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Bryophytes Collected in the Arctic Tundra of Calypsostranda Region (Western Spitsbergen) in 1987 and 1988

Mszaki zebrane w tundrze arktycznej w rejonie Calypsostrandy (Zachodni Spitsbergen) w r. 1987 i r. 1988

INTRODUCTION

The study characterized bryoflora in the Calypsostranda area in Western Spitsbergen (Fig. 1). Botanical studies were conducted during Polar Expeditions II (1987) and III (1988) of the Maria Curie-Skłodowska University in Lublin (26, 36). The oldest studies on the bryoflora in Svalbard area and in other parts of Arctica that merit attention are those by Arnell (1), Arnell and Mårtensson (2), Berggren (5), Kuc (18) and Philipi (23). Introductory data on the bryoflora of Calypsostranda and the neighboring regions have already been published (11, 12, 29, 30, 33). Similar bryological studies were conducted in the surroundings of Calypsostranda (13, 14, 34–36).

THE SCOPE AND METHODS OF INVESTIGATION

The presented data on bryoflora come from 124 described stations of phytosociological records on the area of 100 m^2 (Fig. 1). The records cover the most representative tundra expanses situated in accessible places. 20 ecological-floristic groups of tundra communities were discussed. A general floristic and ecological characteristics of those tundra communities was given in an earlier publication (33) and in a separate chapter of the present study.

Bryophyte species discussed in this study were collected by F. Święs. The results of bryological investigations, as in earlier publications (13, 14, 34–36), were presented comprehensively and statistically in Table 1.

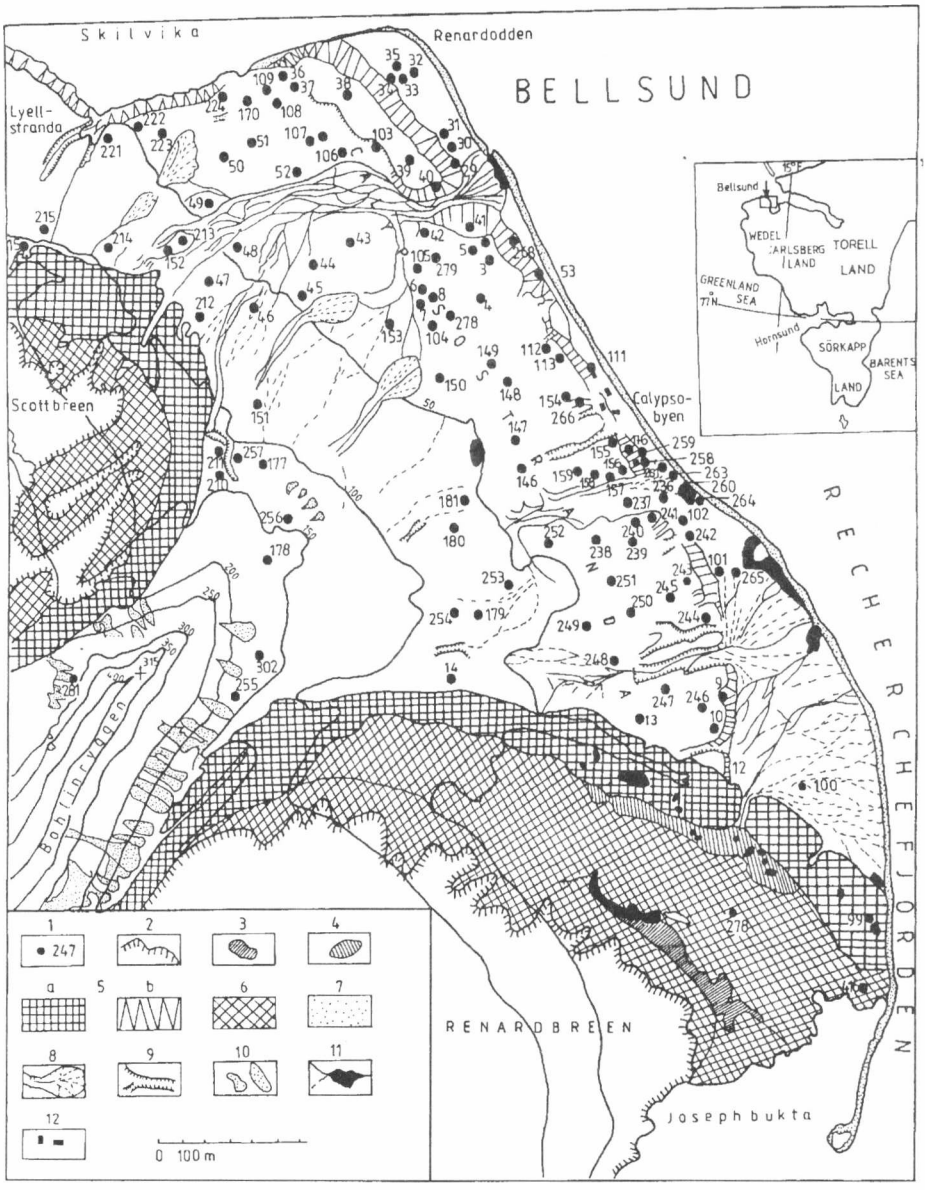


Fig. 1. Location sketch of the studied area; 1 — studied bryophyte stations, 2 — glaciers, 3 — ice-sheets, 4 — kame terraces, 5 — glacial moraines: a — lateral, b — ground moraine, 6 — current or fossil cliff, 7 — sea beach, 8 — erosion incisions, 9 — stony talus fans, 10 — outer and inner sandurs with permanent and intermittent streams, 11 — rivers and lakes, 12 — buildings of the old coal-mine in Calypsobyen

Two-letter abbreviations used in the descriptions of the appended bryophyte stations denote: Bn — Bohlinryggen 515 m a.s.l., Ca — Calypsostranda, Cn — Calypsobyen, Rn —Renardodden.

THE AREA OF STUDIES

Localization and Main Geological and Geomorphic Properties

The Calypsostranda region under investigation is situated in Western Spitsbergen in the north-eastern part of Wedel Jarlsberg Land over Bellsund fiord (Figs. 1, 4–11). The data on the geological and geomorphological profile of the region in question are found in items 6, 7, 21, 22, 25 and 32.

The oldest rocky bedding are metamorphic rock of Hecla Hoek formation, consisting of slate tillites with limestone and quartzite inclusion and of grey limestone and solid dolomites (6, 7, 21). In the substratum on the seaside plain of Calypsostranda there are predominantly Tertiary sandstones and mudstones with carbon inclusions. These rocks are covered with a several meter thick layer of Quartenary deposits of marine, glacial and fluvioglacial origin. Most frequently these are sandy, gravelly, clayey, loamy and block formations mixed together.

Numerous permanently wet, loamy-stony sites of the slopes of heights, terraces and cliffs are subjected to various processes of solifluction and frost segregation. These are frequently textured grounds with different forms of stony traverses and frost cracks as well as clayey outflows (Figs. 7, 8).

The Calypsostranda area is a vast and fairly homogeneous marine plain 5 km long and 1.5–2 km wide (Figs. 2, 3). In the whole of its north-eastern part it borders with the sea while at its opposite south-western side it neighbours the Bohlinryggen massif (315 m a.s.l.) and the moraines of the Scott and Renard glaciers (Figs. 4, 5, 10). The Calypsostranda plain is slightly inclined towards north-west. It consists of a system of isostatically-elevated marine terraces up to 100 m high. Among several-level marine terraces, the largest is the area at 25–30 m a.s.l. In the wide, low-situated marine terraces there are vast depression areas (Fig. 5). In the marine terraces numerous sites of relic rocks and erosion incisions of rivers and streams of varying sizes are also noticeable. In the studied region large areas are covered by older and younger, outer and inner stony-gravel sandurs with differing degree of outwashing and silting-up. In sandur fields there are numerous permanent or intermittent streams and flood waters. On the

rim of the lowest marine terrace there is a well-formed, sandy-pebble-gravel beach (Fig. 4), up to 4 m high and 150 m wide (10).

Slopes and ridges of heights are as a rule highly stony (Fig. 10). At the bottom of height slopes various types of rock-debris can often be observed. A very large area is covered by a complex system of lateral and ground moraines of the Renard and Scott glaciers (Fig. 1).

Climatic and Water Conditions

Data on the climatic conditions in the north-eastern coast of Bellsund have been published earlier (8, 9, 19, 24, 27, 28, 31).

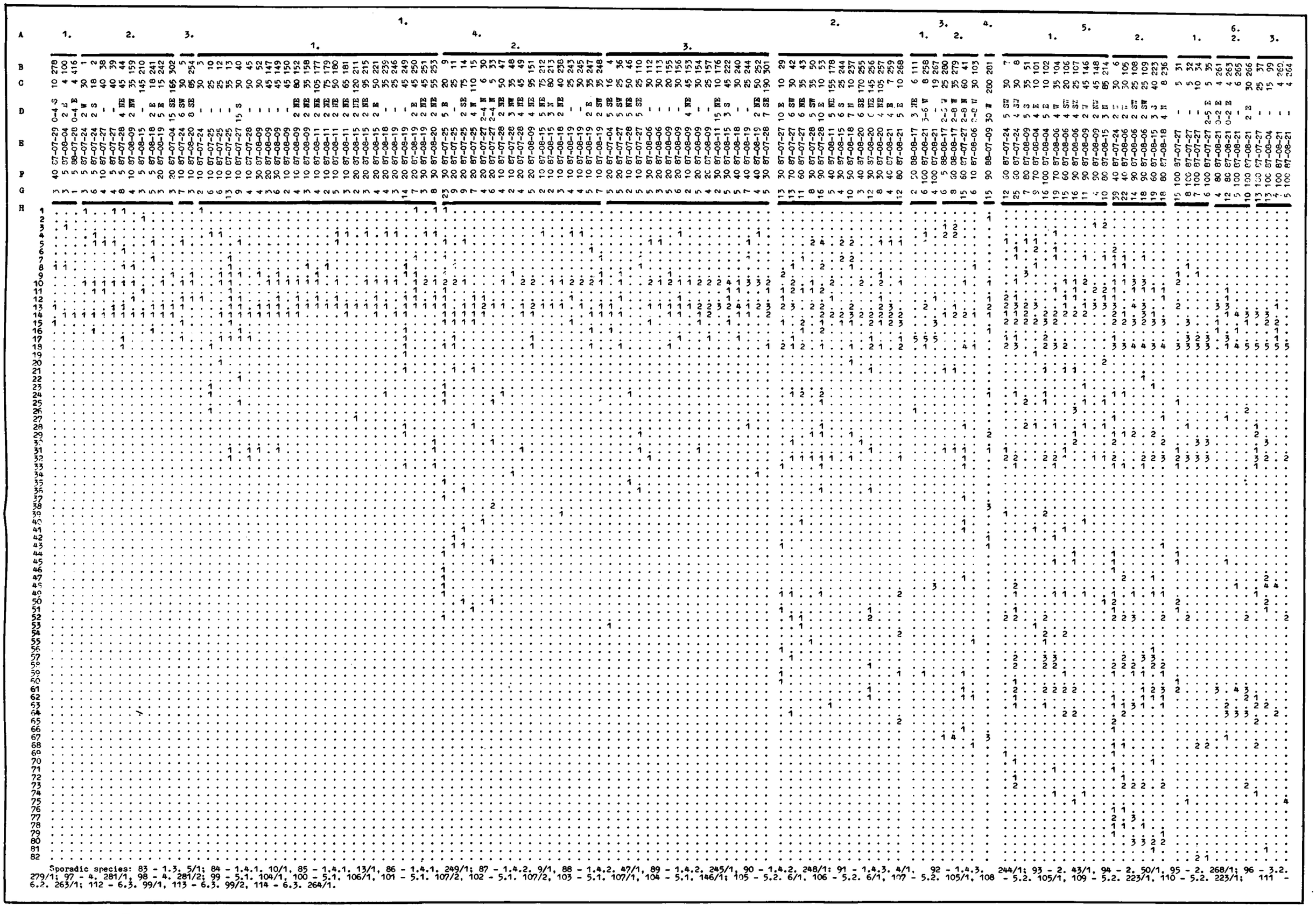
In the Bellsund coast region the areas of Calypsostranda, Lyellstranda and Dyrstad may belong to comparatively the driest and warmest (8, 14, 27, 28, 33, 36). The climatic properties of the three regions over Bellsund fiord are probably determined by the local geomorphological, edaphic and microclimatic factors rather than macroclimatic (14, 33, 36). The optimum vegetation period in this area basically lasts from mid-June to mid-August (33).

The local network of surface waters is hardly diversified (3, 4, 20, 25). There is one glacial river and several dozen permanent and intermittent streams and flood waters (Fig. 1). Scarce and small lakes can be found mainly on the sea-coast and glacial moraines (Fig. 1). The wetting of the surface of the studied area is seasonally highly variable (3, 4, 33). During the spring thaw almost the whole of the region is flooded with snow melt and permafrost waters (Fig. 8). In summer, thaw water disappears as well as most streams and overflow waters. With time ground over-dessication occurs from the sea-coast as far as the peaks of heights.

Soils

In Calypsostranda there are soils with similar properties as those in other regions of Bellsund (15–17). On the youngest and least weathered, gravelly-sandy rock sediments there are widespread initial soils of rygosol and lithosol types. Locally, only brown and boggy soils are comparatively well formed. They are often found on lower, flat or sloping marine terraces. Brown soils occur mainly on mesophilous loamy-stony ground. These are most often weakly-formed, shallow and skeletal soils. Boggy soils of gley or peat type are usually formed on permanently flooded ground composed of mixed clayey or loamy formations with gravel or larger rock-grains. In loamy--stony or solifluction sites and in sites with polygonal structures (Fig. 8)

Table 1. Bryophyte occurrence in the Calypsostranda Region



Sporadic species: 83 - 1.3. 5/1; 84 - 1.4.1. 10/1, 85 - 1.4.1. 13/1, 86 - 1.4.1. 249/1; 87 - 1.4.2. 9/1, 88 - 1.4.2. 47/1, 89 - 1.4.2. 245/1, 90 - 1.4.2. 248/1; 91 - 1.4.3. 4/1, 92 - 1.4.3. 244/1; 93 - 2. 43/1, 94 - 2. 50/1, 95 - 2. 268/1; 96 - 3.2. 279/1; 97 - 4. 281/1, 98 - 4. 281/2; 99 - 5.1. 104/1, 100 - 5.1. 106/1, 101 - 5.1. 107/2, 102 - 5.1. 107/2, 103 - 5.1. 107/1, 104 - 5.1. 146/1; 105 - 5.2. 6/1, 106 - 5.2. 6/1, 107 - 5.2. 105/1, 108 - 5.2. 105/1, 109 - 5.2. 223/1, 110 - 5.2. 223/1; 111 - 6.2. 263/1; 112 - 6.3. 99/1, 113 - 6.3. 99/2, 114 - 6.3. 264/1.

Explanation: A. Tundra plant communities: 1. Type of dry lichen-moss tundra in subtypes: 1.1. — initial tundra, 1.2. deflational spotty tundra, 1.3. tundra with *Dryas octopetala*, 1.4. grey-lichen tundra with *Cetraria delisei* in forms: 1.4.1. — typical lichen tundra with *Cetraria delisei*, 1.4.2. — lichen-moss tundra, 1.4.3. — lichen-moss-floral tundra. 2. Type of mixed mesophilous tundra. 3. Type of mesophilous morass tundra in subtypes: 3.1. — tundra of synanthropic morass, 3.2. — tundra of snowbeds morass. 4. Type of tundra of slope morass. 5. Type of boggy, moss-grass tundra in subtypes: 5.1. — tundra of wet, compact morass, 5.2. — boggy tundra with *Deschampsia alpina*. 6. Type of tundra flooded morass in subtypes: 6.1. tundra of seasonally flooded morasses, 6.2. tundra of permanently flooded morass on the rim of water overflow-arms, 6.3. tundra of permanently flooded morass on lake shores. B. No. of station. C. Position of the studied bryophyte station in altitude m a.s.l. D. Ground inclination in degress and exposure. E. Date of bryophyte collection. F. General bryophyte coverage. B/H. Classes of percentage coverage of bryophyte species: 1 — 1-5%, 2 — 6-20%, 3 — 21-50%, 4 — 51-80%, 5 — 81-100%. H. Nos of bryophyte and liverwort species (h): 1. *Pohlia acuminata* Hoppe at Hornsch., 2. *Racomitrium lanuginosum* (Hedw.) Brid., 3. *Aulacomnium turgidum* (*Wahlenb.*) Schwaegr., 4. *Polytrichum juniperinum* Hedw., 5. *Schistidium apocarpum* (Hedw.) B.S.G., 6. *Distichium hagenii* Ryan, 7. *D. inclinatum* (Hedw.) B.S.G., 8. *Bryum pallens* Sw., 9. *Dicranoweisia crispula* (Hedw.) Milde, 10. *Oncophorus wahlenbergii* Brid., 11. *Distichium capillaceum* (Hedw.) B.S.G., 12. *Polytrichum alpinum* Hedw., 13. *Drepanocladus uncinatus* (Hedw.) Warnst., 14. *Ditrichum flexicaule* (Schwaegr.) Hampe, 15. *Campylium polygamum* (B.S.G.) Lange et Jens., 16. *Tortula ruralis* (Hedw.) Gärtn., Meyer et Scherb., 17. *Drepanocladus fluitans* (Hedw.) Warnst. v. *fluitans*, 18. *D. revolvens* (Sw.) Warnst., 19. *Bryum arcticum* (R.Br.) B.S.G., 20. *Cynodontium polycarpum* (Hedw.) Schimp., 21. *Blepharostoma trichophyllum* (L.) Dum. v. *trichophyllum*, 22. *Polytrichum strictum* Menz. ex Brid., 23. *Calliergon trifarium* (Web. et Mohr) Kindb., 24. *Tortella fragilis* (Hook. et Wils.) Limpr., 25. *Myurella julacea* (Schwaegr.) B.S.G., 26. *Calliergon stramineum* (Brid.) Kindb. 27. *Plagiomnium ellipticum* (Brid.) Kop., 28. *Calliergon turgescens* (Th. Jens.) Kindb. v. *tenue* Berggr., 29. *Orthothecium rufescens* (Brid.) B.S.G., 30. *Drepanocladus exannulatus* (B.S.G.) Warnst., 31. *Pohlia cruda* (Hedw.) Lindb., 32. *Calliergon turgescens* (Th. Jens.) Kindb. v. *turgescens*, 33. *Orthothecium strictum* Lor., 34. *Hylocomium splendens* (Hedw.) B.S.G., 35. *Schistidium alpicola* (Hedw.) Limpr., 36. *Orthothecium intricatum* (Hartm.) B.S.G., 37. *Philonotis fontana* (Hedw.) Brid., 38. *Kiaeria blyttii* (B.S.G.) Broth., 39. *Drepanocladus vernicosus* (Lindb.) Warnst., 40. *Grimmia torquata* Grev., 41. *Campylium zemliae* C. Jens., 42. *Blepharostoma trichophyllum* (L.) Dum. v. *brevirete* Bryhn et Kaal., 43. *Encalypta alpina* Sm., 44. *Cyrtomnium hymenophylloides* (Hüb.) Nyh., 45. *Cephaloziella grimsulana* (Gott. et Rabenh.) Lac., 46. *Meesia longiseta* Hedw., 47. *Aplodon wormskjeldii* (Horn.) R. Br., 48. *Bryum purpurascens* (R. Br.) B.S.G., 49. *B. rutilans* Brid., 50. *Platydictya jungermannioides* (Brid.) Crum, 51. *Bryum teres* Lindb., 52. *Calliergon richardsonii* (Mitt.) Kindb., 53. *Brachythecium turgidium* (Hartm.) Kindb., 54. *Bryum crispulum* Hampe, 55. *B. pendulum* (Hornsch.) Schimp., 56. *Hygrohypnum luridum* (Hedw.) Jenn., 57. *Calliergon sarmentosum* (Wahlenb.) Kindb., 58. *Cinclidium arcticum* (B.S.G.) Schimp., 59. *Bryum pallescens* Schwaegr., 60. *Stegonia latifolia* (Schwaegr.) Vent., 61. *Philonotis tomentella* Lor., 62. *Catoscopium nigritum* (Hedw.) Brid., 63. *Splachnum vasculosum* Hedw., 64. *Bryum pseudotriquetrum* (Hedw.) Schwaegr., 65. *Cyrtomnium hymenophyllum* (B.S.G.) K. Holmen, 66. *Bryum cirrhatum* Hoppe et Hornsch., 67. *Timmia austriaca* Hedw., 68. *Meesia uliginosa* Hedw., 69. *Drepanocladus badius* (Hartm.) Roth, 70. *Aneura pinguis* (L.) Dum., 71. *Cnestrum schisti* (Wahlenb.) Hag., 72. *Drepanocladus latifolius* (Lindb. et Arn.) Broth., 73. *Meesia triquetra* (Hook. et Tayl.) Ångstr. f. *triquetra*, 74. *Bryum nitidulum* Lindb., 75. *B. calophyllum* R. Br., 76. *Tetraplodon mnioides* (Hedw.) B.S.G. v. *mnioides*, 77. *Aulacomnium palustre* (Hedw.) Schwaegr., 78. *Bryum inclinatum* (Brid.) Bland., 79. *Ceratodon purpureus* (Hedw.) Brid., 80. *Orthothecium chryseon* (Schwaegr.) B.S.G., 81. *Campylium stellatum* (Hedw.) C. Jens., 82. *Drepanocladus aduncus* (Hedw.) Warnst. v. *kneiffii* (B.S.G.) Mnkm., 83. *Bryoerythrophyllum recurvirostre* (Hedw.) Chen, 84. *Pohlia ludwigii* (Spreng.) Broth., 85. *Oncophorus virens* (Hedw.) Brid., 86. *Brachythecium trachypodium* (Brid.) B.S.G., 87. *Bryum neodamense* Itzigs., 88. *Brachythecium collinum* (C. Müll.) B.S.G., 89. *Schistidium confertum* (Funck) B.S.G., 90. *Polytrichum norvegicum* Hedw., 91. *Timmia norvegica* Zett. 92. *Drepanocladus aduncus* (Hedw.) Warnst. v. *tenuis* (Schimp.) Mnkm., 93. *Barbula asperifolia* Mitt., 94. *Trichostomum articum* Kaal., 95. *Orthothecium strictum* Lor., 96. *Pohlia drummondii* (C. Müll.) Andrews, 97. *Pohlia crudoides* (Sull. et Lesq.) Broth., 98. *Dicranum mühlenbeckii* B.S.G., 99. *Mniobryum albicans* (Wahlenb.) Limpr., 100. *Rhizomnium andrewsianum* (Steere) Kop., 101. *Cephalozia ambigua* C. Mass., 102. *Lophozia alpestris* (F. Web. Isov., 103. *Drepanocladus aduncus* (Hedw.) Warnst. v. *kneiffii* (B.S.G.) Mnkm. f. *intermedius* (B.S.G.) Mnkm., 104. *Schistidium gracile* (Schleich.) Limpr., 105. *Dicranum spadiceum* Zett., 106. *D. fragilifolium* Lindb., 107. *Tetraplodon mnioides* (Hedw.) B.S.G. v. *cervifolius* Schimp., 108. *Bryum caespiticium* Hedw., 109. *Ditrichum flexicaule* (Schwaegr.) Hampev. *brevifolium* Berggr., 110. *Meesia triquetra* Ångstr. f. *crassifolia* Kabiersch, 111. *Bryum bimum* (Brid.) Turn., 112. *Calliergon obtusifolium* Kar., 113. *Rhizomnium pseudopunctatum* (B.S.G.) Kop., 114. *Bryum ovatum* Jur.

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there is a mosaic of structural, initial, brown deeply humic, gley or other soils.

Predominant in the whole area are alkaline soils with a different content of humus, $CaCO_3$ and other chemical compounds assimilated by plants. These soils, usually found on wetter habitats, are more acidified and $CaCO_3$-free than in drier habitats.

Plant Cover

In the Calypsostranda region most ecological-floristic groups of Arctic tundra communities are found that belong to the described tundra communities in other areas of the Bellsund fiord coast (13, 14, 29, 33–36). In the Calypsostranda coast 7 types, 10 subtypes and 3 forms of tundra communities were distinguished. These communities are locally widespread on marine terraces situated in the area spreading from the sea-coast as far as the steep slopes of heights (Fig. 1).

In the type of dry lichen-moss tundra (1.) 4 subtypes and 3 forms of plant communities were distinguished (Figs. 6, 7, 10). The most widespread is the grey-lichen tundra subtype with *Cetraria delisei* (1.4.) differentiated into 3 subordinate forms: typical lichen tundra with *Cetraria delisei* (1.4.1.), lichen-moss tundra (1.4.2.) and lichen-moss-floral tundra (1.4.3.). The three types of communities are found mainly on flattened or slightly inclined ridges of marine terraces with a loamy-stony surfaces, seasonally overdessicated to a varying degree or highly moistened (Fig. 10). The subsoil starting from the tundra form with *Cetraria delisei* (1.4.1.) and going towards lichen-moss tundra (1.4.2.) and lichen-moss-floral (1.4.3.) tends to be successively more compact and moistened.

Other 4 subtypes of lichen-moss tundra (1.) occur very rarely, forming small expanses developing in rather specific habitats. The initial tundra subtype (1.1.) is characteristic of older ridges of riverside sandurs, not too overdessicated, with a gravelly-loamy-muddy structure (Fig. 6). The spotty tundra subtype (1.2.) is characterized with scattered tufts of vegetation. This type of tundra is found mainly on slightly convex ridges and slopes of marine terraces with a gravelly-sandy-loamy surface, highly dispersed by the wind (Fig. 7). The last subtype of dry tundra with *Dryas octopetala* (1.3.) occurs sporadically in small patches up to 0.5 are. It is formed mainly on the sloping ridges of the oldest marine terraces with a gravelly-loamy surface, with eolian microterraces strengthened by dense shoots of *Dryas octopetala*.

Mixed mesophilous tundra is found in this area exceptionally frequently (2.), it is widespread in mesophilous habitats. This occurs on wide, flattened

or slightly concave ridges of marine terraces composed of mixed loamy and gravel formations. Floristically this tundra type is marked with a predominance of bryophytes and anthophytes over lichens (Fig. 10).

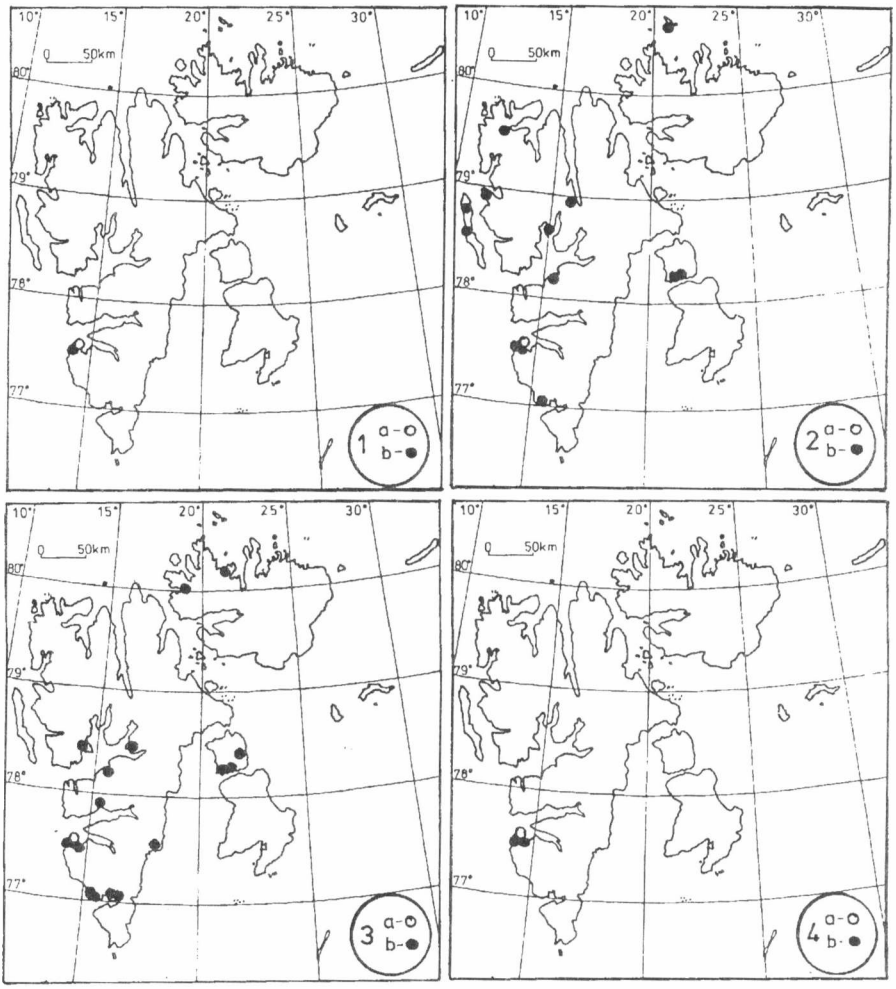

Fig. 2. Distribution of selected rare bryophyte species in the Svalbard archipelago; 1 — *Cnestrum schisti*, 2 — *Meesia uliginosa*, 3 — *M. triquetra*, 4 — *M. longiseta*; a — new stations currently published, b — know stations (1, 2, 5, 13, 14, 23, 34, 36)

In the mesophilous morass tundra type (3.) two subtypes of plant communities were distinguished. The first subtype was classified as synanthropic morass (3.1.). This community develops on synanthropic habitats in the squares around old buildings, in the former coal-mine in Calypsobyen

(Fig. 1). It covers flattened ridges and slopes of gravelly-loamy marine terraces with a sandy-gravelly surface, mixed with concrete grains, and even with slag and cast-iron pieces.

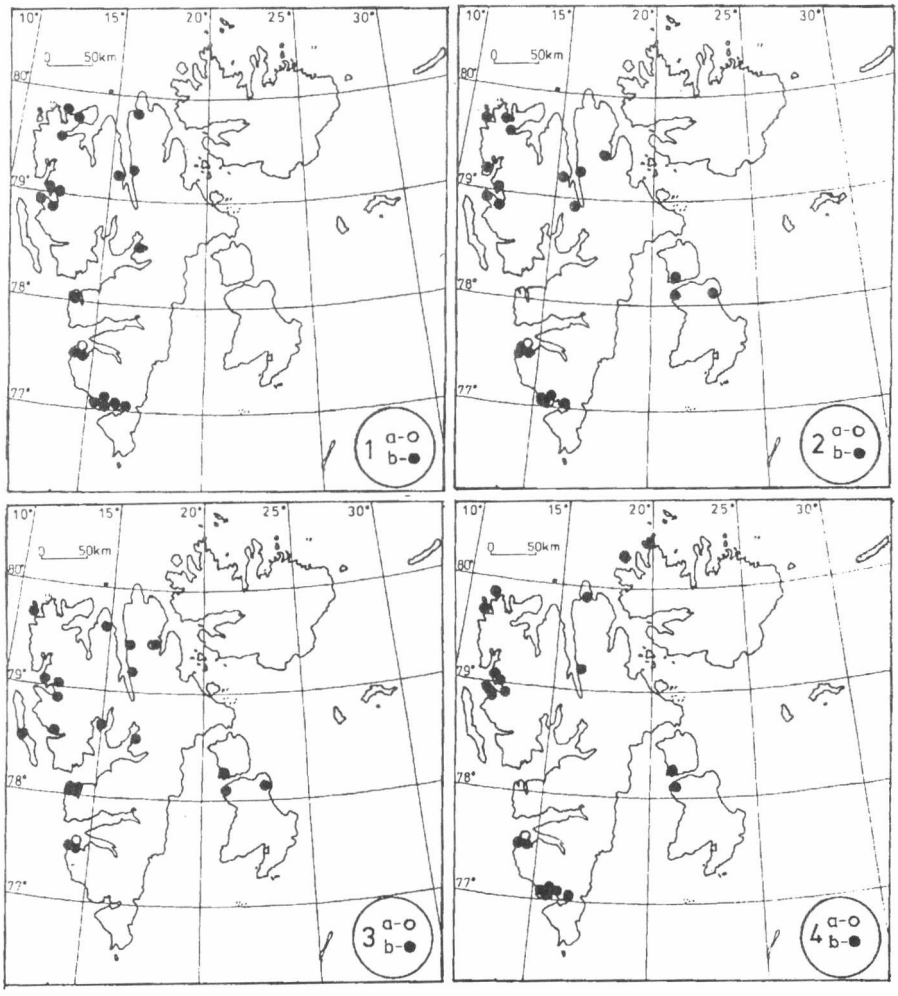

Fig. 3. Distribution of selected rare bryophyte species in the Svalbard archipelago; 1 — *Tortella fragilis*, 2 — *Bryoerythrophyllum recurvirostre*, 3 — *Catoscopium nigritum*, 4 — *Platydictya jungermannioides*; a — new stations currently published, b — known stations (1, 2, 5, 13, 18, 23, 34–36)

The subtype of snowbed morass tundra (3.2.) is formed on concave slopes of erosion incisions. These sites are characterized by long snow coverage and

a shorter vegetation season. In those habitats there are dense bryophytes with scarce small-sized anthophytes, lichens being entirely absent.

The type of tundra community of slope morass (4.) was found on weathered rock ledges on the steep slope of Bohlinryggen height (Fig. 1).

The type of boggy, moss-grass tundra (5.) is locally differentiated into two subtypes. One is the subtype of compact wet morass tundra (5.1.). It is characteristic of different, permanently wet depression sites, and is formed on the ridges of lower marine terraces, composed of solid clayey-gravelly formations. The other subtype of typically boggy tundra with *Deschampsia alpina* (5.2.) is characteristic of permanently flooded, boggy, clayey-stony habitats. It occurs on wide, weak-flow depressions on marine terraces, with a permanent overflow of thaw water. This community is characterized by an undivided dominance of bryophytes over anthophytes and lichens. Numerous compact tufts of *Deschampsia alpina* give the community a specific appearance (Fig. 11).

In the flooded moss tundra (6.) the following 3 subtypes were distinguished: morass of seasonally flooded habitats (6.1.), morass occurring on stony-gravelly sites of periglacial water overflow arms (6.2.), and morass growing on silted-up, stony-clayey lakes or permanent water overflow-arms (6.3.).

In the Calypsostranda region on the youngest stone deposits there is a marked absence of compact vegetation of the arctic tundra. This applies primarily to such habitats as weathering stony slopes and ridges of heights, boulders of glacial moraines, inner and outer sandurs, various rock screes and pebbly and sandy sea-shores (Fig. 3).

With respect to differentiation of tundra communities the Calypsostranda region stands out distinctly as compared with the neighbouring regions on the Bellsund (13, 14, 34–36). On the one hand, the absence of tuphuric morass, morass with the dominant *Racomitrium lanuginosum* and dry grey-lichen tundra with dominant species like *Luzula* should be noted, as well as sporadic occurrence of grey-lichen tundra with the dominant *Dryas octopetala* and coprophilous tundra of slope morass. On the other hand, frequent occurrence of communities of the initial tundra subtype (1.1.) and synanthropic morass tundra subtype (3.1.) should be emphasized, which have not been described so far on the studied Bellsund coast (13, 33–36).

STATIONS OF *BRYOPHYTES*

1. Type: dry lichen-moss tundra

1.1. Subtype: initial tundra

278* (=III/01). Ca, SE, ground moraine of the Renard glacier. A gravelly-sandy overlay of old sandur.

100. Ca, SEE, the SW part of sandur under the Renard glacier moraine. An old alluvial, gravelly-sandy talus.

416. Ca, SE, Josephbukt coast. A gravelly-sandy overlay of old sandur.

1.2. Subtype: deflational, spotty tundra

1. Ca, NEE, at the corner edge of an old cliff at the mouth of the Scott river. A blown-out, pebbly-sandy-loamy marine terrace with polygonal frost cracks.

2. Ca, NE, at the edge of an old cliff at the S side of the Scott river mouth. A blown-out, pebbly-sandy-loamy marine terrace with polygonal frost cracks.

38. Rn, NW, near an old cliff. A flat blown-out, pebbly-sandy-loamy marine terrace with polygonal frost cracks.

39. Rn, SE, the cliff coast near the lower section of the Scott river overflow arm. A flat, blown-out, pebbly-sandy-loamy marine terrace with polygonal frost cracks.

44. Ca, NW, at the S side of the middle section of Scott river. The slope of a convex, blown-out, gravelly-loamy marine terrace with irregular stone wreaths.

159. Ca, mid-eastern part, at the N side of the Wydrzyca river. A blown-out, gravelly-loamy marine terrace with indistinct polygonal frost cracks.

210. Ca, NWW, under the Scott glacier moraine. The flat ridge of the overlay of a blown-out marine terrace, gravelly-loamy-boulder.

241. Ca, mid-eastern part, at the S side of the Wydrzyca river mouth. A blown-out, pebbly-loamy-sandy marine terrace with indistinct, polygonal frost cracks.

242. Ca, mid-eastern part, at the S side of the Wydrzyca river mouth. The slope of an old cliff: alluvial, pebbly-sandy-loamy.

302. Ca, mid-western part, at the foot of the Bohlinryggen height (315 m a.s.l.). The blown-out, stony-loamy slope of a marine terrace.

1.3. Subtype: tundra with *Dryas octopetala*

5. Ca, NEE, at the S side of the Scott river mouth. The gravelly-loamy-sandy ridge of a marine terrace.

254. Ca, SW, near the Renard glacier moraine, at the relic rocks. The stony-loamy slope of marine terrace with indistinct polygonal stone structures.

1.4. Subtype: grey-lichen tundra with *Cetraria delisei*

1.4.1. Form: lichen tundra with *Cetraria delisei* — typical

3. Ca, NEE, at the S side of the Scott river mouth. A flat, pebbly-loamy-sandy marine terrace with polygonal frost cracks.

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* See Fig. 1.

10. Ca, SE, near the Renard glacier moraine, at an old cliff. A flat gravelly-loamy marine terrace with polygonal frost cracks.

12. Ca, SE, at the Renard glacier moraine. A flat gravelly-loamy marine terrace with polygonal frost cracks.

13. Ca, SE, near the Renard glacier moraine. A flat gravelly-loamy marine terrace with polygonal frost cracks.

40. Ca, NW, on the N side of the lower Scott river. Below the ridge of an old, gravelly--loamy cliff.

45. Ca, NW, between right-side tributaries of the Scott river. A flat, gravelly-loamy marine terrace with indistinct fissures and wreaths of polygonal structures.

52. Ca, NW, on the N side of the middle Scott river. A flat, gravelly-loamy marine terrace with indistinct fissures and wreaths of polygonal structures.

147. Ca, mid-eastern part, west of the old Calypsobyen settle-ment. A flat, gravelly--loamy marine terrace with indistinct, polygonal frost cracks.

149. Ca, NE, north-west of the Calypsobyen settlement. A flat, gravelly-loamy marine terrace with indistinct, polygonal frost cracks.

150. Ca, NW, north-west of the Calypsobyen settlement. A flat, gravelly-loamy marine terrace with indistinct, polygonal frost cracks.

152. Ca, NWW, the upper arm of the Scott river overflow. A gravelly-clayey marine terrace.

158. Ca, mid-eastern part, on the N side of the Wydrzyca river. A loamy-gravelly marine terrace.

177. Ca, NWW, near the Scott glacier moraine. A gravelly-clayey marine terrace.

179. Ca, SW, ca. 300 m north-west of the sandur below the Renard glacier moraine. A stony-loamy marine terrace.

180. Ca, central part, above the top of the Wydrzyca river catchment. A gravelly--loamy marine terrace.

181. Ca, central part, on the NW side of the Wydrzyca river catchment. A gravelly--loamy marine terrace.

211. Ca, NWW, near the Scott glacier moraine. A slightly convex, stony-loamy marine terrace.

215. Ca, NWW, near the Scott glacier moraine. A gravelly-loamy marine terrace.

221. Ca, NWW, the Skilvik bay coast. A pebbly-gravelly-loamy marine terrace.

239. Ca, mid-eastern part, on the S side of the Wydrzyca river. A flat, loamy-gravelly marine terrace.

246. Ca, SE, between the Wydrzyca river and the marine moraine of the Renard glacier. A flat, loamy-gravelly marine terrace.

249. Ca, SE, on the N side of the overflow arm of the Renard glacier. A flat, gravelly--loamy marine terrace.

250. Ca, SE, between the Wydrzyca river and the Renard glacier moraine. A gravelly--loamy marine terrace.

251. Ca, SE, between the Wydrzyca river and the Renard glacier moraine. A gravelly--loamy marine terrace.

253. Ca, mid-southern part, between the upper Wydrzyca river and the Renard glacier moraine. A gravelly-loamy marine terrace.

1.4.2. Form: lichen-moss tundra

9. Ca, SE, above the sandur on the sea-coast. An erosion niche on an old cliff, loamy--gravelly with indistinct polygonal frost cracks.

11. Ca, SE, at the Renard glacier moraine. A flat, gravelly-loamy marine terrace with instistinct polygonal frost cracks.

14. Ca, SWW, near the Renard glacier moraine. A clayey-stony marine terrace with indistinct, clayey-stony polygonal structures.

15. Ca, NWW, below the Scott glacier moraine. A clayey-stony marine terrace with indistinct polygonal frost cracks.

30. Rn, SEE, below an old cliff. The convex part of a marine terrace, gravelly-loamy--sandy.

33. Rn, NE, below an old cliff, the convex part of a marine terrace, gravelly-sandy--loamy.

47. Ca, NWW, below the Renard glacier moraine, between the Scott river overflow arms. An old riverside sandur, silted-up, gravelly-stony with indistinct polygonal stony structures.

48. Ca, NWW, on the bed of the upper, main overflow arm of the Scott river. A convex, gravelly-loamy marine terrace with indistinct, stony and clayey polygonal structures.

49. Ca, NWW, on the N side of the upper, main bed of the Scott river. A gravelly--loamy marine terrace with irregular stony and clayey polygonal structures.

151. Ca, NWW, near the Scott glacier moraine. A gravelly-loamy marine terrace, silted-up, with rock grains and polygonal stony rings.

212. Ca, NWW, near the moraine and overflow arm of the Scott glacier. A gravelly--clayey marine terrace.

213. Ca, NWW, the upper overflow arm of the Scott river. A gravelly-clayey marine terrace with indistinct, stony and clayey polygonal structures.

238. Ca, mid-eastern part, on the S side of the Wydrzyca river. A gravelly-loamy marine terrace with indistinct, polygonal stony structures.

243. Ca, SE, between the Wydrzyca river gap and the Renard glacier river gap. A flat, loamy-gravelly marine terrace with polygonal frost cracks.

245. Ca, SE, between the Wydrzyca river gap and the Renard glacier river gap. A flat, gravelly-loamy marine terrace with indistinct frost cracks.

247. Ca, SE, near the Renard glacier river gap. A loamy-gravelly marine terrace.

248. Ca, SE, the upper overflow arm of the Renard glacier river. A gravelly-loamy marine terrace between erosion incisions.

1.4.3. Form: lichen-moss-floral tundra

4. Ca, NE, south of the lower Scott river. A marine terrace with a wet, loamy-stony solifluction ground.

36. Rn, NNW, near the cliff coast. A clayey-gravelly marine terrace with numerous polygonal frost cracks.

46. Ca, NWW, on the bed of the right-side tributary of the Scott river. A gravelly--loamy marine terrace with indistinct polygonal frost cracks.

110. Rn, NNW, near the cliff sea-coast. A loamy-gravelly marine terrace with irregular stony wreaths.

112. Cn, NNE, near an old cliff. A flat, loamy-gravelly marine terrace with polygonal frost cracks.

113. Cn, NNE, near an old cliff. A flat, loamy-gravelly marine terrace with polygonal frost cracks.

155. Cn, SW, the corner of an erosion incision and an old cliff. A flat, loamy-gravelly marine terrace with polygonal frost cracks.

156. Cn, SW, the corner of the Wydrzyca river gap and an old cliff. A flat, loamy--stony marine terrace with polygonal frost cracks.

153. Ca, NW, the area of the right-side tributaries of the Scott river. A stony-loamy marine terrace with indistinct stony rings.

154. Cn, WW, near an old cliff. A flat loamy-gravelly marine terrace with polygonal frost cracks.

157. Cn, SSW, on the Wydrzyca river-bed. A flat, loamy-gravelly marine terrace with indistinct, polygonal frost cracks.

176. Cn, SE, the N side of the Wydrzyca river gap. The flowing loamy-rubble slope of an old cliff.

222. Rn, NWW, on the cliff coast. A clayey-gravelly marine terrace with a dense network of polygonal frost cracks.

240. Ca, SE, the S side of the Wydrzyca river gap. A flat, loamy-gravelly marine terrace with indistinct, polygonal frost cracks.

244. Ca, SE the corner of an old cliff and an erosion incision. A flat, loamy-gravelly marine terrace with indistinct, polygonal frost cracks.

252. Ca, SE, the S side of the upper Wydrzyca river gap. A flat, loamy-gravelly marine terrace with indistinct, polygonal frost cracks.

301. Ca, SWW, at the foot of the Bohlinryggen height, near the Renard glacier moraine. A flowing, loamy-stony ground.

2. Type: mesophilous mixed tundra

29. Rn, SSE, the N side of the Scott river overflow arm. The foot of an old cliff, sloping, wet, loamy-stony.

42. Ca, NE, the S side of the lower Scott river. The flowing, wet, loamy-stony slope of a marine terrace.

43. Ca, NE, the S side of the middle Scott river. A wet, loamy-stony marine terrace with polygonal, clayey and stony structures.

50. Rn, SWW, the N side of the middle Scott river. A flowing, wet, clayey-stony marine terrace with elongated, polygonal, clayey and stony structures.

53. Ca, NEE, the S side of the Scott river mouth. The foot of the slope of an old cliff, flowing, wet, loamy-stony.

178. Ca, mid-western part, in front of the NE slope of the Bohlinryggen height. The flowing, wet, clayey-stony slope of a marine terrace, with irregular stony wreaths and clayey overflow arms.

224. Rn, NNW, on the cliff coast. The flowing, wet, clayey-stony slope of a marine terrace, with irregular stony wreaths and clayey overflow arms.

237. Ca, SEE, the slope of the lower Wydrzyca river gap. The ground with a flowing, wet, loamy-stony soil.

255. Ca, the mid-western part of the foot of the Bohlinryggen height. The flowing, wet, loamy-stony slope of a marine terrace, with irregular stony wreaths.

256. Ca, mid-western part, in front of the NE slope of the Bohlinryggen height. The flowing, wet, clayey-stony slope of a marine terrace, with irregular polygonal wreaths.

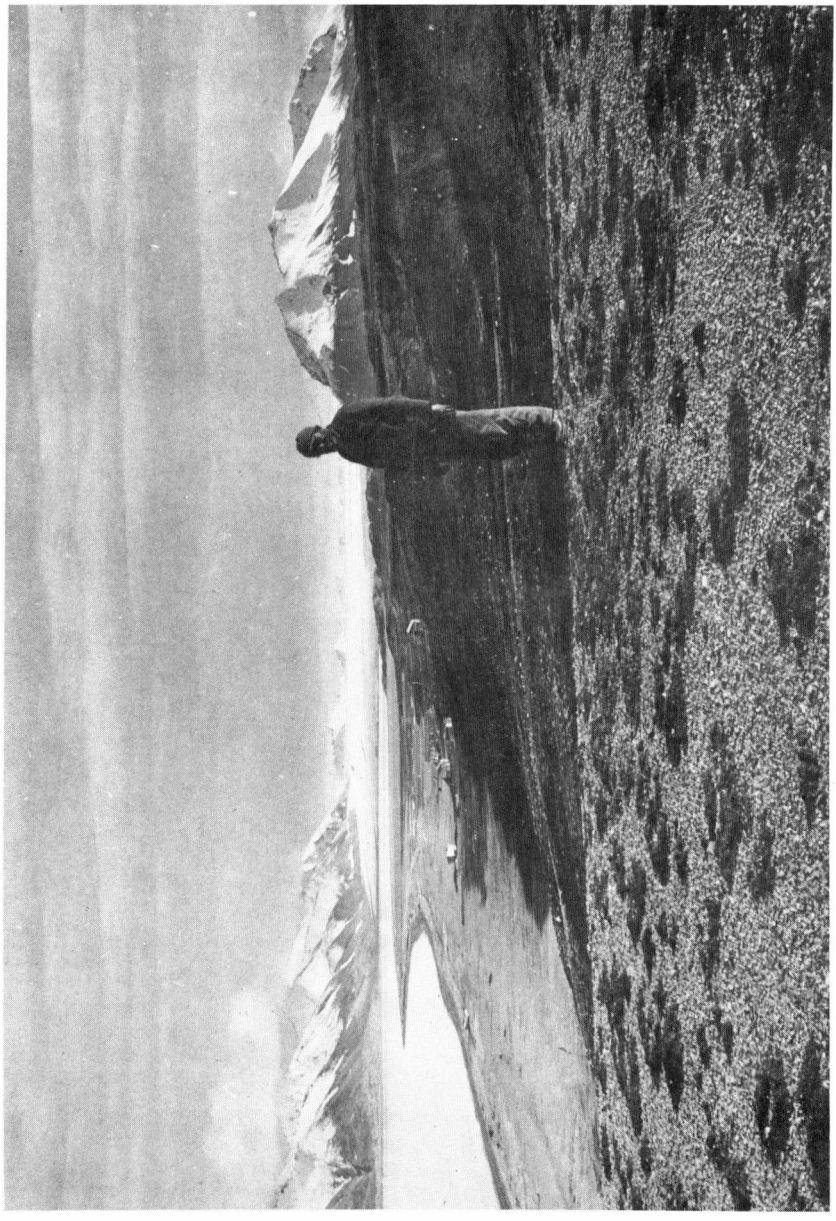

Fig. 4. Calypsostranda, near Calypsobyen. In the foreground; Recherchefjorden, a sea beach and slopes of a fossil cliff, in the background: the Recherche glacier and the heights of Observatoriefjellet (565 m a.s.l.) and Martinfjellet (805 m a.s.l.)
Photo by F. Święs

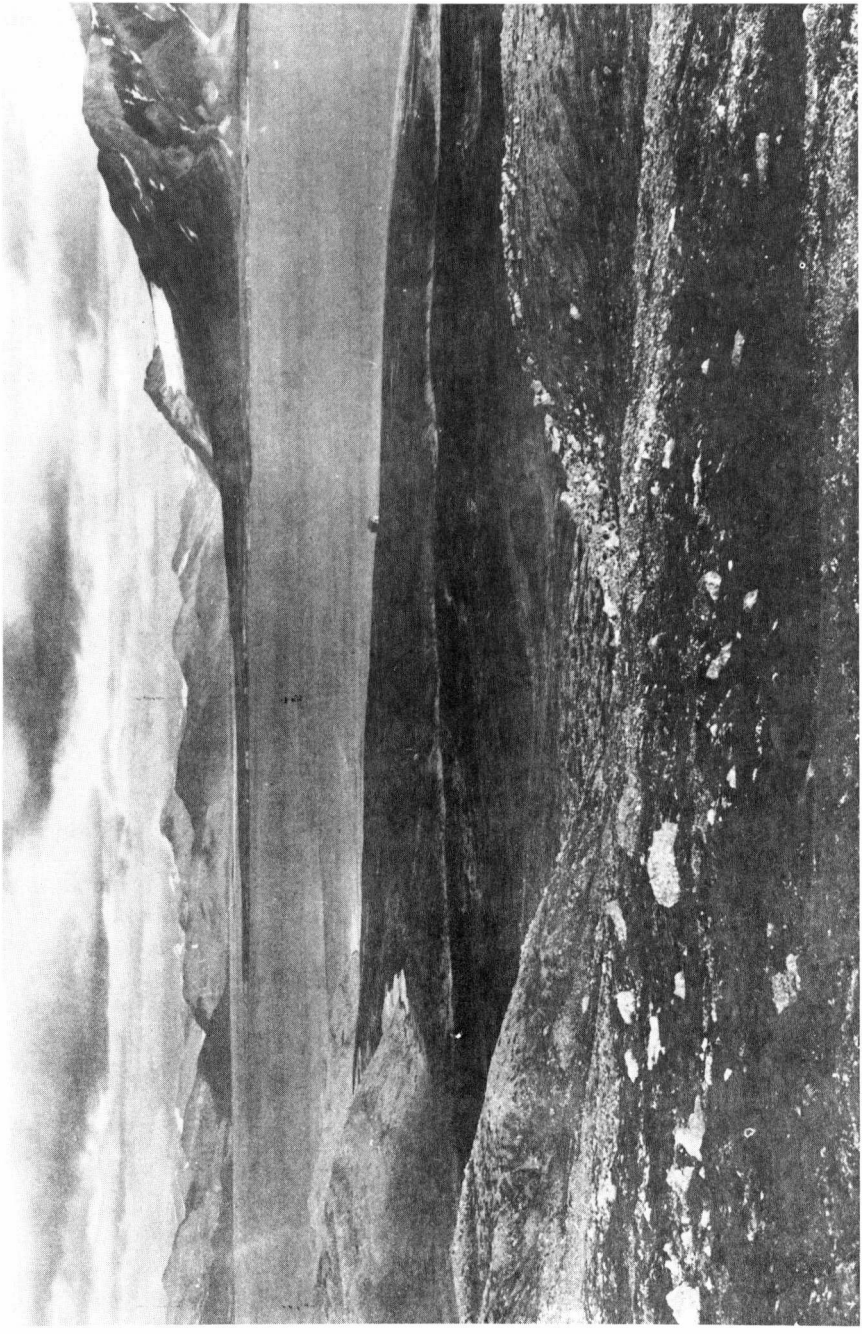

Fig. 5. Calypsostranda, mid-eastern part. Landscape between the foot of the Bohlinryggen height and the sea-side plain in Calypsobyen with predominant grey-lichen tundra with *Cetraria delisei*

Photo by F. Święs

Fig. 6. Calypsostranda, SEE part. In the foreground: a blown-out marine terrace with scarce spotted tundra, in the background: snow-covered areas of higher marine terraces, the lateral moraine of the Renard glacier and the SE slope of Bohlinryggen (515 m a.s.l.)

Photo by F. Święs

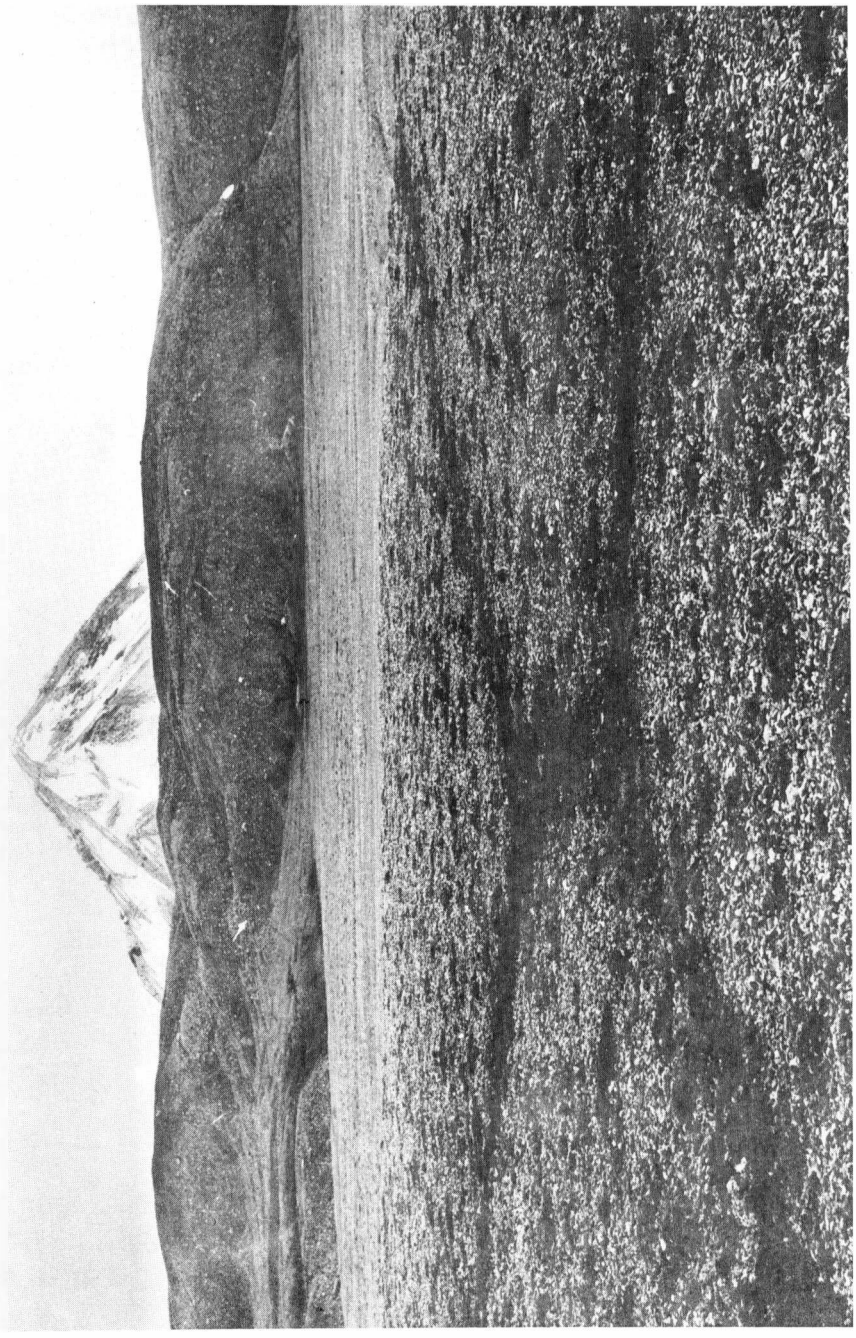

Fig. 7. Calypsostranda, SE part of Renardodden. Delational, spotted tundra on a gravely-loamy marine terrace with polygonal frost cracks

Photo by F. Święs

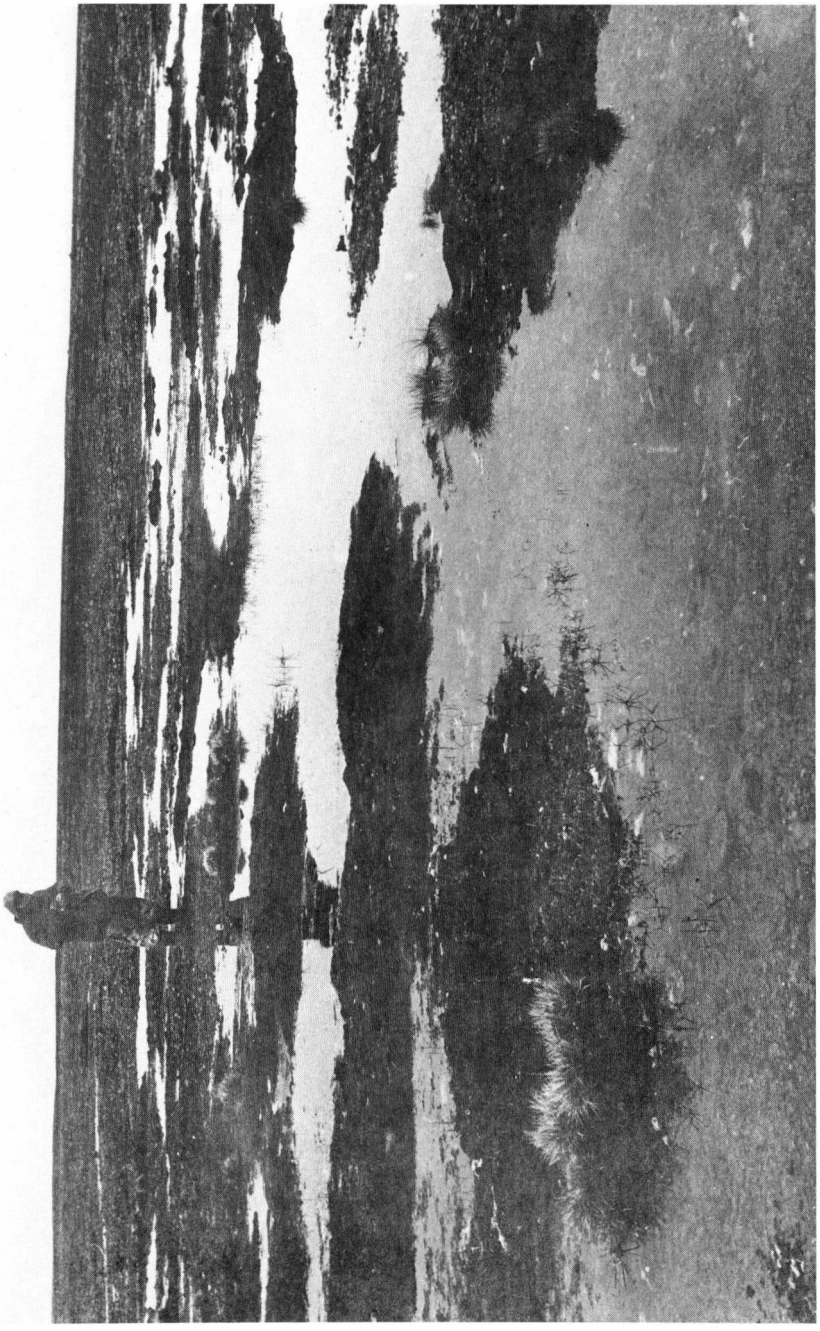

Fig. 8. Calypsostranda, SW part. A spring overflow-arm of periglacial waters on a marine terrace with irregular polygonal structures

Photo by F. Święs

Fig. 9. Calypsostranda, NNW part. The depression ridge of a marine terrace with polygonal soil and expanses of boggy tundra with *Deschampsia alpina*

Photo by F. Święs

Fig. 10. Calypsostranda, SW part. In the foreground: grey-lichen trundra with *Cetraria delisei* one a marine terrace with irregular stony wreaths, in the foreground: the Scott glacier with the heights of Bohlinryggen (515 m a.s.l.) and Wijkanderberget (561 m a.s.l.)

Photo by F. Święs

Florian Święs, Kazimierz Karczmarz

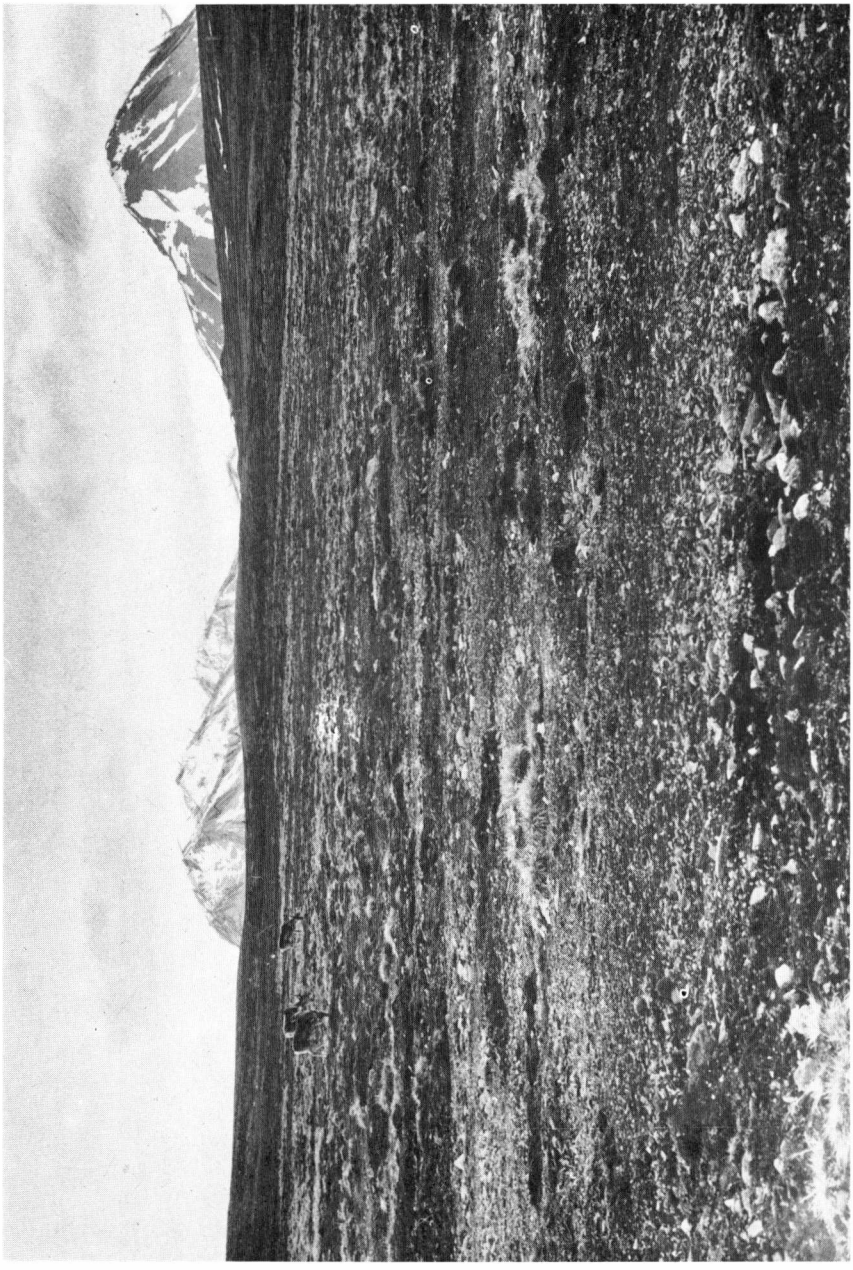

Fig. 11. Calypsostranda, NNW part. In the centre: boggy moss-grass tundra with *Deschampsia alpina*, in the foreground: the ridges of Observatoriefjellet (565 m a.s.l.) and Activekammen (538 m a.s.l.)

Photo by F. Święs

257. Ca, NWW, near the Scott glacier moraine. The flowing, gravelly-clayey slope of a marine terrace.

259. Cn, SEE, the N side of the Wydrzyca river mouth. The foot of an old cliff: flowing, wet, clayey-stony.

268. Ca, NEE, the S side of the Scott river mouth. The foot of an old cliff: flowing, wet, clayey-stony.

3. Type: tundra of mesophilous morass

3.1. Subtype: tundra of synanthropic morass

111(=III/zp. 17) Cn, NWW, next to an old building. The sloping side of a marine terrace, a ruderal habitat with a sandy-gravelly surface mixed with slag and coal ash.

258. Cn, SWW, next to an old building. The sloping side of a marine terrace, a ruderal habitat with a sandy-gravelly surface with numerous brick grains and cast-iron pieces.

267. Cn, NW, next to an old building. A flat marine terrace, a ruderal habitat, sandy--gravelly on top, rich in slag and glass grains.

3.2. Subtype: tundra of snowbed morass

280(=III/03). Ca, NE, the E side of the lower Scott river. The niche-like, loamy--gravelly terrace slope.

279.(=III/02). Ca, NE, the E side of the lover Scott river. The eroded, niche-like, loamy-stony terrace slope.

41. Ca, NE, above the right side of the Scott river, below the ridge of an old cliff. The eroded, niche-like, loamy-gravelly terrace slope.

103. Rn, SW, the N side of the lower Scott river. The eroded, niche-like, loamy--gravelly terrace slope.

4. Type: Tundra of slope morass

281(=III/zp. 1). Rn, SW, the slope below the rock ridge of a height. An old, weathered, stony talus fan with a loamy-humus-rock surface, permanently highly wet.

5. Type: boggy moss-grass tundra

5.1. Subtype: compact tundra of wet morass

7. Ca, NW, on the rightside tributary of the Scott river. A wet, clayey-stony marine terrace with irregular polygonal frost cracks.

8. Cn, NW, on the rightside tributary of the Scott river. A wet clayey-stony marine terrace with irregular polygonal frost cracks.

51. Rn, SW, the N side of the middle Scott river. A wet, clayey-stony marine terrace with irregular polygonal frost cracks.

101. Ca, SEE, the N side of the upper overflow arm of the Renard glacier river. A wet, clayey-stony marine terrace with irregular polygonal frost cracks.

102. Ca, SEE, the S side of the Wydrzyca river overflow arm. A sloping erosion incision on an old cliff: flowing, wet, clayey-gravelly.

104. Ca, the E side of the rightside tributary of the Scott river. A wet, clayey-stony marine terrace with an indistinct polygonal structure.

106. Rn, SS, near the middle Scott river. A wet, clayey-gravelly marine terrace with an indistinct polygonal structure.

146. Ca, mid-eastern part, the N side of the upper Wydrzyca river. A wet, clayey--gravelly marine terrace with an indistinct polygonal structure.

148. Ca, NE, the W side of Cn. A wet, loamy-gravelly marine terrace with an indistinct polygonal structure.

214. Ca, NWW, below the Scott glacier moraine. A wet, clayey-gravelly marine terrace with indistinct polygonal frost cracks.

5.2. Subtype: boggy tundra with *Deschampsia alpina* — typical

6. Ca, NE, the S side of the lower Scott river. A boggy, clayey-stony marine terrace with irregular, clayey-stony polygonal structures.

105. Ca, NE, on the rightside tributary of the Scott river. A boggy, clayey-stony marine terrace with irregular, clayey-stony polygonal structures.

108. Rn, NW, ca. 300 m away from the sea-coast. A boggy, stony-clayey marine terrace with irregular clayey and stony polygonal structures.

109. Rn, NW, ca. 100 m away from the sea-coast. A boggy, clayey-stony marine terrace with irregular, polygonal clayey-stony structures.

223. Rn, NW, ca. 150 m away from the sea-coast. A boggy, clayey-stony marine terrace with irregular, polygonal clayey-stony structures.

236. Ca, SEE, the Se side of the Wydrzyca river bed. The slope of an old cliff: boggy, clayey-stony with elongated streaks of polygonal stony and clayey structures.

6. Type: flooded morass tundra

6.1. Subtype: tundra of seasonally* flooded morasses

31. Rn, SE, near the lower Scott river, below an old cliff. The eroded, niche-like, clayey-sandy-gravelly part of a marine terrace.

32. Rn, NW, ca. 250 m south-west of the cape top, below an old cliff. The eroded, niche-like, clayey-sandy-gravelly part of a marine terrace.

34. Rn, NW, ca. 250 m south-west of the cape top, just below an old cliff. The eroded, niche-like, clayey-sandy-gravelly part of a marine terrace.

35. Rn, NW, ca. 250 m south-west of the cape top, below an old cliff. The eroded, niche-like rim of the convex part of a marine terrace: clayey-sandy-gravelly.

6.2. Subtype: tundra of permanently flooded morass on the rim of water overflow-arms

261. Cn, SE, the sea-coast on the N side of the Wydrzyca river overflow-arm. A grassy, cap-like heap of old river mud: flooded, sandy-muddy-gravelly.

263. Cn, SE, the sea-coast on the N side of the Wydrzyca river overflow-arm. A grassy, cap-like heap of old river mud: flooded, sandy-muddy-gravelly.

265. Ca, SEE, the sea-coast, the NE rims of the Renard glacier river overflow-arms. The sandy-gravelly edge of a stream overflow-arm.

266. Cn, mid-western part. The flat bottom of an erosion incision on the slope of an old cliff. The edge of a stream overflow-arm with a gravelly-clayey ground with alluvial deposits.

* Flooding with thaw water on the turn of spring; at the end of summer there is high over-dessication, often with the complete drying out of the morass.

6.3. Subtype: tundra of permanently flooded morass on lake shores

37. Rn, NNE, ca. 150 m, south of the cliff sea-coast. The clayey-muddy-stony edge of a lakelet.

99. Ca, SE, the NE edge of the coast of Josephbukt a bay, in the depression of the Renard glacier moraine. The clayey-muddy-stony edge of a lakelet.

260. Ca, SEE, the sea-coast, the Wydrzyca river overflow-arm. The clayey-muddy--gravelly edge of a lakelet.

264. Ca, SEE, the sea-coast, the Wydrzyca river overflow-arm. The clayey-muddy--gravelly edge of a lakelet.

RESULTS OF STUDIES

1. In the Calypsostranda region there is a predominant type of dry lichen-moss tundra (no. 1.) in the subtype of grey lichen tundra with *Cetraria delisei* (no. 1.4.) differentiated into 3 forms: typical lichen tundra with *Cetraria delisei* (1.4.1.), lichen-moss tundra (1.4.2.) and lichen-moss--floral (1.4.3.). Other local communities of arctic tundra occur very seldom and in small areas.

2. 109 species and other (leafy) moss taxones and 5 species of liverworts were reported. Of the two plant groups, 82 species were classified as frequent and 32 as sporadic species. Among liverworts, 3 species occur frequently and 2 species sporadically.

3. In the studied expanses of 16 defined groups of tundra communities 5 to 56 bryophyte species were reported. In single expanses of particular tundra communities the number of reported bryophyte species ranged from 1 to 39. Most bryophyte species were reported in two subtypes of boggy--moss-grass tundra: that of wet compact morass (no. 5.1.) and typical boggy tundra with *Deschampsia alpina* (no. 5.2.). In the former, 63 bryophyte species were found, in the latter 56 species. A comparatively large number of bryophytes were also found in the tundra communities of the grey-lichen subtype with *Cetraria delisei* developed in the form of lichen-moss tundra (no. 1.4.2.) and in the community of mesophilous mixed tundra (no. 2.). 49 different bryophyte species occurred in each case. The fewest bryophyte species were reported in the first 3 subtypes of dry lichen-moss tundra (1.1.3.): initial (5 species), spotted (16 species) and with *Dryas octopetala* (7 species).

4. The most common bryophytes in all the studied group of arctic tundra communities include the following: *Campylium polygamum*, *Calliergon turgescens* var. *turgescens*, *Ditrichum flexicaule*, *Drepanocladus revolvens*, *D. uncinatus*, *Oncophorus wahlenbergii*. In the tundra communities growing in dry habitats the prevalent bryophytes included most often:

Oncophorus wahlenbergii and *Drepanocladus uncinatus*, and locally *Dicranoweisia crispula*. In mesophilous and hygrophilous habitats there are most often: *Campylium polygamum, Calliergon sarmentosum, C. turgescens* var. *turgescens, Ditrichum flexicaule, Drepanocladus revolvens* and *Philonotis tomentella*.

5. Some well-differentiating ecological groups of bryophyte species e.g. calciphilous or nitrophilous were not reported. Specimens of the two ecological groups are mostly mixed in the studied tundra communities. Calciphilous mosses include: *Bryum ovatum, Calliergon trifarium, C. turgescens, Drepanocladus revolvens, Meesia triquetra, Timmia austriaca*. The nitrophilous bryophyte group is represented by: *Aplodon wormskjeldii, Splachnum vasculosum, Tetraplodon mnioides*. Bryophytes characteristic of typical acidiphilous habitats were not reported. This primarily applies to peatmosses.

6. Rare specimens of bryophytes of the Arctic-mountain group include: *Brachythecium trachypodium, Bryum arcticum, Cnestrum schisti, Conostomum tetragonum, Cyrtomnium hymenophyllum, Distichium hagenii, Drepanocladus badius, D. latifolius, Grimmia torquata, Hygrohypnum luridum, Meesia longiseta, M. uliginosa, Rhizomnium andrewsianum, Schistidium alpicola, S. confertum, Stegonia latifolia* and *Timmia norvegica*. The circumpolar element is represented by: *Bryum wrightii, Calliergon obtusifolium, Campylium zemliae* and *Trichostomum arcticum*. Among liverworts widespread in the Arctic, worth noting is the scarce occurrence of *Gymnomitrion concinnatum* and the total absence of *Ptilidium ciliare* stations in the studied area. We also have to emphasize the frequent presence of bryophyte species stations that are otherwise rare in the Svalbard region: e.g. *Cnestrum schisti, Distichium hagenii, Drepanocladus badius, D. latifolius, Meesia longiseta, M. uliginosa* and *Rhizomnium andrewsianum*.

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STRESZCZENIE

Przedstawiono stosunki briologiczne w rejonie Calypsostrandy na Spitsbergenie Zachodnim (ryc. 1–11). Odnosi się to do 109 gatunków mchów liściastych i 5 wątrobowców zebranych na 124 reprezentatywnych powierzchniach o wymiarze 100 m^2 w obrębie 6 typów, 11 podtypów i 3 postaci ekologiczno-florystycznych zbiorowisk tundry. Główne wyniki badań zestawiono w formie syntetyczno-statystycznej w tab. 1. Uwzględniono też udział ważniejszych elementów ekologicznych i geograficznych gatunków mszaków na badanym obszarze. Podobne badania briologiczne przeprowadzono na kilku najbliższych obszarach rejonu Calypsostrandy.