

DET KONGELIGE DEPARTEMENT  
FOR HANDEL, SJØFART, INDUSTRI, HÅNDVERK OG FISKERI

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NORGES SVALBARD- OG ISHAVS-UNDERSØKELSER  
LEDER: ADOLF HOEL

# SKRIFTER OM SVALBARD OG ISHAVET

No. 59

B. LYNGE

ON DUFOUREA AND DACTYLINA  
THREE ARCTIC LICHENS

WITH 2 PLATES AND 6 FIGURES IN THE TEXT



OSLO  
I KOMMISJON HOS JACOB DYBWAD  
1933

## Results of the Norwegian expeditions to Svalbard 1906—1926 published in other series. (See Nr. 1 of this series.)

The results of the Prince of Monaco's expeditions (Mission Isachsen) in 1906 and 1907 were published under the title of 'Exploration du Nord-Ouest du Spitsberg entreprise sous les auspices de S. A. S. le Prince de Monaco par la Mission Isachsen', in *Résultats des Campagnes scientifiques, Albert I<sup>er</sup>, Prince de Monaco*, Fasc. XL—XLIV. Monaco.

ISACHSEN, GUNNAR, Première Partie. Récit de voyage. Fasc. XL. 1912. Fr. 120.00.

With map: Spitsberg (Côte Nord-Ouest). Scale 1:100 000. (2 sheets.) Charts: De la Partie Nord du Foreland à la Baie Magdalena, and Mouillages de la Côte Ouest du Spitsberg. ISACHSEN, GUNNAR et ADOLF HOEL, Deuxième Partie. Description du champ d'opération. Fasc. XLI. 1913. Fr. 80.00.

HOEL, ADOLF, Troisième Partie. Géologie. Fasc. XLII. 1914. Fr. 100.00.

SCHETELIG, JAKOB, Quatrième Partie. Les formations primitives. Fasc. XLIII. 1912. Fr. 16.00.

RESVOLL HOLMSEN, HANNA, Cinquième Partie. Observations botaniques. Fasc. XLIV. 1913. Fr. 40.00.

A considerable part of the results of the ISACHSEN expeditions in 1909 and 1910 has been published in *Videnskapsselskapets Skrifter. I. Mat.-Naturv. Klasse, Kristiania (Oslo)*.

ISACHSEN, GUNNAR, Rapport sur l'Expédition Isachsen au Spitsberg. 1912, No. 15. Kr. 5,40.

ALEXANDER, ANTON, Observations astronomiques. 1911, No. 19. Kr. 0,40.

GRAARUD, AAGE, Observations météorologiques. 1913, No. 1. Kr. 2,40.

HELLAND-HANSEN, BJØRN and FRIDTJOF NANSEN, The sea west of Spitsbergen. 1912, No. 12. Kr. 3,60.

ISACHSEN, GUNNAR, The hydrographic observations. 1912, No. 14. Kr. 4,20.

With chart: Waters and anchorages on the west and north coast. Publ. by the Norw. Geogr. Survey, No. 198.

HOEL, A. et O. HOLTEDAHL, Les nappes de lave, les volcans et les sources thermales dans les environs de la Baie Wood au Spitsberg. 1911, No. 8. Kr. 4,00.

GOLDSCHMIDT, V. M., Petrographische Untersuchung einiger Eruptivgesteine von Nord-westspitzbergen. 1911, No. 9. Kr. 0,80.

BACKLUND, H., Über einige Olivinknollen aus der Lava von Wood-Bay, Spitzbergen. 1911, No. 16. Kr. 0,60.

HOLTEDAHL, OLAF, Zur Kenntnis der Karbonablagerungen des westlichen Spitzbergens. I. Eine Fauna der Moskauer Stufe. 1911, No. 10. Kr. 3,00. II. Allgemeine stratigraphische und tektonische Beobachtungen. 1912, No. 23. Kr. 5,00.

HOEL, ADOLF, Observations sur la vitesse d'écoulement et sur l'ablation du Glacier Lilliehöök au Spitsberg 1907—1912. 1916, No. 4. Kr. 2,20.

VEGARD, L., L'influence du sol sur la glaciation au Spitsberg. 1912, No. 3. Kr. 0,40.

ISACHSEN, GUNNAR, Travaux topographiques. 1915, No. 7. Kr. 10,00.

With map: Spitsberg (Partie Nord-Ouest). Scale 1:200 000 (2 sheets).

GUNNAR ISACHSEN has also published: Green Harbour, in *Norsk Geogr. Selsk. Aarb.*, Kristiania, 1912—13, Green Harbour, Spitsbergen, in *Scot. geogr. Mag.*, Edinburgh, 1915, and, Spitsbergen: Notes to accompany map, in *Geogr. Journ.*, London, 1915.

All the above publications have been collected into two volumes as *Expédition Isachsen au Spitsberg 1909—1910. Résultats scientifiques. I, II.* Christiania 1916.

As the result of the expeditions of ADOLF HOEL and ARVE STAXRUD 1911—1914 the following memoir has been published in *Videnskapsselskapets Skrifter. I. Mat.-Naturv. Klasse*.

HOEL, ADOLF, Nouvelles observations sur le district volcanique du Spitsberg du Nord 1914, No. 9. Kr. 2,50.

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The following topographical maps and charts have been published separately:

Maps:

Bear Island. 1:25 000. 1925. Kr. 10,00.

Bear Island. 1:10 000. (In six sheets). 1925. Kr. 30,00.

East Greenland. Eirik Raudes Land from Sofiasund to Youngsund. 1:200 000. 1932. Kr. 5,00.

Charts:

No. S. 1. Bear Island. 1:40 000. 1932. Kr. 4,00.

” S. 2. Bear Island Waters. 1:350 000. 1931. Kr. 5,00.

” S. 3. From Bellsound to Foreland Reef with the Icefjord. 1:200 000. 1932. Kr. 5,00.

” S. 5. Norway—Svalbard, Northern Sheet. 1:750 000. 1933. Kr. 4,00.

” S. 6. Norway—Svalbard, Southern Sheet. 1:750 000. 1933. Kr. 4,00.

A preliminary edition of topographical maps (1:50 000) covering the regions around Kings Bay, Ice Fjord, and Bell Sound, together with the map of Bear Island (1:25 000), is published in:

Svalbard Commissioner [Kristian Sindballe], Report concerning the claims to land in Svalbard. Part I A, Text; I B, Maps; II A, Text; II B, Maps. Copenhagen and Oslo 1927. Kr. 150,00.

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A. W. BRØGGERS BOKTRYKKERI A/S

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## I. Preface.

During my work on Arctic lichens I became interested in the genera *Dactylina* and *Dufourea*, on account of the remarkable distribution of the two species of the latter genus. In a paper, published in cooperation with P. F. Scholander (*Lichens from North East Greenland, Skrifter om Svalbard og Ishavet*, No. 41, 1932, p. 85—87) I ventured some suggestions on their distribution which I suspected to be due to their geological history. The same idea was suggested in my paper: *Om utbredelsen av endel arktiske laver, Svensk Bot. Tidskrift*, 1932, p. 411.

In 1931 my friend, Dr. P. F. Scholander, had the good fortune to detect fertile plants of *D. ramulosa* in the North East Land of Svalbard and he generously allowed me to describe its apothecia, with the permission of the leader of the expedition, Professor H.W:son Ahlmann.

After that I studied in detail the distribution of the three species in question. Firstly, I had to collect as much information as possible on the localities, represented in the leading Arctic herbaria. I am much indebted to the scientific staffs of all these museums for their precise and prompt answers to my questions. The present information is based on the material of the following museums: Berlin, Genève, Harvard, Helsingfors, Krakow, København, Leningrad, London (Kew and Brit. Mus.), München, Oslo, Ottawa, Paris, Stockholm, Upsala and Wien. The very important information from Leningrad was procured for me by a foreign botanist who visited that city. — I have also received information from the Spanish *Academia de Ciencias y Artes* in Barcelona.

The literary references are based on Zahlbruckner's *Catalogus Lichenum*, to which have been added some results from my own literary research work. Very few papers have been cited which I have not seen myself. In such cases I have tried to obtain copies of the text from my colleagues, many of whom have placed their precious time, and their literary possibilities at my disposal.

During my work many problems suggested themselves, botanical as well as geological, and I had to avail myself of the knowledge and the good-will of so many colleagues and friends that I really hesitate to mention their names, for fear of forgetting many of them. I feel

so deeply indebted to each and every one of them that I do not know how to express my gratitude. I have never published a paper the results of which were so markedly dependent on the cooperation of so many scientific friends. — I may perhaps mention that the control of one statement in literature (which proved erroneous) necessitated 10 letters, and as many answers.

At the end of this paper I have not the usual feeling of being the "author", but rather the feeling that I have been the collector of facts, a lens through which rays of many kinds have converged, to form a clear picture.

I especially beg to extend my profound thanks to the following scientists: Doctors Ahlmann, Asahina, Bergersen (and his assistants), Bouly de Lesdain, Chodat, Darbishire, Dodge, Du Rietz, Fernald, Florin, Frey, Gams, Gran, Holmboe, Holtedahl, Keissler, Linkola, Magnusson, Malme, Motyka, Ramsbottom, Samuelsson, Scholander, Miss A. L. Smith, Suza, Szafer, Tolmatcheff, Th. Vogt, and Zahlbruckner.

I am also much indebted to the head of *Norges Svalbard- og Ishavs-undersøkelser*, Mr. Adolf Hoel, and to the staff of his office, for their untiring willingness to place their great Arctic experience at my disposal.

My own library contained a considerable part of the papers that had to be consulted. Others were found in our University Library, in the Oslo Botanical Museum, and in the library of *Norges Svalbard- og Ishavs-undersøkelser*. A few additional items were obtained through foreign friends.

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## II. General Remarks.

The lichen genus *Dufourea* was established by Acharius in *Lichographia Universalis*, 1810, p. 524. His diagnosis runs:

“Apothecium orbiculatum in thallo tubuloso id marginate terminale, ambitu affixum subtus liberum; Lamina prolifera discum formante plano-convexa, intus similari.

Thallus membranaceus ramosus intus stuppeus fistulosus”.

He included five species under this genus. Two of them were simply registered as “species”, viz.:

1. *Dufourea mollusca*, later called *Combea pruinosa* by De Notaris (*Giorn. Bot. Ital.* vol. I, pars 1, 1846, p. 225), and

2. *Dufourea flammea*, now referred to the genus *Xanthoria* as *X. flammea* (L.) Hillm., (*Hedwigia*, vol. LXIII, 1922, p. 199 and 206).

The other species were registered as “species dubiae”, viz.;

3. *Dufourea ryssolea*, now *Parmelia ryssolea* (Ach.) Nyl., and

4. *Dufourea madreporiformis*, and lastly

5. *Dufourea obtusata*, now called *Pertusaria oculata* (Dicks.) Th. Fr.

These species are now referred to five different genera, so different that they belong to five different families.

It is fully clear that Acharius based his genus *Dufourea* on the two “species” *mollusca* and *flammea*, and not on the three “species dubiae”, or on any of them. — It is, of course, impossible to unite the two “species” in the same genus, and, that being so, it seems natural to regard the first mentioned “*mollusca*” the type of the genus *Dufourea* Ach.

The consequence is that we must reserve the combination *Dufourea mollusca* for this species, and reject the genus name *Combea* De Notrs.

The first to accept this consequence was Th. M. Fries, *Genera Heterolichenum*, 1861, p. 113: “Sub nomine *Dufoureae* variae species conjunctae sunt, quarum vera natura nimis est dubia. Quum vero hoc nomen alteri (exoticarum) specierum, ab Achario pro typo sui generis declaratarum (*D. molluscae* = *Combea pruinosa* DNtrs. et *flammeae*), servari debeat neque “speciebus incertis” auctoris imponi (*D. ryssoleae*, *madreporiformi*, *obtusatae*)”, et cet.

This opinion was also endorsed by Tuckerman (1862, p. 396) who there reserved the genus name *Dufourea* for *D. mollusca* Ach.

It should be unnecessary to say that we cannot refer the *madreporiformis* to the same genus as *Dufourea mollusca*. Zahlbruckner placed them in different families, and with full reason, the former in the *Usneaceae*, the latter in the *Roccellaceae*, on account of its gonidia (*Trentepohlia*).

Our present knowledge of *Dufourea mollusca* is amply sufficient to justify a distinction of that kind. A little additional information was gathered from my examination of a plant from Lüderitz Bay in South Africa, collected by H. Eberlanz in 1929, a gift from the Berlin Botanical Museum to our Oslo Museum.

The excipulum of the strictly apical apothecia is uncoloured, as is also the hypothecium. The gonidia (*Trentepohlia*) are developed in radiating stripes under the hypothecium, in the latter I was unable to detect a double stratum. The hymenium is 75—80  $\mu$  high, the paraphyses intensely intricately ramose and very coherent (ramoso-connexae), not incrassated at the tips. The asci are pyriform, octosporous, the spores parallel in their asci, uncoloured, three-septated, 17—20  $\times$  5  $\mu$ . — The pycnides are very numerous, ostiole not protruding. The perifulcium pale yellow, brown around the ostiole. The pycnoconidia are slightly arcuated, at times more so, cylindrical or a little narrower towards the apices, 8—10  $\mu$  long. They are detached from the tips of very short and much branched fulcra (pycnoconidia exobasidialia).

The genus *Dactylina* was established by Nylander, Synopsis Lichenum, 1858—60, p. 286, a genus, closely related to *Dufourea* Ach. These genera are Nos. 3 and 4 in Nylander's Tribus IX, *Ramalinei*, his Tribus VIII is the *Usnei*. It is unnecessary to repeat Nylander's diagnosis from this well-known paper. He finds the distinguishing character in the thallus which is "cavus cylindrico-turgidus" in *Dactylina*, whereas *Dufourea* has a thallus "intus medulla stuppea repletus".

Zahlbruckner follows Nylander. In Lichenes, Engler-Prantl, 1926, p. 239, he makes the following distinction:

- \*Lager aufgeblasen walzig            5. *Dactylina*.  
 \*\*Lager nicht aufgeblasen walzig    6. *Dufourea*".

But it is evident from the descriptions in the present paper, as well as in many earlier papers, that grave objections can be advanced against this distinction. Firstly, the thallus is not at all "medulla repletus" in the genus *Dufourea*, as limited by Nylander. *Dufourea madreporiformis* has a medulla of that kind, but not the other species, *D. ramulosa*. Already in the first description of the species, the excellent diagnosis by Hooker (1825, p. 424) we find "thallo . . . fistuloso",

Tuckerman also made this fully correct observation (1862, p. 397—8): “within hollow”.

In reality we find no other generic distinction than the turgid thallus of *D. arctica*, against the more tiny thallus of the two other species. This difference is very important for the habitus, an excellent species character. But if characters of that kind were to be admitted for generic distinction, we should have to accept many wonderful lichen genera.

If we compare the descriptions of the apothecia, given in the present paper, it is hardly possible to find distinguishing characters of generic importance. In all the three species we find the same low hymenium, the small simple spores, the double “hypothecium”, composed of a genuine hypothecium, and under it a stratum that agrees entirely with the exterior cortex — in my opinion the remainder of the old thalline cortex which the hyphae of the paraphyses and the initiating asci have penetrated and extended when the apothecium was formed.

This opinion that the three species should belong to the same genus was already expressed in Hooker’s first description of his “*Dufourea arctica*”, and also in its first name *Dufurea rugosa* R. Br. (1819, p. 195, a nomen nudum). Since that time the generic agreement has been fully acknowledged by several prominent lichenologists. Tuckerman united them under the name *Dactylina* (1862, p. 396). Other lichenologists, such as Vainio (1909), Elenkin and Savicz (several papers) also referred them to the same genus, but, unfortunately, these authors used the genus name *Dufourea*.

Nylander would not hear of such an idea. In his paper of 1870, p. 177, he declared that the name *Dufourea* should be conserved for Acharii species *madreporiformis*, and in his polemic paper of 1871, p. 298—9, against his “enemies”, Müller Argoviensis and Th. M. Fries, he angrily fought for his view. But as far as I can see, he gave no valid arguments, only his authority. Sic volo, sic jubeo.

This species has been passed on from genus to genus, but fortunately enough there has never been any doubt as to its species name, *madreporiformis*. The only difficulty is that this name has been used for two very different lichens, viz. the present species and *Cladonia Papillaria*. It is quite clear that Wulfen’s name in Jaquin Collect. Bot., vol. III, p. 105, and tab. 3, fig. 2, stands for the *Cladonia*. This is evident from his description, his figure, his reference to Dillenius Hist. Musc., tab. XVI, fig. 28 — a British plant —, and especially from his description of the locality: “Saepius hunc in sylvis abiegnis & Labaci sub Turre, & Clagenfurti intra Calvariae montem ac Ziguln, invenimus in terra argillosa, aut margacea, sterili, quam adinstar Lichenis Ericetorum, ampla per spatia, integris cauliculorum, stipatissime aggregatorum obducit cespitibus”.

I have been unable to check the other 3 "*Lichen*" *madreporiformis* names (p. 27), viz. Gmelin's name of 1791, Laichaiding's of 1794, and Jolyclerc's of 1799.

If we are obliged to leave out of account these three authors, which we probably must, we shall have to base the species name on Acharii *Dufourea madreporiformis* in Lich. Univ., 1810, p. 525. Acharius cites "*Lichen madreporiformis*" Wulf. as a synonym, but with a "?", expressing his well-founded doubts.

Most authors have based the species name on Wulfen's paper. The correct reference is to be found in Müller's paper of 1871, p. 394.

If we cannot use the name *Dufourea*, for the reasons stated above, we must fall back on the genus name *Dactylina*, and call them *Dactylina arctica* (Hook.) Nyl., *Dactylina madreporiformis* (Ach.) Tuck., and *Dactylina ramulosa* (Hook.) Tuck.

Lastly, we shall have to consider the family affinity. Nylander referred the two genera to his tribus *Ramalinei* (1858—60, p. 286—7). As long as the apothecia were unknown, or insufficiently studied, this opinion was quite as reasonable as any other. They agree with the *Ramalinei* in the structure of the cortex, built up of thick-walled palisade hyphae in a direction at right angles to the surface, forming a mighty armour around the thallus. But it seems to me that a cortex of this kind is a very natural structure for a lichen of this habitus. We find much the same structure in *Sphaerophorus* and *Roccella* (A. L. Smith, Lichens, 1921, p. 83, fig. 44 and 45), certainly not related to *Dactylina*. In *Cornicularia aculeata* the exterior brown cortex is also built up of very thick-walled hyphae at right angles to the surface. Inside of this exterior stratum we find thick-walled hyphae, running in all directions.

A cortex of this kind is, perhaps, a convergence, induced by similar physiological demands, rather than a character of systematical importance.

Müller Argoviensis was the first to find the apothecia of *D. madreporiformis*, in 1869. He described them in his important paper of 1870, p. 325, in Flora, vol. LIII. Müller found that "Diese Früchte sind nun in Bezug auf generische Structur- und Formverhältnisse vollkommen identisch mit denen von *Cetraria* und gleichen sogar auffallend denen der *Cetraria juniperina*". His conclusion is: "Nach obigen Erörterungen der Structurverhältnisse und der eigenthümlich complizirten Synonymie wird also unsre Flechte jetzt zu: *Cetraria madreporiformis* Müll. Arg."

Tuckerman who also recorded fertile plants from the Rocky Mountains (Synopsis, 1882, p. 30) referred *D. madreporiformis* to the genus *Cetraria* in that paper. But Tuckerman evidently found it difficult to arrive at definite results, for he attempted many solutions in his other papers.

With his usually keen intuition Reinke was fully convinced that *Dactylina (arctica)* was closely related to *Cetraria*. He writes (1895, p. 194): "Der Thallus ist hohl, aufgeblasen-röhrig und läßt sich von dem

Thallus einer *Cetraria* so leicht ableiten, wie jeder hohle Phanerogamenstengel von einem gefüllten, wobei hier der flache in den kreisförmigen Querschnitt übergeht”.

In my opinion there is no difference of generic importance to be detected in the structures of the apothecia in the genus *Dactylina*, as here limited, and in the genus *Cetraria*. It is sufficient to compare the descriptions in the present paper with my former descriptions of Norwegian *Cetrariae* in my “Studies on the Lichen Flora of Norway” (Vid. Sels. Skr., Oslo, 1921, I, No. 7). In that paper I have described the apothecia of 13 different species of *Cetraria*. The general structure is remarkably uniform; it does not even give us specific differences which must be based on the different and characteristic exterior habitus of all these species.

On principle Müller Argoviensis always neglected characters derived from pycnides and pycnoconidia. That was particularly unfortunate in this case, for, as far as I can find, the difference between the genera *Dactylina* and *Cetraria-Cornicularia* can only be based on the pycnides. In the former genus they are more or less immersed into the thallus, such as is the case in *Parmelia*, or in *Physcia*; in the latter genera they are “papillis elevatis v. spinulis inclusae” (Th. Fries Lich. Scand. I, 1871, p. 97).

This difference was also, and with full right, sharply emphasised by Nylander in his polemic paper of 1871, p. 299: “Sufficit ut notetur, ei” (i. e. Müll. Arg.) “quidem plane ignotum esse primarium characterem generis *Platysmatis*, quem scilicet sistunt conceptacula spermogoniorum papilliformia h. e. papillose protrusa et prominula, quae nihil obvenit apud *Dufoureas* nec apud ullum aliud genus Lichenum. In *Dufourea* spermogonia observantur omnino externe conformia cum iis *Everniarum* et *Parmeliarum*”.

In *D. madreporiformis* the pycnides are not quite immersed into the thallus, for they have a protruding apex, see pl. II, fig. 1. But they are not placed in protruding papillae.

In some lichens apothecia are always present. In others they are more or less rare, often so rare that we are very glad to find them, in other species again they are entirely unknown. In the *Dactylina* species they are so rare that several authors have not been aware of their existence.

From my own experience I can mention some other lichens, the apothecia of which are extremely rare. In the genus *Cetraria* there are interesting cases of parallel development. In some species apothecia are hardly ever lacking, e. g. in *Cetraria juniperina* and in *C. saepincola*, but in the related species *C. caperata* (= *C. pinastri*) and in *C. chlorophylla* they are extremely rare. Though the two last mentioned species are amongst the commonest lichens in Norway, I have only seen one fertile plant in either of them.

In the genus *Alectoria* there is but one find of a fertile *A. Fremontii* in Norway, one of *A. nidulifera*, none of *A. simplicior*, one of *A. nigricans*, and one of *A. cincinnata*. On the central Norwegian mountains *A. ochroleuca* is often fertile, but apart from these mountains very few apothecia have been detected in our country, though the species is widely distributed. These apothecia of *Cetraria* and *Alectoria* have been described in my "Stud. Lich. Flora of Norway", 1921.

The most astonishing case is, perhaps, *Cornicularia divergens*. In 1928 a fertile plant was detected on the Dovre mountain in Norway, the only Norwegian find of a fertile plant. There is also one Swedish find, from Juckasjärvi in Northern Sweden. Apart from these two I only know of one fertile plant, from "Insula Äsä, Mare Ochotzk", described by Nylander in his Lich. Middend., 1867, see: Lynge "Cornicularia divergens found fertile in Europe", Nyt Mag. Naturv., vol. LXVII, 1928.

Why are some lichens so well fertile, others so sterile?

Substratum and climate could be the cause. Our government mycologist, Mr. Ivar Jørstad, has told me that the fungus *Phytophthora infestans* only develops oospores on a substratum, containing Silicium. Furthermore that "*Penicillium glaucum*" develops ascospores in concentrated solutions of sugar. Amongst the fungi numerous cases of that kind could be mentioned. — But it is difficult to understand that factors, such as substratum and climate, could act so locally, as the above-mentioned finds of fertile lichens would suggest.

It might be a better explanation if we could prove that there were different races of such lichens, different physiologically, but not morphologically. Amongst the *Micromycetes* many cases are known of differences of that kind. The idea is good enough, but we have no proofs of its validity.

Professor H. H. Gran, of Oslo University, has suggested a comparison with heterothalline fungi.

The + and — mycelia of *Mucor* are well known. We cannot distinguish between them morphologically, but they are sexually differentiated, and zygosporangia are formed only if either sex is present in the culture. — In some *Basidiomycetes* one basidiospore can grow out to a thallus with a complete cyclus, developing basidiospores again (homothalline species). In others this fructification is only formed in cultures, originating from two spores of different sexual polarity (heterothalline species), such as in species of *Coprinus*, cfr. researches by Brunswik and Kniep, described in Kniep's "Die Sexualität der niederen Pflanzen", 1928.

We know that there is a full homology between *Basidiomycetes* and *Ascomycetes* with respect to their cytology before and during the formation of asci and basidia. We also know that lichens behave like

other *Ascomycetes* before and during the formation of their asci, cfr. Moreau "Les Lichens", 1927, p. 66 and 74. We have the same "anse", the same dikaryon in either group.

In eventual heterothalline lichens the rareness of their apothecia would be well explained if it could be proved that one of the sexes was common, the other very rare. Cytological researches of that kind are much to be desired. The difficulty is that lichens resist the usual methods of cultivation, developed for fungi.

### III. Special Part.

#### *Dactylina* (Nyl.) Tuck.

Bibliographia generica: Vide Zahlbruckner *Catalogus Lichenum Universalis*, vol. VI, p. 368 (*Dufourea*), et p. 371 (*Dactylina*).

Thallus podetiiformis, podetia subcylindrica vel inflata, medulla arachnoidea repleta vel intestiniformia, textura radiantia, undique cortice firmo instructa, hyphis pachydermaticis superficiei perpendicularibus formato.

Apothecia apicalia vel lateralia, thallo marginata. Hypothecium incoloratum, hymenium angustum, sporae parvae, globosae vel ellipsoideae, simplices (vel in 1 specie uniseptatae?). — Pycnides thallo plus minusve immersae, fulcra exobasidialia, pycnoconidia cylindrica, recta vel arcuata.

The genus can be divided into two sections, usually regarded as two distinct genera, viz.: Sect. *Dactylina* (Nyl.) Lyngé, with one species: *D. arctica*, and Sect. *Dufourea* (Ach.) Lyngé, with (at least) three species: *D. madreporiformis*, *D. endochrysea* and *D. ramulosa*. The three species: *Dufourea flabellata* Hue, *Dufourea floccosa* Nyl., and *Dufourea physcioides* Mass. are unknown to me; neither of them is found in the Arctic.

#### 1. *Dactylina arctica* (Hook.) Nyl.

Tab. I, fig. 1, text fig. 6.

Nylander, W.: *Enumération générale des Lichens & c.* Mém. Soc. Imp. Sci. Nat. Cherbourg, vol. V, 1857, p. 99 ("America arctica", nomen nudum).

Nylander, W.: *Synopsis Lichenum*, 1858—60, p. 286 (Nylander's first description, also of apothecia).

Nylander, W.: *Ad Lichenographiam Groenlandiae quaedam addenda.* Flora, XLV, 1862, p. 81 (Description, especially of pycnides, but no localities).

Nylander, W.: Lichenes Middendorffiani, in Middendorff Reise in den äussersten Norden und Osten Sibiriens, vol. IV, Anhang No. VI, St. Petersburg 1867, p. LVIII. (Boganida).

Nylander, W.: De reactionibus in Everniis et Parmeliopsibus. Flora, neue Reihe, vol. XXVII, 1869, p. 445. (Note, also on the reaction of *Dactylina arctica*).

Nylander, W.: Enumeratio Lichenum Freti Behringii. Bull. Soc. Linn. Normand, 4. sér., 1888, p. 239 and 257 (Finds from Alaska, the Vega Expedition).

Lindsay, W. Lauder: Memoir on the Spermogones and Pycnides of Filamentous, Fruticulose and Foliaceous Lichens. Transact. Royal Soc. Edinb., vol. XXII, Edinb. 1861, p. 132. (Long description of pycnides and pycnoconidia, correct description of podetia, coming off from a horizontal stem).

Lindsay, W. Lauder: Lichens collected by Dr. Robert Brown in West Greenland. Transact. Linn. Soc. London, vol. XXVII, 1869, p. 323, pl. XLVIII, fig. 18. (Description of pycnoconidia, West Greenland localities).

Lindsay, W. Lauder: Lichens, in R. Brown Florula Discoana, from the Admiralty Manual of the Natural History of Greenland (1875?), p. 262 and 274. (*Dactylina arctica* from "Illartlek Glacier").

Lindsay, W. Lauder: The Lichen Flora of Greenland, with Remarks on the Lichens of other Arctic Regions. The Admiralty Manual of the Natural History of Greenland: prepared for the Use of the Arctic Expedition of 1875. — Reprinted, by Permission, from the Transactions Bot. Soc. Edinb. vol. X, p. 32—65 (*Dactylina arctica* mentioned p. 290 and p. 305, without localities, with reference to Brown Florula Discoana, Transact. Bot. Soc. Edinb. vol. IX, p. 454, furthermore mentioned from Melville Island, p. 299).

Trevisan, Victor Gr.: Ueber Atestia, eine neue Gattung der Ramalinen aus Mittel-Amerika. Flora, 1861, p. 51. (The genus *Dactylina* is referred to the "Evernien", the Subtribus I. *Eueverniae*).

Tuckerman, Edw.: Observations on North American and other Lichens. Proc. Amer. Acad. Arts and Sciences, vol. V, 1862, p. 396. (Excellent description, also of apothecia, North American localities).

Tuckerman, Edw.: Genera Lichenum: An Arrangement of the North American Lichens, Amherst 1872, p. 7. (Description of the genus *Dactylina*, remarks on its affinity to *Dufourea*, especially *D. ramulosa*).

Tuckerman, Edw.: List of Lichens collected in the vicinity of Ananactook Harbor, Cumberland Sound, at about Lat. 67° N., Long. 68° 49' W. Contributions to the Natural History of Arctic America, made in connection with the Howgate Polar Expedition, 1877—78. Bull. U. S. Nat. Museum, No. 15, 1879, p. 167. (Only the names of the lichens recorded).



Durand, E., Thos., P. James and Saml. Ashmead: Enumeration of the Arctic Plants collected by Dr. J. J. Hayes in his Exploration of Smith's Sound, between the parallels 78th and 82th, during the months of July, August and beginning of September, 1861. Proc. Acad. Nat. Sciences of Philadelphia 1863 (1864), p. 96 (*Dactylina arctica* mentioned, without localities).

Leighton, W. A.: Notes on the Lichens collected by Sir John Richardson in Arctic America. Journ. Linn. Soc. London, vol. IX, 1867, p. 184 et 192, pl. II, fig. 11—17. (Great Bear Lake, Great Slave Lake, description and good figure of pycnoconidia).

Livesay, William: Plants collected in Spitzbergen and Nova Zembla. Transact. Bot. Soc. Edinb. vol. X, 1870, p. 333—341. (*Dactylina arctica* from Cloven Cliff Island).

Schmidt, Friedrich: Wissenschaftliche Resultate der zur Aufsuchung eines angekündigten Mammuthcadavers von der Kais. Akad. d. Wissenschaften an den unteren Jenisei ausgesandten Expedition. Mém. l'Acad. Imp. des Sciences de St. Pétersb. VII e sér., tome XVIII, no. 1, 1872, p. 131 (*Dactylina arctica* found in the Mt. Noril, near Dudino).

Stizenberger, Ernestus: Index Lichenum Hyperboreorum, 1876, p. 14. (Distribution).

Almquist, Ernst: Lichenologiska iakttagelser på Sibiriens Nordkust. Vega-Expeditionens Vetensk. Iakt. I, Stockholm 1882, and in Øfv. Kgl. Vetensk.-Akad. Förh., 1879, No. 9, Stockholm, p. p. 35, 36, 37, 38, 40, 43, 47, 51 and 55 (Notes on distribution and frequency).

Almquist, Ernst: Die Lichenenvegetation der Küsten des Beringsmeeres. Vega-Expeditionens Vetensk. Iakttagelser, vol. IV, Stockholm 1887, p. 520 (522), 523 (528, 533), 537 (540, 541). (Notes on distribution, frequency and development).

Hue, A.: Lichenes Exotici, No. 571, p. 70 (the separate), in Nouv. Arch. du Muséum, sér. 3, vol. II, 1890, p. 278.

Reinke, J.: Abhandlungen über Flechten. Pringsh. Jahrb. Wiss. Bot., vol. XXVIII, 1895, p. 391 (separate p. 193), fig. 111. (Near affinity to *Cetraria*, figures often copied by other authors).

Darbishire, O. V.: Lichens collected during the 2nd Norwegian Polar Expedition in 1898—1902, and determined by O. V. D. Report of the Second Norwegian Arctic Expedition in the "Fram", 1898—1902, No. 21, Kristiania 1909, p. 37. (Several localities from West Greenland and the Ellesmereland region).

Darbishire, O. V.: Flechten aus dem Umanakdistrikt. Botanische Ergebnisse der von der Gesellschaft für Erdkunde zu Berlin ausgesandten Grönlandexpedition, nach Dr. Vanhöffen's Sammlungen bearbeitet. Bibliotheca Botanica, vol. VIII, Stuttgart 1899, p. 57. (Description of fertile plants).

Zahlbruckner, A.: Lichenes, apud Engler-Prantl, Die Natürlichen Pflanzenfamilien, 1907, p. 219, fig. 113, et ed. II, 1926, p. 241, fig. 116. (Description, with Reinke's figures).

Zahlbruckner, A.: Catalogus lichenum universalis, VI, 1930, p. 371.

Olivier, H.: Lichens d'Europe. Mém. Soc. National Scienc. Natur. Cherb. vol. XXXVII, 1909, p. 189. (Only recorded from Kolguev in Europe).

Lyngé B.: Lichens from the Gjøa Expedition. Vid. Selsk. Skr. I. Math.-Naturv. Kl. 1921, No. 15, p. 5. (Find from the Canadian Arctic coast).

Lyngé, B.: Lichens from Novaya Zemlya. Report Scient. Results of the Norw. Exped. to Novaya Zemlya 1921, No. 43, 1928, p. 211. (Recorded from Karmakuly).

Lyngé, B.: The Lichens. The Godthaab Expedition 1928. Medd. om Grønland. vol. LXXXII, No. 3, p. 6. (Recorded from Inglefield Land).

Smith, Annie Lorrain: Lichens, Cambridge Botanical Handbooks, 1921, p. 339, 340 and 346. (Referred to the *Usneaceae*, remarks on distribution).

Merrill, G. K.: Lichens, in Report Canad. Arctic Expedition 1913—18, vol. IV, part D, Ottawa 1924, p. 10 D. (Localities from Arctic America).

Summerhayes, V. S. and C. S. Elton: Further Contributions to the Ecology of Spitsbergen. The Journal of Ecology, vol. XVI, 1928, p. 232 and 234. (Finds from North West Spitsbergen).

Malme, Gust. O. A. n.: Lichenes Orae Sibiriae borealis inde ab Insula Minin usque ad Promontorium Ryrkajpia in Expeditione Vegae lecti. Arkiv för Botanik, vol. XXV A, No. 2, Stockholm 1932, p. 33. (Localities from the Taimir Peninsula).

Oxner, A. N.: Де - що з флори обрїєників Уукотського півострова. — (Etwas über die Flechtenflora der Tschuktschenhalbinsel). (*Dactylina arctica* recorded from the said peninsula).

#### *Dufourea* (?) *rugosa* R. Br.

Brown, Robert: Appendix, No. VI, to John Ross A Voyage of Discovery for the Purpose of exploring Baffin's Bay &c. London, vol. II, 1819, p. 195. (Nomen nudum).

#### *Dufourea arctica* Hook.

Hooker, William Jackson: in John Franklin Narrative of a Journey to the Shores of the Polar Sea in the Years 1819, 20, 21 and 22, Botanical Appendix, No. VII, by John Richardson, London 1823, p. 762 (not 761, as has often been stated). (The first description of the species, fertile plants, collected on the "Barren Grounds from Point Lake to the Arctic Sea". — I found no mention of Hooker's name in the paper).

Hooker, William Jackson: Botanical Appendix to Captain Parry's Journal of a Second Voyage for the Discovery of a North-West Passage from the Atlantic to the Pacific. London 1825, vol. IV, p. 424. (Three localities from the expedition).

Hooker, William Jackson and G. A. Walker Arnott: The Botany of Capt. Beechey's Voyage &c. London 1841, p. 133. (Find from Kotzebue Sound near the Bering Strait).

Lindsay, W. Lauder: Observation on the Lichens collected by Dr. Robert Brown, in West Greenland. Transact. Linn. Soc., London, vol. XXVII, London 1871, p. 319, tab. XLVIII, fig. 18. (Found near Disco, figure of pycnoconidia).

Elenkin, A. A.: Краткій предварительный отчетъ о споровыхъ, собранныхъ въ саянскихъ горахъ лѣтомъ 1902 г. (Notice préliminaire sur la récolte de cryptogames pendant le voyage au plateau de Saïan, en 1902). Bull. Jard. Imp. Bot. St. Pétersb. vol. II, 1902, p. 1—3 (sep.). (The two lichens *Dufourea arctica* and *D. madreporiformis* are characteristic of the high mountain passes in the Saïan Mts., between 7000 and 10000 feet above sea level).

Elenkin, A. A.: Lichenes Florae Rossiae et regionum confinium. Acta Horti Petropolitani, vol. XXIV, 1904, p. 20. (Apothecia rare in Siberia, valuable information on its distribution, notes on chemical reaction).

Elenkin, A. A.: Лишайники полярнаго побережья сибирѣ. (Les Lichens des côtes polaires de la Sibérie). Mém. Acad. Imp. des Sciences de St. Pétersb. VIII Sér. Classe Phys. Math., vol. XXVII, No. 1, 1909, p. 11. (Valuable information on its distribution, between Dickson Bay and the New Siberian Islands, description of var. *minor*).

Elenkin, A. A. et V. P. Savicz: Списокъ лишайниковъ, собранныхъ ир м шеголевымъ въ якутскѣй и приморскѣй областяхъ по хребту Джугжур (становому) и его отрогамъ между нельканомъ и аянномъ въ 1903 г. (Enumeratio lichenum in Sibiria orientali a cl. J. Sczegolev anno 1903 lectorum). Traveau du Musée de l'Acad. Imp. des Sciences de St. Pétersb., livr. VIII, 1910, p. 43. (Localities in the Primorski region, near the Okhotian Sea).

Branth, J. S. Deichmann og Chr. Grønlund: Grønlands Lichen-Flora, 1887. Medd. om Grønl. vol. III, 1888, p. 465. (Distribution in Greenland, not so common as *Thamnotia vermicularis*).

Vainio, Edv. A.: Lichenes in Sibiria meridionali collecti. Acta Soc. pro Fauna et Flora Fennica, vol. XIII, No. 6, 1896, p. 5. (Locality "prope Krasnojarsk et Minusinsk").

Vainio, Edv. A.: Lichenes in viciniis stationis hibernae expeditionis Vegae prope pagum Pitlekai in Sibiria septentrionali. Arkiv för Botanik, vol. VIII, Stockholm 1909, p. 15—16. (Excellent description, sterile plants).

Savicz, V. P.: Списки лицевниковъ собранныхъ Р. Ф. Ниманомъ въ Лапланди и Новой Землѣ въ 1903 и 1908—9 г. г. (Enumerations lichenum in Lapponia Rossica et Novaja Zemlja a cl. R. Nieman an. 1903 et 1908—9 lectorum). «Труд. Студенч. Науч. Круж. Физ.-Мат. Фак. Спб. Университета» вып. 3 1911 г. (Distribution in Matotchkin Shar, with var. *minor* Elenkin).

Savicz, V. P.: Лицевника, собранные Р. Р. Поле на Крайнемъ сѣверѣ Европейской Россіи. (Lichenes in regionibus septentrionalibus Rossiae Europaeae a R. R. Pohle collecti. Acta Horti Petropolitani, vol. XXXII, (Jurjev) 1912, p. 25. (Description of sterile plants from Kolguev).

Savicz, V. P.: Новые ВидьиФормы Лицевниковъ Камчатки. (Neue Flechten aus Kamtschatka).

Savicz, V. P.: Новые Види и Формы Лицевниковъ Камчатки. (Neue Flechten aus Kamtschatka). Bull. Jard. Imp. Bot. de Pierre le Grand, vol. XIV, 1914, p. 119. (Recorded from Kamtschatka, var. *papillata* Sav. described).

Savicz, V. P.: Уукотскіе Лицевники изъ Коллекціи Г. А. Борисова. (Matériaux pour la flore des Lichens de la Péninsule Czukotsky). Институтъ споровыхъ Растеніи Императорскаго Ботаническаго Сада Петра Великаго. 1915, p. 542. (Recorded as common from the above-mentioned peninsula, with description).

Savicz, V. P.: Лицевники, собранные И. И. Тржемескимъ въ поллярной сибирп. (Les Lichens des côtes polaires de la Sibérie recueillis par M. J. J. Trchemesky). (Recorded from the mouth of the Jenisei, with var. *minor* Elenk.).

Howe, R. Heber, jr.: Classification de la Famille des Usneaceae dans l'Amérique du Nord, 1912, p. 18, tab. I, fig. 33 and tab. III, fig. 6. Thèse. (Not sufficient reason for generic distinction between this species and the two species of *Dufourea*, fig. 33 apothecium, not good, fig. 6 good illustration of cross section).

Galløe, Olaf: Forberedende Undersøgelser til en almindelig Likenøkologi. Dansk Botanisk Arkiv, vol. I. No. 3, København 1913, p. 80, fig. 129—132. (Excellent figures, description of thallus: erect podetia from creeping thallus, development of hapterae between connivent podetia, also between podetia and mosses).

Olivier, H.: Prodromus lichenum europeorum fruticulosi et foliacei. Memor. de la Real. Acad. de Ciencias y Artes de Barcelona, ser. 3, vol. XVI, 1921, p. 9. (Short description, note on distribution).

*Evernia arctica* (Hook.) Tuck.

Tuckerman, Edw.: A Synopsis of the Lichens of New England, the other Northern States, and British America. Cambridge 1848, p. 11. (Referred to *Evernia*, description of species, recorded from Bear Lake, and elsewhere in Arctic America).

*Dufourea polaris* Ruprecht.

Ruprecht, F. J.: Ueber die Verbreitung der Pflanzen im nördlichen Ural. Nach den Ergebnissen der geographischen Expedition im Jahre 1847 und 1848. Beitr. zur Pflanzenkunde des Russischen Reiches, Lief. VII, St. Petersburg 1850, p. 76. (Description of sterile plants from Northern Ural, with notes on distribution and systematical position).

*Cladonia arctica* (Hook.) Th. Fr.

Fries, Th. M.: Lichenes Arctoi Europaeae Groenlandiaeque hactenus cogniti. Ex Actis Reg. Soc. Scientiarum Upsaliae seriei III vol. III, 1860, p. 160. (Good description, discussion of systematical position, known distribution in Greenland).

*Cetraria arctica* (Hook.) Tuck.

Tuckerman, Edw.: Synopsis of the North American Lichens, vol. I, 1882, p. 30. (Description, also of apothecia and pycnoconidia, congeneric with *C(etraria) madreporiformis*).

Gray, Asa: Plants, in report of the International Polar Expedition to Point Barrow, Alaska. Washington 1885, p. 192. (Lichens determined by W. G. Farlow, recorded from Point Barrow).

Macoun, J. M.: A List of the Plants of the Pribilof Islands. The Fur Seals and Fur-Seal Islands of the North Pacific Ocean, part III, Washington 1899, p. 580 (Recorded from St. Paul Island).

Cummings, Clara E.: The Lichens of Alaska. Harriman Alaska Expedition, Alaska V, New York 1904, p. 145. (Valuable information on its distribution in Alaska and the Bering Strait region).

Thallus ex surculis repentibus vel plus minusve adscendentibus formatus. Ex his surculis (deinde emorientibus) podetia erecta exsurgunt. Podetia magnitudine valde variantia, 2—6 cm longa et usque ad 10—12 mm crassa, sed vulgo minora. Podetia saepe indivisa, sed interdum plus minusve ramosa, podetia erecta tum furcata, ex podetiis decumbentibus emorientibus rami erecti prolificant. Podetia pallide stramineo-flavescentia vel plus minusve in flavo-fuscescentem vergentia, basin versus obscurius colorata. Podetia inflata, intestiniformia, nitidiuscula, plus minusve foveolato-scrobiculata, sorediis isidiisque destituta, apice rotundata vel obtuse apiculata.

Stratum corticale firmum, 25—40  $\mu$  crassum (sec. Vainio, 1909, p. 15—16: 22—30  $\mu$ ), ex hyphis superficiei perpendicularibus arcte conglutinatis, pachydermaticis, 8—10  $\mu$  crassis, valde indistinctis, formatum. Infra stratum corticale hyphae laxae contextae sunt, secundum lumen interiorem arachnoideae. Gonidia sat dispersa, diam. 10—15  $\mu$ .

Apothecia rarissima, terminalia, rotundata, diam. 5 mm, discus castaneus, subnitidus, epruinosis, convexus, margine thallico tenui crenato circumdatus. Cortex excipuli crassus, 25—37 (—40)  $\mu$  altus, incoloratus vel in parte exteriori leviter flavo-fuscescens, hyphis crassis, valde pachydermaticis, refractivis, superficiei plus minusve perpendicularibus formatus. Cortex infrahypothecialis eadem structura, sed hyphae minus pachydermaticae sunt. Hyphae medullares excipuli arachnoideae, adspersae, 3—5  $\mu$  crassae. Hypothecium verum tenue, hyphae superficiei plus minusve paralleles, crebre intricatae. Hymenium angustum: 35—40  $\mu$ , superne strato amorpho incolorato tenui tectum. Paraphyses indistinctae, arcte cohaerentes, capitatae, diam. 4—5  $\mu$ , et apice dilute flavo-fuscescentes. Asci numerosissimi, late pyriformes, 25—30 (—35)  $\times$  10—13  $\mu$ , membrana in parte superiore incrassata. Sporae octonae, globosae, parvae, diam. 4.5—5.5  $\mu$ , sat late limbatae.

Pycnides haud frequentes, depresso globosae, omnino immersae, perifulcrum circum ostiolum fusco-nigrescens, praeterea incoloratum. Sterigmata ut videtur pauciarticulata. Pycnoconidia recta, anguste bacillaria, 5—6 (—7)  $\mu$  longa, 1  $\mu$  vel ad 1  $\mu$  crassa.

Thallus KOH non reagens, sed addito hypochlorite calcico intus rubescens, extus leviter flavescens.

Exsic. Elenkin Lich. Flor. Ross. No. 66 a, b (s. n. *Dufourea arctica*), Merrill Lich. Exsic. No. 5 (s. n. *Cetraria arctica*), Savicz Lich. Ross. No. 13 (s. n. *Dufourea arctica*).

The above description of the apothecia is based on the plants which Richardson collected at Bear Lake, during Franklin's First Voyage. I have loaned the plants from the herb. Tuckerman, a courtesy for which I am very thankful.

Dr. Magnusson has allowed me to see fertile plants from Tolstoi Noss (unpublished), collected by M. Brenner in 1876. These apothecia are 3—5 mm in diam., a little smaller than in the American plants. Habitually they very much resemble the apothecia of some *Cetrariae*, e. g. the American *C. platyphylla*.

In his paper of 1861, p. 133, Lindsay described its pycnoconidia: "The spermatia are rod-shaped, about 1/6000th long, with a breadth of 1/2500th. The sterigmata are frequently about 1/300th long, and are either simple linear cells, variously bulging in their walls, or composed of two or three linear elongated cells or articulations". In his figure, pl. VI, fig. 23, he depicts pycnoconidia of the "bayonette" type which we find in *Parmelia*.

If this picture were correct it would, perhaps, be difficult to include *D. arctica* in the same genus as the two species of "*Dufourea*" where the apparatus is not a little different (see Nylander's figure of *D. madreporiformis*, Synopsis, pl. VIII, fig. 23).

I did my best to clear up this intricate difficulty. The pycnides were often empty, and the pycnoconidia so easily shed from their sterigmata that it was difficult to find them in connection. But as far as I could see the apparatus was of the same type in all the three species, with very short and little branched sterigmata.

Galløe has well described its habitus (1913, p. 80, figs. 129—132). Galløe's figures are excellent, as they always are. — He finds faults with Nylander's description (Synopsis, p. 286), as well as with Reinke's description and figures (1895, p. 391 (193), fig. 111) which have been copied by many authors.

But Galløe evidently overlooked the first excellent description by Hooker in Richardson's paper (1823, p. 762): "Ex thallo vetusto fistuloso prostrato surculi subulato-ventricosi exsurgunt, saepe caespitosum, sese inter muscos erigentes, thallo primordiali destructo hi surculi thallos erectos fere palmares, sulphureo-flavos, ad basin flavescenti-brunneos saepissime simpliciusculos efficiunt".

The habitus was correctly described also by Lindsay (1861, p. 133).

The present writer never collected this species in nature. But to judge from herbarium plants the decumbent shoots do not live long, and these dying parts of the plants are generally not collected. Its branching is either furcate or papillata, in the latter case the branches begin as small lateral papillae which grow out to normal branches. If an erect podetium falls to the ground, it readily proliferates by new erect branches, just the same proliferation as is so common in the needle-like *Cladoniae*.

Almquist has given valuable information on its variation in size (e. g. in his paper of 1887, p. 537). At the far Arctic Cape Tscheljuskin he found very small plants, only 1 cm long, at Irkaipij (Nordkap) and the Preobraschenie Isl. larger plants, 3—4 cm long, and at St. Lawrence Island far south in the Bering Strait he measured 5—6 cm. Darbishire described small plants from Umanaq north of the Disko district in Greenland (1899, p. 57), farther south much larger plants have been collected, up to 6—7 cm (in the Holsteinsborg district). It is evident that the size of the plants is to some degree adapted to the surrounding conditions of life.

Two formae have been described:

Var. *minor* Elenkin, (1909, p. 11): "Thallo podetiis duplo aut quadruplo minoribus, obscurioribus et magis proliferis a forma typica differt", and

Var. *papillata* Savicz (1914, p. 119): "Thallus 1—2 cm, pallidovirescenti flavidus, ramosus, similis *Dufoureae madreporiformis*, sed intus vacuus. Podetia papillis vestita".

A fastigate habitus, resembling *Dufourea madreporiformis*, was described by Tuckerman (1862, p. 396), evidently var. *papillata* Savicz. But Tuckerman did not name this modification.

To clear up the section of the thallus I applied alcohol and then chloral hydrate. The cortical hyphae are very indistinct. They are of the palissade type, perpendicular to the surface. They are more distinctly seen on a tangential section, cut near the surface. The cortex is well set off from the inner strata. The hyphae are here more and more arachnoid. This thin stratum cannot give any strength to the podetia, but its hyphae form a hold for the gonidia, and perhaps they also absorb water. The gonidia are scattered, especially near the cortex. I do not think it natural to describe a special stratum gonidiale and a medulla in this plant.

The pycnoconidia have repeatedly been described, e. g. by Nylander (1862, p. 81): "sterigmata pauci-articulata (ut saepius in genere *Parmelia* formata), spermatia recta, cylindrica, gracilia,  $5 \times 1 \mu$ ". — Lindsay (1869, p. 323) also calls attention to their *Parmelia* structure. His figure (pl. VI, f. 23) might equally well have represented a *Parmelia*.

#### Distribution of *Dactylina arctica*.

##### Europe.

Spitsbergen. Cloven Cliff Island (Livesay 1870, p. 333—341; plant not seen). Liefde Fjord: Bock Fjord, and at Aldert Dirkses Bay (Summerh. and Elton, 1928, p. 232 and 234). North East Land (leg. Elton, Oxford Expedition).

Novaya Zemlya-Kolgujev. Matotchkin Shar (Nieman, f. *minor*, Leningrad). Karmakuli (leg. Alm, — Lynge 1928, p. 211). Kolgujev (leg. Pohle, — Savicz 1912, p. 25).

Ural. Nöunga-pai  $66\frac{3}{4}^{\circ}$  (Ruprecht 1850, p. 76). "Montes Urales" (Stizenb. 1876, p. 14).

##### Siberia.

Tobolsk. Between the rivers Chaniza and Charava (not located, leg. Sukatchev, Leningrad).

Jenisei. Dickson Bay (leg. Almquist, Sth.). Dickson Island (leg. Almquist 1879, p. 35). Ostrov Kuskinja, with var. *minor* (leg. Birulja, — Elenkin 1909, p. 11). Cape Schajtansky,  $72^{\circ}$  n. (leg. Lundström 1875, Ups.). Schirokaja Bay (not located, leg. Kusnetzow a. o., Leningrad). Tolstoj Noss (leg. Trybom 1876, Ups., and leg. Brenner 1876, Stockholm, according to Magnusson in lit. also c. fr.). Mouth of Jenisei: Batnja (Leningrad). Middendorff Bay (not located, leg. Birulja; — Elenkin 1909, p. 11). Dudinka (leg. Brenner, according to Magnusson, unpublished paper). Noril Mountains (Schmidt 1872, p. 131, Leningrad). Distr. Turuchansk  $69^{\circ}$ — $71^{\circ}$  44 N (leg. Pulkow, Kuznetzow, Reverdatto and Motveer, — Savicz Lich. Ross. No. 13). "Ad Golgiha et alibi in Sibiria", near Krasnojarsk and Minussinsk (Vainio 1896, p. 5). Sajansk mountains:



7000—10000 feet above sea level (Elenkin 1902, p. 3), Gargan Pass (Elenkin Lich. Ross. 66 a), Targansky Pass pluribi (leg. Elenkin, hb. Leningrad), and Jablonov mountains, 1500 metres above sea level (leg. Prochoff and Kuzeneva, hb. Leningrad). Lake Baikal (1807, leg. ? , hb. Berlin).

Taimir Peninsula and Chatanga River. "Inter promont. Vildi et Schtelling, 75° 40.2' N, 91° 26.3' E (leg. Trschemesky, — Savicz 1916, p. 134). Minin Island, 74° 5' N, 85° 3' E (leg. Almquist, — Almquist 1879 and 1882, p. 37). Actinia Harbour, 76° 19' N, 95° 48' E (leg. Almquist, — Almquist 1879 and 1882, p. 38. Insula parva prope insula Taimir (leg. Almquist, — Malme 1932, p. 33). Cape Tscheljuskin (leg. Almquist, — Almquist 1879 and 1882, p. 40, see also Malme 1932, p. 33. — Leg. Birulja, — Elenkin 1909, p. 11). Preobraschenie Island (leg. Almquist, — Malme 1932, p. 33), Boganida River in the Chatanga district (Ruprecht 1850, p. 76, and Nylander 1867, p. LVIII).

Lena River. Usjuma Bay (not located, leg. Preborov and Kuzenewski, hb. Leningrad). Bulum, 70° 43, and Kumachsur, 70° 30 (leg. Brenner, — Magnusson unpublished paper). "Lena Valley", locality not stated (leg. Kolikarov, hb. Leningrad). Werchojansk, f. *robusta* (leg. Olenin, hb. Leningrad). Sources of River Doegoe (not located, leg. Tscherk, hb. Leningrad). Tantschja Pass (not located, leg. Sokolev, hb. Leningrad).

Swiatoi Noss (leg. Strikadomsky, hb. Leningrad). — Indigirka (leg. ? , det. Savicz, hb. Leningrad).

New Siberian Islands: with f. *minor* (leg. Birulja, a. o., hb. Leningrad, and leg. Toll, hb. Stockholm). Kotelny Island, also var. *minor* (leg. Birulja ? , — Elenkin, 1909, p. 12). Ljachow Island: Mt. Sannikow (leg. Bunge 1886, hb. Stockholm). Bennett Island, with var. *minor* (leg. Kolczak, — Elenkin 1909, p. 11).

Kolyma River. Majak ad ostium fluminis Kolyma (leg. Augustinovicz 1875, — Elenkin Lich. Ross. 66 b). Bay between the Capes Vigoda and Shtenginga (not located, leg. Trushemevsky, hb. Leningrad).

Czukotsky Peninsula (Tschuktscher Peninsula) and Bering Strait district. Cape Ryrkajpia, 68° 55' N, 180° E (leg. Almquist, — Almquist 1879 and 1882, p. 43). Czukotsky Peninsula (leg. Almquist, — Almquist 1887, p. 520, and leg. Borissow, hb. Leningrad). Pitlekaj, frequent at many localities (leg. Almquist, — Almquist 1879 and 1882, p. 47, 51 and 55, and Vainio 1909, p. 15). Konyam Bay (leg. Almquist, Vega Expedition, — Nylander 1888, p. 214, s. n. *Dufourea ramulosa*). St. Wladimir Bay (not located) and St. Nikolai Bay (not located, leg. Borisov, — Savicz 1915, p. 542). St. Olga Bay (not located, leg. Kirillov, hb. Leningrad). Fretum Beringianum (leg. Mertens, — Ruprecht 1850, p. 76). Plover Bay (leg. Trelease, Coville and Kearney, — Cummings 1904, p. 145). See also Alaska.

Camtchatka. Valagin Mountains, in regione alpina, var. *papillata* (leg. Savicz, hb. Leningrad). Kronski Pass (leg. Komarov, hb. Leningrad). Schtschapina (leg. Savicz, hb. Helsingfors).

Okhot Sea region. Between Ajano and Nelkanense, Jakutsk district, (leg. Sokolov, hb. Upsala). Primorski district: The Ajan side of the Pass (Elenkin and Savicz 1910, p. 43). Frontier between Jakutsk and Primorski districts, in the Pass over the Stanovoi mountains (Elenkin and Savicz 1910, p. 43).

#### America.

Alaska, coast. Pribiloff Islands: St. Paul, 57° N, 171° W (leg. Macoun, — Macoun 1899, p. 580, Merrill Lich. Exs. No. 5). St. Matthew Island (leg. Coville and Kearney, — Cummings 1904, p. 145). Port Clarence (leg. Almquist, — Nylander 1888, p. 257). Lawrence Island (leg. Almquist, — Nylander 1888, p. 239). Kotzebue Sound (reported by Hooker and Arnott 1841, p. 133, see also Cummings 1904, p. 145). Point Barrow (Asa Gray 1885, p. 192; Farlow in Ray: Report of the International Polar Expedition to Point Barrow). Camden Bay (Merrill 1924, p. 10 D). Not located finds: Bernard Harbour (Merrill 1924, p. 10 D), and Taku (leg. Hayes, according to Cummings, 1904, p. 145).

Arctic coast between Alaska and Hudson Bay. King Point (leg. Lindstrøm, — Lynge 1921, p. 5).

Baffin Land—Hudson Bay. Baffin Land: Admiralty Inlet (leg. Dewey Soper, com. Prof. Malta). Melville Peninsula: Barrow River, between 81°—82° W, a little more than 67° N (Hooker 1825, p. 424), Igloodik, between 81°—82° N, 69½° W. (Hooker 1825, p. 424), and Duckett Cove (not located, Hooker 1825, p. 424). Georgia Island near Vansittard Island south of Melville Peninsula (5th Thule Expedition, unpublished, hb. Copenhagen). Hudson Bay: NW shore (leg. George Comer 1893—94, hb. Copenhagen and Oslo). East coast at Clearwater River, 56° 15' N (leg. Low, hb. Ottawa), and Near Whale River, about 56° N (leg. Low, hb. Ottawa). Hudson Strait: Digge's Island (leg. Macoun, hb. Ottawa and several other herbaria); Upper Savage Islands, 62° N, 70° W (leg. R. Bell, hb. Ottawa); Ungava (leg. Kohlmeister, hb. v. Flotow, Berlin). Kikkerton Island c. fr. (Lindsay 1869, p. 323).

Melville Islands to Ellesmere Land. Melville Island (Lindsay 1861, p. 133 and 1875, p. 299). Koly Sound (not located, leg. Beechey, — Lindsay 1861, p. 133). Ellesmere Land region: Cape Viele, Cape Rutherford, Sir Hugh's Peak, Pim Island: Rice Strait. King Oscar Land: Harbour Fjord, Sir Inglis Peak and Goose Fjord (all of them leg. Simmons, — Darbishire, 1909, p. 37, hb. Oslo).

Labrador. "Labrador" (leg. Webb, hb. Nylander No. 35 820 in Helsingfors, and hb. Curie No. 42, Berlin, and hb. Laurer, Berlin).

Missionary station Nain (leg. ?, hb. Upsala). Okate (not located, leg. Wenck, comm. Bouly de Lesdain).

South of the Arctic coast. Yukon in Alaska: Mouth of Bonanza Creek near Dawson (leg. Macoun, hb. Ottawa), and The Dome (a mountain near Dawson), elev. 4000 feet (leg. Macoun, hb. Ottawa). Great Bear Lake (leg. Richardson, — Hooker-Richardson 1823, p. 762, c. fr., further Tuckerman 1848, p. 11, and 1862, p. 396, and Leighton 1867, p. 192). Great Slave Lake (Leighton 1867, p. 192). Point Lake "ad Oceanum Glaciale" (Richardson-Hooker 1823, p. 762, and Ruprecht 1850, p. 76. Is there a Point Lake also in Alaska?). "Lat. 62° 45', Long. 103°" (leg. Tyrrell, hb. Ottawa). Morelorjuaq near the junction of Kazan River with Yathkyed Lake (5th Thule Expedition, hb. Copenhagen). Alberta (Macoun Canadian Lichens No. 6): Lake Agnes at the summit of Mt. Niblock, el. 8000 feet (leg. Macoun, hb. Ottawa), and Emerald Lake south of Laggan, el. 5500 feet (leg. Bean, hb. Ottawa), and St. Piran, el. 8000 feet (leg. Bruce Fink, hb. Ottawa).

#### Greenland.

North West Greenland. "Smith's Sound", between 78°—82° N (Perhaps in Grinnell Land, — Durand, James and Ashmead 1864, p. 96). Inglefield Land: Pandora Harbour (leg. Seidenfaden, — Lynge 1932, p. 6). Foulke Fjord (leg. Simmons, — Darbishire 1909, p. 37). Wolstenholme Fjord: Thule (leg. Nygaard, hb. Copenhagen). Sofie Havn (not located, leg. Berlin 1883, hb. Stockholm). Cape York (leg. Nathorst 1883, hb. Stockholm).

Umanaq district. Karajak Nunatak (Darbishire 1899, p. 57).

Disco district. Ritenbenk (leg. J. Vahl, hb. Copenhagen, and Th. M. Fries, hb. Stockholm and Oslo). Nordfjorden and Mellemfjorden (leg. Th. M. Fries, hb. Stockholm and Oslo). Blæsedalen (leg. ?, hb. Copenhagen). Skansen, Mudderbukt, Disko Fjord, Lakselvbukt and Unartuarssuk (leg. Porsild, hb. Copenhagen). Godhavn (leg. Kruuse, hb. Copenhagen).

Holsteinsborg district. Nordre Strømfjord: Tiggak (leg. H. P. Sørensen, hb. Copenhagen). Isortoq Fjord (leg. J. Vahl, hb. Upsala, and leg. Kornerup, hb. Copenhagen). Holsteinsborg (leg. J. Vahl, Kolderup Rosenvinge and Hartz, hb. Copenhagen): Kærtingehætten and Kangerdluarssuk (leg. Warming, hb. Copenhagen).

Godthaab district. Baals Revier (leg. J. Vahl, hb. Copenhagen), Ameralik (leg. J. Vahl, hb. Copenhagen), and Ikatoq (leg. J. Vahl, hb. Copenhagen).

General statements. Grönlandiae, semper sterilis (hb. Nylander, No. 3582, Helsingfors). West Greenland (Lindsay 1869, p. 323).

Not located Greenland finds. Niarsunguak, Narkaosuugoak and Sakkane (all of them leg. Vahl, hb. Copenhagen).

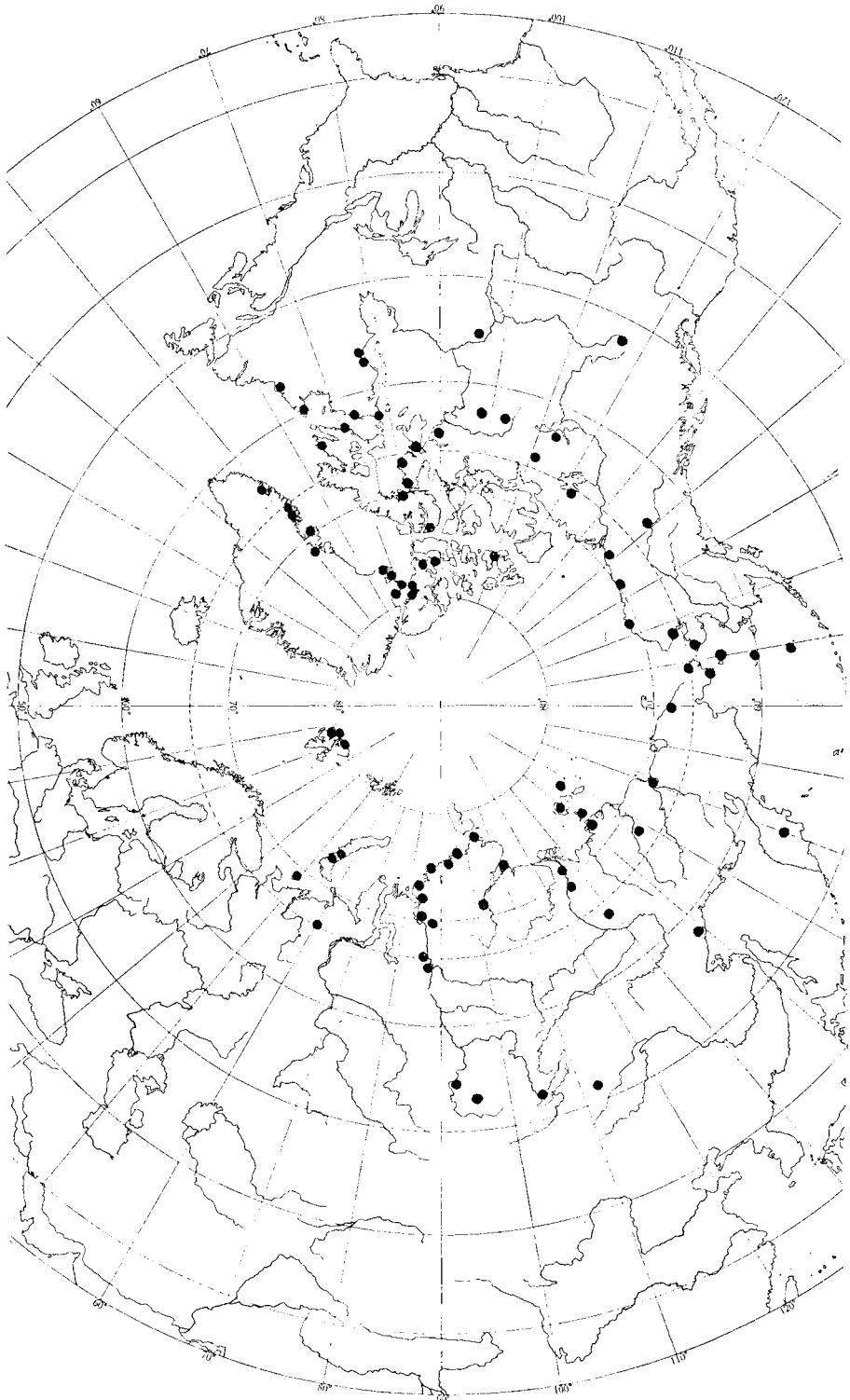


Fig. 1. Distribution of *Dactylina arctica*.

2. *Dactylina madreporiformis* (Ach.) Tuck.

Tab. I, fig. 2, II, fig. 1—3, text fig. 2, 4, 6.

Tuckerman, Edw., Lichens of California, Oregon and the Rocky Mountains so far as yet known. Amherst 1866, p. 12 (Recorded from the Rocky Mountains, without locality).

Tuckerman, Edw.: Observations on North American and other Lichens. Proc. American Academy of Arts and Sciences, vol. V, 1862, p. 398. (Recorded from the Rocky Mountains, with description).

Tuckerman, Edw.: Genera Lichenum, Amherst 1872, p. 7 (The affinity between *Dufourea*, *Dactylina* and *Cetraria* is clearly pointed out).

“*Lichen madreporiformis* Wulf.”

Gmelin, Joh. Friedrich: Caroli a Linné Systema Naturae, tom. II, pars II, 1791, p. 1378. (Short description).

von Laicharding, Johann Nepomuc: Manuale Botanic., 1794, p. 526. (Not seen, after Zahlbruckner Cat. Lich. VI, p. 370).

Jolyclerc, N.: Cryptogamie complete etc., Paris 1799, p. 115 (Not seen; — According to Lindau et Sydow Thesaurus, vol. I, p. 725: 1796, cited after Zahlbruckner Cat. Lich. VI, p. 370).

I have been unable to check these records, they possibly stand for *Cladonia Papillaria*.

*Dufourea madreporiformis* Ach.

Acharius, E.: Lichenographia Universalis, 1810, p. 525. (Excellent description, pycnides seen, distribution Schweiz and Kärnthen, figure refers to “*Dufourea mollusca*”, not to *D. madreporiformis*).

Acharius, E.: Synopsis Lichenum, 1814, p. 247. (Description.)

Röhling, Joh. Christoph.: Deutschlands Flora, II Abt., IV Ordn., 1813, p. 119. (Description, not much of interest).

Steudel, Ernst Gottlieb: Nomenclator Botanicus, 1824, p. 158 (not seen, cited after Zahlbruckner Cat. Lich. VI, p. 369).

Laurer, F. in Sturm Deutschlands Flora in Abbildungen nach der Natur mit Beschreibungen, Heft 24, Nürnberg 1832, p. 27, pl. 11. (Good description, and excellent figures: branch habitus, branch magnified and in longitudinal section).

Dietrich, David: Lichenographia Germanica, 1832—37, p. 21, tab. 92 (Not seen, cited after Zahlbruckner Cat. Lich. VI, p. 369).

Nylander, W.: Synopsis Lichenum, 1858—60, p. 287, tab. VIII, fig. 23 (Excellent description and figure of pycnoconidia).

Nylander, W.: Circa Dufouream animadversio. Flora, 1871, p. 298. (Position of *D. madreporiformis*, cfr. p. 9, of the present paper).

Koerber, G. W.: Parerga Lichenologica, 1859, p. 15 (Description, several localities from the Alps).

Krempelhuber, August von: Die Lichenen-Flora Bayerns & c. Denkschriften der k. bayer. bot. Gesellschaft zu Regensburg, vol. IV, Zweite Abteilung, 1861, p. 123. (*D. madreporiformis* from the Berchtesgaden Gebirge).

Lindsay, W. Lauder: Memoir on the Spermogones and Pycnides of filamentous, fruticulous and foliaceous Lichens. Transact. Roy. Soc. Edinburgh, vol. XXII, 1859 (1861) p. 132, pl. VI, fig. 22. (The first study on the pycnides and the pycnoconidia).

Trevisan, Victore: Ueber Atestia, eine neue Gattung der Ramalinaceen aus Mittelamerika. Flora vol. XLIV, 1861, p. 51 (The species *madreporiformis* belongs to the genus *Evernia*, on account of the structure of the thallus).

Roumeguère, Casimir: Cryptogamie Illustrée, Lichens, 1868, p. 36, tab. VII, fig. LXII (Not seen, after Zahlbruckner Cat. Lich. VI, p. 369, and Dr. Bouly de Lesdain in litt.: Description, figure of habitus and pycnides and pycnoconidia).

Müller Argoviensis, Jean: Ueber Dufourea (?) madreporiformis Ach. Flora, vol. LIII, 1870, p. 325 (Important paper, often overlooked, first description of apothecia, affinity to *Cetraria* clearly pointed out, Acharii genus *Dufourea* based on *Dufourea mollusca*, later called *Combea* by De Notaris).

Müller Argoviensis, Jean: Replik auf dr. Nylander's "Circa Dufouream animadversio" in Flora 1871, p. 298. Flora, vol. LIV, 1871, p. 391—394 (The author argues for his opinion — Flora, 1870, p. 325 — that the species belongs to *Cetraria*, and that the genus name *Dufourea* must be reserved for the species *Dufourea mollusca*, later called *Combea mollusca*).

Von Heuglin, W. Th.: Reisen nach dem Nordpolarmeer in den Jahren 1870 und 1871, Teil III, Braunschweig 1874, p. 311 (First record from Novaya Zemlya).

Arnold, F.: Lichenologische Fragmente No. XXIV, Flora, vol. LXIV, 1881, p. 171. (Localities and literary references).

Markham, Albert H.: A Polar Reconnaissance being the Voyage of the "Isbjørn" to Novaya Zemlya in 1879, London 1881. IV Lichens (named by J. G. Baker) p. 332. (Found in Novaya Zemlya).

Stizenberger, Ernestus: Lichenes Helvetici I. Jahresber. der St. Gallischen naturw. Gesellschaft 1881—82 p. 51. (Several finds from Switzerland).

Sydow, P.: Die Flechten Deutschlands, 1887, p. 13 (Figure, not good, p. 6, description, find from Baiern).

Jatta, A.: Monographia Lichenum Italiae Meridionalis, 1889, p. 92, tab. I, fig. 58—60 (Not seen, after Zahlbruckner Cat. Lich. VI, p. 369).

Jatta, A.: Sylloge Lichenum Italiae, 1900, p. 61. (Description, Italian localities).

Jatta, A.: Flora Italica Cryptogama III. Lichenes, 1909, p. 159. (Description, Italian localities).

Brotherus, V. F.: Contributions à la flore lichénologique de l'Asie Centrale. Öfersikt Finska Vetenskaps Societetens Förh., vol. XL 1897—98, p. 3. (Recorded from the Alatau mountains).

Glück, Hugo: Entwurf zu einer vergleichenden Morphologie der Flechten-Spermogonien, 1899, p. 104 (24), 138 (58) and 169 (89). From Verh. des Naturh.-Mediz. Vereins zu Heidelberg, N. F., vol. VI, Heft. 2. (Literary records, unfortunately no personal investigations).

Hue, A.: Lichenes Extra-Europaei. Nouv. Arch. du Muséum, sér. 4, vol. I, 1899, p. 60. (Excellent description of thallus, apothecia and pycnides, distribution, e. g. from China).

Vainio, Edw. A.: Lichenes e Caucaso et e Peninsula Taurica. Termész. Füzetek, vol. XXII, 1899, p. 277. (Recorded from Caucasus).

Vainio, Edw. A.: Lichenes ab Ove Paulsen praecipue in provincia Ferghana (Asia media) et a Boris Fedtschenko in Tjanschan anno 1898 et 1899 collecti. Botanisk Tidsskrift, Kb.havn, vol. XXVI, 1904, p. 241. (Several localities recorded, var. *irregularis* described).

Elenkin, A. A.: Lichenes florum Rossiae et regionum confinium orientalium. Acta Horti petropolitani, vol. XIX, 1901, p. 26. (Schedae of Elenkin's Exsic., valuable information on the distribution from the Crimea to East Siberia, apothecia, found in the Saján Mountains, described).

Elenkin, A. A.: Краткій предварительный отчетъ о споровыхъ, собранныхъ въ саянскихъ горахъ лѣтомъ 1902 г. (Notice préliminaire sur la récolte de cryptogames pendant le voyage au plateau de Saïan, en 1902). Bull. Jard. Imp. Bot. St. Pétersbourg, vol. II, 1902, p. 3 (sep.) (Characteristic of the high mountains, from 7 000—10 000 feet above sea level).

Elenkin, A. A.: Лишайники полярнаго побережья сибирѣ — — —. (Les Lichens des côtes polaires de la Sibérie). Mémoires de l'Académ. Imp. des Sciences de St. Petersb., VIII Sér. Cl. Phys.-Math. vol. XXVII, 1909, No. 1, p. 13. (The only record of *Dufourea madreporiformis* from Franz Josef Land).

Elenkin, A. A. et V. P. Savicz: Лишайники, собранные И. В. Палибинымъ въ плаваніе ледокола «Ермакъ» въ сѣверномъ ледовитомъ океанѣ въ 1901 г. (Lichenes in regionibus arcticis Oceani Glacialis ab J. V. Palibin anno 1901 collecti). Acta Horti Petropolitani, vol. XXXII, 1912, p. 75. (Description, found in Kristovii Gouba in Novaya Zemlya).

von Dalla Torre, K. W. und Ludwig Grafen von Sarntheim: Die Flechten (Lichenes) von Tirol, Vorarlberg und Lichtenstein, 1902, p. 23. (Many localities).

Olivier, H.: Lichens d'Europe. Mém. Soc. Nat. Sciences Natur. Cherb., vol. XXXVI, 1907, p. 92. (Distribution in the highest mountains of Europe).

Olivier, H.: Prodromus lichenum europeorum fruticulosi et foliacei. Memor. de las Real Acad. Cienc. y Art. Barcelona, ser. 3, vol. XVI, 1921, p. 447. (Information on its distribution).

Lettau, G.: Beiträge zur Lichenographie von Thüringen, p. 230 (the separatum). From Hedwigia, vol. LI—LII, 1912. (Recorded from Altvater in the Gesenke Mountains, in the Sudeten, — not in Thüringen).

Lindau, G.: Die Flechten, 1913, p. 200, fig. 253, and ed. II, 1923, p. 200, fig. 253. (Description, illustration, distribution).

Zschacke, Hermann: Zur Flechtenflora von Siebenbürgen. Verh. und Mitteil. des Siebenb. Vereins für Naturwissensch., vol. LXIII, 1913, p. 114 and 160. (Recorded from Transsylvania).

Migula, Walther: Flora von Deutschland, Österreich und der Schweiz, vol. XII, 1925, p. 170. (Short description and distribution).

Suza, J.: Les Lichens des Carpathes Tschécoslovaques. Sborníku Klubu Přírodovědeckého v Brně za rok, 1925, Ročník VIII, 1925 p. 11. (Written in the Czecho-Slovakian language, sociological notes, many finds from the high mountains between 1800—2000 m above sea level).

Suza, J.: De lichenum distributione in Sudetis I. Sborníku Klubu Přírodovědeckého v Brně za rok, 1928, Ročník XI, p. 26. (Written in the Czeco-Slovakian language, finds from Alpach and the Tatra mountains).

Anders, Josef: Die Strauch- und Laubflechten Mitteleuropas, 1928, p. 178. (Description and distribution).

Lynge, B.: Lichens from Novaya Zemlya, Oslo 1928, p. 210, in Report of the Scientific Results of the Norw. Exp. to Novaya Zemlya 1921, No. 43. (Many localities from Novaya Zemlya).

Lynge, B. and P. F. Scholander: Lichens from North East Greenland. Skrifter om Svalbard og Ishavet, No. 41, 1932, p. 86. (Not found in Greenland, summary of its distribution, parallelism with *D. ramulosa*).

Zahlbruckner, A.: Catalogus lichenum universalis, vol. VI, 1930, p. 369. (Bibliography).

Zahlbruckner, A.: Lichenes, in Heinrich Handel-Mazzetti Symbolae Sinicae, vol. III, Wien 1930, p. 200. (Chinese locality).

Bouly de Lesdain, (Maurice): Lichens de l'Etat de New-Mexico (U. S. A.) recueillis par le Frère g. Arsène Brouard. Annales de Crypt. Exot., vol. V, 1932, p. 122 (*D. madreporiformis* from Baldy Peak, the southernmost find in America).

Malme, G. O. A.:n: Lichenes Orae Sibiriae borealis inde ab Insula Minin usque ad Promontorium Ryrkajpia in Expeditione Vegae lecti. Arkiv för Botanik, vol. XXV A, 1932, p. 33. (Localities near the Taimir Peninsula).

*Lichen squarrosus* \**Dufourea madreporiformis* (Wulf.) Lam.

de Lamarck, Jean Baptiste Antoine Pierre Monnet: Encyclopédie Méthodique, Botanique, vol. III, 1813, p. 419. (Not seen, after Zahlbruckner Cat. Lich. VI, p. 370 — Lindau et Sydow Thesaurus I, p. 823: vol. III, 1789).



*Pycnothelia madreporiformis* (Wulf.) Duf.

Dufour, Léon: Révision des genres *Cladonia*, *Scyphophorus*, *Helopodium* et *Baeomyces* de la flore française. Annales Générales des Sciences physiques, vol. VIII, 1821, p. 47. (Not seen, contents: description of a plant from Switzerland, accord. to a letter from dr. Robyns, Bruxelles).

Rabenhorst, Ludwig: Deutschlands Kryptogamen-Flora, vol. II, 1845, p. 110. (Description).

Fries, Th. M.: Genera Heterolichenum, 1861, p. 112. (Important notice on its synonymy: Acharii genus *Dufourea* is based on *Dufourea mollusca*, later referred to *Combea* by de Notaris, the name *Dufourea* must be reserved for that species).

*Cladonia madreporiformis* (Wulf.) Schaer.

Schärer, Ludov. Emanuel: Lichenum Helveticorum Spicilegium, sect. I, 1823, p. 43, et sect. VI, 1833, p. 319. (Description, locality in Switzerland).

*Parmelia madreporiformis* (Wulf.) Spreng.

Sprengel, Curt: Systema Vegetabilium, vol. IV, pars I, 1827, p. 278. (Not seen, after Zahlbruckner Cat. Lich. VI, p. 370).

*Siphula madreporiformis* (Wulf.) Duby.

Duby, I. E.: Botanicon Gallicum etc., vol. II, 1830, p. 619. (Description).  
Petermann: Pflanzenreich, 1845, p. 73, tab. XVI, fig. 60. (Not seen, after Zahlbruckner Cat. Lich. VI, p. 370).

*Evernia madreporiformis* (Wulf.) Fr.

Fries, Elias: Lichenographia Europaea Reformata, 1831, p. 25. (Short description).

Bischoff, Gottlieb Wilhelm: Handbuch der botanischen Terminologie, vol. II, 1842, p. 63, tab. LIX, fig. 2884. (Not seen, after Zahlbruckner Cat. Lich. VI, p. 370).

Dietrich, David: Deutschlands kryptogamische Gewächse, 4 Abt., 1846, p. 111, tab. 6. (Not seen, description of var. *flava* p. 111, tab. 241, according to Zahlbruckner Cat. Lich. VI, p. 370). Zweite Auflage, Jena 1860, p. 3, tab. 272. (Short description).

Del Amo y Mora M.: Flora Cryptog. Peninsula Ibérica etc., 1870, p. 354. (Not seen, after Zahlbruckner Cat. Lich. VI, p. 370. Description, recorded from "In Alpibus Europae", no record of its presence in Spain. I am indebted to the librarian of the Academia de Ciencias y Artes in Barcelona for this information).

*Cetraria madreporiformis* (Wulf.).

Schärer, Ludov. Emanuel: Enumeratio critica Lichenum Europaeorum, 1850, p. 14, s. n. *Cetraria nivalis* var. *madreporiformis*. (Only a brief description).

Fries, Th. (M.): Lichenes, p. 14, in A. Blytt: Bidrag til Kundskaben om Vegetationen på Nowaja Semlja, Waigatschøen og ved Jugorstrædet. Videnskabs Selskabets Forhandlinger for 1872, Christiania. (Recorded from Cape Nassau).

von Heuglin, W. Th.: Reisen nach dem Nordpolarmeer in den Jahren 1870 und 1871, Teil III, Braunschweig 1874, p. 311. (Novaia Semlja, 76° 30' N. L., 61° 25' E. L.).

Tuckerman, Edw.: A Synopsis of the North American Lichens, vol. I, New York, 1882, p. 30. (Description, fertile from the Rocky Mountains).

## Not:

1. *Lichen madreporiformis* Dill. Withering, William: A Botanical Arrang. of all the Vegetables Naturally growing in Great Britain, vol. II, 1776, p. 726. — *Dactylina madreporiformis* has never been found in Great Britain, and it was not natural that Withering's record should stand for that species. It is fully evident from his description, as well as from his quotation of Dillenius Tab. XVI, fig. 28 that Withering's plant is *Cladonia papillaria* var. *molariformis*. — I have not seen the book myself, but I am indebted to Dr. Malme and Ramsbottom for copies from the text.

2. *Lichen madreporiformis* Wulfen, Franciscus Xaver: Plantae rariores Carinthiae, in Jaquin Collectanea Botanica, vol. III, Vindobonae 1789, p. 105, tab. III, fig. 2. (Arguments, see p. 9).

3. *Isidium madreporiforme*, Chevalier, F. F.: Flore générale des environs de Paris, 1826, p. 598. — Dr. Bouly de Lesdain has kindly communicated the contents to me. It is quite evidently a *Pertusaria*.

4. *Dufourea madreporiformis*, Darbshire, O. V.: Flechten aus dem Umanakdistrikt. Botanische Ergebnisse der von der Gesellschaft für Erdkunde zu Berlin ausgesandten Grönlands-Expedition, nach Dr. Vanhöffens Sammlungen bearbeitet. Bibliotheca Botanica, vol. VIII, 1899, p. 57. — It is a *Sphaerophorus*, according to a letter from Dr. Darbshire to the present author.

5. *Dufourea madreporiformis*, Merrill, G. K.: Lichens, in Report Canad. Arct. Exped. 1913—18, vol. IV, part D, p. 9 D, Ottawa 1924. — I have seen the plant and found it to be *D. ramulosa*.

It is quite probable that some other references to old literature also stand for other species, e. g. *Cladonia Papillaria*.

Podetia 1—2, rarius usque ad 3.5 cm. longa, basi emorientia, apice accrescentia, subteretia vel compressa cylindrica, apicem versus leviter claviformiter incrassata et in ipso apice rotundata, usque a basin crebre divergenter ramosa vel furcata, rami deinde erecti vel suberecti et thallum fruticosum plus minusve caespitosum formantes. Podetia ochroleuca vel straminea vel virescenti-straminea, saepe fusco-capitata, nitidiuscula, sorediis isidiisque destituta, epruinosa, saepe foveolato-scrobiculata.

Thallus isolateralis, undique corticatus, strato amorpho incolorato tenui, 3—4  $\mu$  lato tectus. Cortex 30—35 (—40)  $\mu$  crassus, satis coriaceus, fusco-flavescens (vulgo dilute), hyphis valde indistinctis, conglutinatis, superficiei perpendicularibus, formatus. Medulla subsolida, sed in centro valde arachnoidea, corticem versus crebrius contexta, hyphae medullaris ramosae, adpersae, satis pachydermaticae, diam. 4—5  $\mu$ . Gonidia rotundata, diam. 12—18  $\mu$ , infra corticem plus minusve dispersa vel interdum magis glomerata, partes interiores versus mox sparsius evoluta et in centro late desunt.

Apothecia rarissima, lateralia, et breviter stipitata, rarius terminalia, diam. 2—4 mm. Discus pallide castaneus, nitidulus, grosse rugulosus, margine thallogli crasso et crenato, dein tenui circumdatus. Hymenium superne pallide lutescens, strato amorpho hyalino tectum, angustum, 35—40  $\mu$  altum. Paraphyses arcte cohaerentes, in apice incrassatae, 4—5  $\mu$  crassae. Asci pyriformes, 25  $\times$  12—14  $\mu$ . Sporae 6:nae vel 8:nae, ellipsoideae vel ovae, simplicius (vel uniseptatae?), 7—10  $\times$  4  $\mu$ . (7—8  $\times$  3.5  $\mu$ , sec. Müller, 1870, p. 2, the separate).

Pycnides (saltem in plantis arcticis) numerosissimae, in lamina versus apicem ramorum sitae, distinctae, prominulae, globosae vel subglobosae, diam. circiter 100  $\mu$ . Perifulcrum infuscatum, circum ostiolum obscurius coloratum. Sterigmata brevia, pauciarticulata, in apice solum pycnoconidia efferentia, pycnoconidia undulata vel leviter arcuata, acicularia, 13—18 (—20)  $\times$  0.5  $\mu$ .

Thallus extus et intus KOH immutatus, etiam CaCl<sub>2</sub>O<sub>2</sub> si addito, sed cortex KOH + CaCl<sub>2</sub>O<sub>2</sub> distincte flavescens. Asci J persistenter caerulescentes, gelatina hymenialis J immutata.

Exsic. Arnold Lich. Exs. No. 447 a, b (*Dufourea*), Elenkin Lich. Flor. Ross. No. 13 a—d (*Dufourea*), Erb. critt. Ital. I, No. 1416 (*Dufourea*), Flora Hungar. No. 417 (*Dufourea*), Krypt. Exsic. Vind. No. 2967 et 3069 (*Dufourea*), Rabh. Lich. Eur. No. 753 (*Dufourea*), Schaerer Lich. Helv. No. 85 (*Cladonia*), Schleicher Plant. Crypt. Helv. Cent. II, No. 67 (*Lichen*), Suza Lich. Bohem. No. 29 (*Dufourea*).

The apothecia of *D. madreporiformis* are extremely rare. I have only seen one description of fertile plants in literature, viz. Jean Müller's find from Grand Muveran ("Grand Muveran, rocher des chasseurs"),

described by him in *Flora*, 1870, p. 325, sequ. Furthermore, I have received information of a fertile plant in the Leningrad herbarium (Satchan Char, Gams in litt.). In literature we also find a few other records of fertile plants, but without descriptions.

With his wonted generosity Professor R. Chodat, Genève, was kind enough to send me a fertile plant for examination, out of Müller's find. My above description of the apothecium is in part based on that plant. Unfortunately it was not a good plant, and I am not quite certain whether the apothecia are lateral or terminal, in the latter case placed on the apices of short podetia with a long sympodial ramification.

I was happy enough to detect a well fertile plant in my great Novaya Zemlya collection. When I wrote my paper on the lichens of the expedition I was not aware of the importance of this find, and I made no mention of it. These apothecia are not full-grown. But nevertheless I was very glad to have them for comparison. In one of them I saw 1-septated spores, in the others I was unable to confirm that observation, but these latter apothecia were very young, with few and unripe spores.

As was to be expected, the data given by Müller have been copied by many authors, with or without citation of their sources, e. g. by Lindau, 1913, p. 200, Migula, 1925, p. 170, and by Anders, 1928, p. 178. Sydow simply states "Früchte unbekannt" (1887, p. 13). The first three authors mentioned have placed their description of the apothecia in the generic diagnosis. We are a little astonished to find that in the species diagnosis each of them states "Apothecien unbekannt", in spite of the description by a leading lichenologist in a leading German periodical. After that we should, perhaps, not be surprised to find Migula's record "Grand Muveran oberhalb Bex fruchtend" five lines after his words "Apothecien unbekannt" in the specific description.

The pycnides are generally found to be sterile, but at last I found a fertile pycnide. Evidently the pycnoconidia are shed very quickly after maturation. My simple hand sections were not sufficient to give full information on the structure of the very delicate fulcra. I found with certainty apical pycnoconidia, and my impression is that the fulcra are very short, and that they are articulated with constricted septa and isodiametrical articuli. I was unable to detect pycnoconidia from the non-apical articuli, this agrees with the usual statement that the fulcra are exobasidial (e. g. Zahlbruckner, 1926, p. 240). Lindsay has not depicted articulated fulcra (1861, pl. VI, fig. 22); it seems to me, however, that his figure can hardly be quite correct. — If Nylander's figure (1858—59, pl. VIII, fig. 23) is correct the fulcra must be endobasidial. This is more in accord with the view that the genus should be related to *Cetraria*, or better to *Cornicularia*, where the fulcra are endobasidial.

Glück repeatedly mentions the pycnoconidia of this species. But as far as I can find from his paper (1899, p. 24, 58, and 89), he has

not examined the species on his own sections. — The difficulty could be cleared up by good microtome sections.

My friend, Professor Birger Bergersen, of our High School of Dentistry, who is one of our best experts on microtome sectioning was kind enough to cut several sections of thalli with pycnides. But unfortunately this lichen proved very difficult to section. The thin cobweb inside of the cortex could not resist the process, neither could the wall of the pycnides. The pycnoconidia were found isolated all over the pit inside of the cortex, detached from their fulcra.

Better results were obtained by a very simple method, developed by Dr. P. F. Scholander (see Lynge and Scholander "Lichens from North East Greenland", 1932, p. 60). The thallus fragment was placed in alc. abs., then in water, after which it was dried up to a convenient degree, placed between two slices of Sambucus pith, and cut directly on a microtome. He used auto blades of high quality as a knife. The sections were caught on a needle, dipped into alcohol of 60<sup>0</sup>/<sub>0</sub>, and placed in alcohol of the same concentration. After some minutes they were stained.

Sections of that kind cannot be cut in series, but they are quite good enough for taxonomical purposes. They can be cut down to 10  $\mu$  thin, and can be studied under a microscope of high power, even under oil immersion.

The very delicate texture of the cobweb tissue was preserved, evidently intact, by this method.

The podetia cannot be called fistulous. Towards the centre the medullary hyphae only form a very loose cobweb, and occasionally the cross sections show a rupture along the longer axis. The medulla is very distinctly limited from the coriaceous cortex with its palissade structure. The gonidia are rather scattered, at least this is the case with the glomeruli of gonidia, and we are hardly justified in describing a stratum gonidiale of the medulla.

#### Distribution of *Dactylina madreporiformis*.

##### Arctic Europe and Asia.

Spitsbergen. Wijde Bay (leg. Th. Wulff, hb. Upsala): Kartdalen (leg. Høeg, hb. Trondheim and Oslo).

Franz Josef Land. Recorded by Elenkin (1909, p. 13; gives no locality).

Novaya Zemlya and Waigatch. "Nova Zembla" (leg. Capt. Markham, — Markham, 1881, p. 332). Bessimyannii Bay c. fr. (leg. B. Lynge, — Lynge 1928, p. 210). Matotchkin Shar: Sinus Neznajemyj (leg. Chirikin and Batjanov, hb. Leningrad), Mt. Wilczek, — Krypt. Vind. No. 3069 —, East of Cape Jouravlev, and at Mt. Syernaia (leg. B. Bynge, — Lynge 1928, p. 210). Serebryanka Fjord (leg. B. Lynge, —

Lyngé 1928, p. 210). Kristovii Fjord (leg. Palibin, — Elenkin et Savicz, 1912, p. 75). Mashigin Fjord: Trehørningen (leg. B. Lyngé, — Lyngé 1928, p. 211). Arkhangel Bay district: Bird Cliff south of Arkhangel Bay, Lichutin Island, Mainland east of Lichutin Island, Berkh Island, Eastern and Northern Kristovii Islands (leg. B. Lyngé, — Lyngé 1928, p. 211). Cape Nassau,  $76^{\circ} 30' N$ ,  $61^{\circ} 25' E$  (leg. Aagaard, hb. Upsala, — Th. Fries 1872, p. 14). East coast: Udde Bay (leg. Kjellman and Lundström).

Waigatch (leg. Almquist, hb. Stockholm, and leg. Bothin, hb. Leningrad).

Siberian coast. Dickson Harbour (leg. Almquist, hb. Stockholm). Taimir: Preobraschenie Island, Chatanga district (leg. Almquist, hb. Stockholm). Konyam Bay (leg. Almquist, hb. Stockholm). This species has not been mentioned by Nylander in Lich. Freti Behringii, and not by Vainio in Lich. Pitlekai.

#### Alpine regions in Central Europe and Asia.

Spain. In Lich. Eur. Ref., 1831, p. 25, Elias Fries records: "*Evernia madreporiformis*" from "In alpihus Europae mediae, inque Hispania". His references to literature are, perhaps, not quite clear, but anyhow he cites Schaer. Lich. Helv. No. 85 which is undoubtedly this species. Fries may have seen a plant from the Spanish Pyrenees, a locality like that would not have been at all improbable. But I have not had an opportunity of seeing his plant, and there is no other record of its presence in Spain. Del Amo does not mention Spanish localities (1870, p. 354). E. Fries's vague record, which is perhaps uncertain, has not been entered on the map.

I have tried to obtain information from Spain on its eventual presence there, but without much success. The Spanish Academia de Ciencias y Artes sent me the following information: "Respecto a la *Dufourea madreporiformis* se ha encontrado en Medina-Sidonia, Alcalá de los Gazules y Cabo de Gata sobre los árboles, las rocas y la tierra hasta 800 metros de altura sobre el mar segun nota M. Colmeiro". It seems to me that this information must stand for another species than *D. madreporiformis*.

Germany. Bayern: Berchtesgadner Gebirge, "auf dem Gipfel des Fundensee-Tauerngipfels bei 7888 f. auf dem Boden zw. Moosen und Gräsern" (leg. Krepelhuber, — Krepelhuber, 1861, p. 123).

"Alt Vater im Gesenke", Sudeten. (Lettau, 1912, p. 230, also other authors. — Suza is of opinion that this record is improbable, Suza, 1928, p. 26).

Switzerland. Wallis (leg. Schimper, comm. Reimers in litt.). Alpes du Valais (leg. Mougeot 1841, hb. Paris). Bas Valais (leg. Thomas, hb. Paris). Gemmi (leg. ?, Schaer. Lich. Helv. No. 85;

leg. Schimper, hb. Paris; leg. R. P. Gave 1886, 2300 m above sea level, hb. Bouly de Lesdain; leg. Lochenies 1901, hb. Bouly de Lesdain; leg. Du Rietz, 2230 m above sea level. It has been found at Gemmi also by other botanists). Grand Muveran, the famous find of fertile plants (leg. Müll. Arg., hb. Chodat, Genève). Mt. Cenis (leg. ?, hb. Chodat, Genève). Bernina: Bernek (leg. ?, hb. Chodat, Genève) and Faulhorn (leg. Kovatz, hb. Wien). Zermatt (hb. Hepp, London): Rothehorn (leg. Müll. Arg., hb. Kew). Graubünden: Stutzerhorn bei Chur, 2200 m above sea level (leg. Theobaldi, hb. Harvard). Letscherberg — now Lötschberg, in summo monte (leg. Schleicher, hb. Kew, and from the same mountain "autopticum Acharii", hb. Harvard).

Tirol. Stanzertal: Kaiserjoch v. Arlberg, 2305 m (leg. Arnold, Zwackh Lich. Exsic. No. 1160). Waldrast: Serles, 2270 m (leg. Arnold, — Arnold Lich. Exsic. No. 447), Matrei am Brenner, 7500 feet (leg. Arnold, — Arnold Lich. Exsic. 447 b). Auf steinigem Kalkboden der Höhen zwischen den Blaser u. d. Matreier Grube (leg. Arnold, hb. Suza). Brenner: Hühnerspiel, 2200—2500 m above sea level (leg. Stein, hb. Wien). Tuxerjoch, Zillertaler Alpen 2300 m above sea level (leg. Handel Mazzetti, hb. Wien). Sonnwendjoch bei Brixlegg i. Inntal (leg. Arnold, — Arnold Lich. Exsic. No. 86). Rofanspitz am Achensee 2260 m (leg. Stein, hb. Wien). Mieselkopf (Gams in litt.).

Italia. Valle d'Aosta (leg. Carestia, — Erb. Critt. Ital. No. 416—1416, and Rabenhorst Lich. Eur. No. 753). Valle d'Aosta: Gressoney St. Jean, (leg. Carestia, hb. Paris). Valpelline (leg. Abbé Henry, hb. Bouly de Lesdain). "In Aprutio" (Jatta, 1900, p. 61; from a locality not exactly located.

Steiermark—Kärnten. Hochgolling bei Schladming, 2800 m above sea level (leg. Baumgartner, hb. Wien). Kuppe des Sinabell bei Schladming, 2340 m above sea level (leg. Baumgartner, hb. Wien). Gamsfeldspitze d. Dachsteingruppe, 2500 m (leg. Baumgartner, hb. Wien). Gamsfeldspitze d. Dachsteingruppe, 2500 m (leg. Baumgartner, hb. Wien). Hochschwab, 2250 m above sea level (leg. Baumgartner, hb. Wien). — Groß Glockner (leg. Laurer, hb. Chodat, Genève), Pasterze, 2400 m (leg. Redinger, hb. Wien), and Pfandelscharte east of Groß Glockner, 2460 m (leg. Redinger, hb. Wien). Glockner: Salmshöhe (leg. A. Braun, hb. Paris, and leg. Schrader, hb. Leningrad). Heiligenbluth (leg. Welwitsch, hb. Wien). Hohe Tauern: Rottenkogel (Gams in litt.). Möserling (Gams in litt.). Linke Pasterze (leg. Laurer, hb. Wien). Küstenland: Mangart *Alpium Juliarum* (leg. Glowacki, hb. Uppsala and Harvard).

Carpati. Tatra (Tatry), very many finds, e. g. Bielské Tatry: Monte Havan, 1800—2160 m above sea level (leg. Suza, — Krypt. Exsic. Vindob. No. 2967, and Suza Lich. Boh.-Slov. No. 29, text fig. 4, p. 51). Magas Tatra: Bolond Gero, comit. Szepes, 2050 m above sea level (Flora Hungarica No. 417). Mt. Gievont (leg. Motyka, hb. Oslo). Wrótka and Schlucht Koakow unterhalb der Gradskie Uptarinskie (leg. Motyka, hb. Krakow). Hohe Tatra pluribi (leg. Motyka, Suza and

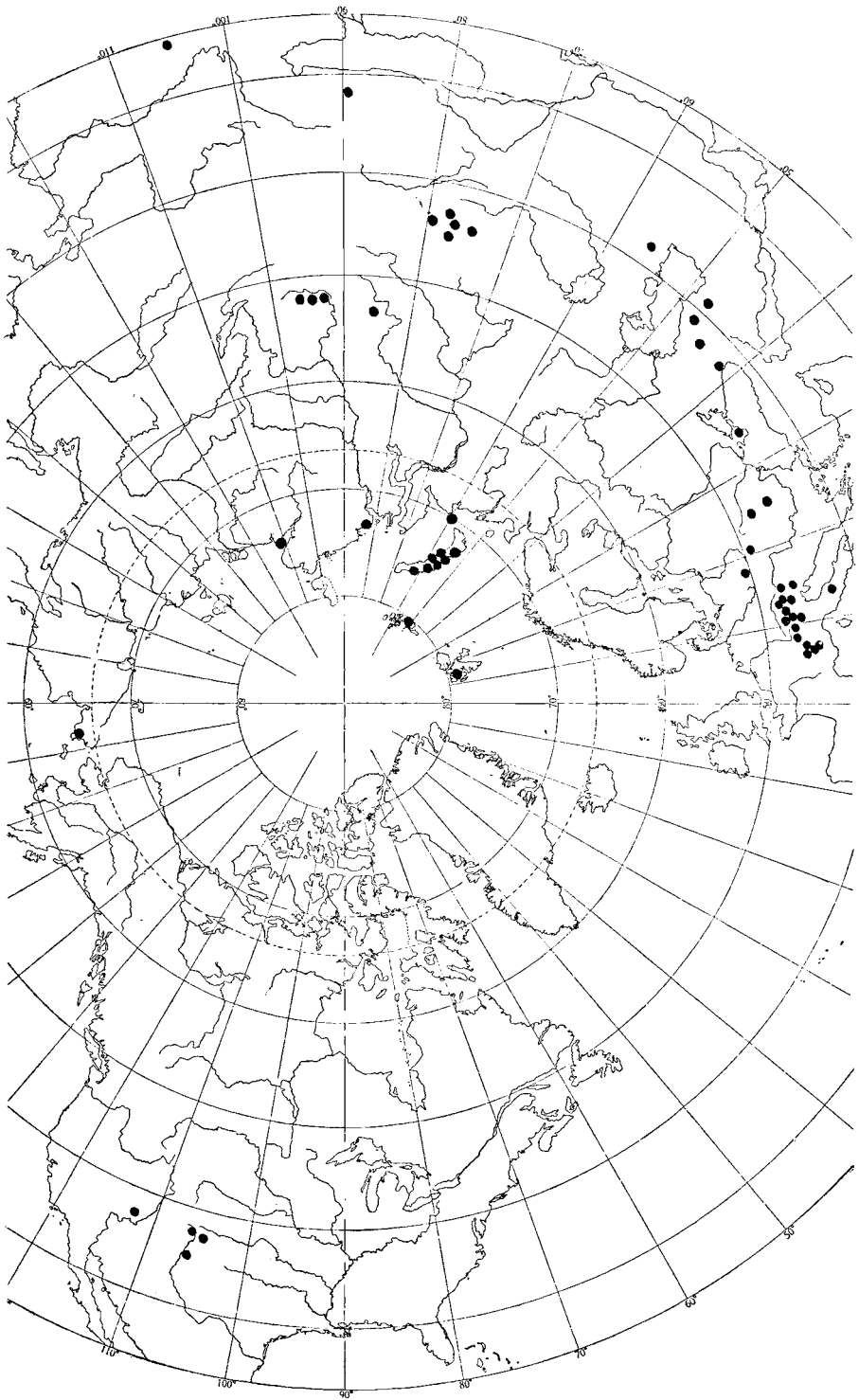


Fig. 2. Distribution of *Dactylina madreporiformis*.



Timko, several herbaria). — Siebenbürgen (Transsylvania): Carpati austro-orientales: Bucsecz an dem Wege von Omu nach der Caraiman (leg. Zschacke, — Zschacke, 1911, p. 378).

The Crimea. Tschatyr-Dag (leg. Elenkin, — Elenkin Lich. Ross. No. 13 a). Ai-Petri (leg. Elenkin, hb. Leningrad).

Caucasus. Ossetia (leg. Marlovicz, hb. Leningrad). Kasbek (leg. Elenkin, hb. Leningrad). Dagestan: Schach-Dag, gub. Baku (leg. Alexeenko, — Elenkin Lich. Ross. No. 13 b). Dikto, in monte Sadischi, 1750—1730 m. (leg. Ruprecht 1861, hb. Nylander in Helsingfors). Terschetia (leg. Ruprecht, hb. Leningrad).

Turkestan and surrounding regions. Kisyl-Art (leg. Korshinsky, hb. Leningrad). Fergonskaja, distr. Osch, Valle Alaj (leg. Roshevitz, hb. Wien). Reg. Semireczensk: Bolschaja Almatinka (leg. Fedtschenko, hb. Harvard and Oslo). Alexandrowsky Mountains in Semiretscha, 1670—3300 m above sea level (leg. Abramov, Abolin, Lipsky, a. o., hb. Leningrad). Trans-ilsky Alatau = Alatau Transilicum (leg. Brotherus, hb. Helsingfors, and leg. Lipsky and Abolin, hb. Leningrad). Terskei Alatau (leg. Brotherus, — Brotherus 1897—98, p. 3). Djungarsky (leg.?, hb. Leningrad). Kaschgaria: Thlan-Schan (leg. Elenkin, — Elenkin Lich. Ross. No. 13 c).

Not located Turkestan finds: Werchny Syrt, elev. 12 000 feet (leg. Roborovsky, hb. Leningrad), and Birdada (leg. Fedtschenko, hb. Leningrad).

f. *irregularis* Vain.: Manas Mountains in Western Tjanschan, elev. 8—10 000 feet (Vain., 1904, p. 241).

Tomsk. The sources of Tunguska (leg. Kusnetzow, hb. Leningrad). Sajan Mountains, Altai. Montes Sajanenses (leg. Elenkin 1902; leg. Garganinsky, hb. Upsala). Zargansky Pass (= Sagan Char), and "ad flum. Char" (leg. Elenkin, — Elenkin Lich. Ross. No. 13 d). Satchan Char, c. fr. (leg. Czeski and Hartung, hb. Leningrad). In pratis alpinis pass. Gargan in Montibus Sajanensibus ad fines gub. Irkutsk et Mongolia borealis (leg. Elenkin 1902, hb. Upsala, also Elenkin Lich. Ross. 13a, bis).

Tibet. "Ohne nähere Angabe" (comm. Reimers in litt.).

China. Yunnan. Mt. de Li-Kiang, 4000 (m?) above sea level (leg. Delavay 1886, hb. Hue in Paris? — the specimen in herb. Nyl. in Helsingfors is *D. endochrysea* Lyngé, p. 62 of the present paper.

#### America.

Alaska. Zeller Mission (not located find, leg. Palmer 1922, hb. Harvard). Alta or Alter Island (not located find, perhaps Atka Island in the Aleutic Islands, or perhaps Otter Island south of St. Paul's Island. Leg. Macoun, during the British Behring Sea Commission, Aug. 1891, hb. London).

Colorado. Mt. Lincoln (leg.?, hb. London). Pikes Peak, elev. 11000 feet (leg. Plitt, hb. Harvard; and leg. Du Rietz, hb. Du Rietz). San Elmo (not located, leg. Brandegee, hb. Harvard, London, Oslo).

Utah. Grassy alpine summit at Fish Lake, Quintal Mountains (leg. Godding 1902, hb. Oslo).

New Mexico. Environs de las Vegas: Baldy Peak, 3850 m above sea level (leg. Frère Arsène Brouard, — Bouly de Lesdain, 1932, p. 122).

It has occasionally been recorded from Greenland and from the Arctic North-Eastern Canadian regions. But all such plants which the present writer has seen, belonged to *D. ramulosa*, or to other lichens. So far there is no find of *D. madreporiformis* from these regions.

### 3. *Dactylina ramulosa* (Hook.) Tuck.

Tab. I, fig. 3, II, fig. 4—5, text fig. 3 and 6.

Tuckerman, Edw.: Observations on North American and other Lichens. Proc. Amer. Acad. Arts and Sciences, vol. V, 1862, p. 397—8. (Notes on distribution, very full description, first description of apothecia).

Tuckerman, Edw.: Lichens of California, Oregon and the Rocky Mountains so far as yet known. Amherst, 1866, p. 11. (Recorded from Rocky Mountains).

#### *Dufourea ramulosa* Hook.

Hooker, (William Jackson): Botanical Appendix to Captain Parry's Journal of a Second Voyage for the Discovery of a North-West Passage from the Atlantic to the Pacific, London, 1825, vol. IV, p. 424. (The original description, sterile plants from Igloodik in Melville Peninsula).

Stizenberger, Ernestus: Index Lichenum Hyperboreorum, 1876, p. 14. (Note on distribution, Cumberland Strait).

Stizenberger, Ernst: Lichenes Helvetici I, p. 52, in Jahresber. der St. Gallischen naturwiss. Gesellschaft, 1881/82. (On the highest Alps near the eternal snow, with some localities).

Nylander, W.: De Anzi Lichenibus Langobardiae exsiccatis observationes quaedam. Flora, vol. XLVI, 1863, p. 76. (Note on synonymy).

Nylander, W.: Novitiae quaedam Lichenum Europaeorum variarum tribuum. Flora, vol. XXIII, 1865, p. 212. (Recorded from Spitsbergen).

Nylander, W.: Recognitio Monographica Ramalinarum. Bull. Soc. Linn. de Normandie, Caen, 2 sér., vol. IV, 1870, p. 177, — sep. p. 79. (Description, distribution and nomenclature, cfr. p. 9 of the present paper).

Nylander, W.: Enumeratio Lichenum Freti Behringii. Bull. Soc. Linn. Norm. 4 sér., I, 1887, p. 214. (Recorded from Konyam Bay).

Almquist, Ernst: Die Lichenen Vegetation der Küsten des Beringsmeeres. Vega-Expeditionens Vetenskapliga Iakttagelser, vol. IV, Stockholm 1887, p. 540. (Found in Siberia, rather common — "recht viel" — rare and scarce at the Bering Sea).

Hue, A.: Addenda nova ad Lichenographiam Europeam. I. Revue de Botanique, 1886, p. 38 (the separate). (Note on the distribution in the highest European Alps).

Hue, A.: Lichenes Exotici, No. 570, p. 70 (in the separate). Nouv. Arch. du Muséum, sér. 3, vol. II, 1890, p. 278. (Localities from North America, Spitsbergen, and the European Alps).

Jatta, A.: Sylloge Lichenum Italicorum, p. 61, Trani 1900. (Short description, distribution in the nivale alpine region).

Jatta, A.: Lichenes, p. 160, in Flora Italica Cryptogama, III, Rocca S. Casciano, 1909—11. (Short description, distribution).

Dalla Torre et Sarnthelm: Die Flechten von Tirol, p. 23, Innsbruck 1902. (Found on crystalline chalk and on calcareous mica slate, many localities).

Olivier, H.: Lichens d'Europe, I, Mém. Soc. Nation. Sciences Natur. Cherb. vol. XXXVI, 1907, p. 92. (From the highest mountains, very rare in Europe).

Olivier, H.: Prodromus lichenum europeorum fruticulosi et foliacei. Memor. de la Real Academia de Ciencias y Artes de Barcelona, ser. 3, vol. XVI, 1921, p. 9. (Summary of distribution).

Elenkin, A. A.: Лишайники полярнаго побережья сибиря. (Les Lichens des côtes polaires de la Sibérie). Mém. Acad. Imp. des Sciences de St. Pétersb. VIII Sér. Cl. Phys. Math. vol. XXVII, No. 1, 1909, p. 12, tab. I, fig. 3. (Notes on habitus, differences from *D. madreporiformis*, recorded from the New Siberian Islands).

Elenkin, A. A. and V. P. Savicz: Лишайники, собранные Н. В. палибинимъ въ плаваніе ледокола «Ермакъ» въ сѣверномъ ледовитомъ въ 1901 г. (Lichenes in regionibus arcticis Oceani Glacialis ab I. V. Palibin anno 1901 collecti). Acta Horti Petropolitani, vol. XXXII, 1912, p. 75. (Addition to the lichen flora of Novaya Zemlya).

Vainio, Edv. A.: Lichenes in viciniis hibernae expeditionis Vegae prope pagum Pitlekai in Sibiria septentrionali a D:re E. Almquist collecti. Arkiv för Botanik, vol. VIII, No. 4, 1909, p. 16. (Locality near Pitlekai in East Siberia, valuable bibliographical references).

Lyngé, B.: Lichens collected on the North Coast of Greenland by the late Dr. Th. Wulff. Medd. om Grøn. vol. LXIV, 1923, p. 283. (Localities from the north coast of Greenland).

Lyngé, B.: Lichens from Novaya Zemlya, Oslo 1828, p. 211, in Report of the Scientific Res. of the Norw. Exp. to Novaya Zemlya 1921, No. 43. (Several localities from Novaya Zemlya).

Lyngé, B.: The Lichens. The Godthaab Expedition 1928. Medd. om Grøn. vol. LXXXII, Nr. 5, 1932, p. 6. (Recorded from Inglefield Land, N.W. Greenland).

Lyngé, B. and P. F. Scholander: Lichens from North East Greenland. Skrift. om Svalbard og Ishavet, Nr. 41, 1932, p. 45. (Notes on

its distribution in Greenland, a circumpolar species, supposed to be a relic plant).

Lindau, G.: Die Flechten, p. 200, Berlin 1913, et edit. 2, p. 200, Berlin 1923. (Short description).

Merrill, G. K.: Lichens, in Rep. Canad. Arct. Exped. 1913—1918, vol. IV, part D, p. 9 D, Ottawa 1924. (Localities from Arctic Canada).

Migula, Walter: Flora von Deutschland, Österreich und der Schweiz. Abt. II, vol. XII, p. 170, 1925. (Short description, with some localities).

Anders, Josef: Die Strauch- und Laubflechten Mitteleuropas, p. 178, Jena 1928. (Short description, with note on distribution).

Malme, G. O. A.: Lichenes Orae Sibiriae borealis inde ab Insula Minin ad Promontorium Ryrkajpia in Expeditione Vegae lecti. Arkiv för Botanik, vol. 25 A, No. 2, 1932, p. 33. (Recorded from Cape Tscheljuskin).

Zahlbruckner, A.: Catalogus lichenum universalis, vol. VI, p. 371, Leipzig 1930.

Hillmann, Johannes: Beitrag zur Flechtenflora Bayerns I. "Kryptog. Forschungen", herausgeg. von der Bayer. Botan. Gesellschaft zur Erforschung der heimischen Flora, vol. II, 1931, p. 237. (Find from Berchtesgaden in Bayern).

*Dufourea muricata* Laur.

Laurer, F.: in Sturm, Deutschlands Flora in Abbildungen nach der Natur mit Beschreibungen, Heft 24, p. 30 und pl. 12, Nürnberg 1832. (Excellent figure, habitus, magnified branch, longitudinal section of branch, very good description, based on author's plant from Kärnthen).

Koerber, G. W.: Parerga lichenologica, Breslau 1859, p. 16. (Description, recorded from Kärnthen).

Nylander, W.: De Anzi Lichenibus Langobardiae exsiccatis observationes quaedam. Flora, vol. XLVI, 1863, p. 76. (Note on synonymy).

Fries, Th. M.: Lichenes Spitsbergenses. Kgl. Svenska Vetensk. Akad. Handl. vol. VII, No. 2, Stockholm 1867, p. 10. (Recorded from several localities in Northern Spitsbergen, addition to the lichen flora of Spitsbergen).

Lindsay, W. Lauder: On the Lichen Flora of Greenland, with Remarks on the Lichens of other Arctic Regions. The Admiralty Manual of the Natural History of Greenland: prepared for the Use of the Arctic Expedition of 1875, p. 298). (*D. m.* is an American Species, not yet found in Greenland).

Darbishire, O. V.: Lichens collected during the 2nd Norwegian Polar Expedition in 1898—1902, and determined by O.V.D. Report of the Second Arctic Expedition in the "Fram" 1898—1902, No. 21, p. 37, Kristiania 1909. (Localities from Ellesmereland &c.).

Galløe, Olaf: Lichens from North-East Greenland (N of 76 N. Lat.). Medd. om Grønl., vol. XLIII, 1910, p. 190. (First find from Greenland).

Galløe, Olaf: Forberedende Undersøgelser til en almindelig Likenøkologi. Dansk. Bot. Arkiv, vol. I, No. 3, 1913, p. 82, fig. 133—137. (Important information on its morphology and branching).

*Pycnothelia muricata* (Laur.) Rabh.

Rabenhorst, L.: Deutschlands Kryptogamenflora, vol. II, 1845, p. 110. (Short description, based on Laurer's plants from Kärnten).

*Evernia ramulosa* (Hook.) Tuck.

Tuckerman, Edw.: A Synopsis of the Lichens of New England, the other Northern States, and British America. Cambridge, 1848, p. 11. (Arctic America, with description).

*Dactylina muricata* (Laur.) Tuck.

Tuckerman, Edw.: Genera Lichenum, 1872, p. 7. (The two species of *Dufourea* are related to *Dactylina arctica*, and they are also related to *Cetraria* which has similar apothecia).

*Cetraria ramulosa* (Hook.) Tuck.

Tuckerman, Edw.: A Synopsis of the North American Lichens, vol. I, 1882, p. 30. (Description, also of apothecia, distribution, related to *C. (etraria) aculeata*).

*Podetia fragilia*, erecta vel suberecta, brevia, 1—1.5(—2) cm. longa, basi emorientia, apice accrescentia, subteretia vel compressa cylindrica, podetia majora apicem versus interdum appanata et tum in margine papilliformiter dissoluta. Podetia vulgo monopodialiter ramosa, sed interdum etiam furcata, ramis divergentibus, brevibus vel etiam papillatis crebre instructa, ob ramos papillasque accrescentes thallum muricatum saepe dense caespitosum formantia, caespites diametro usque ad 3—5 cm. Rami saepe mammiformiter papillati, apice rotundati. Podetia superne olivaceo-fusca vel fusco-violacea, inferne flavo-fuscescentia vel glauco-fuscescentia, madefacta immutata, non vel leviter solum foveolata, sorediis isidiisque destituta, sed superne plus minusve intense pruinosa, pruina albida vel in violascentem vergenti.

Thallus isolateralis, undique corticatus, fistulosus, strato amorpho, incolorato, 5—7  $\mu$  crasso tectus. Cortex 25—35, interdum usque ad 50  $\mu$  altus, in parte exteriori late fuscus, in parte interiori anguste incoloratus. Hyphae corticis valde indistinctae, pachydermaticae, granulis minutis ut striatae videntur, superficiei perpendiculares, saltem in parte colorata corticis, in parte incolorata subamorphe confusae

mihi videntur. Hyphae medullares valde pachydermaticae, 6—7  $\mu$  crassae, plus minusve adpersae, in parte interiori arachnoideae, sub corticem densius contextae.

Apothecia rarissima, sed numerosa, si evoluta, ramos interdum fere tegentia. Apothecia majuscula, diam. vulgo 2—3 mm., rarius usque ad 5—6 mm., primo apicalia, deinde podetiis sympodialiter ramosis lateralialia, ramis brevibus affixa vel subsessilia. Discus subplanus, laevigatus, castaneus, nitidus, epruinosis, margine persistenti circumdatus thallo concolori, ab initio plus minusve grosse crenato, deinde usque appendiculato. Receptaculum fistulosum, lumen tamen angustum, medulla arachnoidea circumdatum, hyphae medullares 5—7  $\mu$  crassae, pachydermaticae, adpersae, ramosae. Cortex receptaculi dilute flavescens, vel in parte exteriori pallide fuscescens, praeterea incoloratum. Hyphae corticis intense conglutinatae, crassae, 10—12(—15)  $\mu$ , oblique striatae, crebre septatae luminibus anguste ellipsoideis, superficiei perpendiculares, in parte interiori superficiei magis paralleles et in medullam transientes. Gonidia receptaculi pulchre laete viridia, diam. 10—15  $\mu$ , plus minusve glomerata, glomeruli infra hypothecium (sensu latiore) stratum subcontinuum formantia, infra corticem minus numerosa vel late deficientia, in ipsa medulla pauca et dispersa. Hypothecium (s.l.) duo strata continere videtur: 1. stratum inferius crassius incoloratum, corticis structura et in corticem transiens, hyphis crassis, diam. 12—15  $\mu$ , valde pachydermaticis, refractivis, ramosis, pro majore parte hymenio perpendiculis, et 2. stratum superius, hypothecium verum, tenuius, circiter 37—40  $\mu$  crassum, incoloratum, hyphis minus refractivis, multo tenuioribus, superficiei hymenii magis parallelibus formatum. Haec strata strato tenui flavescenti distinguuntur. Hymenium angustum: 42—50  $\mu$  altum, strato amorpho incolorato tectum, in parte superiori flavo-fuscescens, praeterea incoloratum. Paraphyses basin versus crebre ramosae, praeterea indivisae vel hinc inde furcatae vel ramosae, in apice valde incrassatae, fusco-capitatae vel fusco-clavatae, capitulis diametro 4.5—5  $\mu$ , paraphyses arcte cohaerentes. Asci saccati vel pyriformes, hymenio multo breviores, 28—32  $\times$  8—10  $\mu$ , membrana superne incrassata (ut in *Parmelia*). Asci sporis saepe carentes, vel sporis 6:nis-8:nis instructi. Sporae globosae vel (abortu?) angulosae, diam. 4—5.5  $\mu$ , satis pachydermaticae, episporium 0.7—0.8  $\mu$ .

Pycnides fertiles rarissimae, in plantis apotheciiferis solum invenimus, globosae vel subglobosae. Fulcra articulata, brevia, exobasidialia. Pycnoconidia recta, cylindrica, 5—6(—7)  $\times$  1  $\mu$ .

Thallus KOH extus et intus immutatus vel extus (plantae pallidae) leviter flavescens, CaCl<sub>2</sub>O<sub>2</sub> extus et intus immutatus, et his reagentiis coalitis decoloratus. Hymenium J primo caerulescens, asci deinde mox inferne fusciscentes, et superne sordide caeruleo-nigricantes, gelatina hymenialis flavo-fusciscens (sectio tenuis). Hypothecium verum dilute

caerulescens, cortex et stratum infrahypothecialis J haud colorantur. Apices paraphysum KOH fuscescentes et turgescentes, usque ad 7—8  $\mu$ , praeterea omnia decolorantur. Hymenium HNO<sub>3</sub> non mutatur.

Exsic. Anzi Lich. Lang. No. 18 (*Dufourea muricata*), Arnold Lich. Exsic. No. 485 a (*Dufourea ramulosa*), 485 b, c (*Dufourea ramulosa* f. *muricata*). Wartm. et Schenk: Schweiz. Krypt. 455 (*Dufourea muricata*).

I have seen one single record of its pycnides: "Auch erscheinen bei dieser Art die Spermogonien viel mehr als bräunliche, dicht gehäufte, eingesenkte Punkte, während die Endwärtchen der Spitzen gewöhnlich etwas mehr erhaben zu sein pflegen" (Koerber, 1859, p. 16). I am not quite convinced that this record really stands for the pycnides, Koerber has possibly described very young, papillate branches. — The pycnoconidia were formerly entirely unknown, and I did my best to find them in our great herbarium material, all of which was destitute of apothecia. But it was all in vain. At last the happy idea struck me that they might possibly be found in Scholander's fertile plants, and there they were. It may be a chance, but nevertheless it seems to me that it suggests the pycnoconidia to be sexual organs (spermatia). In *D. madreporiformis* the pycnides are much more common, at least in the Arctic plants, though the apothecia are rare enough.

*D. muricata* is easily distinct from *D. madreporiformis* in its smaller size, its colour and pruina, its muricate branching, and its fistulous thallus.

Galløe has a remark on its morphology (1913, p. 82), translated from the Danish text: "Like *D. arctica* it consists of decumbent podetia, forming erect, irregular shoots, it can develop small tufts with centrifugal growth".

Most fruticulose lichens with narrow erect podetia are able to develop new erect shoots if the "mother podetium" falls to the ground. This is well known for *Cladoniae*, *Stereocaulons*, and other lichens, also for the present species. But I have never seen normally decumbent podetia ("nedliggende Podetier") in *D. muricata*. Its normal branching must result in a centrifugal growth, but we never find dead podetia in the centre of the tufts.

#### Distribution of *Dactylina ramulosa*.

##### Arctic Europe.

Spitsbergen. Red Bay (leg. Høeg, hb. Trondhjem and Oslo). Liefde Bay (leg. Th. M. Fries 1868, hb. Stockholm and Oslo). Bock Bay (Summerh. and Elton, 1928, p. 234). Wijde Bay (leg. Malmgren 1861, — Th. Fr. 1867, p. 10, see also Oxford Expedition, — Summerh. and Elton, 1928, p. 232, 234). Treurenberg Bay (leg. Malmgreen 1861,

— Th. Fr. 1867, p. 10; leg. Scholander at the inland west side, 1931, hb. Oslo and Stockholm). Treurenberg Bay: Hecla Cove (leg. Th. Wulff 1899, hb. Upsala). Mt. Lovén, elev. 1000 feet above sea level (leg. Malmgren 1861, — Th. Fr., 1867, p. 10). Lomme Bay (leg. Malmgren 1861, — Th. Fr., 1868, p. 10; leg. Th. Fries 1868, hb. Stockholm and Oslo). Lomme Bay: at the head of the Fjord, and at Dvergbreen, c. fr. (leg. Scholander 1931, hb. Oslo and Stockholm). Lomme Bay: Faksedalén and Faksefjellet, 360 m above sea level (leg. Scholander, 1931, hb. Oslo and Stockholm).

Nordostlandet (North East Land). Kapp Torell: "Terre Gustav Adolf" (leg. Scholander, 1931, hb. Oslo and Stockholm). Wahlenberg Bay (leg. Oxford Expedition, British herb., and also leg. Scholander at Round Hill, 1931, hb. Oslo and Stockholm). Øyfyorden (other names: Bay mit de Eilanden, or Murchison Bay): Rissa Lake, Hvalrosodden at the north point, Snaddbugta c. fr., Pelarberget, Mt. Flora, and Wargentindalen (leg. Scholander, hb. Oslo and Stockholm). Mainland south of Claravågsundet (leg. Scholander 1931, hb. Oslo and Stockholm). Westman Bay (leg. Scholander, 1931, hb. Oslo and Stockholm). Lady Franklin Bay: Franklínfjellet, west side of the mountain, and on the coast plain west of Franklínfjellet (leg. Scholander, hb. Oslo and Stockholm). Brennevinsbukta (Brandewijne Bay): Kapp Hansteen (leg. Scholander, hb. Oslo and Stockholm).

#### Europe, the Alps.

Germany. Bayern: Berchtesgaden (leg. Royer, — Hillmann, 1931, p. 237).

Switzerland. Alps in the Wallis province (Gams in litt.). Graubünden: St. Moritz (leg. Laurer 1863, hb. Upsala). Chur (leg. Theobaldi, hb. Paris, and hb. Stockholm). Stätzerhorn bei Chur, Wartm. et Schenk Schweiz. Krypt. No. 455 (leg. Theobaldi, hb. Wien).

Tirol. Oetztal: Gurgl and Geisberggletscher (leg. Arnold, hb. Wien). Waldrast Spitze b. Matrei a. Brenner (leg. Arnold, hb. Wien). Kugelhänge bei Waldrast, elev. 7500 feet (leg. Arnold, — Arnold Lich. Exsic. 485, b). Serles bei Waldrast (leg.?, Gams in litt.). Kraxentrag bei Gossensast, Sterzing, elev. 7000 feet, (Arnold Lich. Exsic. 485). Hohe Tauern (leg. Arnold, hb. Stockholm).

Italia. Valle d'Aosta (leg.?, Gams in littere). Bormio 3870 m above sea level (leg. Calar, Zebbru and Sobretta, — Anzi Lich. Lang. No. 18). Piz Lischanna, 3060 m above sea level (leg. Kiliás, — Stizenberger 1881—82, p. 52).

Kärnten and Steiermark. Windisch-Matrei (leg.?, hb. Nylander). Glockner (leg. Laurer, — Laurer, 1832, p. 30 and pl. 12). Albitzengrat,



to 3000 m above sea level (Frey in litt.). Pasterze (leg. Laurer, several herbaria). — Niedere Tauern: Steirischer Kalkspitz, 2400 m, and Hochgolling, on calcareous mica slates, 2840 m above sea level (Frey in litt.). Kalkspitze bei Schladming, 2400 m above sea level (leg. Baumgartner, hb. Wien).

#### Novaya Zemlya.

Matotchkin Shar: Mt. Wilczek (leg. B. Lynge, — Lynge 1928, p. 211), Belushii Bay (leg. B. Lynge, — Lynge 1928, p. 211) and South side of the Shar at the Kara Sea entrance (leg. B. Lynge, — Lynge 1928, p. 211). — Kristovii Fjord (leg.?, Elenkin and Savicz, 1912, p. 75). — Mashigin Fjord: Blomster Bay (leg. B. Lynge, — Lynge 1928, p. 211). — Bird cliff south of Arkhangel Bay (leg. B. Lynge, — Lynge 1928, p. 211).

#### Asia.

Arctic coast of Siberia. Dickson Harbour (leg. Almquist, Vega Expedition, hb. Stockholm). Cape Tscheljuskin (leg. Almquist, Vega Expedition, — Malme 1932, p. 33). Chatanga: Preobraschenie Island (leg. Almquist, Vega Expedition, hb. Stockholm). Nordkap: Ryrkaipia (leg. Almquist, Vega Expedition, hb. Stockholm). Czukotsky Peninsula: East of Koljuzin (leg. Almquist, Vega Expedition, — Vainio 1909, p. 16). Bering Strait: Aratzamtschetchene (leg.?, Hb. North Pacific Exploration Expedition, specimen found in herb. London and Paris). — (The plant from Konyam Bay (leg. Almquist, Vega Expedition, — Nylander 1888, p. 214) is *D. arctica*).

#### America.

Arctic American coast. Alaska: Tin City (leg. Palmer, hb. Harvard). Bernard Harbour: Chantry Island, 68° 47' N, 114° 46' W (leg. Frits Johansen, hb. Ottawa, — Merrill 1924, p. 9 D, s. n. *Dufourea madreporiformis*). Wollaston Land: Franklin, hb. Ottawa, "69°—70° N, 115° W" (leg. Frits Johansen, hb. Ottawa, — Merrill 1924, p. 9 D). Gjøa Harbour (leg. Lindström, Roald Amundsen North West Passage Expedition, — Lynge 1921, p. 5). Melville Peninsula: Igloolik (Hooker 1825, p. 424). Hudson Strait: Digge's Island (leg. Macoun 1855, hb. Ottawa a. o., and Bell 1885, hb. Ottawa and Harvard). Cumberland Strait (=Cumberland Sound?, leg.?, hb. London, see also Stizenberger 1876, p. 14).

Ellesmere Land region. North Devon (leg. Simmons, Second Fram Expedition, — Darbishire, 1909, p. 37). King Oscar Land: Goose Fjord and Reinbukta, Harbour Fjord, Valley at Sir Inglis Peak (leg. Simmons, Second Fram Expedition, — Darbishire, 1909, p. 37). Ellesmere Land: Cape Viele and Fram Harbour (leg. Simmons, Second Fram Expedition, — Darbishire 1909, p. 37).

The Rocky Mountains. Bon River Pass, 51° N (leg. Macoun 1879, hb. Ottawa). Lake Agnes: Summit of Mt. Niblock, elev. 8000 feet (leg. Macoun 1891, hb. Ottawa). Summit of Sulphur Mountains (leg. Macoun 1891, hb. Ottawa, and leg. Samson, hb. Harvard). Laggan: Mt. San Piran (leg. Bruce Fink 1906, hb. Ottawa). Bragg's Creek (leg. ?, hb. Ottawa). Pipestone Creek in Alberta (Macoun Canadian Lichens No. 280, s. n. *Dufourea madreporiformis*). Moose Mountains in Saskatchewan (leg. Macoun, hb. Harvard).

In American herbaria and literature this species is sometimes found under the name of *Dufourea madreporiformis*.

#### Greenland.

North East Greenland: Snenæs at Danmarks Havn 76° 40 N (Danmark Expedition, — Galløe 1910, p. 190). North Greenland: Lemming Fjord and Centrum Island (leg. Wulff, — Lynge 1923, p. 283). North West Greenland: Inglefeld Land: Pandora Harbour (leg. Seidenfaden, — Lynge 1932, p. 6). Disko: Nordfjorden (leg. Th. Fries, preliminarily published in Lynge and Scholander, 1932, p. 85).

### IV. General Distribution.

*Dactylina arctica* is a very rare species in the Atlanto-European Arctic sector. It has never been collected, and most probably it is lacking, on the North and East coast of Greenland. — It is very rare in the Svalbard region, only found in the northernmost parts of Spitsbergen and the North East Land (Nordostlandet). — There are a few finds from Novaya Zemlya and Kolgujev.

So far there is no find from the European continent. We might, perhaps, hope to find it on the Russian coast of the Polar Sea.

East of Ural that is entirely different. There are a lot of finds from the whole Siberian coast, and from the northernmost parts of the great Siberian rivers. To judge from several remarks in Almquist's papers it must be really common there. — It is difficult for me to state the exact northern limit of the Siberian forest. But it seems to me that it is lacking in the forest region, at least we have no records from it.

*D. arctica* has a considerable distribution in the Altai mountains far eastwards, and it is not improbable that it is found continuously all the way to the Pacific Ocean along the East Siberian mountains, for we find it again in the Stanovoi Mountains, and also in Camtchatka.

It is equally common all the way along the Arctic coasts of the American continent and the American Arctic islands from the Bering Sea region to the West coast of Greenland down to the Godthaab district.

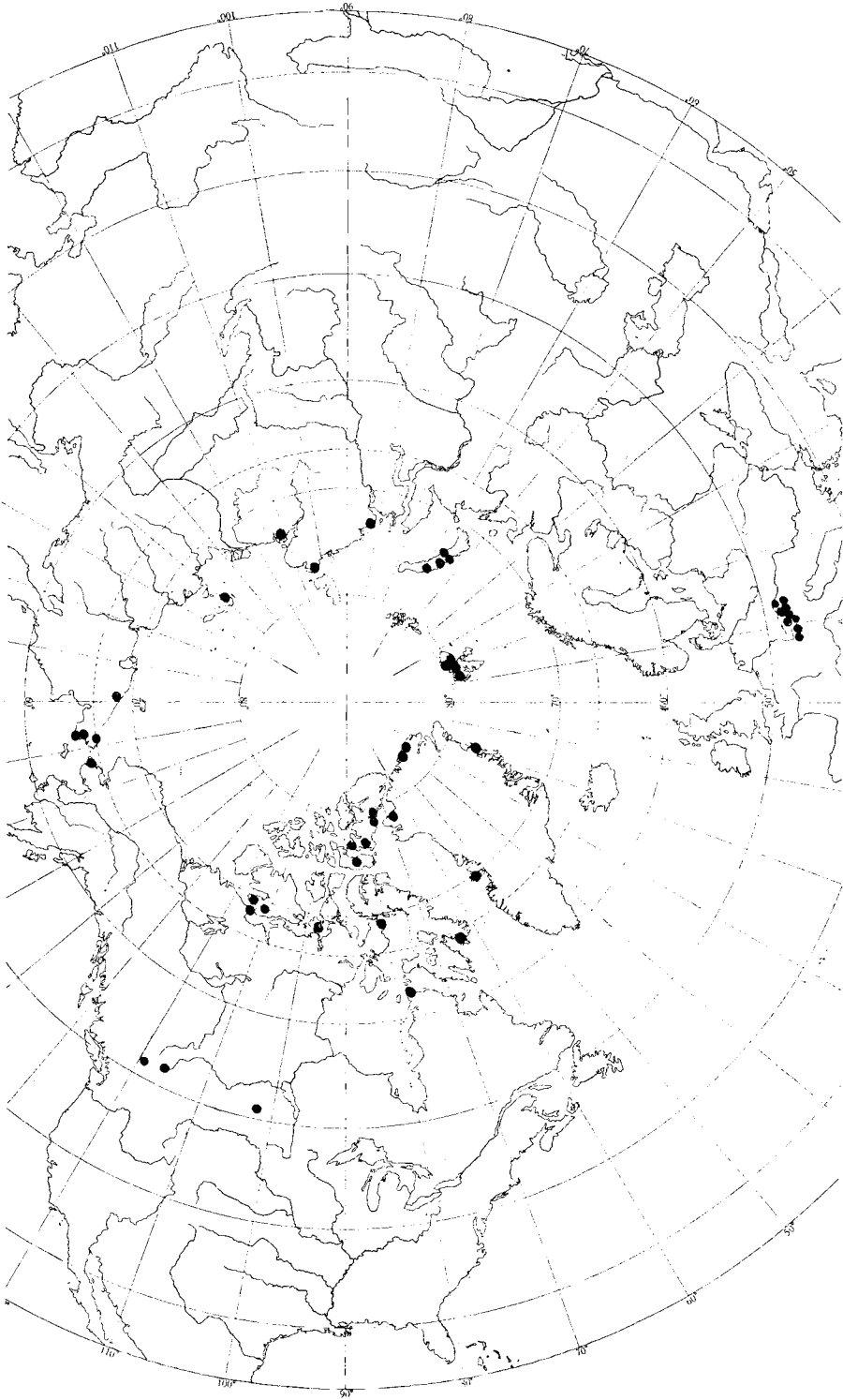


Fig. 3. Distribution of *Dactylina ramulosa*.

We have also several finds from the American continent south of the Arctic coast as far south as Alberta. These finds are scattered, and they possibly suggest a greater distribution than we know at the present day. These regions are difficult of access, and they have not been much investigated lichenologically.

On the whole *D. arctica* is typically a circumpolar Arctic species, only touching the northernmost land in the European sector, much more common and more widely distributed in Asia and in America.

The distribution of the two other species, *D. madreporiformis* and *D. ramulosa*, is much more interesting.

*D. madreporiformis* is extremely rare in the Atlantic Arctic sector, entirely lacking in Greenland, and recorded only from the continental part of a single fjord in Northern Spitsbergen.

We have only one record from Franz Josef Land, but in Novaya Zemlya it is "widespread and generally abundant" (Lyngé, 1928, p. 211). It has also been collected in Waigatsch.

There are a few finds from the Siberian coast, where it has been collected only by Almquist during the Vega Expedition. The (3) localities are scattered over this enormous coast. Considering the well-known thoroughness of Dr. Almquist's work we are justified in concluding that *D. madreporiformis* must be rare in Arctic Siberia.

It has an extensive and evidently continuous distribution on the highest mountains in Europa and Asia from (Spain?) the Alps all the way to the Sajan mountains in the Altai.

The number of localities in the Alps is very considerable, in reality so great that it cannot be duly expressed on a map of this size. Dr. Frey writes to the present author: "*Dufourea madreporiformis* ist in den Alpen in der alpinen Stufe ganz allgemein verbreitet, aber nirgends häufig, sie sucht meistens die Kämme und Gräte und windgefeigten Rücken auf, wo sie auf steinigem, ausgeblasenen Boden oder noch häufiger in Felsschichten auf Feinerde wächst. Höchster von mir beobachteter Standort: Großglockner i. d. Hohen Tauern bei 3600 m, so viel ich weiß der höchste Standort, auf ziemlich kalkhaltigen Grünschiefern. In den Schweizeralpen beobachtete ich sie mehrfach bis 3300 m Meereshöhe. Wie häufig sie in den Westalpen ist, kann ich nicht sagen, in den Schweizer- und Ost-Alpen scheint sie gleich häufig zu sein, fehlt also den Gebieten mit kalkarmen Silikaten und kompakten Kalken". . . . "Steigt kaum unter die Waldgrenze herab". . . . "Am reichsten auf eugeogenen Kiesel-Kalken der Kreide, des Doggers und des Tertiärs".

Dr. H. Gams, Innsbruck, writes (translated): "Restricted to the most continental regions in the East and West Alps, it demands but little snow cover during the winter. Most of the localities which I know are found on calcareous rocks between 2200—2900 m above sea level especially in the Elymeta of the summits".

Dr. J. Suza, Brno, writes (letter to the present author) "in montibus Carpaticis in parte occidentali et austro-orientali occurrit, solum in zona alpina, in rupibus calcareis vel dolomiticis, sterilis".

Dr. J. Suza writes (1928, p. 26, translated into German by Dr. Sulma, Krakow): "Die Flechte ist eine charakteristische Leitart der terrestrischen Hochgebirgsassoziationen auf Kalkunterlage, in den Alpen, in der Bielaer Tatra etc". And furthermore on its distribution in the Tatra (1925, p. 11, translated by Dr. Sulma): "Eine für den ganzen Kalkgebirgskamm der Bielske Tatra sehr charakteristische Flechte oberhalb der oberen Knieholzgrenze, von ca. 1800 m bis zur höchsten Spitze des Hawran, 2154 m".

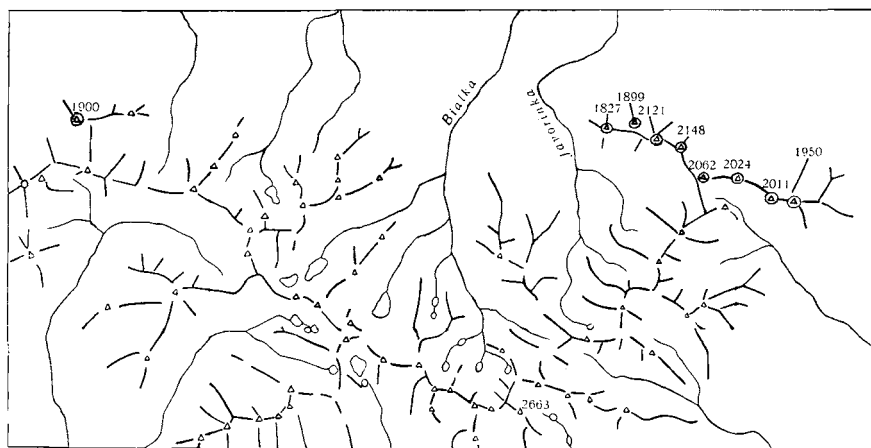


Fig. 4. Distribution of *Dactylina madreporiformis* in the Tatra Mountains. It is found on all the calcareous and dolomitic peaks of the "White Tatra" (north-east), and on Mt. Giewont (north-west), but it is entirely lacking in the central, granitic "High Tatra".

The author is indebted to Dr. J. Suza for this map.

Dr. Suza has also been kind enough to send me a map of its distribution in the Tatra (Tatry) mountains. It shows, better than words, how strictly it is limited to the calcareous and dolomitic mountains in the N.-E. Tatra, and to Mt. Giewont farther west, whereas it is entirely lacking in the central granitic massive of the High Tatra.

Farther east there is a continuous area of distribution through the mountains of the Crimea, Caucasus, Turkestan and Western Altai as far east as the Sajon region. — There are a few localities in Tibet and in China, so far scattered, but lichenologically these parts of Asia have not been much explored.

Its distribution in America is very interesting. It is entirely lacking all over Greenland, at least we have no finds to day. Lichens have been collected in Greenland for more than 100 years, and a species

so conspicuous as this is could hardly have escaped attention if it had been there. Nor has it been found in Canada. I have revised several finds of it from Arctic Canada and from Greenland, but they stand for *D. ramulosa*, or for other species.

There are a few finds from Alaska. Unfortunately I have been unable to locate them, and I could not enter them on the map.

Finally we have a well-known area of distribution in the Southern Rocky Mountains, between 35—40° N. — I cannot estimate the intensity of the lichenological research here, and I do not know whether the area is really so isolated as it looks at the present day.

But it is an important fact that a distribution of that kind (cfr. also *D. ramulosa*) is not restricted to this (these) species alone. Some maps of distribution in a paper by the Russian botanist A. Tolmatchew called my attention to the distribution of several Vascular plants, i. a. *Lloydia serotina*. Professor M. L. Fernald, of the Gray Herbarium, was kind enough to state its distribution on a map which he sent to me, a courtesy which must have cost him a great amount of work, and for which I am glad to express my profound gratitude (fig. 5, p. 53).

In North America *Lloydia serotina* is found in several localities along the coasts of Alaska. It has also two areas of distribution farther south, chiefly in the Rocky Mountains. One in the states of Washington, Montana, and the adjacent part of Wyoming. The other in Colorado and New Mexico, with an isolated find farther west, in Nevada. This southern area agrees remarkably well with the Rocky Mountain area of *D. madreporiformis*.

Professor Fernald was kind enough to add the following remarks: "The isolation from the Arctic and Subarctic region in the Cordilleran region far to the south is a very general one, this showing in so large a proportion of cases that I take it to be a natural isolation. North of lat. 55° or thereabouts the mountains gradually become lower and at lat. 60—65° very many of the Arctic species seem to be wanting on them".

It will be seen that the area of *D. madreporiformis*, between 35—40° N, is far to the south of the latitudes where the mountains become lower. — Even if the lichenological research of the Rocky Mountains should not be so intense as was to be desired, this analogy, and Professor Fernald's information, make it probable that our present knowledge of the American distribution of these rather conspicuous lichens is representative, and that it proves isolated centres of distribution.

The other species, *D. ramulosa*, has two distinct centres of distribution in the Atlanto-European sector.

Firstly we have the strictly northern region in North and North-East Greenland down to about 77° N on the East coast of Greenland. In addition to this we have an area along the north coast of Spitsbergen and the North East Land (Nordostlandet). In the eastern part

of this coast it is really common. There is hardly any other part of its area where we have so many finds from a small district.

It has never been found south of Danmarks Havn in East Greenland, in spite of intense lichenological research during several Norwegian and Danish expeditions. And it has never been found on the west coast of Spitsbergen. This coast has been explored by many trained lichenologists, hardly any other part of the Arctic being so well known, lichenologically. We have every reason to conclude that it is really lacking there, an important point.

Secondly there is the very limited area in the Alps from Wallis in the west to Steiermark and Kärnthen in the east. Though there are

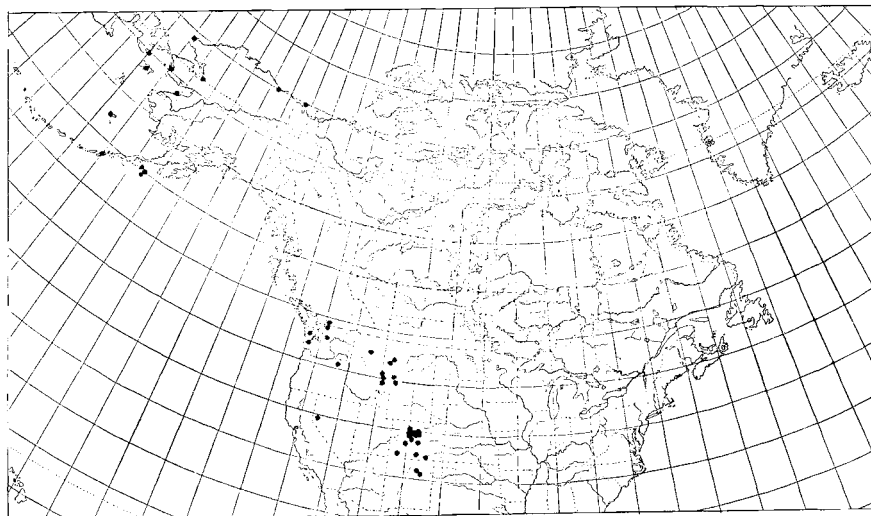


Fig. 5. American distribution of *Lloydia serotina*, as shown at Gray Herbarium. The author is indebted to Professor M. L. Fernald for this map.

a considerable number of finds it is not supposed to be common here. Dr. Ed. Frey, the Swiss lichenologist, writes to the present author: "In der Schweiz sammelte ich sie einzig im Gebiet des Nationalparkes, Unterengadin, auf Kalk- und Dolomitgestein, zw. 2600 und 3200 m" (we have Italian finds up to 3870 m, and Swiss finds down to 2000 m above sea level), "nur sehr vereinzelt und spärlich. In den Ostalpen scheint sie auch ziemlich spärlich".

Dr. H. Gams, Innsbruck, never collected it in the Alps. He writes that it is found on calcareous rocks between 2200—2900 m above sea level, especially in the Elymeta of the summits, restricted to the most continental parts of the West and the East Alps. — It requires places where there is but little snow cover during the winter.

We have no literary record of finds in the European mountains east of Steiermark and Kärnthen. After an extensive correspondance

with lichenologists and other botanists who know everything about the botany of these well-explored mountains, I find it highly improbable that it should be found there. Its area in the European Alps is, accordingly, isolated to an exceptional degree.

In Asia we have not a single find from the continent south of the coast. We cannot conclude with certainty that it is lacking there, but we have good reason to suppose that this is so.

There are several finds of *D. ramulosa* from the Arctic coast. To begin with (the European) Novaya Zemlya, the present writer found it "widespread, but scarce" in Novaya Zemlya (Lyngé, 1928, p. 211), and Almquist writes: "Ich habe sie in Sibirien recht viel, beim Beringsmeere selten und spärlich gefunden".

In America there is an isolated find on the coast of the Bering Strait. We have no record from the western part of the American Arctic coast which, however, has been insufficiently investigated. But there is a considerable number of finds from the Canadian Arctic islands, and also from the adjacent Canadian continent. Considering the modest intensity of the investigation, only by non-lichenologists, we are justified in supposing it to be quite common here. — There are a few finds from West Greenland.

Lastly we have some important finds from the Rocky Mountains in Alberta and in Saskatchewan, all of them just north of 50° N. So far these finds are quite as isolated as are the European alpine finds. But I am not quite convinced that the intensity of the field research work is here so great that we can exclude its presence in the alpine regions farther north.

We have no finds from the southern Rocky Mountains, in Colorado and Utah.

It is natural for me to begin a general discussion on the distribution of these species with the Svalbard region.

As formerly stated, there are but three finds of *D. arctica*, all of them from the north coast of Spitsbergen and the North East Land, and but two finds of *D. madreporiformis* from the continental part of Wijde Bay, on the north coast of Spitsbergen. — We cannot conclude much from a few isolated finds, such as these. *D. ramulosa* is very common along the whole north coast of Spitsbergen and the North East Land (Nordostlandet); in reality it is probable that we have here the greatest known density of finds in the whole world.

It is a very remarkable fact that we have not a single find of any of these species from the west coast of Spitsbergen. It cannot be due to insufficient investigation. For very many expeditions have worked along this coast, and several trained lichenologists have taken part. Each of them would have been much interested in finding these species, and it is not easily understood how three so conspicuous lichens could have



escaped the quest of so many botanists. On the north coast they have been found by a large number of collectors, lichenologists as well as non-lichenologists. I wonder whether a single botanist has collected lichens on the north coast without finding at least one of them.

Accordingly I consider their distribution exclusively in the northernmost Svalbard region to be a well-established fact which calls for an explanation.

The likeliest explanation is that they should be especially well adapted to the conditions of life in these high latitudes, being highly Arctic species. The climate is not known in detail along the Svalbard

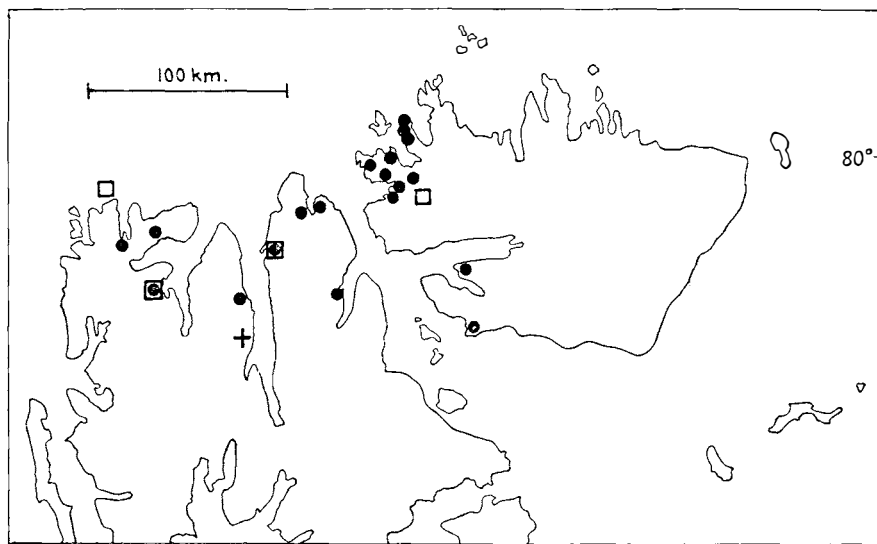


Fig. 6. The Svalbard distribution of the 3 *Dactylina* species:

- *Dactylina arctica*.
- + *Dactylina madreporiformis*.
- *Dactylina ramulosa*.

coasts. But we know that the most clement climate is found in the fjords of North West Spitsbergen, and also in the continental part of Isfjorden (Ice Fjord). It becomes ever more Arctic eastwards along the north coast of Spitsbergen proper and the North East Land, and the amplitude is supposed to be considerable. There is no reason whatever to suppose that climatic conditions should exclude any of these three species from the west coast of Spitsbergen. It is impossible to understand why the climate should be better for them along the north coast.

The sandstones of Northern Spitsbergen contain some lime; and calcareous rocks are also common in the Hecla Hook formation, which has a considerable extension in Northern Svalbard. *D. madreporiformis* and *D. ramulosa* are much dependent on calcareous soil. But there is much calcareous soil in West Spitsbergen also. And the geological strike

of the rocks is largely North-South in West Spitsbergen, we find much the same profile in Isfjorden (Ice Fjord) as we find along the north coast. It is hardly possible to explain the Svalbard distribution of these three species from the condition of the soil.

We might speak of "chance", the sum of all unknown factors. But that is, unfortunately, no explanation. Ignorance remains ignorance, even if we try to conceal it behind a fine term.

It seems to me that time factors might suggest a possible explanation. We should then have to consider two possibilities, viz.: 1. That the species should be recent introductions which had not yet reached their final distribution, and 2. That they should be old species, relic types, which for unknown reasons had lost their power of spreading under present conditions, as relic species often do.

Either of these possibilities seems equally reasonable for the two rare species, *D. madreporiformis* and *D. arctica*. But if *D. ramulosa* had been a species in vigorous spreading, it would be difficult to understand its absence on the west coast, considering the great density of finds along the north coast. I can, however, give no conclusive arguments in favour of this view, and it is evidently open to criticism.

If preference is given to the relic hypothesis we must presume unglaciated areas in Northern Svalbard at a time when the other parts of the islands were glaciated. A comparison with other parts of the Arctic lends support to this idea. We have today the greatest glaciated area in the Arctic in Greenland, but in this continent we find that the northernmost part presents very considerable unglaciated areas (Peary Land, Nyboe Land, Hall Land, Washington Land, Inglefield Land).

Glaciation is a very complicated phenomenon, dependent on the relation between precipitation, evaporation, and temperature. It is largely independent of the geographical latitude.

If Northern Svalbard had been unglaciated at a time when glaciers covered the remaining islands, it would be quite natural to expect relic plants just here, provided that they had lost their power of spreading, or had it reduced.

It is impossible for me, a botanist, to discuss geological questions of this kind. I have therefore consulted my geological friends.

Professor Olaf Holtedahl, of Oslo University, calls attention to the well-known fact that at the present day Northern Svalbard has unglaciated areas of considerable extent. He is of opinion that if there have been unglaciated areas during the last glaciation we should expect to find them in Northern Svalbard. He considers the idea of such refuges as possible, supposing the glaciers to have been valley glaciers.

Professor Thorolf Vogt, of the Technical University in Trondheim, fully agrees with my views. He has studied the geology of Northern Svalbard during his expedition of 1928. He has written to me (letter

of 23. May 1933, translated): "Alpine topography, e. g. west of Red Bay, between Wood Bay and Wijde Bay, and perhaps also in the Seven Islands (Sjuøyane) and Karl XII Island, suggests ice-free nunataks during the last glaciation. It is, however, more important that the level of the sea was much lower than at the present day, probably several hundred metres lower, and several facts favour the view that just a part of the land which is now submerged was then unglaciated. We have the analogy with North Greenland, which is remarkably unglaciated along the Arctic Ocean, certainly on account of the low precipitation. There cannot be much evaporation from an ice-covered sea, such as the Arctic Ocean north of Greenland, the air must be dry, and the air moisture from other regions must be condensed before it attains these regions. — In Spitsbergen we have the lowest amount of precipitation in the inner parts of Wijde Bay where the snow limit is very high, and where I have repeatedly seen incrustations of salts on the ground. During the last glaciation when the marine ice advanced farther south than it does today, and when the land was more extensive, we should expect a continental climate along the north coast of Spitsbergen and the North East Land, and accordingly little land ice".

The Swedish geologist, Professor Hans W:son Ahlmann, of *Stockholm's Högskola*, visited Northern Spitsbergen and the North East Land in 1931. He is of another opinion. He has been kind enough to write to me (letter of 26. May 1933, translated): "Nothing suggests that the north coast of the North East Land was not glaciated during the last Ice Age. But decisive proofs of the reverse are difficult to find, for moraines are rare all over the North East Land, on account of the solifluction, and all the glacial striae are lacking, on account of the intensive mechanical erosion. I think it very probable that the continental ice cap reached the Foyen Island during the last glaciation, and that it probably covered the Seven Islands (Norw.: Sjuøyane). But the Quaternary part of the expedition's results has not yet been worked up, and these remarks are only suggestions, based on my general knowledge of the facts".

The present writer might perhaps be allowed a little objection to Professor Ahlmann's remarks. He expressly calls attention to the scarcity of the moraines on the coasts of the North East Land, and he explains this fact by solifluction. But I have nowhere in the world seen mightier moraines than in Bell Sound, farther south in Spitsbergen and Mr. Adolf Hoel, our well-known expert on Spitsbergen geology, has told me that he has seen great moraines in the north part of the New Friesland peninsula, between Wijde Bay and Hinlopen Strait. Should solifluction really have been so much more ineffective in Bell Sound and in New Friesland than along the north coast of North East Land that it had left the moraines intact in Bell Sound whereas it should entirely have

destroyed them along the north coast? Would not a better explanation be that the last glaciation was so local along the north coast, for the reasons suggested above, that it had not left large moraines?

Botanists are obliged to wait until geologists have definitively solved these important problems. Anyhow, the present stage of our knowledge, geological as well as botanical, allows us to suppose a possible connection between the distribution of these plants today and the geological history of their present area.

It is not necessary to suppose a great area of ice-free land for their refuges during a glaciation, greater than the present. I have repeatedly called attention to that fact, e. g. in *Svensk Botanisk Tidsskrift*, 1932, p. 424. — I might here again call to mind the fact that we know about 200 different species of lichens from the strictly Antarctic regions, the continent and the nearest islands; regions which are so intensely glaciated that only very small strips of unglaciated land are left.

Also in Greenland *D. ramulosa* has a distribution which much resembles its distribution in Svalbard: Along the north coast from Disko in the west to Danmark Harbour in the east, and never collected south of these localities. The parallel is striking; we can take the field with the same arguments to explain it.

The distribution of these species on the European continent is equally interesting. *D. arctica* is entirely lacking there if we cannot regard the Ural find as European. It can possibly be expected from the Eastern Russian Arctic coast south of its Kolguev find. That would add a new locality to its map of distribution, but it would not be of general interest.

In Fenno-Scandia the two other species, *D. madreporiformis* and *D. ramulosa* are also lacking, as far as our present knowledge goes. Can we expect to find them? Scandinavian lichenologists are proud of the exploration of the lichen flora of our countries. Since the days of Linnaeus our science has witnessed days of unequal intensity, but it has never stopped for a single year. In some regions lichenological exploration is inferior to that of no other area of the world, in others the lichen flora is little known. If species, such as these, should be expected anywhere in our countries we should first think of our rich Arctic colonies on the Dovre mountains, further on the mountains of Salten, Nordreisa or Finnmark, or perhaps along the east coast of Finnmark and Petsamo. From the earliest days of lichenological research lichens have been collected just here, and no *Dactylina* has been detected. The Lofoten mountains consist of gabbros with very little lime. If a *Dactylina* should occur in Fenno-scandia the most probable locality would, perhaps, be the calcareous mountains in Western Finnmark, such as in Sørøya. At present I can only say that a *Dactylina* from Norway would be one of the most surprising finds which I could imagine.

The plains of Central Europe do not offer them suitable localities, but we find them again in the Alps, on the high calcareous summits. The special localities have been enumerated in the previous text.

I have asked Dr. H. Gams, Innsbruck, whether these localities had been glaciated during the Ice Age. Dr. Gams answered (translated from the Norwegian letter of 10. April 1933 from my polyglot friend): "In the Alps there are lots of places which have never been glaciated, and in the glaciated areas were always many nunataks. Most of the *Dufourea* localities in the Alps are typically nunataks, they have never been glaciated, but most probably covered by snow during the greater glaciations. We have also many nunataks of lower elevation in the North, and especially in the South Alps. In my opinion the Siberian "Elyna-Flora", which also comprises the (two) species of *Dufourea*, immigrated during one of the earlier Glacial periods (the Riss?), but hardly during the earliest (Günz and Mindel), and not during the youngest (Würm). Many Siberian species, such as *Lomatogonium carinthiacum* and *Clematis alpina*, are typically bicentric, suggesting two refuges. The most important was evidently found in the Dolomites, where the *Dufoureas* are supposed to have had many localities also during the heaviest glaciations".

This information from the prominent expert on the history of the Central European plants lends strong support to my own ideas on a relic nature of the two species of *Dactylina*, *D. madreporiformis* and *D. ramulosa*.

It would be quite natural to look for palaeontological evidence in support of such ideas. But unfortunately we have not a single Arctic lichen fossil, so we shall have to look for analogies amongst other plants.

For that purpose I had to appeal to the assistance of my friends, the palaeontologists. Dr. Rudolf Florin, Stockholm, did not only give me references to many important papers, but he generously sent me this literature for study. I found the most valuable information in papers by Clement and Eleanor M. Reid, especially in their: *The Pliocene Floras of the Dutch-Prussian Border*, Mededeel. van de Rijksopsporing van Delfstoffen, No. 6, The Hague 1915. — Professor Jens Holmboe, of our University, also called my attention to that paper.

In the remains from the Reuverian Flora of the Middle Pliocene deposits (the Tertiary Age), they found "a surprising resemblance to the living flora of the mountains of western China . . . . A less close relationship exists with the flora of Europe, the Caucasus, and the Mediterranean, a still remoter with the flora of North America" (p. 15—16). Special attention is called to the fact that "the nearest congeners of the Reuverian plants now inhabiting southern China, are nearly all mountain plants". Numerous instances are given of such plants.

The explanation is based also on the results obtained, firstly by Asa Gray and then by Wilson and Sargent, from their studies on the distribution of plants on the earth. All available facts "indicate three great streams of migration, radiating from some common centre in the north, and directed towards warmer climates", on account of increasing cooling during later tertiary times. "Two of these streams of migrants effected their escape to congenial latitudes. The American found its way directly open to the tropics. The East Asian, by way of the coastal plains of China, and the great valley systems of that country, ultimately reached warm temperate and sub-tropical regions". — "It would appear that the third stream of migrants, that which entered Europe, the existence of which is proved by the Reuverian fossils, was less fortunate. Driven southward by the ever-advancing cold, by no route could it unimpeded reach climates more genial than were offered by the Caucasus, and the south of France. Throughout the whole length of Europe and Asia, till the coastal plains of China were reached, the retreat to the south was cut off by one unbroken barrier of seas, deserts, and mountains, through which no rivers opened a way to the south." — The species which this wave of migration brought must have perished, cut off by the cold of the north behind and of the mountains in front. South Europe was unsuited to act as a refuge on account of its dry and hot climate.

The free southward passages in China and in America saved the Reuverian species during the Glacial Periods when the temperature was falling. During the Interglacial Periods, with their often rapidly rising temperature, the plants were again driven northwards or forced to climb the mountain slopes, from which they returned to the valley bottom when the temperature fell during the Glacial Periods.

At the present day we are living in an Interglacial Period, and we find the old tertiary plants high up the mountain slopes.

The Reid paper is exceptionally well written, and its arguments sound very convincing. It might, perhaps, be objected that there is some risk in drawing such general conclusions, based on the results of one find, however well it may be worked up. It is, therefore, highly satisfactory that also other investigations fully confirm the results, obtained in the above cited paper, *cfr. i. a. Eleanor Mary Reid: A Comparative Review of Pliocene Floras, Based on the Study of Fossil Seeds, Quart. Journ. Geol. Soc. London, Paleobot., vol. LXXVI, Part 2, 1920, p. 145—161.*

The Reuverian flora of the Dutch-Prussian border was a flora that suggested a rather hot climate, to judge from the present distribution of its species and their congeners.

But we must not forget the geological history of the earth during the Tertiary Period. It was during that time that the present relief of

the earth was determined. Mighty mountain chains rose up, in part in connection with more ancient alpine regions. Since then erosion has been in action, and reduced their height.

In the light of these facts we can try to understand the present distribution of *D. madreporiformis* and *D. ramulosa*. During the Tertiary Age alpine plants, driven to the valleys and to the beach by the increasing cold towards the end of the Tertiary Age, driven southward by the advancing ice cap, expelled from Fenno-Scandia, refugees on the nunataks in Central Europe (and farther east), and on eventual ice-free beaches during the greatest glaciations, driven to the highest summits by the heat of the Interglacial Ages, such as the present time. Now they live on these summits, cut off from other possible, often near, localities by hot surrounding lowlands. They are like plants living in isolated islands on the great ocean. Being alpine Tertiary plants, they live today higher than the Reuverian plants in China and in North America.

When the time comes for the high Chinese mountains to be better explored, I venture to predict a great increase of *Dactylina* finds there. The East American mountains are, perhaps, not high enough, the *Dactylinas* may have been destroyed there during a warm Interglacial Period. I do not quite understand why we should only find them so far south in the Rocky Mountains. Will a better exploration bring them to light farther north? Or is this case an analogy to Fenno-Scandia? Has the advancing ice entirely extinguished them there, and did the ice-cap retire so rapidly that they were cut off, being unable to follow the melting ice?

We know that many relic plants have a reduced power of spreading. That is just one of the reasons why they are relic. It is sufficient to call to mind plants such as *Sequoia gigantea*, and many other species, the distribution of which has been carefully mapped in several of Fernald's papers, which are too well known to necessitate special reference.

If there were no ice-free coasts, or no nunataks, in the present Arctic during the heaviest glaciations, the *Dactylina* distribution there must be due to a later immigration during interglacial or postglacial times. In that case the Ural and Novaya Zemlya must have been a very important route for *D. madreporiformis*, connecting its present Arctic distribution with its refuges in the Altai mountains. — We have no finds in Altai and Ural for *D. ramulosa*. For that species it would be more natural to consider a western route of migration, from North America by the Canadian islands, north of Greenland to Northern Svalbard, and finally to Novaya Zemlya. There are no great distances across the sea by this route.

## V. Supplement.

### *Dactylina endochrysea* Lynge n. sp.

Podetia 1—2 cm. longa, basi (ut videtur) emorientia, apice accrescentia, leviter appressa vel subcylindrica, apice late rotundata vel truncata. Podetia (in specimine) flavo-fuscescentia, nitidiuscula, sorediis isidiisque(?) destituta, laevigata vel levissime solum foveolata.

Textura thalli ut in *D. madreporiformi*. Cortex 30—40(—50)  $\mu$  crassus, medulla subsolida, hyphae medullares ramosae, adpersae, flavescens.

Apothecia desunt.

Pycnides numerosae, distincte prominulae, pycnoconidia leviter arcuata, 14—15  $\times$  0.5—1.0  $\mu$ .

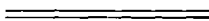
Reactio chemica ut in *D. madreporiformi*, medulla flavida KOH non violacea, sed solutione dilutissime flavescens solum effundenti.

China: Yunnan. "Lieux ombragés sur la montagne de Li Kiang à 4000 m. d'altitude". Leg. Delavay 1886, hb. Nylander, Helsingfors.

On the thallus there are numerous black papilliform to disc-like, small excrescences. No structure of an apothecium could be detected in them. They might be peculiar isidia, but it seems to me that they look more like deformed pycnides.

Nylander labelled the plant "*Dufourea madreporiformis* Ach.?". It agrees with that species in its habitus, and in the size of its pycnoconidia, but it differs in its more brownish colour, and especially in its yellow medulla. The yellow colour was not changed into violet by KOH, only a faintly yellow solution was seen.

It is hardly possible to form a correct judgment on the systematical value of this species from a single herbarium plant. It may, perhaps, be a chance modification only. But if we should anywhere expect to find an interesting new species of this old type it should be in China. This is evident from the above extract from the Reid paper.



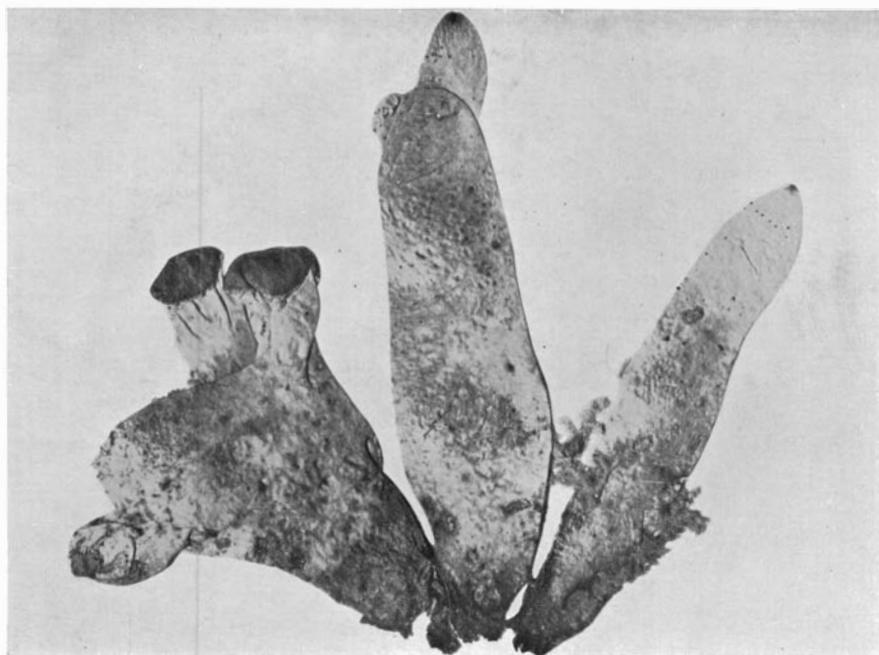


## PLATES

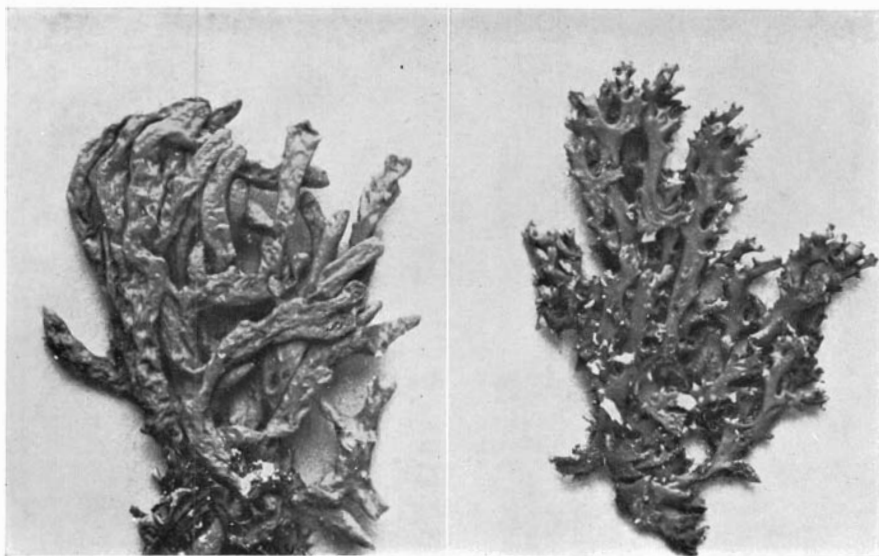
**Pl. I.**

- Fig. 1. *Dactylina arctica* (Hook.) Nyl. Bear Lake, herb. Tuckerman, Harvard University.
- Fig. 2. *Dactylina madreporiformis* (Ach.) Tuck. Novaya Zemlya: Northern Kristovii Island (leg. B. Lynge, herb. Oslo).
- Fig. 3. *Dactylina ramulosa* (Hook.) Tuck. Novaya Zemlya: Mashigin Bay, Blomster Bay (leg. B. Lynge, herb. Oslo).

Phot. Lily Monsen.



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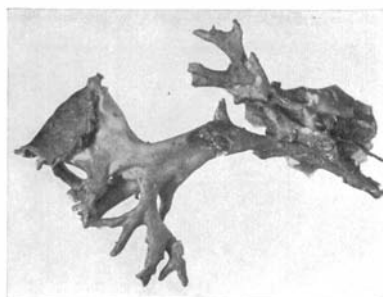
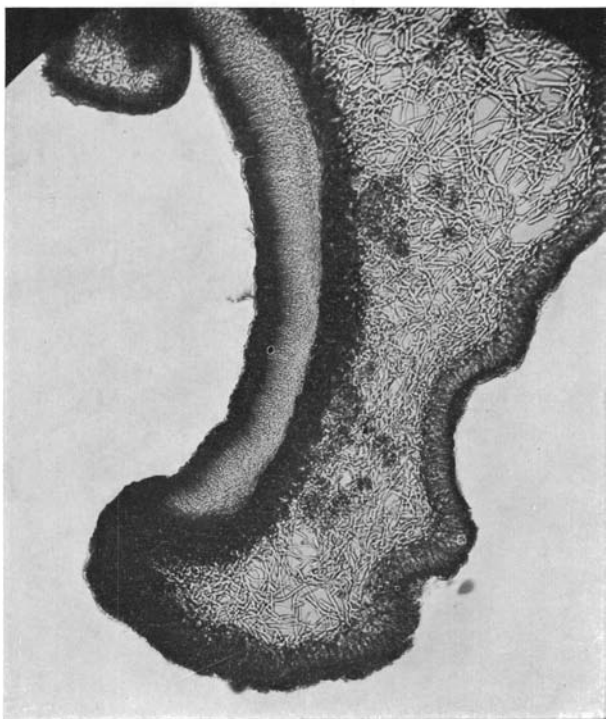
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## Pl. II.

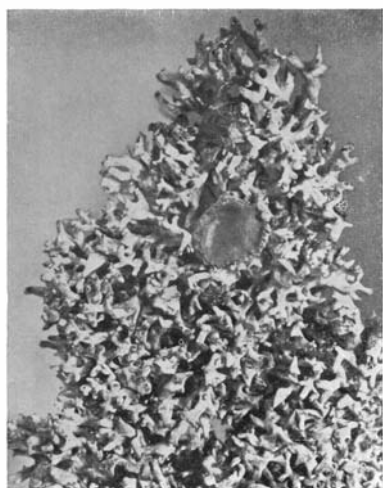
- Fig. 1. *Dactylina madreporiformis* (Ach.) Tuck. Section of pycnide. Novaya Zemlya: Bessimyannii Bay (leg. B. Lynge, herb. Oslo).
- Fig. 2. *Dactylina madreporiformis* (Ach.) Tuck. Section of apothecium. Same plant as fig. 1.
- Fig. 3. *Dactylina madreporiformis* (Ach.) Tuck. Habitus of apothecia and pycnides. Same plant as fig. 1 and 2.
- Fig. 4. *Dactylina ramulosa* (Hook.) Tuck. Fertile plant, from above. Svalbard: Nordost Landet (North East Land), Murchison Bay (leg. P. F. Scholander, herb. Oslo).
- Fig. 5. *Dactylina ramulosa* (Hook.) Tuck. Same plant as fig. 4, fertile branch.

Fig. 1—3 phot. (and sect.) P. F. Scholander, fig. 4—5 phot. Lily Monsen.

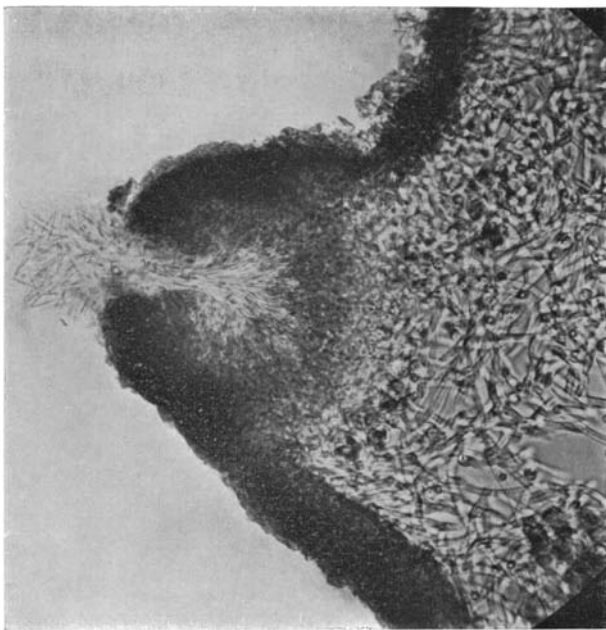
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## SKRIFTER OM SVALBARD OG ISHAVET

- Nr. 1. HOEL, ADOLF, *The Norwegian Svalbard Expeditions 1906—1926*. 1929. Kr. 10,00.  
 ” 2. RAVN, J. P. J., *On the Mollusca of the Tertiary of Spitsbergen*. 1922. Kr. 1,60.  
 ” 3. WERENSKIOLD, W. and IVAR OFTEDAL, *A burning Coal Seam at Mt. Pyramide, Spitsbergen*. 1922. Kr. 1,20.  
 ” 4. WOLLEBÆK, ALF, *The Spitsbergen Reindeer*. 1926. Kr. 10,00.  
 ” 5. LYNGE, BERNT, *Lichens from Spitsbergen*. 1924. Kr. 2,50.  
 ” 6. HOEL, ADOLF, *The Coal Deposits and Coal Mining of Svalbard (Spitsbergen and Bear Island)*. 1925. Kr. 10,00.  
 ” 7. DAHL, KNUT, *Contributions to the Biology of the Spitsbergen Char*. 1926. Kr. 1,00.  
 ” 8. HOLTEDAHL, OLAF, *Notes on the Geology of Northwestern Spitsbergen*. 1926. Kr. 5,50.  
 ” 9. LYNGE, BERNT, *Lichens from Bear Island (Bjørnøya)*. 1926. Kr. 5,80.  
 ” 10. IVERSEN, THOR, *Hopen (Hope Island), Svalbard*. 1926. Kr. 7,50.  
 ” 11. QUENSTEDT, WERNER, *Mollusken aus den Redbay- und Greyhookschichten Spitzbergens*. 1926. Kr. 8,50.

Nos. 1—11: Vol. I.

From Nr. 12 the papers will not be collected into volumes, but only numbered consecutively.

- Nr. 12. STENSIÖ, ERIK A:SON, *The Downtonian and Devonian Vertebrates of Spitsbergen*. Part I. *Cephalaspidae*. A. Text, and B. Plates. 1927. Kr. 60,00.  
 ” 13. LIND, J., *The Micromycetes of Svalbard*. 1928. Kr. 6,00.  
 ” 14. *A paper on the topographical survey of Bear Island*. (In preparation.)  
 ” 15. HORN, GUNNAR and ANDERS K. ORVIN, *Geology of Bear Island*. 1928. Kr. 15,00.  
 ” 16. JELSTRUP, HANS S., *Déterminations astronomiques*. 1928. Kr. 2,00.  
 ” 17. HORN, GUNNAR, *Beiträge zur Kenntnis der Kohle von Svalbard (Spitzbergen und der Bäreninsel)*. 1928. Kr. 5,50.  
 ” 18. HOEL, ADOLF, *Das Festungsprofil auf Spitzbergen. Jura und Kreide. I. Vermessungsergebnisse*. (In preparation.)  
 ” 19. FREBOLD, HANS, *Das Festungsprofil auf Spitzbergen. Jura und Kreide. II. Die Stratigraphie*. 1928. Kr. 3,00.  
 ” 20. FREBOLD, HANS, *Oberer Lias und unteres Callovien in Spitzbergen*. 1929. Kr. 2,50.  
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