the humidity of the air; the air is usually dry with westerly wind; this applies, at any rate, to the summer-period. When the sea is open the percentage of moisture is somewhat increased during easterly wind or calm. In autumn, however, a low percentage of moisture often coincides with calm, while a higher percentage may occur with wind from the north-west.

An unusual mildness prevailed in December 1907 during the days from the 17th to the 21st, when the temperature oscillated between — 0.6° and — 8.9°. The ground was covered with snow which lay slushy and heavy; without being acted upon, to any particular degree, by the wind, the snow was allowed to fill the low-lying places and depressions so that it made one uniform surface.

The last day of the year 1907 was until that time also the coldest day of the winter with a temperature of — 32.0°.

January 1908 was somewhat milder than in 1907. A violent snowstorm, in the middle of the month, blew the hills free from snow, and considerable quantities of gravel and pebbles were carried in the drift so that the snowdrifts were coloured dark thereby. Some snow fell again some days later during calm weather, so that an opportunity offered itself to measure the thickness of the layer of fresh snow which had fallen. It is very difficult to get a reliable computation of the precipitation which falls in the form of snow by the ordinary apparatus, especially when it is blowing. For that reason it may be of interest to give some figures which show the unreliability of the results, even under conditions of calm. On January 18, 7 cm. of fresh snow fell, which according to the rain-gauge measured 3.4 mm. On the day following 11 cm. fell, which according to the rain-gauge amounted to 2.6 mm. only. It is often quite impossible to decide, during drifting, whether any fresh snow is falling or not.

As I stayed at the station at Pustervig from January 29 to March 6, 1908, I had an opportunity of comparing the atmospheric conditions which prevail there during a winter-month with the conditions at Danmarks Havn. As was to be expected they agreed fairly well as regards temperature, pressure and amount of moisture. At Pustervig also, the snow-covering was inconsiderable on the more level ground. The distance from Danmarks Havn is about 75 km., the indentation of coast-line is the deepest in Germania Land. Unfortunately I had no opportunity of visiting the place at summer-time as the station there was vacated on June 1st.

I have calculated the mean temperature for a month of 29 days, from February 7th to March 6th. The result is — 28.07° at Danmarks Havn as against — 28.0 at Pustervig, where, however, there were many days far colder than any in the former place, where only one day, February 21 (— 37.7°), had a temperature below — 35.0° as against five such, and even colder, days at Pustervig.

The month of March had less precipitation than in 1907. On the 28th we had the last snowstorm of that winter; during the storm snow, to a depth of 25—30 cm., was blown away from the level ground round the pathway from the house on the land to the thermometer-stand ("Die englische Hütte"), and after that the eastern side of Harefjeld stood out fairly bare. Immediately before the snowstorm we had peculiarly mild weather with easterly winds, which was probably due to a great deal of open water at sea.

A raven was seen at the end of the month, and seals also were seen on the ice as early as during this month.

On April 5 the Snow Bunting arrived. Otherwise the month was cold and dry as in 1907. The minimum temperature, — 33.7° fell on the 3rd, and the maximum, — 3.5°, on the 28th. Towards the end of the month it was milder than in 1907, and as was afterwards seen this mildness proved to be the beginning of a summer both earlier and warmer than that of the year before. The mean temperature of the month was — 19.2°, somewhat lower than in 1907, which was due to the severe cold in the beginning of the month. A comparison between the mean temperature of this and the following month showed also what was, on the whole, the greatest temperature-gap which occurred between any two successive months. A similar gap occurred between the mean temperatures for September and October. Here these numbers are compared

for	September	and October	
1906	— 3.3	— 14.0	Dif. 10.7
1907	— 4.0	— 14.3	Dif. 10.3

and for the months

	April	May	
1907	— 19.0	— 7.9	Dif. 11.1
1908	— 19.2	— 6.1	Dif. 13.1

The weather during the first days of May formed an immediate continuation of that of April, but already on the 6th the temperature rose fairly considerably and after this intimation the temperature of the 7th ultimately reached the positive side: at 5 o'clock in the afternoon the thermometer stood at + 3.0°. So high a temperature was not reached in 1907 until June 1; also a positive temperature on the whole was not reached until 17 days later in 1907 than in 1908.

This early occurrence of a higher temperature was visibly indicated by the small pools due to melting snow, which formed about three weeks earlier than the year before, when such pools were not found until towards the end of the month. Already for a long time ago the mountain-sides facing east and south have been darkening considerably, and only the higher parts — seen from a distance — are still white. The air is, on the whole, dry — also with easterly wind: a somewhat higher percentage of moisture is common with calm.

With these possibilities for the reawakening of plant-life, spring must be said to have commenced, and a fortnight later I also found decidedly new leaf-shoots upon a *Cerastium*-tuft which on May 21 stood under the snow with flowers from the preceding autumn which looked so fresh, that at first sight they could very well be supposed to have expanded recently.

On the 9th and 10th we had dense frosty fogs with falling temperature, down to —15.4°. The following days were also rather cold with frequent fogs. But the snow was seen to disappear day by day as soon as the sun came out and exerted some power.

On the 20th snow fell and formed a thin layer; the following day was also densely cloudy, and there was a fine sprinkling of snow which melted immediately in places previously bare. Then it cleared up for a few days with westerly winds and a temperature of about —5.0°, until on the 24th we again had fog and snow-squalls. On the 25th a positive temperature was again reached which continued for a longer time. It was cloudy from early morning and in the course of the forenoon snow began to fall so heavily that gradually a layer of it covered everything. But although the sun did not come out this snow melted rather quickly during the afternoon; small pools were formed only upon the bare primitive rocks; otherwise the soil quickly absorbed the moisture thus conveyed to it. At last on the 28th the sun shone in all its splendour from early morning, and as early as 9 a. m. we had a temperature of + 3.0°. The wind was then westerly; but soon afterwards it turned to the east and the temperature again went down to below zero. Later in the day the fog rolled over the land, and the sun's rays penetrated only slightly through it late in the afternoon. At this time of the year the gravel-fields are thawed to a depth of about 10 cm. Evidently only the warmth of the sun was wanting to call the plants forth. The appearance of a fly announced the reawakening of insect-life.

At night a large flight of birds occurred and in the evening I saw in Basiskæret Dunlin, Turnstone and Ringed Plover. Further towards the south Sea Gulls had been seen; Buffon's Skua, also, was seen the same night; last year the first one was shot on June 5, but, as mentioned above, I had then already seen two at Cape Marie Valdemar on April 23rd.

When I ascended the mountains on the 29th and surveyed the sea-ice it displayed several cracks, and it was said that a movement in the ice-fields had also been observed. In spite of an almost positive temperature during the last days of May practically no progress could be traced as regards the vegetation. Only the lichens stood fresh, especially upon stones. But under the fresh snow which frequently covered everything, much was being prepared, hidden from sight.

The upper layer of the soil was thawed at that time wherever it had no snow-covering, and the clay in Basiskæret had already become so muddy that it was quite laborious to walk about on it. Larger pools were also met with at this time where the numerous wading-birds lived.

When, in the night of the 30th, I drove to Pustervig snow began, and as the wind grew stronger later in the night there was considerable snow-drift. The boggy tracts around Stormkap were mostly covered with snow and had a very winterly aspect in spite of the year being well advanced. In several places Snow Buntings were found which had evidently died of hunger, as the ground had been frozen where they should find their food. The snow was damp when it fell and in many places it froze and occurred as an icy covering upon the ground and upon the projecting parts of plants; this is not to be wondered at as the temperature was still low by night, and even went down to —9.3 during the last 24 hours of May.

The vegetation at this time was not further developed in Pustervig than at Danmarks Havn.

At the end of May everything was at a standstill, so to speak, and was far from having reached the development which the warm days on the 6th and 7th had at that time indicated; but a considerable amount of moisture had been conveyed to the ground, far more than was registered by the 5.0 mm. downfall; and owing to the fact of the ground being thawed earlier and containing more moisture, preparations were being made for a quick development of the spring flora, even if it began later than there had at first been reason to expect — as regards *Saxifraga oppositifolia* and a very few other species even later than in 1907.

The month of June 1908 began with clear weather and relatively cold nights. Not until the 8th did we have a positive temperature at all three readings. This was reached last year as early as May 30; and occurred again on five additional days in June before the 8th; which was probably the reason why *Saxifraga* was then in flower as early as the 4th, while this year that stage of development was not reached until the 7th.

Then came again some days with fogs from the east and south and a low temperature so that the melting of the snow progressed slowly. Not until the 12th was there enough running water in

Basiskæret for us to be able to obtain drinking water there — several days later than last year. A small lake near the station was almost free from ice and was visited by Long-tailed Ducks and loons. The next day the wind was again north-west and the sun was allowed to shed its rich warmth without hindrance over all the country and call forth the humble-bee simultaneously with the first flowering *Salix*. And now the awakening process proceeded without intermission, so that every day new species appeared: *Draba hirta*, *Draba alpina*, *Eriophorum polystachyum*, *Ranunculus sulphureus*, etc. The 18th was the first real summer day, on which the maximum reached + 8.2°. Vester Elven "forced," i. e. made its way through its upper course, and as this phenomenon occurred two days earlier than was the case last year, so also everything appeared at this time to be further developed than the year before; this also applies to the first-flowering of the above-mentioned species which occurred from one to four days earlier than in 1907. On the same day *Ranunculus glacialis* and *Oxyria digyna* were seen in flower. The mean temperature of June was 0.2° lower than that of last year. The mean for five days was as follows: — —2.3°, — 0.03, — 0.82, + 2.38, + 3.35 and + 5.37. Consequently, the warmth did not set in until the middle of the month. We had a positive mean on the 8th, 9th, and 15th. After that the mean temperatures were exclusively positive, although the minimum did not become positive until the 18th. The latter half of the month was decidedly more favourable for the vegetation than was the case last year, and many species were well in progress as regards fruit-setting before the end of the month.

The absolutely highest temperature was + 11.6° in the afternoon of the 28th. Last year the maximum, + 7.3, was reached on the 20th. There is thus a considerable difference as regards the warmth of the same two months in 1907 and 1908 respectively, and the difference is in the latter half of the month, which this year had been freer from fogs than was the case last year.

The ice between the ship and the land was traversed for the last time on June 30th; in 1907 it could be traversed until July 6th.

The month of July began by being warm. The wind continued from the west and the air was clear and dry. From June 24 to July 12 there was no frost, consequently, there were in June 9 days, as against 6 last year, and in July 12 days without frost. In 1907, there were 18 days in the whole of July without frost. From the 13th the wind often veered to the south and east, which caused fogs and low temperature, and thus the days continued till our departure from Danmarks Havn on the 21st.

In continuation of the foregoing remarks regarding the climate and the phenology I shall now give some observations concerning the insolation. These measurements were effected with a black-bulb thermometer in vacuum and an ordinary swinging thermometer, which were placed at a height of 2½ metres on the southern gable of the villa against a background of black roofing paper. The temperature of the air is given according to the thermometer in the thermometer-case.

March 3, 1907. Sun's altitude at midday 6°17′

Time	1 p. m.	1.15 p. m.
Air	— 29.6	— 29.4
Black bulb	— 4.6	— 9.0
Blank bulb	— 21.0	— 20.0

March 10, 1907. Sun's altitude 9°

Time	11.30 a. m.	12.30 p. m.
Air	— 29.5	— 28.8
Black bulb	0.0	+ 0.8
Blank bulb	— 23.0	— 20.2

March 11, 1907.

Time	11.30 a. m.	12 midday	12.35 p. m.	1 p. m.	1.30 p. m.
Air	— 26.0	— 25.8	— 25.6	— 26.5	— 25.1
Black bulb	+ 0.9	— 0.2	+ 0.5	+ 0.5	— 1.0
Blank bulb	— 16.7	— 18.8	— 16.9	— 14.9	— 17.8

March 12, 1908.

Time	11 a. m.	12 midday	12.50 p. m.
Air	— 29.0	— 27.0	— 26.2
Black bulb	+ 1.0	+ 3.8	+ 4.5
Difference	30.0	30.8	30.7

March 13, 1907.

Time	10 a. m.	10.30 a. m.	11 a. m.	11.30 a. m.	12 midday
Air	— 19.6	— 18.6	— 18.5	— 17.7	— 19.5
Black bulb	+ 5.4	+ 8.0	+ 10.0	+ 10.8	— 5.2
Blank bulb	— 12.0	— 7.0	— 6.2	— 2.2	— 10.2

During the last observation the sun was somewhat clouded.

March 15, 1907. Sun's altitude 11°

Time	10 a. m.	10.30 a. m.	11. a. m.	11.30 a. m.	12 midday	12.30 p. m.	1 p. m.
Air	— 21.0	— 20.9	— 20.4	— 19.0	— 21.0	— 20.5	— 21.2
Black bulb	+ 2.6	+ 1.4	+ 4.5	+ 9.5	+ 9.2	+ 8.6	+ 8.0
Blank bulb	— 11.8	— 15.6	— 10.0	— 4.9	0.0	— 0.3	— 1.8

March 15, 1908.

Time	12.5 p. m.	12.50 p. m.
Air	— 22.6	— 23.2
Black bulb	+ 5.7	+ 4.5
Difference	28.3	27.7

March 21, 1908. Sun's altitude 13°19′

Time	11 a. m.	11.30 a. m.	12 mid.	12.35 p. m.	1.10 p. m.	1.30 p. m.
Air	— 27.2	— 25.6	— 26.5	— 28.5	— 26.5	— 27.0
Black bulb	+ 5.0	+ 7.0	+ 5.2	+ 6.1	+ 6.6	+ 3.3
Difference	32.2	32.6	31.7	34.6	33.1	30.3

March 26, 1908.

Time 1 p. m. Air — 11.3 Black bulb + 15.6

March 31, 1907. Sun's altitude 17°14′

Time	11 a. m.	11.30 a. m.	12.30 p. m.
Air	— 19.2	— 19.5	— 19.4
Black bulb	+ 15.0	+ 18.0	+ 14.4
Blank bulb	— 5.0	— 3.8	— 3.7

March 31, 1908.

Time	11 a. m.	2 p. m.
Air	— 21.5	— 18.8
Black bulb	+ 7.6	+ 12.0
Difference.	29.1	30.8

April 2, 1908.

Time	12 midday	12.50 p. m.	2 p. m.
Air	— 27.2	— 26.4	— 23.2
Black bulb	+ 9.3	+ 6.6	+ 11.0
Difference.	36.5	33.0	34.0

These observations, which were distributed over 11 days during the years 1907 and 1908, show what is especially characteristic of the radiation, viz. its quick rise in the spring. On March 10, 1907, the black-bulb thermometer, for the first time, reached a positive temperature, and differed from the temperature of the air by 29.6°. Three days afterwards the insolation was + 10.8°; the difference being then 28.5°, the temperature of the air having simultaneously risen 11.1°. The reading on the 15th at 11.30 a. m. gave the same difference. But on the 31st the black-bulb thermometer registered + 18.0° with about the same temperature of the air as on the 15th, and the difference then reached 37.5°; this was the maximum for the year 1907.

In 1908 observations were made for the first time on March 12, and even then the black-bulb thermometer stood 30° higher than the station-thermometer; 3 days earlier, therefore, than in the previous year, when this result was not attained till March 15. But the greatest difference is a little lower than in 1907, and occurs a little later — April 2nd.

For some of my measurements of temperature in the field, I also employed the black-bulb thermometer and, at the same time, thermometers with a blank bulb and with a coloured, brown bulb. For the measurement of the temperature of the air the swinging thermometer was then employed.

May 17, 1907, at 3 p. m.
Air — 7.0°
Black bulb + 13.0° } lying on a level gravel-field.
Blank bulb + 6.8° }

May 20. Air — 2.0°
At 1.35 p. m. Black bulb upon the mountain, in a tuft of *Luzula* .... + 29.6°
At 1.45 p. m. Black bulb in wet clayey soil..... + 26.6°
At 1.55 p. m. Black bulb upon the snow........ + 34.0°

On July 3, at 5 p. m. Air + 8.6°, the black-bulb thermometer registered on an irrigated gravel-field facing the south .... + 24.7°
(with running water upon the ground .... + 14.8°)
on a tuft of *Draba*........................ + 29.7°
on light-coloured clayey soil .... + 31.2°

July 4, at 11 a. m. Air + 8.3
Black bulb in a tuft of *Potentilla* on the mountain + 35.8
(The earth at a depth of 4 cm. showed........ + 13.8°
and the water in a small tarn with a snowdrift on its bank showed........................ + 13.0)

July 21, at 7.45 p. m. Air + 1.5°
Black bulb + 17·0 } all three thermometers lying insolated on flowering *Cassiope*.
Brown bulb + 10.6 }
Blank bulb + 10.0 }

The day had begun with fog, but this lifted about 2 o'clock, when the sun shone slightly.

July 31, at 1 p. m. Air + 10.3
Black bulb + 42.0
Brown bulb + 34.0

During the observations the wind changed and became easterly, whereupon all the thermometers commenced to fall. Both with this observation and with the following observations made with the black-bulb thermometer in 1907, the thermometers were placed on the gable of a house, in the same way as during the observations made in the month of March.

On August 7, 1907, at 2 p. m.; temp. + 1.7; amount of cloud 10°

Time	2.30	2.45	3	4	5
Air	+ 4.5	+ 4.3	+ 4.1	+ 4.8	+ 3.3
Black bulb.	12.0	11.5	11.5	24.8	10.7
Brown bulb	9.0	9.6	8.8	13.8	7.5
Blank bulb.	8.3	8.4	8.0	10.8	5.9

At four o'clock the sun was out, but not in great strength.

At five o'clock there was only very slight insolation.

After a night with a positive temperature the following were the measurements on August 8th.

Time	11.30 a. m.	11.45 a. m.
Air	+ 8.4	
Black bulb	+ 30.5	38.5
Brown bulb	+ 24.0	28.0
Blank bulb	+ 18.0	23.5

Even as late as October 1, when the air was — 12.0°, the black bulb showed + 12.0° at midday. The sun's altitude was almost the same as on March 15th.

October 7, at 12.45 p. m. Air — 4.4
Black bulb thermometer + 13,0

But on October 15 the importance of the insolation was nearly at an end, as is shown by the following figures: —

October 15, at 2 p. m.	Air	— 19.5	Black bulb shows	— 9.7
— 16, - 10 a. m.	-	— 14.6	—	— 9.6
— 17, - 2 p. m.	-	— 16.1	—	— 10.5
— 18, - 12 a. m.	-	— 15.3	—	— 3.0
— 18, - 2 p. m.	-	— 15.3	—	— 11.3
— 19, - 12 a. m.	-	— 14.4	—	— 1.4
— 19, - 2 p. m.	-	— 15.8	—	— 10.5

The difference between insolation and non-insolation was practically *nil.* Just at midday, the effect was somewhat noticeable if the thermometer, as in this case, was placed high up, where it could catch the rays of the low-lying sun—surreptiously as it were. On level ground the effect was almost unnoticeable.

When no mention is made of the amount of cloud, the observations have been made beneath a cloudless sky. The amount of cloud 10 with the exponent 0 signifies that the sky was entirely covered with a thin layer of cloud.

The observations of the insolation which especially concern the midday radiation differ most astonishingly from the temperature of the air, so long as this is still low — therefore, early in the year, although the sun's altitude is then also low. A comparison of two measurements shows that the difference was less on July 31 than on March 31 1907, and that the rise in the temperature of the insolation does not keep pace with the rise in the temperature of the air, in spite of the sum-total of the radiation lying naturally nearer its maximum in July than in March.

	Air	Black-bulb thermometer	Difference
March 31, at 11.30 a. m.	— 19.5	+ 18.0	37.5
July 31, at 1.0 p. m.	+ 10.3	+ 42.0	31.7
	Difference 29.8	Difference 24.0	

The sun's altitude, respectively: 17°14′ and 31°36′. The sun's culmination at Danmarks Havn 36°41′.

Notwithstanding the problematic value of these figures to indicate the warmth which is conveyed to the vegetation by the radiation, I have employed them, well knowing that they do not afford absolute data for arriving at a decision. We have no means of establishing such data, as we do not possess any registration-apparatus which can indicate the course of the radiation through any complete period — twenty-four hours a week, or longer — which would perhaps illustrate the conditions rather more reliably, and especially might be able to give us a better idea of the sum-total of the radiation.

We know from experience that there is a supply of warmth, but its magnitude depends on many factors; the conditions of the country and the nature of the ground play their part, as the height of the sun in the sky at different times also plays its part.

In addition to the measurements which have already been given of the temperature at the surface of the ground, amongst plants, and in pools, lakes and rivers, with special reference to its relation to the cloud-covering and its more or less complete independence of direct sunlight, I have made, at different times during the twenty four hours, and at shorter or longer intervals, many other measurements which elucidiate the warmth-conditions which usually prevail.

July 1, 1907	8 a. m.	2 p. m.	9 p. m.	Calm, with a fog in the morning, and amount of cloud 10[1] during the whole day.
Air . . .	+ 1.7	+ 2.0	+ 0.5	

At 12 midnight. Air + 2.8; Vester Elven + 4,2.

July 5, at 2 p. m. Air + 5.4, clear.

The water in Øster Elven	+ 11.2
Irrigated moss and *Salix* at a depth of 5 cm.	+ 11.2
Damp tuft of *Dryas* - — - 6 —	+ 10.4
— — - — - — - 12 —	+ 8.8
Stagnant water	+ 12.5
Dry, rather compact clay	+ 18.4
Dry, pulverized clay	+ 20.2

July 7	8 a. m.	2 p. m.	9 p. m.	In the morning amount of cloud 10[1], at midday the sun shone.
Air . .	+ 5.1	+ 4.8	+ 4.5	

	9.45 a. m.	6 p. m.
Main channel of Vester Elven (strong current) . . .	+ 8.5	+ 11.2
Stagnant water in a hole.	+ 5.0	
Running water at the side of the hole	+ 10.5	+ 13.2
Moist soil at a depth of 3 cm.	+ 11.0	
Soil less moist, but grown over	+ 12.8	
Wet clay in a depression	+ 11.5	
Dry clay	+ 14.0	+ 21.5
A dry tuft of *Dryas* between the withered leaves .	+ 13.5	+ 22.0
A dry tuft of *Dryas* at a depth of 6 cm.	+ 10.2	

Notwithstanding the sunshine in the afternoon the maximum of the day was only + 7.4, on account of a south-easterly wind.

July 10	8 a. m.	2 p. m.	9 p. m.	South-easterly wind of inferior strength.
Air . .	+ 3.4	+ 3.5	+ 0.7	

	12 midday	3 p. m.	6 p. m.
Blank bulb on the ground.	+ 22.0		
On a declivity with *Taraxacum*, *Draba hirta*, *Saxifraga rivularis*, *Ranunculus pygmæus*, and others at a depth of 5 cm.	+ 12.6		
Loose gravel at the surface	+ 16.2		
The water in a small lake with a barren, stony bottom		+ 12.2	

	12 midday	3 p. m.	6 p. m.
Moist ground with *Cassiope*, *Dryas* and moss at a depth of 8 cm.		+ 8.5	
Dry ground with lichens and *Pedicularis*, at the surface		+ 10.0	
The main channel of Vester Elven			+ 9.0
Water and moss			+ 9.2

July 15	8 a. m.	2 p. m.	9 p. m.	
Air	— 0.1	+ 0.9	— 0.7	foggy all day.

	1 p. m.
Moist ground with *Salix* and *Cassiope*	+ 8.0
Dry tuft of *Dryas*	+ 9.1
Vester Elven	+ 8.6
A snow-bridge across the river	+ 0.2

Notwithstanding rain and fog and a dense covering of cloud during the four previous days, the ground as well as the water was considerably warmer than the air.

July 21	8 a. m.	2 p. m.	9 p. m.	
Air	+ 0.7	+ 5.5	— 1.2	foggy all day.

	10.15 a.m.	7.45 p.m.
Vester Elven	+ 6.9	+ 8.7
Wet ground	+ 7.5	
Dry ground	+ 10.0	
Dry sand		+ 13.6
Dry tuft of *Silene*		+ 11.0
Tuft of *Cassiope*		+ 7.6
Damp, luxuriant tuft of *Dryas*		+ 11.6
Submerged gravel-field		+ 9.2
The water on the field		+ 8.8
Luxuriant submerged bog-vegetation		+ 11.6
The water thereon		+ 9.2

July 24	8 a. m.	2 p. m.	9 p. m.	
Air	+ 1.8	+ 3.5	+ 0.5	Clear the whole day with a south-easterly wind and a little foggy in the evening.

	4 p.m.	8.45 p.m.	10.30 p.m.
Insolated, brown bulb in the plant-covering	+ 21.8		
The water in a small lake, to windward	+ 14.0		+ 7.0
— — — , to leeward	+ 15.5		
Juncus and *Eriophorum* at the height of water-level	+ 9.0		

	4 p.m.	8.45 p.m.	10.30 p.m
Damp moss with *Salix*, at the surface ...	+ 16.5		
— — — —, at a depth of 6 cm.	+ 8.6		
— — — —, at a depth of 12 -	+ 7.5		
Dry soil in a crevice in the rock	+ 12.9		
The water in a small lake with a barren, stony bottom		+ 10.5	
Damp rocky flat		+ 8.3	
Rocky flat, drier, with *Carex nardina* and *Salix*, in the shade		+ 6.0	
Tuft of *Carex*, in the sun		+ 9.0	

July 25	8 a. m.	2 p. m.	9 p. m.	
Air....	+ 6.1	+ 7.7	+ 5.1	Clear. Westerly wind, almost calm.

	7 p.m.
The water in the same lake which was measured at 4 p. m. on July 24	+ 11.2
Juncus and *Eriophorum* at the height of water level	+ 7.0
Damp moss with *Salix*, at the surface	+ 9.8
— — — —, at a depth of 6 cm..............	+ 8.2
— — — —, at a depth of 12 cm..............	+ 6.2
Dry soil in the stone-crevice	+ 12.4
Damp soil	+ 11.7

Although these measurements were taken 3 hours later than on the previous day I did not expect the temperature to be lower, as the temperature of the air was considerable higher. Nevertheless there was a fall throughout.

July 31	8 a. m.	2 p. m.	9 p. m.	
Air....	+ 5.6	+ 11.1	+ 3.0	Clear weather. The warmest day of the year.

	1 p.m.
Blank bulb on dry gravel ...	+ 16.8
Brown — - - — ...	+ 18.2
Wet moss and *Salix*	+ 8.0
Damp tuft of *Dryas*	+ 8.7
Stagnant water in a pool....	+ 13.0
Running water on field	+ 12.0
Main channel of Vester Elven	+ 10.6

August 13	1.30 p. m.	
Air......	+ 4.5	Dense covering of cloud during the whole day and considerable precipitation.

In wet ground with moss, *Salix* and *Polygonum*, at a depth of 2 cm.	+ 5.2
In wet ground with moss, *Salix* and *Polygonum*, at a depth of 7 cm.	+ 5.5
In wet ground with moss, *Salix* and *Polygonum*, at a depth of 14 cm.	+ 5.6
Gravel-field, at the surface	+ 4.7
— , at a depth of 6 cm.	+ 5.3

The gravel cools more quickly on the surface, and responds more quickly to the temperature of the air than does ground of more solid consistency.

June 9, 1908	4.30 p.m.
In a pool, at the surface	+ 10.0
— — , at a depth of 5 cm.	+ 9.0
In moss down towards the frozen ground at a depth of 4 cm.	+ 4.5
In dry moss and grass	+ 7.5
Blank bulb lying upon moss	+ 14.9
Brown — — — —	+ 18.4
Air	— 2.0

June 14	8 a. m.	2 p. m.	9 p. m.	
Air	— 1.5	0.0	+ 0.3	Sunshine.

	10.50 a.m.
Wet ground with *Draba alpina*, c. fl., at a depth of 4 cm.	+ 10.0
Under a tuft of flowering *Saxifraga*	+ 8.0
The ground at the side of this, at the surface	+ 10.5
Slowly running water	+ 9.3

June 20	8 a. m.	2 p. m.	9 p. m.
Air	— 0.1	+ 3.6	+ 1.0

	3.35 p.m.
The water in Øster Elven	+ 3.0
Light-coloured, dry clay, at the surface	+ 17.5
— — — , at a depth of 7 cm...	+ 14.0
Light-coloured, dry clay at a depth of 14 cm.	+ 11.0
Blank bulb on light-coloured ground	+ 17.5
Brown bulb - — —	+ 20.6

Immediately afterwards the two thermometers showed respectively, on a darker background + 23.2° and + 27.0°.

The first cover of snow in the autumn of 1907 was formed during the snowstorm on September 27, after a mean temperature of 4.0° for the five previous days. The lowest temperature to which the vegetation until then had been exposed at Danmarks Havn was — 11.6. Some days later I made measurements of the temperature in the snow.

Date	Air	The surface of the snow	at a depth of 25 cm.	at a depth of 50 cm.	at a depth of 1 metre
Sept. 30	— 10.5	— 12.3°			— 5.8°
Oct. 1	— 12.1	— 14.8	— 9.6		— 8.0
— 15	— 19.5	— 24.2	— 13.0	— 12.0	— 11.0
— 16	— 14.6	— 20.8	— 18.5		

As is shown by the above, the temperature in the snow ranges downwards. The low temperature on October 15 was noticeable, even the day after, at a depth of 25 cm., while the temperature of the surface rose again with the rise of the temperature of the air, without, however, following the latter entirely; in fact, it actually presents the greatest difference from the air-temperature which I have ever measured, namely 6.2°; and here there was no question of a Foehn, but of a steady rise during the night until the moment of observation at 10 a. m. on October 16.

North of the station there was a large stretch of bog which, on account of its superficial conditions, had been employed as a triangulation-base from which it got the name of "Basiskæret" (the Basis-bog). Towards the north it was bounded by some low "roches moutonnées" at the foot of which, in the autumn, considerable snowdrifts were deposited. One of these was utilized for the following measurements: —

Date	Air	Mean temperature of the month	Surface	at a depth of 35 cm.	at a depth of 50 cm.	at a depth of 70 cm.	at a depth of 1 metre	at a depth of 1.60 metre	at a depth of 2 metres	at a depth of 2.50 metres	Remarks
1907											Measured by
Feb. 23	— 27.8	— 25.9	— 28.5	„	„	— 22.0	— 20.0	„	— 16.5	„	digging and
April 7	— 22.8	— 19.0	— 24.0	„	— 21.5	„	— 20.8	— 18.4	„	— 17.5	by boring the
May 7	— 14.5	— 7.9	— 17.5	„	„	„	— 15.0	— 16.2	— 15.5	— 15.0	thermometer
1908											into the
March 23	— 21.5	— 20.9	— 22.6	— 27.0	„	— 23.5	— 20.5	„	„	„	snow-wall.

As the table shows, the first of these measurements took place on February 23, 1907.

First of all, it was of importance to find a drift which had been lying somewhat undisturbed since the autumn, and which had merely been increased, without, at other times, with changes of the wind, having yielded any of the snow at one time deposited; as in such a case, a lower temperature would have availed itself of the opportunity to penetrate to a greater depth than, later in the winter, and in accordance with the thickness of the layer of snow, it might be expected to be found. Therefore the winter of 1906—1907 was more suitable for these measurements than the following winter when less snow fell, and no great snowdrifts lay unaffected by such erratic snowstorms, which might at times sweep away layers one metre in thickness, which layers would be replaced only when a storm from the direction of the prevalent wind (NW.) brought new layers upon the ordinary deposits to leeward. For the measurements, this lack of a constant layer of snow causes the results to be arbitrary, and makes it impossible to establish absolute values for the range of the temperature in the snow.

Even at a depth of 2 metres, I did not reach the rock beneath the snow; but this was as hard as ice, and of a consistency that only allowed of a very lengthened process of melting. As a rule, a vegetation which is covered by such an enormous layer will see daylight only so late in the year that it will never, in any case, be able to reach the flowering stage, and will not even be able, every year, to awake to life.

The figures show that the temperature is considerably higher downwards in the snow. Still, the mean temperature for the month stands rather high in the layer of snow, at a depth of about 30 cm., I think.

Twenty-four hours later, in the same hole, the snow-walls of which had been exposed to the temperature of the air, the following measurement was taken at a depth of 2 metres: —22.5. The surface, like the air, being —32.0.

Again, on April 7, I took measurements in the same place. But the layer of snow had increased by about 45 cm. in thickness. At this depth a hard crust was then lying, which indicated the surface of the snow on February 23; as this was now well hidden beneath the new cover of snow, it also showed a rise in temperature (from —28.5 to —21.5) owing to the fact that now the radiation of heat from below was prevented.

The same circumstance was noticed at a depth of 1.60 metre, which almost corresponds with the depth of 1 metre on February 23 (—18.4 against —20.0). Here also a hard crust was found, which, earlier in the winter, had been the surface of the snow.

The latter depth corresponds with the former depth of 2 metres; here the temperature is shown to have fallen, viz. from — 16.5 to — 17.5. Here the new deposit has been unable to prevent the low temperature already existing from continuing its range downwards.

The mean temperature for this month, — 19.0, therefore lay at a depth of from 1 metre to 1.60 metre, perhaps at about 1.30 metre, or almost 1 metre lower than the temperature of February, and there is no probability of the low temperature descending lower at this juncture. The sun already stands high in the heavens, and the temperature is rising on account of the advanced time of the year.

The observations on May 7 cannot be considered as comparable with the earlier ones, as the old hole in the snow was now only half filled, and had perhaps stood open for a long time, so that the walls of the hole had been exposed to the direct influence of the air. In addition, the loose snow in the hole was far more porous than the old snow, which was now very hard everywhere, and had to be hacked up like ice.

The mean temperature for the month of March 1908, taken on the 23rd, lay at a depth of 1 metre, which corresponds well with expectations from the measurements in February and April 1907.

It is, of course, generally admitted that the snow-covering is an external factor of great importance as regards plant-life in the Arctic regions, and then, certainly, the snow is most frequently thought of as the sheltering cover which protects the vegetation against the severe cold of winter, and thereby renders possible the existence of more sensitive species. And, consequently, when a considerable layer of snow, even in the autumn, covers the ground and is allowed to remain, then the plants which pass the winter under this are not exposed fully and entirely to the same temperature that the snowless vegetation has to endure during winter. But in those parts of Germania Land with which I became acquainted, I have noticed that the snow is a very capricious protector, which may fail without warning, and at any time leave its protégés in the lurch. Layers of snow, so very great as to be able to preserve for the ground and its vegetation the relatively high temperature from the autumn, do not occur in the neighbourhood of Dove Bay. Inwards in the bay, at Pustervig, I found on March 1, 1908, on a gravel-ground south of the creek, a branch of *Salix* with full-blown male flowers, lying freely exposed. Probably, after a summer which had terminated abruptly the year before, this branch had been hidden beneath the snow for the eventual, further development of the flowers in the succeeding year. But the snow shifts its position many times in the course of the winter, which may result in the plant, as in this case, being exposed at the very coldest period. I had no opportunity to observe the fate with which these flowers met.

When the snow lies longer on large flat stretches of land than on a more rugged ground, it is due both to the fact that on the plain there is a thicker layer of snow and to the fact that the sun dissolves this more easily on a rise in the ground.

The thickest covering of snow which I have seen disappear so early in the year that the underlying vegetation could come forth was the 2-metre thick layer of snow between the thermometer-stand and the villa, which, in 1908, melted before the middle of July. But here, this deposit of the layer of snow was owing to the presence of the villa, so that the condition of the vegetation previously existing was changed by chance. The appearance of the vegetation does not enlighten us, therefore, with regard to what the aspect would have been if the place had been hidden every year under such a covering.

As already mentioned the snow lay somewhat more continuously in 1907 than in 1908. But there are always places where, in accordance with the nature of the ground, the snow must be heaped up in drifts, for instance in narrow fissures, and rock-crevices. Here it might be expected, then, that the snow would cover those species which, on account of their delicate nature, had not dared to venture forth in more exposed places; where, moreover, they would not find such a good substratum as such fissures, with their great possibility of humus-formation, might be able to offer.

When, now and again in the winter, I found such a fissure which, in consequence of its favourable exposure, might be supposed, during summer, to contain species which usually did not occur near that place on the rocky flat, I always visited it in the summer, provided it was possible to do so, and if it was early in the summer I regularly suffered the disappointment of finding it filled with ice, and otherwise, if the ice had managed to melt away, I found it, in most cases, quite barren; as it naturally must be, seeing that the ice, as a rule, does not have time to melt.

Many such well-protected localities lose their importance as regards the vegetation just by this, that, early in the summer, melted snow from higher lying places oozes into them during the day and saturates a part of the snow, which then, during the cold of the night, is transformed into a solid mass of ice, which thaws very slowly.

From a biological point of view the essential importance of the snow is that it prevents evaporation in winter and produces moisture in summer. When, as is the case, the conditions are such that the country receives almost all its precipitation in the winter, the

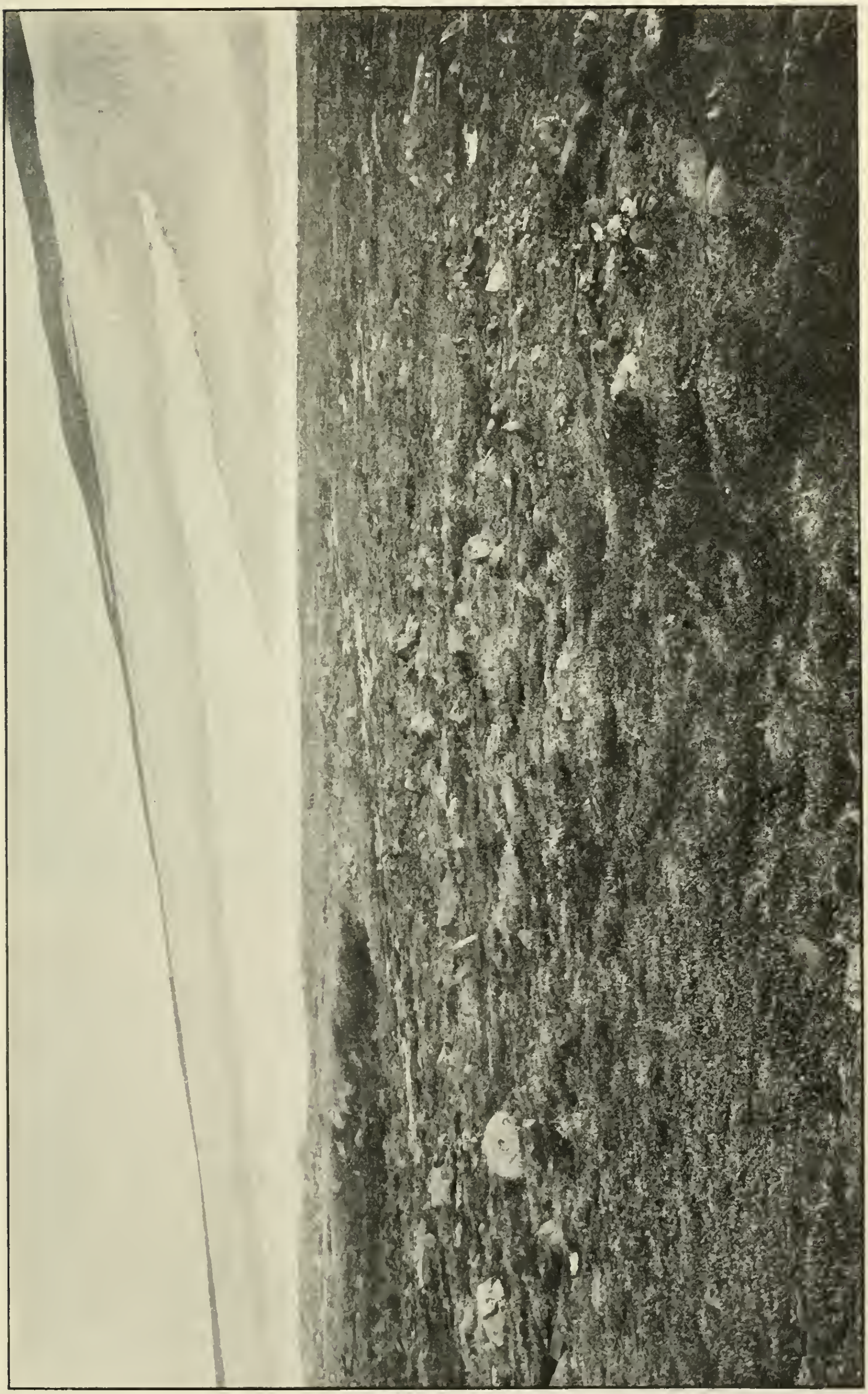


Fig. 5. *Eriophorum*-bog, to the east of Hulesøen, watered by a perennial snowdrift upon which the remains of the previous winter's snow is still seen (Aug. 5, 1907).

snow is a very convenient form for this, because it affords a possibility of regulating the moisture during the summer.

Compared with this, the importance of the snow as a protecting cover is very subordinate, because this cover is not constant, nor are there many species which rely on it, and with regard to which it may reasonably be supposed that they require a snow-covering for their existence in these regions.

The main result of my measurements really shows me only what was to be expected, that in the summer there may be a con-

Fig. 6. *Hippuris*-association in a lakelet near Danmarks Havn.

siderably higher temperature in the earth and the water, which is independent of a far lower temperature in the air. And a short period with a temperature below zero need by no means prove fatal to the parts of the plant above ground; but I do not know the temperature which causes the death of the protoplasm, nor whether the same low temperature always has the same effect; presumably the conditions during the thaw also play a rôle in this connection. Further it would be of interest to obtain measurements of the temperature of the living parts of plants during assimilation.

Even long before the snow-covering disappears, radiant heat is conveyed to the soil below it, as has been proved by measurements taken with a black bulb thermometer.

On April 27, 1908, between 1 and 2 p. m., the meteorologist of the expedition, Dr. A. WEGENER made an experiment, regarding which he writes as follows in "Meddelelser om Grønland," XLII, p. 300: —

"C. Strahlung durch Schneeschichten hindurch. Um die in botanischer Beziehung wichtige Frage zu untersuchen, wie weit sich die Sonnenstrahlung durch Schneeschichten hindurch bemerkbar macht, wurde des Schwarzkugelthermometer und ein ungeschütztes Thermometer in Höhlungen in einer Schneewehe derart

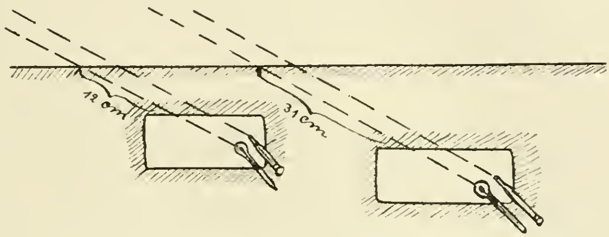


Fig. 7. Anbringung der Strahlungsthermometer unter dem Schnee.

angebracht, dass sie sich dort unabhängig von der aussen herrschenden Lufttemperatur einstellten. Die Länge des Weges, den die Sonnenstrahlen bei ihrem schrägen Einfallswinkel durch den Schnee hindurch zurückzulegen hatten, wurde dann unter Benutzung des Schattens ausgemessen. Die Anordnung des Versuchs ist in Fig. 7 dargestellt. Es ergab sich:

Zeit	Weglänge der Strahlen im Schnee	Unbeschütztes Thermometer	Schwarzkugel-Thermometer	Differenz
1p00	12 cm	— 9.2	—5.7	3.5
1 15	11 -	—10.4	—8.3	2.1
1 40	31 -	— 9.3	—9.4	—0.1
2 15	31 -	— 9.9	—9.9	0.0

Die hier benutzte Schneewehe war von derselben Festigkeit wie Nr. 1 in der Versuchreihe vom 24.—25. April, der Wassergehalt war also ungefähr: 1 cm Schnee = 4 mm Wasser. Die Ablesungen zeigen, dass bei ca. 12 cm Weglänge das Schwarzkugelthermometer noch merklich höher steht als das unbeschutzte Thermometer aber nicht mehr bei 31 cm. Eine Wirkung der Sonnenstrahlung dürfte demnach durch mehr als 20 cm Schnee (im schrägen Schnitt) nicht mehr vorhanden sein."

This heat causes considerable melting from below. This may be observed, e. g. on undulating ground, in places where the snow-covering is thin, viz. on the top of hills, and at the outer edge of the gently sloping snowdrifts where low, hollow spaces, several metres in extent, may be found beneath the snow-covering; and as a result the parts of the snowdrift thus hollowed are easily broken when trodden upon. This is often found to be the case in localities with a continuous covering of plants, e. g. *Cassiope*. On the other hand, at the foot of steeper snowdrifts, these hollows are not often known to occur, the reason being that only at its outermost edge is the snow-covering thin enough to permit the radiation to penetrate; besides, at its foot, a steep snowdrift easily becomes ice, owing to the melting snow, and then forms a compact mass on the ground. At the foot of such a perennial snowdrift I found, late in the year, only a few moss-fragments and a crust of *Nostoc* with *Gloeocapsa magna* and *Phormidium autumnale*. The presence of the moss-fragments proved that the snow had not always been lying there; but in this place it was not possible to demonstrate which species approach nearest to such an ice-edge, and are the first to take possession of the ground. When such an enormous snowdrift melts, the result often is that the ground below it remains a barren slush of clayey mud, until it again becomes frost-bound.

III. The Vegetation. The Biology of the Flowers.

As the list by Ostenfeld & Lundager shows, the country is very poor in species. Out of the small number 92, 14 species have been found at only one or at most two places, and a few were found as single individuals only.

In the above I have tried to show how inhospitable are the conditions offered by so important a factor as the climate, and in this I found a probable reason for the poverty of species. And yet I was sometimes disappointed because localities, which must be termed relatively good, nevertheless showed a still more decided poverty of species than did the exposed rocky flat.

The most important point is not that, on the whole, a favourable season of the year for the vegetation is wanting, but that the time when moisture and warmth are to hand is too short.

The climate determines the condition of the substratum. As the summer is so short — only two months, reckoning from midsummer towards the end of August — sufficient organic matter cannot be formed from plant tissues during that time. There is scarcely a single spot where real humus-formation can be demonstrated. Even in places where the conditions appear most favourable, as upon sheltered hill-slopes where fallen and decaying parts of plants are really deposited and are here and there allowed to remain in peace, the material in question is of such a nature that (as for instance the *Cassiope*-leaves) it decays very slowly, and certainly with a greater tendency to peat-formation than to the formation of mild humus. Even manured spots are not capable of producing a richer life, although these appear to be able to offer an equivalent to the presumed advantage of greater distance from the coast, as the conditions on Maroussia indicate.

Around skulls and other parts of skeletons, beautifully green oases in the surrounding desert are often to be seen, even from a distance; and in this relative luxuriance may grow vigorous tufts of *Melandrium triflorum* and *Hierochloë*, as also *Cerastiums* and *Stellaria longipes* with elongated internodes, the thick-leaved *Saxifraga cernua*, and the inevitable *Polygonum viviparum*. A similar though less decided luxuriance is sometimes due to the manure around lemming-holes.

As regards the development of Formations, at the outset, water is the most important factor: how much or how little and under what circumstances it is conveyed to the ground is the momentous point here, far more than the nature of the soil. From an orographical point of view, great uniformity prevails. As regards the solid elements, the maritime country consists of "moutonnées" primitive rocks of a height of as much as about 400 metres; further into the country, around Mörkefjord and Pustervig, a table-land occurs; its greatest height, 812 metres, is reached in Stjernefjeldene. Fuglenæbsfjeld, which I visited in August 1906 is of about the same height. The surface which slopes gently towards the north consists of loose boulders with intervening large, flat patches of gravel, the vegetation of which is sparingly-occurring tufts of *Saxifraga oppositifolia*.

Loose material, consisting of clay and gravel, is present to a great extent as moraine-formations around Stormelven and the inner part of Dove Bay. The depth of these layers is of no consequence, as the frost binds the ground into a frozen mass at a short distance from the surface. The extent of this distance is of course dependent upon the degree of moisture which is conveyed to the soil. It is true that, in the case of gravel-mounds which occurred scattered like those near Stormelven and the Bastions near Lakseelv, the mass of earth thaws rather far down, but then the surface is so dry that there is nothing to foster the growth of plants; consequently, it is barren there. As a rule the soil is not utilized to a greater depth than about 6 cm.

Plants are offered somewhat better conditions in places where the more recent layer is found deposited in depressions either entirely or partly surrounded by the primitive rocks, but with such possibilities of outlet that the water is not higher than some parts of it and the ground may protrude and allow the formation of tufts. In such places I always found *Carex pulla*, *Arctagrostis latifolia* and occasionally *Juncus triglumus*.

If the loose deposits are absent from the bottom of such a depression it is converted into a water-filled basin with a stony bottom devoid of vegetation. Where this kind of small pond becomes dry, the bottom is found to be black with *Gloeocapsa* and *Phormidium autumnale*.

Where the gravel and clay layers are found deposited in depressions between higher masses of rocks, so that there is enough moisture throughout the summer, *Carex*-bogs are developed as, e. g. in Vesterdalen between Harefjeldet and Varderyggen and in the valley east of the latter.

Slightly sloping or horizontal gravel-deposits, which in the first part of summer (June) are continually irrigated by melting snow, soon form a flourishing bog of *Eriophorum polystachyum* from which *Arctagrostis latifolia* is rarely wanting.

The rocky flat proper is formed by the gravel and clay layers to which must suffice the moisture which either the snow which covers the spot or the adjacent drifts of snow can provide from the time when the snow begins to melt in spring. These constitute by far the largest part of the area (with loose material), and it is the only formation which exhibits some alternation in the composition

Fig. 8. Slope with *Dryas* near Snenæs. In the foreground luxuriant mats of *Dryas* (30. 6. 1908).

of its vegetation. As a formation it also includes the scattered sparing vegetation of the primitive rocks.

Nature in its entirety has a stingy hand in these regions; poverty peeps through everywhere, and any extent of sociability cannot be afforded. Not even the most robust proletarian dares to associate in large quantities for fear of mutual deprivation of sustenance. If ultimately some associations are formed, e. g. the *Carex*-bogs along the small streams, the societies are always very exclusive, though not in the sense that the members exact too much of life: a drink of water during summer and a covering of snow during winter is all that they demand.

I will take the permission to quote from my diary the impressions I received during a visit in the summer of 1908 to Kløftfjeldet between Snenæs and Lille Snenæs: the slope there in my opinion is one of the most beautiful in north-east Greenland.

"There is an apparently enormous luxuriancy upon the irrigated terraced hill-side facing south-west. Here is a valley below in a direction about west to east. The south wind alone blows directly against it. And then there is water here, and water will continue to flow for a long time yet. Today it is July 7, and it has been very warm considering the time of year. Consequently, we must expect to find at any rate indications of everything which subsequently will make its appearance, because in 7 or 8 weeks we may have frost again, as we had it last year on Sept. 1.

But wherein does this luxuriancy consist? Well, there is a continuous carpet of vigorous specimens of *Salix*, richly flowering *Cassiope*, and luxuriant broad-leaved *Dryas*. *Vaccinium* has fresh, green shoots everywhere and flowers here and there. Then — ofcourse — there is never-ending abundance of *Polygonum viviparum* — this intruder which does not leave any society in peace. *Dryas* has almost finished flowering in the drier places. Thus, the terraced slope, seen from below, looks very well; but as soon as one has ascended, nothing of this is seen, as the most luxuriant vegetation occurs upon the slopes of the terraces (especially upon the more abrupt ones) and is hidden by their edges (Fig. 8).

And then what is my reward when I come upon the top of the hill: flowering *Campanula!* That is the culmination here! Under similar conditions in West Greenland, e. g. on Præstefjeldet, I found *Alchemilla*, *Thalictrum*, *Veronica* and *Bartsia* on June 2, 1905, and tall willow-copses along the banks of the small water-courses. Here it is only a question of the willow flinging itself along the rock and adhering to it, just barely venturing its catkins as far out as possible.

The greensward hereabouts is formed by *Luzula*, *Hierochlöe* (of course), a few *Poa cenisia* and *Cobresia Bellardii* together with *Carices* such as *C. misandra* and *Carex rigida*."

These few species supplemented by *Rhododendron*, which I found in the same society in Pustervig, on Fuglenæbsfjeldet and on Muskusoksefjeldene, are the only attempt towards the formation of a heath I ever found, with the exception of a small society of *Empetrum* intermixed with *Salix herbacea* near Hulesöen.

Of the peculiar formations which I have met with I shall here mention only a remarkable patch near the shore at the head of Yderbugt which I found on July 28, 1907. The ground is level and is only a few metres above sea-level at high tide. The surface is dark and has white patches as of salt. The patches are due to a lichen, doubtless a *Lecidea* which has occurred in many places, but never bearing fruit. Not far from here the primitive rock outcrops at an inconsiderable height.

Scattered over a belt of about 20 metres in length and 30 metres in breadth there occurred here a peculiar community of flowering *Papaver* which was conspicuous even from some distance. With intervening spaces, ranging from a few cm. to above one metre, the plant stood here and flowered richly. The ground was also covered with a rich vegetation of *Cochlearia officinalis* L. var. *groenlandica,* f. *minor* (Lge.) Gelert, which however in the flowering-stage greatly resembles the white lichen-spots. Also *Draba arctica,* a single specimen of *Luzula confusa* and *Phippsia algida* were present. *Saxifraga rivularis,* which is certain to occur in small depressions where melted snow has flowed, does not count for much, but is nevertheless found in the community. Here and there is found a small *Sagina intermedia* and *Alsine verna* f. *rubella,* c. fl. A single tuft of *Saxifraga groenlandica* was also noted. In the inner part of the belt, i. e. towards the primitive rocks, were found *Draba fladnizensis, Saxifraga nivalis, S. cernua* and *S. oppositifolia* together with indications of *Salix* and *Cerastium.* The transition to true rocky flat is indicated not only by the *Salix,* but also by tufts of *Poa abbreviata* and by a more frequent occurrence of *Saxifraga nivalis* and *S. oppositifolia.* These two species are not found in the lower part of the community, while *Cochlearia* and *Papaver* occur commonly everywhere. As soon as one leaves this community in a very true sense of the word, *Papaver* becomes rare and *Potentilla emarginata* takes its place. Here *Salix,* with a few *Stellaria longipipes,* becomes dominant. In this community, *Papaver* and *Cochlearia* dominate. I was surprised not to find *Pedicularis* where *Salix* and *Potentilla emarginata* occurred.

I found a very conspicuous community on July 5, 1908, upon Kløftfjeldet where *Epilobium* was spreading out with great splendour upon flat gravelly tracts through which tiny water-courses were flowing. But there the plant was far from reaching the size attained in West Greenland.

On the same day, upon the rocky flat between Snenæs and Lille Snenæs, I came across a small patch which from a distance attracted my attention by its yellow colour, and which, *a priori,* I thought resulted from *Papaver,* but on closer inspection it proved to originate from a richly flowering clump of *Potentilla nivea* upon a gravelly slope facing south which apparently afforded a convenient dwelling for a family of foxes whose continual use of the passages was revealed by the loose hairs found in them. This association of *P. nivea* was pure; only at the outer edge a single *P. emarginata* was found. Some exceedingly vigorous tufts of *Poa abbreviata* proved that the latter also throve in the neighbourhood of the fox-hole.

Between Stormkap and Snenæs the ground is fairly level and only slightly elevated. There are many small lakes and small bogs of *Eriophorum polystachym* of the usual monotonous composition, i. e. with *Carex pulla* and *Arctagrostis latifolia*. Where the ground is drier, *Salex*, *Cassiope* and *Hierochloë* dominate. Also the following occur scattered — *Papaver, Polygonum,* a small-leaved *Dryas, Luzula confusa, Cobresia Bellardii, Carex nardina, C. rupestris, Poa abbreviata, P. glauca, Melandrium affine, Silene, Stellaria lougipes, Saxifraga oppositifolia, S. cernua* and *Potentilla emarginata*.

During an excursion from Lille Snenæs to Trekroner on June 27, 1908, I found the first and only plant belonging to N. O. *Liliaceæ* in these regions, viz. *Tofieldia coccinea*, whose northern limit was thereby removed above 4 degrees of latitude further north. It was not exactly what I had expected to find. It formed very compact and dense tufts, sometimes alone, and sometimes together with *Cassiope* or *Dryas*. The roots twined so closely together that they could scarcely be separated without being torn. Neither *Cassiope* nor *Dryas* was flowering as yet, so the snow must have been lying a long time. *Tofieldia*'s nearest neighbours were *Vaccinium, Polygonum, Silene, Juncus biglumis, Pedicularis hirsuta, Salix* and a specimen of *Carex* (*rupestris* ?); also a small poor-looking *Papaver* which did not appear to thrive in these surroundings. These are without doubt the plant-growth of a heather-moor, but they occur here under such modified conditions that they do not constitute a formation which can be included in the definition of a heather-moor, with the significance that the word has when used in connection with West Greenland. The whole of this small locality consisted of a depression about 70 metres above sea-level.

In the dry sandy deserts north of Lumskebugten the vegetation consisted of only *Saxifraga oppositifolia, Carex nardina* and a few specimens of *Salix*. Further north there was quite a flat area covered almost exclusively with *Dryas* which had here very narrow leaves with revolute margins so that it closely resembled *Dryas integrifolia*. Below the snowdrifts at the foot of the small hills occurred the largest and flattest bogs of *Carex* and *Eriophorum* that I ever saw. The ground being so flat, these bogs looked exceedingly pleasant when seen from a distance, but, viewed nearer they did not appear to such advantage. To a certain extent they were reminiscent of the tufted bogs in Denmark, only the tufts here were very low and without the usual packing of moss with which we are acquainted in our bogs. There is running water almost everywhere.

There were also tracts which reminded one of the sandy *Calluna* heaths ("Hedesande") of Jutland where the fire has burnt off the surface layer. Here were tufts of *Dryas* which were not yet in flower (June 27), and flowering *Saxifraga oppositifolia; Oxyria* enlivens the scene wonderfully with its splendid inflorescences, but *Carex nardina* of course was not absent from the group, nor failed to give the whole a gloomy, withering and dying appearance. Fine, loose sand occurred between the tufts.

If moisture supervenes then we get in addition *Salix, Statice* and *Hierochloë.* Then *Dryas* comes into flower and then there is also a chance for *Carex misandra.* Moss occurs very sparingly even if there is water. But the water which stood there then would soon evaporate, and then the whole area would be dry. When seen from a distance such wet spots stand out like magnificient oases in the gravel and stone desert.

In towards the south-east side of Trekroner I saw the mountain in its most forbidding aspect. For a distance of several hundred metres the primitive rock was found torn up by the disruptive power of frost, so block was found by block in wild chaos without the least particle of loose material between them; consequently, all higher plant-life was absent.

In a single place at Lumskebugten there was found an attempt towards the formation of downs. At the foot of a bank of quicksand between two river-mouths some small individuals of *Alopecurus* and *Festuca ovina* occurred — the latter was viviparous there; also *Poa abbreviata, Poa cenisia* and *Luzula confusa* were found. Somewhat higher up were *Carex nardina*, sand-covered *Papavers* and tufts of *Alsine rubella.* I wondered at the occurrence of *Trisetum* in this society which, in addition, contained sand-covered *Salix, Lesquerella, Dryas, Saxifraga oppositifolia* and *Silene,* all bearing the stamp of the particular conditions in which they occurred.

As examples of typical localities I may mention my t e n t - g r o u n d at L i l l e S n e n æ s and the parts around the station at Danmarks Havn. The illustration from Lille Snenæs was taken on June 30, 1908 (Fig. 9). The tent was pitched on June 1 upon a small, flat patch of gravel which at that time was lying like an island in the snow, about 4—5 metres above sea-level (Fig. 10). Further out, the shore was formed by the primitive rock and a quantity of loose blocks and large stones which protruded through the ice-foot — and lay somewhat inwards upon the land. This outermost part was almost free from snow when I arrived there on the morning of June 22. Even at

Fig. 9. The tenting-place seen from the south. (Lille Snenæs; 6. 30. 1908).

Fig. 10. The tent seen from the north. "Orienteringssøerne" in the background. (Lille Snenæs; June 1).

that time *Cochlearia* was flowering between the stones upon the shore; a week into July *Stellaria humifusa* came into flower there; somewhat higher up a single *Braya* occurred. *Cochlearia* and *Stellaria* were alone within their dominion where the snow had been lying for a relatively long time. The rest of the large snowdrift above the tent did not disappear until July 9. The direction of the place is about S.—N. and it is protected towards the east by an edge, a few metres high, of the primitive rock which further inwards was covered by loose masses of gravel and clay — an old sea-bed and an old shore-formation. The snowdrift in towards this rock-edge, as also the snow on the whole, presumably had disappeared earlier than in 1907. And yet it was barren where it had been lying, which indicated that often it did not succeed in melting during the course of one summer. In the uppermost northern part of the place which had been occupied by the snowdrift, *Cochlearia* f. *minor* stood in flower on July 9. Though *Salix* ventured near to the places where the snow lay longest, yet it was not found where the snow had last disappeared. In the somewhat lower ground, between the snow and the more stony and somewhat higher part around the tent, distinctly marked belts of *Alopecurus* occur, about one metre in breadth; also *Luzula confusa*. Between the tent and these belts occur in a scattered manner — *Papaver, Oxyria* and *Salix,* as also *Cardamine bellidifolia; Glyceria angustata, Alopecurus, Cerastium, Stellaria longipes, Saxifraga oppositifolia, Potentilla emarginata* and *Juncus biglumis* extend inwards towards the lower, southern part of the snowdrift which at the extreme outside merged into the ice-foot. Where the ground sloped upwards against the rock-edge and the surface was damp and had cracked into polygonal cakes (a kind of "Rudemark") there nothing had appeared as yet (July 9), and there it was quite barren next the snow below the highest edge of the rock. Where the snow had just disappeared from the lowest part, not even moss was found.

In the most northerly part of the area from which the snow first disappeared, the above-mentioned belt of *Alopecurus* had wedged itself in between the foot of the edge of rock and a lower belt of *Luzula* which grew in tufts upon the polygonal cakes and imparted a greenish-brown tone of colour to the ground. Into this community there had ventured also a few specimens of *Poa, Oxyria, Salix* and *Potentilla emarginata.* There *Oxyria* had begun to flower, and there a single, fresh shoot of *Cerastium alpinum* was also found. Just at the edge of the belt towards the north, where it becomes more dry, a solitary *Saxifraga cernua* occurred. Here, and further in beneath the snowdrift, the lemming had left three holes, and a dead lemming was lying upon the ground.

Outside this belt of *Luzula*, somewhat lower, and sloping slightly towards the gravel patch on which the tent stood, came the *Salix*-belt which on July 9 was intermixed with crowds of flowering *Pedicularis*, and next to the gravel patch with numerous *Polygonums*, a few *Papavers, Potentilla emarginata* and *Silene*. On the western edge, in the outermost part of the belt which is about 10 metres broad, *Salix* had finished flowering, while in the inner part it had just begun. At the border there were a few tufts of *Cobresia Bellardii*,

Fig. 11. "The Island" ("Øen").

while *Hierochloë, Carex misandra* and *Luzula* occurred here and there. Around the tent occurred *Melandrium, Lesquerella* and *Potentilla pulchella*, as also *Arenaria ciliata, Dryas, Taraxacum phymatocarpum* and *Alsine rubella*.

Point I upon the map of the station which was the "Danmark's" winter quarter, I have called "The Island" (Øen). As may be seen from the map and the illustration (Fig. 11), the ground west of the mouth of Øster Elven slopes gently from the 6-metre curve down to the shore which is here quite flat. During the melting of the snow, Point I at first emerged as a small island which daily increased in size, and there already on June 14, 1908, a *Draba alpina* was in flower. In the saturated soil around the plant a temperature of

+ 10° was measured on the above-mentioned day, at 10.50 a. m., at a depth of 4 cm.; beside it in slowly running water, the thermometer showed + 9.3°, in dry sand + 10.5°; and in the air + 0.5°.

The conditions at this spot are favourable: sloping ground with a southern aspect and plenty of moisture, which features serve to minimize the difference between the day and night temperatures. The illustration was taken on June 15, 1908. At that time was found *Saxifraga oppositifolia* which predominates in the assemblage and as a great part of it was already flowering it gave a colour-tone among the black surroundings, where also the yellowish-grey tufts of *Carex misandra* were seen. Soon came the species next in conspicuousness, *Pedicularis hirsuta*, which was already peeping out with its fresh shoots in the drier spots. *Salix* also was flowering. *Saxifraga nivalis* and *Papaver* occurred with fresh rosettes, and *Ranunculus glacialis* was almost out. Moreover fresh shoots were seen on *Silene, Alsine verna, Cerastium alpinum* and *Potentilla emarginata*. In one place *Melandrium affine* stood alone, still with its stems of the previous year. *Stellaria longipes* was lying with apparent indifference still in its winter-clothes; but a closer inspection showed that in it also there was life in the nooks and corners of the tufts. *Draba hirta* had fresh rosettes; also *Luzula confusa*, a *Poa* and a few tufts of *Festuca ovina* showed the first signs of reawakening life. Add to this green algæ in the small pools, and the *Nostoc*-lumps in the running water, these all taken together formed a picture of a small, isolated, favourably-situated spot in spring-attire.

When I returned home from Lille Snenæs on July 2 "The Island" was covered with flowering poppies. There was still something left of the snowdrift along the 6-metre curve, where the cross-hatched part indicates a pronounced *Cassiope*-locality. In that part of "The Island" which was the first to become free from snow *Saxifraga oppositifolia* had already almost finished flowering. But *S. flagellaris* was in flower and some unusually luxuriant *Cerastium*-tufts, the flowers of which measured 20 mm. (cf. List, p. 20, the note to *Cerastium*; the illustration (Fig. 12) shows a tuft with stems stretched out and lying prostrate upon the ground). Towards the *Cassiope*-slope, at about the 5-metre curve, *Cerastium alpinum* f. *pulvinata* Simm. occurred here and there. It lay for a long time hidden under the snowdrift and in 1907 did not appear until the month of August; the next year it was at that stage of development even before our departure on July 21. At the same level, between the *Cassiope*-belt and the small masses of primitive rocks nearer to the water, *Alsine biflora* was found (cf. List, p. 18). Later in the summer the ground becomes dry and the surface cracks into polygonal cakes (a kind of "Rudemark"): but the cracks did not become so deep here as I saw them in several other places under similar circumstances. True "Rudemarks" probably do not occur at all in Germania Land; they were indicated most decidedly where the snow had been lying so far into August that the ground did not succeed in producing any vegetation at all.

On July 17, 1908, were found in addition upon "The Island" *Draba subcapitata, D. fladnizensis, Sagina intermedia, Ranunculus pygmœus, Taraxacum arcticum* f. *albiflora* (Fig. 14), *Oxyria digyna* and *Glyceria maritima* f. *reptans.*

Fig. 12. Tuft of *Cerastium alpinum* with espalier-like growth (2. 7. 1908).

The following table shows 48 species which have been found upon "The Island", the tenting ground near Lille Snenæs and in the *Papaver*-association near Yderbugten (July 28, 1907). Consequently, in these three diminutive localities occurs one-half of all the species which have been found, which, it appears to me, is a proof of the monotony of the vegetation in these regions. These three habitats are designated A. B. C. respectively, and the species found are indicated by a ×.

In regard to 8 species it is known for certain that they occurred in all three habitats. *Poa*, as a 9th species, is uncertain, as in the stage of development in which it was found in all three instances it was impossible to determine it as species. Characteristic of the

		A	B	C
1.	*Juncus biglumis*		×	
2.	*Luzula confusa*	×	×	×
3.	*Cobresia Bellardii*		×	
4.	*Carex misandra*	×	×	
5.	*Hierochloë alpina*		×	
6.	*Alopecurus alpinus*		×	
7.	*Phippsia algida*			×
8.	*Glyceria angustata*		×	
9.	— *maritima*	×		
10.	*Poa (glauca?)*	×	×	×
11.	*Festuca ovina*	×		
12.	*Salix arctica*	×	×	×
13.	*Polygonum viviparum*		×	
14.	*Oxyria digyna*	×	×	
15.	*Melandrium affine*	×	×	
16.	*Silene acaulis*	×	×	
17.	*Arenaria ciliata*		×	
18.	*Alsine verna*	×	×	×
19.	— *biflora*	×		
20.	*Sagina intermedia*	×		×
21.	*Stellaria humifusa*		×	
22.	— *longipes*	×	×	×
23.	*Cerastium alpinum*	×	×	×
24.	— f. *pulvinata*	×		
25.	*Ranunculus glacialis*	×		
26.	— *pygmæus*	×		
27.	*Papaver radicatum*	×	×	×
28.	*Cochlearia officinalis*		×	×
29.	*Cardamine bellidifolia*		×	
30.	*Lesquerella arctica*		×	
31.	*Draba hirta*	×		×
32.	— *fladnizensis*	×		×
33.	— *subcapitata*	×		
34.	— *alpina*	×		
35.	*Braya purpurascens*		×	
36.	*Saxifraga oppositifolia*	×	×	×
37.	— *flagellaris*	×		
38.	— *cernua*		×	×
39.	— *rivularis*			×
40.	— *groenlandica*			×
41.	— *nivalis*	×		×

	A	B	C
42. *Potentilla pulchella*		×	
43. — *emarginata*	×	×	×
44. *Dryas octopetala*		×	
45. *Cassiope tetragona*	×		
46. *Pedicularis hirsuta*	×	×	
47. *Taraxacum arcticum*	×		
48. — *phymatocarpum*		×	
Total...	29	30	18

coastal regions there is only *Saxifraga flagellaris* which was absent from the area around Dove Bugt and occurred again on Ymers Nunatak. In this intermediate space, as also on Ymers Nunatak, *Potentilla pulchella* was found which in the coastal regions (around Dan-

Fig. 13. *Ranunculus glacialis.*

marks Havn) had been found only as a single individual on Harefjeld—and again on Maroussia. Without however instituting any connection between the two circumstances of simultaneous occurrence I shall only remark that I found the plant for the first time when, on September 1, 1907, I was with the geologist of the Expedition at a place near Dove Bugt where he, at the same time, found Yoldia-clay.

Point II upon the map of the station indicates a small pond which dried up some time in the course of the summer and was again refilled by the ground-water from the bog above. In the near surroundings of the pond, towards the west, occurred in early summer a rich growth of *Ranunculus glacialis* (Fig. 13) which gradually became intermixed with *Statice armeria* which appears to thrive in the conditions which occur there late in the year.

Point III, upon the flat gravelly field, was the only locality in immediate proximity to the station where *Arenaria*, which was common further into the country, was found. In similar localities

Fig. 14. *Taraxacum arcticum* (Trautv.) Dahlst. f. *albiflora.*

but higher up and on a solid stony bottom, deeply covered with snow during the winter, *Erigeron compositus* was found; it keeps to the southern side and extends upwards, as far as the ground reaches which has previously been a sea-bottom.

The speciality of the small clay-island (Lerö), which is designated Point IV, was *Equisetum arvense* together with a luxuriant growth of *Salix*, *Dryas* and *Draba*. The depression around Point V is filled with snow during winter, and decaying parts of plants also gather there; upon the whole the locality appeared to offer possibilities for the formation of humus; nevertheless its only inhabitants after the melting of the snow were a small association of white-flowering *Taraxacum arcticum* (Fig. 14). Similar localities, especially if watered with running water for some time, were agreeable to *Ranunculus pygmæus* and *Saxifraga rivularis.*

Just above the *Cassiope*-belt north of "The Island" (Point I) the edge of the 9-metre curve was formed by a continuous growth of *Dryas* which kept to the level, dry margin, and did not extend over it in places where it ended abruptly. But *Cassiope* does not care to climb over any edge which does not retain its snow-covering very long; and thus *Vaccinium* is afforded an opportunity for growth

Fig. 15. *Empetrum*-locality to the east of Hulesöen. In the foreground, under the snow, *Empetrum* and *Salix herbacea.* On the margin above, the *Vaccinium*-belt, between *Dryas* upon the level flat and the *Cassiope*-vegetation which begins at the edge of the snow (9. 6. 1908).

between *Dryas* and *Cassiope,* and there it is often found in a sharply defined belt of 20—30 cm.; it occurs almost exclusively on such somewhat rounded surfaces transitional between more level areas and depressions in the ground. *Vaccinium* was found in a specially well-marked area and under such conditions east of Hulesö, where a large, level tract consisted of an *Eriophorum*-bog of copious moisture derived from an enormous snowdrift towards the north-east. A rather broad dyke formed a boundary to the bog and was broken through by small outlets from it. Upon this dyke *Dryas* and *Vaccinium* were distributed as described above. A depression of about one metre in depth contained some luxuriant tufts of *Empetrum* intermixed with *Salix herbacea* which latter did not occur outside this locality (Fig. 15; see also Fig. 5).

North of this *Cassiope*-belt and *Dryas*-border the vegetation became sparse, consisting only of some tufts of, e. g. *Carex nardina* and *Poa abbreviata*. The most northerly part of Basiskær seen upon the map has become drained. There are dark masses of barren clay, and the surrounding parts consist of tufted *Carex*-bog of which the principal contents are mosses, *Carex pulla, Arctagrostis* and *Salix*. Towards the north-west, in the dampest part between pools and water-courses, vigorous individuals of *Ranunculus sulphureus* occurred

Fig. 16. Wind-affected forms of *Dryas*.

and, hidden in mosses, *Juncus biglumis* together with *Cardamine bellidifolia*. At a short distance from that place *Pleuropogon* was floating, late in the summer, in that part of the river which was the first to dry up when frost set in.

Though the area included in the map is limited, yet this patch of ground and its immediate surroundings are relatively rich in the representatives of the vegetation of Germania Land; and I venture to hope that the area may be of interest as a useful illustration *en détail*, on account of the notes I have added upon it.

As peculiar wind-affected forms occur the worn-off tufts especially of *Cobresia Bellardii* and *Carex nardina*, as also of *Silene* and *Dryas*. The illustration of the *Dryas*-tuft (Fig. 16) is of one from the district near Lakseelv, found on June 16, 1907; it measures 2.32 metres in length and 1.45 metre in breadth and is almost withered to windward (NW.) and in the middle, but has a vigorous, though wind-affected border, to leeward. But these tufts keep to the ground and thereby stand in contrast with the curious "column"-forms in which *Potentilla pulchella* occurs both on Ymers Nunatak and in those places upon the gravel-banks near Lille Snenæs which are most exposed to the wind. The individuals from Ymers Nunatak appeared to have struggled against the sand-drift and thereby to have attained the compact, high tuft-form in order that they may be able to keep "above water." But the individuals of this form which I myself collected, stood quite isolated over the field and showed a much wind-affected and leafless base. The conditions there did not in any way permit the sand to gather around these "columns." *Lesquerella* and a *Draba* sp. from the same exposed posts have the same form (cf. List, p. 23 and Pl. V). It appears to me, judging from my observations in the field, that the form *humilis* (Lange) of *P. pulchella* prefers the weather-side to the lee-side though it is found also in that situation in company with *P. nivea*. But on the lee-side the tufts appear far fresher and have always a broad base.

P. pulchella f. *elatior* (Lange) is often found upon high sloping river-banks consisting of loose sand mixed with clay; but in contradistinction to the xerophilous f. *humilis* with its densely hairy, silvery white leaves f. *elatior* has slightly hairy leaves which are green upon the upper surface. In such places it must often stretch far and wide for food; I have found it with roots which measured 1.15 metre and to a great extent were lying so high that a portion of them lay bare.

It seems to me that *Salix* also must allow its form to be determined by such external factors as the wind. The illustration (Fig. 17) shows the largest "copse" I have seen; it occurred upon a stony slope above the station in Pustervig. *Salix* often adopts a curious form according to the adverse circumstances it meets with, but it always keeps close to the ground. The most beautiful branches I have seen I found upon Harefjeld on June 24, 1907. They were two 13-years-old branches, ♂ and ♀, measuring respectively 48 and 57 cm. in length. The male branch was somewhat thicker than the female which had a year's-shoot measuring 9 cm. and bore a leaf the blade of which measured 51×30 mm. The leaves were slightly hairy and the branches smooth. The exposition was as favourable as possible as regards shelter, snow-covering and sun. The male catkins expand first, and upon level ground always earliest in that part of the catkin which faces south.

Saxifraga cernua is a remarkably variable species, though not in response to the conditions of the wind. Its form differs according to the different localities, but it makes its way everywhere: on dry rocky flats where it grows up and becomes large and beautiful in the shelter of a boulder, as well as upon a manured spot around an animal skeleton where it utilises the sources of nourishment to excess and develops thick, swollen and brittle leaves; or along small water-courses down the rocky slopes with a gravelly bottom, but in such a case it rarely flowers until very late; and lastly in bogs and near lakes in the wettest moss, where it scatters its bulbils very

Fig. 17. Willow-copse at Pustervig.

abundantly. Flowers are of secondary importance to it. Here it stands long and straggling — both large and small individuals — and so dense that it characterizes the locality yet without adorning the landscape. The bulbils germinate also upon the parent plant, in the axils of the withered leaves.

Saxifraga groenlandica was found to be almost fully expanded on May 20, 1907, in a valley which lies N.W.—S.E. near Termometerfjeld. It was still snow-covered, but received moisture from snow which, in the form of an ice-collar, hung beyond the small tuft, whose one-year-old stems with withered flowers were protruding. The exposition was southern and shelter was obtained from some stones towards the west and the mountains towards the north and east. The two almost expanded flowers had their development stopped when the snow-layer melted round the tuft and on May 28 they were found to have closed, and no other buds had opened. Not until June 8 were some other buds on longer stems fairly widely open.

Epilobium latifolium is protandrous according to the material first collected by me. Afterwards I investigated some flowers on Moskusoksefjeldene on July 9, 1908, and in them frequently found the style to be further developed relatively to the anthers; I regard protandry to be the most common condition in north-east Greenland. (See also Warming, 1886, in K. Danske Videnskab. Selsk. Oversigt, p. 141, fig. 11).

In 1908 I found the plant in flower on July 7. In the material collected there were also fruits from the previous year, though the summer of 1907 might be regarded as unfavourable, as a relatively low temperature had prevailed during the whole time; therefore it is beyond doubt that the species in the summer of 1908 had set fruit in the majority of the localities in which it reached the flowering-stage as early as the beginning of July. The power of the species to spread below the soil is indisputable; but it is not of necessity of value to the preservation of the plant. Whether the seeds are dispersed by the agency of birds or by the wind or by both I am not prepared to say; but one of these two factors must have been at the disposal of the plant in one case, in which I found the plant in a crack in the rock at some distance from its original locality. It can scarcely have found its way there otherwise than through seeds. (The possibility is not excluded that the seed had been transported by the agency of running water; but this did not occur to me when I saw the plant on the spot and now, after some time has elapsed, nothing can be stated with certainly either for or against such a possibility).

Stellaria humifusa Rottböll. On August 12, 1907, I observed the plant on the shore at Yderbugt where it was visited by a small, grey butterfly which returned to the same tuft over and over again. The flower is decidedly protandrous; the anthers were empty when the stigmas were ripe. The head of the insect-visitor was dusted with pollen from a young flower, but it appeared to be very fond of older flowers also; the insect licked the petals and the ovary of the latter, but also stood head downwards in order to be able to reach the lower part of the flowers; it also tried to thrust itself in between the sepals from the outside. (See also Warming, 1890, in Festskrift udgivet af Den botaniske Forening, p. 212, fig. 8).

Stellaria longipes Goldie. On August 11, 1907, I observed small Diptera visit the plant. (See also Warming 1890 l. c., p. 207, fig. 6).

This species varies highly and appears to understand fully the art of adaption and its signification. Near places where food is plentiful — as in the manured spots around parts of skeletons of the musk-oxen — and also where it is protected by surrounding grass-tufts its internodes always become greatly elongated. On June 16, 1907, I found near Hvalrosodde stems apparently quite dead, with fresh, green buds and green leaves in their upper part. And on May 23, 1908, I came across several places on dry ground where, also upon withered old plants there occurred fresh buds, although the whole was so frozen and dry that it crumbled between my fingers.

Arenaria ciliata (L) var. *humifusa* (Wahlenb.). This plant has decidedly protandrous, insect-pollinated flowers. Honey is secreted abundantly in five glands at the base of the stamens in front of the sepals, and it sometimes occurs in clear beads at the base and gives to the plant a strong, sweetish perfume recalling that of buckwheat (*Polygonum fagopyrum*) or heather (*Calluna vulgaris*). Where the plant occurs in large quantities in a locality it colours the ground as if with balls of snow of purest white; but these white cushions are not very conspicuous when the sun stands high in the sky because in that case they harmonize too closely with the light, clayey soil mixed with sand which this species especially prefers and which, only when otherwise illuminated, presents enough contrast to show up the plant. The perfume is evidently sufficient to attract insects.

This species occurs most frequently with five styles. When only three styles are present these appear to be shorter than in the flowers which are 5-merous, and in contradistinction to such they stand erect and with their reddish-purple stigmas placed closely together. (See Warming, 1890, l. c. p. 221, fig. 14).

On September 4, 1907, this species was flowering on the west side of Varderyggen where it occurs as a spring plant which, in spite of frost, bears fresh shoots; however, the stamp of autumn was imparted by the reddish-brown colour of the young leaves.

Cerastium alpinum L. On May 21, 1908, a tuft was found with flowers that had survived the winter. New, fresh shoots were easily recognizable in the tuft. On the 23rd of the month I found several specimens with flowers from the previous year, as fresh to look at as if newly expanded, had not the protruding seed-capsule betrayed their age. The plant stood under the snow in the shelter of some stones — the protection being lowest towards east — in a depression where the plant must have been covered with snow from the first snowy day in September. Already for a long time the sun's heat had been penetrating the snow-covering, therefore the under part of the snow-crust and the upper layer of the soil, especially that which stood highest (to the north), was frozen ice. Here also a *Melandrium* was found. The soil around the *Cerastium* and at its root was quite dry, as dry as dust. The plant had fresh shoots besides green leaves that had remained through the winter. (For the biology of the flower see Warming, 1890, Festskrift, p. 197, figs. 1, 2).

Ranunculus glacialis L. Homogamy the rule. The nectar-pit is without a scale. (For the biology of the flower see Knud Jessen in Meddel. o. Grönland XXXVI, p. 338, fig. 3).

Within the *Cruciferæ* there is a considerable contrast between *Lesquerella arctica*, which is decidedly xerophilous (as also *Braya* in part) and the majority of the *Drabas*, most of which may be found both in dry and in damp soil. *Draba glacialis* associates itself with any other plant (as also does *Cardamine bellidifolia*) both in the driest gravel and in the wettest moss; and no change can be observed in its appearance as it occurs in the one or the other place.

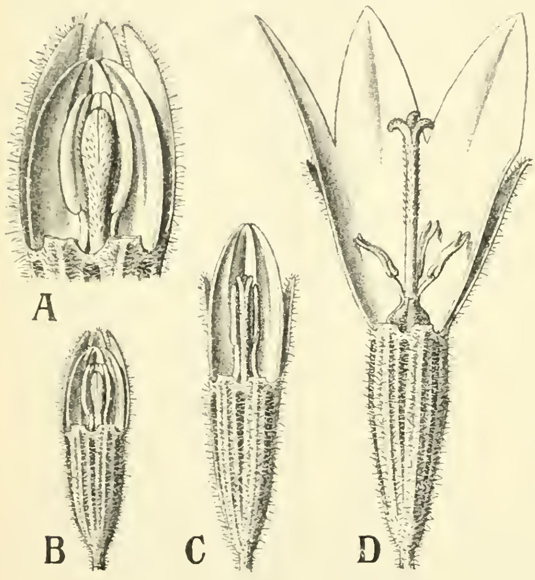


Fig. 18. *Campanula uniflora*.

The Pollination of Campanula uniflora. When in the young bud the anthers and the stigma are at the same level, the anthers begin to open, but the lobes of the stigma keep close together and their apices are bent inward toward each other Fig. 18 A, B). At this time no pollination can take place by the help of outward agencies, the corolla being closed. And as long as the anthers are at a higher level than the stigma, the former are quite closed and then the pistil with its sweeping hairs is also without pollen. But the style elongates rapidly in the yet closed flower and with its hairs sweeps off all the pollen from the open anthers (Fig. 18 C) so that its upper thicker part is everywhere coloured by the pollen. All the pollen is now to be found there, with the exception of a small portion which is left on the inner surface of the anthers. The flower opens simultaneously with the elongation of the style; but not until the pistil has reached its full height do the anthers leave their hold of it and withdraw, doing so gradually as the corolla opens. And not until the latter is fully open (Fig. 18 D) are the anthers found reclining against its inner side. Now all the pollen is freely exposed and may be carried away by insect-visitors. Once only, on Kløftfjeldet, did I have abundant material of the plant in different stages of development, and there appeared to be only one means of pollination, viz. by the agency of insects; but I saw no such visitors. (Regarding the biology of the flowers see also Warming, 1886, in K. Danske Vidensk. Selsk. Oversigt, p. 152, fig. 13).

In November 1906 I planted three crocus-bulbs in a box in soil in which cress had been sown the autumn before; the cress, however, had withered when daylight disappeared and I had not paid proper attention to the plants. The soil had been obtained by crumbling various lumps of sod of presumably the best quality, judging from the plant-growth which had previously found nourishment in it.

When two of these bulbs began to shoot in the beginning of December it interested me to observe the development and growth of the plant as it necessarily was obliged to assume its form in a room without daylight, and with lamp-light for about 18 hours out of the 24.

On December 9 I had made a small mark with ink upon the scales of the bulbs just at the surface of the soil, and above this the two plants measured 39 and 28 mm. respectively. The third bulb had also germinated, but had not yet grown above the surface of the soil.

On December 11, at 10.20 p. m. the plants were measured again; their length had then reached 45 and 33 mm. respectively, the increase during 48 hours being 6 and 5 mm. respectively. In the course of 4—5 days the green leaves grew up outside the scales or basal leaves which were pale and membranous, but they were considerably elongated in length, as if etiolated. The plants were copiously watered with lukewarm water (22°). The respective heights were: —

On the 13th, in the morning		49—35 mm.
— — — , at	10.20 p. m.	51—37.5 —
— — 16th, -	1.15 a. m.	54.5—40 —

The third bulb then had four shoots, about 1 cm. above the surface of the soil. Several cress-seeds germinated owing to the copious supply of water, which benefited the whole.

The respective heights were: —

On the 16th,	at	9 a. m.	56.5—41.5 mm.
— — —,	-	11.45 p. m.	61 —45 —
— Dec. 17,	-	10 a. m.	63 —48.5 —
— — 18,	-	1 a. m.	64 —49.5 —
— — —,	-	8.30 p. m.	65 —49.5 —
— — 19,	-	11.20 p. m.	70.5—54.5 —

Next the largest of the plants had one more shoot below. The third bulb elongated its four shoots very slowly, and the largest was then about 20 mm. above the surface of the soil, the others half as large.

The respective heights were: —

On Dec. 21,	at	12.30 a. m.	74—57 mm.
— — —,	-	10 a. m.	75—59 mm.

Both were then marked afresh with Indian ink for further measurements. The box was turned round to find out whether the lamp-light attracted them: then there was a distinct bending inwards into the room and the light which came from it (the box stood upon the table before the window in the "Villa" on the land).

The respective heights were: —

On Dec. 22,	at	12.30 a. m.	77—60 mm.
— — —,	-	1.10 p. m.	79.5—65.5 mm.
— — 23,	-	12.10 a. m.	81 —63 —

The cress since the noon of Dec. 22 had turned inwards into the room; perhaps the light there had attracted it, or else it avoided the lower temperature at the window and sought the warmth. Then the box was placed away from the window and upon the inner edge of the table, that towards the room, where it remained standing all through the night and the forenoon of the next day during which time it received light from the opposite side, from the lamps hanging over the table.

The respective heights were: —

On Dec. 23, at 1.45 p. m. 82—63.5 mm.

The cress was then standing upright, bending most towards the side which had been illuminated during the forenoon. Then the box was again placed before the window.

The respective heights were: —

On Dec. 24,	at	3 a. m.	84.5— 64.5 mm.
— — 25,	-	1.30 a. m.	87 — 67 —

	On Dec.	26, at	12.5	p. m.	91.5— 71	mm.
	— —	27, -	12.40	a. m.	93 — 73	—
	— —	—, -	11.35	p. m.	96 — 75	—
	— —	28, -	11.35	a. m.	97.5— 76.5	—
	— —	29, -	1.15	a. m.	103 — 80.5	—
	— —	—, -	2	p. m.	106.5— 82.5	—
1907	On Jan.	1, at	12.45	p. m.	112.5— 87.5	mm.
	— —	„ -	12 midnight		114 — 88.5	—
	— —	2, -	1.20	p. m.	115 — 90	—
	— —	3, -	12.30	a. m.	116.5— 91	—
	— —	„ -	3	p. m.	120 — 94	—
	— —	4, -	1.40	a. m.	122.5— 95	—
	— —	„ -	10.30	a. m.	123.5— 95.5	—
	— —	5, -	11.25	p. m.	127.5— 97	—
	— —	6, -	12.5	p. m.	130 —100.5	—
	— —	7, -	1.30	a. m.	133.5—101.5	—
	— —	„ -	12.10	p. m.	136 —102	—
	— —	8, -	9.40	a. m.	140.5—105	—
	— —	9, -	2	a. m.	144.5—107.5	—
	— —	„ -	11	a. m.	146 —108	—
	— —	„ -	10	p. m.	149.5—110	—
	— —	10, -	10.30	a. m.	153 —111.5	—
	— —	—, -	11.30	p. m.	156.5—115	—
	— —	11, -	10.45	a. m.	160 —117	—
	— —	12, -	12.15	p. m.	167.5—120	—
	— —	13, -	12.45	a. m.	172 —124	—
	— —	—, -	12.10	p. m.	174 —124	—
	— —	14, -	11.10	a. m.	180 —126.5	—
	— —	15, -	1.40	a. m.	183 —129	—
	— —	16, -	1.40	a. m.	190 —135	—

Then the measurements were stopped. On February 12, when the higher of the plants had already for several days been showing a tendency to wither, it was dug up. It measured than 227 mm. and had a new corm just above the old one, of about the same size as the latter. This new corm was kept for some time in a dry place and was afterwards planted, but did not sprout.

On February 24 the second of the plants which had been measured had also withered; it had reached a height of 157 mm. The third crocus with its four shoots was fairly well-developed at the end of January; but all the shoots were very slender; the highest had attained 152 mm.

There was no evident difference between the colour of the leaves in December and in January and February although they were exposed to daylight at that time; the sun however was not as yet above the horizon. But it was difficult to decide whether any change of colour had taken place, as in February we had not the December growth for comparison; if there was any change it had come on imperceptibly from day to day.

5.—7.—1912.

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Danmark-Ekspeditionen 1906-08

Højdetal i Meter.

Axel E. Aamodt, Kjøbhvn.