

THE HEPATICAE OF THE YAMAL PENINSULA,  
WEST SIBERIAN ARCTIC

ПЕЧЕНОЧНИКИ ПОЛУОСТРОВА ЯМАЛ, ЗАПАДНОСИБИРСКАЯ АРКТИКА

ALEXEY D. POTEKIN<sup>1</sup>

А. Д. ПОТЕМКИН<sup>1</sup>

Abstract

Hepatic flora of Yamal Peninsula includes 121 species, 2 subspecies, 22 varieties and 11 forms. The conspect includes information about species distribution within the peninsula, their habitat preferences, associated species, and for selected species also taxonomic comments. There is described *Gymnocolea fascinigera* Potemk. sp. nov. and new combinations suggested for *Cephaloziella divaricata* var. *polystratosa* (Schust. & Damsh.) Potemk. comb. nov. (*Cephaloziella byssacea* (A.Roth) Warnst. var. *polystratosa* Schust. & Damsh. and also for two forms in *Barbilophozia*.

Резюме

Флора печеночников полуострова Ямал насчитывает 121 вид, 2 подвида, 22 разновидности и 11 форм. В приводимом конспекте подробно указано распространение видов на полуострове, описаны их местообитания, сопутствующие виды, а для некоторых - даны также таксономические заметки. Описан новый вид, *Gymnocolea fascinigera* Potemk. sp. nov. предложены новые комбинации для *Cephaloziella divaricata* var. *polystratosa* (Schust. & Damsh.) Potemk. comb. nov. (*Cephaloziella byssacea* (A.Roth) Warnst. var. *polystratosa* Schust. & Damsh. и для двух форм в роде *Barbilophozia*.

I. INTRODUCTION

1. HISTORICAL BACKGROUND AND MATERIALS

The report represents the first attempt to bring together in one place and reconsider all available information, published and unpublished, about the Hepaticae of the Yamal Peninsula. Until the last decade, our knowledge concerning this peculiar Arctic region was almost nonexistent. A few reports (Arnell 1918; Ladyzhenskaja 1971; Andrejeva 1981), contain mostly fragmentary data on about 30 species, and several geobotanical papers mention some common hepatics.

The most important contribution to the study of the Yamal flora has been made by Olga V. Rebristaya, the leader of the Yamal group of Polar Expedition of the V. L. Ko-

marov Botanical Institute, St. Petersburg. Besides of study of vascular plants, she and her colleagues collected bryophytes and lichens everywhere they worked from 1973 to 1983, and in 1990 and 1992. These materials form the basis for the reports of A. L. Zhukova and O. V. Rebristaya (1986, 1987) on the Hepaticae of Belyy Island and the Matyuiyaha (Matyuiyakha) River Region and for my studies of Yamal liverworts (Gribova & Potemkin 1988; Potemkin 1988, 1989, 1990 a, b, c, d, e, 1992 a, b, 1993 a, b, Czernyadjeva & Potemkin 1993, etc.). Moreover my own collections (July, Aug. 1988) and collections of L. I. Mel'tzer and A. P. Popov (Institute of Problem of Development of North, Tyumen) made in 1987, 1989 and 1990 were used for the study. Totally about 15 000 specimens of bryophytes and lichens were investigated for hepatics.

<sup>1</sup> - Russia 197376 St.-Petersburg, Prof. Popova str., 2, Botanical Institute of Russian Acad. Sci. (Россия 197376 Санкт-Петербург, проф. Попова, 2, Ботанический институт РАН).

Table 1. Localities of Yamal, where Hepaticae have been collected

N <sup>o</sup> Locality and its abbreviation (in italics)	latitude	longitude
1. SE part of <i>Belyy</i> Island	73° 15' N;	71° 30' E
2. Middle <i>Khabeiyaha</i> River	72° 25' N;	72° 10' E
3. Upper <i>Tambey</i> River	71° 45' N;	70° 30' E
4. Lower <i>Tirvyaha</i> River	71° 35' N;	71° 30' E
5. Basin of right tributary of <i>Kharasavey</i> River - <i>Silyaha</i> River	71° 10' N;	67° 05' E
6. Middle <i>Matyuiyaha</i> River	70° 55' N;	70° 20' E
7. Upper <i>Tiutey</i> River	70° 50' N;	69° 45' E
8. Middle <i>Venuieu</i> River	70° 40' N;	71° 00' E
9. Geological station <i>Bovanenkovo</i>	70° 20' N;	68° 20' E
10. Interfluve of <i>Tomboiyaha</i> and <i>Syoyaha</i> Rivers ( <i>Tomboitosyo</i> )	70° 15' N;	69° 40' E
11. <i>Neromayaha</i> River Basin	70° 10' N;	69° 10' E
12. Middle <i>Syoyaha</i> River, norther of <i>Mantyto</i> Lake	70° 05' N;	72° 10' E
13. 15 km NW of <i>Marre Sale</i> Polar Station	69° 50' N;	67° 10' E
14. <i>Saletayaha</i> River Basin	69° 45' N;	68° 40' E
15. Lower <i>Yuribeitoyaha</i> River	69° 45' N;	72° 25' E
16. Middle <i>Sebayaha</i> River	69° 37' N;	69° 27' E
17. Lower <i>Khakhayayaha</i> River	69° 35' N;	67° 35' E
18. Middle <i>Lyakkotosyo</i> River	69° 30' N;	71° 25' E
19. Lower <i>Khutyayaha</i> River	69° 45' N;	70° 30' E
20. Middle <i>Khevesyo</i> River	68° 35' N;	73° 20' E
21. Middle <i>Yuribey</i> River	68° 25' N;	72° 10' E
22. Lower <i>Laptayaha</i> River (Mys <i>Kamenny</i> )	68° 20' N;	73° 15' E
23. <i>Erkutayaha</i> River Basin, 10 km to N from <i>Kharangyneto</i> Lake	68° 15' N;	69° 55' E
24. Lower <i>Eryaha</i> River	68° 10' N;	72° 50' E
25. Upper <i>Khadytayaha</i> River	67° 35' N;	70° 25' E

## 2. METHODOLOGICAL REMARKS

Taking into account the great malleability of arctic liverworts and the importance of oil-bodies characteristics for their determination, I tried to identify them alive when it was possible. Only complex analysis of variability of morphological features, data on oil-bodies and ecological conditions made it possible to form a notion about specific criteria of many species. Absence of data on oil-bodies of some taxa of *Lophozia*, *Scapania*, *Riccardia*, *Chiloscyphus*, etc. keeps some problems still insoluble. For the analysis of variability of Yamal hepatics see Potemkin (1990b).

## 3. DEFINITION OF YAMAL AND PHYSIOGRAPHIC REMARKS

Yamal Peninsula is situated in the north-western part of the West-Siberian

Lowland and extends from 66° 50' to 73° 30' N and from 66° 45' to 73° 30' E, occupying about 112 000 km<sup>2</sup> of territory (Sisko 1977).

Yamal is considered here in the narrow sense, i.e., its southern limit is the southern boundary of the peninsula (some authors also classify southern territories adjacent to the peninsula as Yamal). At the same time I classify here under Yamal its northernmost part, *Belyy* Island, which has the same genesis and is separated from the peninsula only by the shallow Strait of Malygin. Places were collections have been made are in Table 1 and Fig. 1.

Yamal is unique in respect of its physiographic peculiarities and as the youngest Arctic region (Rebristaya 1989). The lowland landscape, absence of rocky outcrops, predominantly oligotrophic, usually acid, rar-

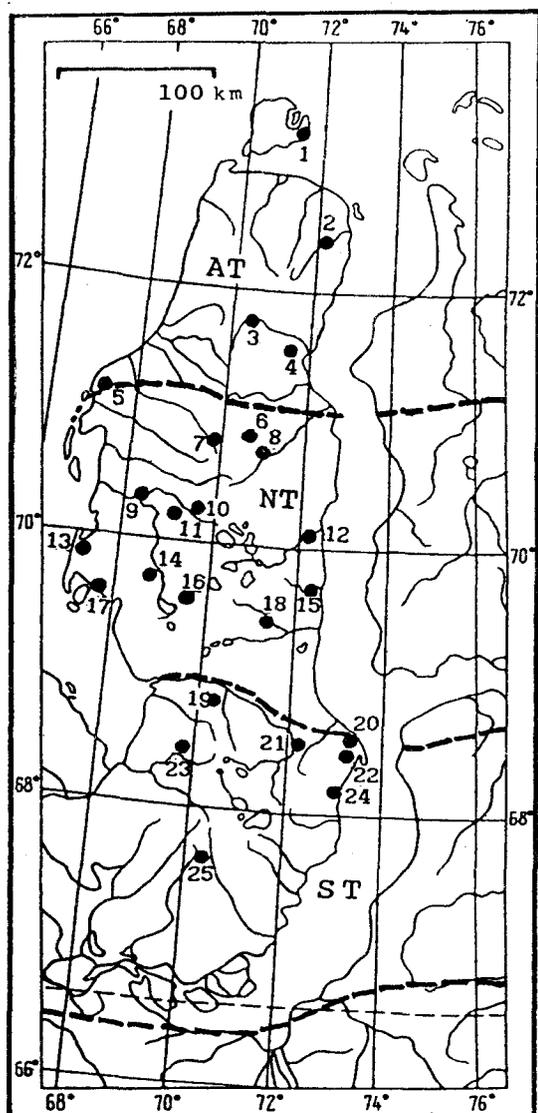


Fig. 1. Cited localities of hepatic collections (see Tab. 1). AT - Arctic tundra, NT - northern hypoarctic tundra, ST - southern hypoarctic tundra.

ely neutral soils together with the rigorous climate and young age of the region cause the poverty of the Yamal flora and the formation of rather monotonous tundra vegetation on the peninsula. According to Yurtsev & al. (1978), the tundra zone of the Yamal Peninsula is divided into three subzones, the southern hypoarctic, northern hypoarctic, and arctic tundras (Fig. 1).

#### 4. AKNOWLEDGEMENTS

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#### II. SYSTEMATIC ACCOUNT

The hepatic flora of the Yamal Peninsula is rather poor. 121 species with 2 subspecies, 22 varieties and 11 forms applied to 39 genera, 20 families and 3 orders, Jungermanniales, Metzgeriales and Marchantiales, are known for the peninsula. The list, which is based on detailed analysis of a huge number of collections should be rather complete. On the other hand, addition of mostly rare to Yamal, temperate, basiphilous and mountain species as well as taxa of such problematic groups as *Lophozia*, *Scapania* and *Riccardia*, which need an investigation based on living plants, is quite possible.

In the following conspect the sequence of taxa follows Konstantinova & al. (1992). Synonyms are listed only (1) when the name of a taxon used here is little-known and (2) to emphasize the author's opinion on synonymy of certain taxa. For taxa which have been erroneously reported for Yamal under other names, these names are noted with reference to corresponding papers. Frequency of taxa is noted for each locality

or, for taxa with similar frequency in all localities of a subzone, for each subzone. The following scale of frequency is used for localities where 300 or more specimens were collected: if a taxon was found in 1 - 2 specimens - I; 3 - 6 - II; 7 - 15 - III; in more than 15 specimens from similar habitats - IV; in more than 15 specimens from different habitats - V. For comparatively poorly investigated places, only the number of collected specimens is listed in Arabic numerals. Literature references are given only for reports not confirmed by specimens, or when there is no collection of a taxon except the published one. For names of subzones the following abbreviations are used: AT (Arctic tundra), NT (northern hypoarctic tundra) and ST (southern hypoarctic tundra).

Characteristic habitats and presence of sexual and asexual reproduction devices are noted for each taxon.

#### ORDER METZGERIALES Chalaud CODONIACEAE Klinggr.

##### FOSSOMBRONIA Raddi

##### *Fossombronia alaskana* Steere & H. Inoue

ST: Khevesyo I, Er'yaha I.

On bare wet loamy soil, associated with *Jungermannia polaris*, *J. obovata*, *Riccia sorocarpa* subsp. *arctica*, *Cephaloziella arctica*, *Blepharostoma*, etc. With mature capsules. Westernmost report for Eurasia. Previously known from Alaska (Steere & Inoue 1974), West Greenland (Mogensen & Brasard 1978) and Chukotka (Afonina & Duda 1983).

Yamal plants of *Fossombronia alaskana* differ somewhat from American ones (Steere & Inoue l.c.; Schuster 1992a). Stems thinner, (8)9 - 11(12) cells high; width/length leaf ratio more variable, from 1:0.65 - 0.90 to (in the rare mod. *angustifolia*) 1:1.0 - 1.4; median cells and spores larger, 30 - 45(60) x 28 - 34(40) mkm and 34 - 42 mkm respectively; greater variability of number of lamellae intersecting spore margin, (23-26)28 - 32(34); elaters occasionally thinner, 2-spiral (5)6 - 8.5 mkm, 3-spiral - 8.5 - 9 mkm in diam. The only seta has been found

On cross section it is only 5 - 6 cells in diam. A development of perianth lamellae is extremely variable. In Yamal plants lamellae are mostly slightly developed and occasionally impossible to find on the surface of perianths with mature capsules. When capsules and perianths are absent this species may be confused with *Lophozia grandiretis*, especially var. *parviretis* Schust. It differs however by the constant absence of gemmae, invariably deep purple rhizoids, position of gametangia, thinner cell walls and, as a consequence, more delicate texture.

#### PELLIACEAE Klinggr.

##### PELLIA Raddi

##### *Pellia neesiana* (Gott.) Limpr.

ST: Khutyaha III, Khevesyo III, Er'yaha II.

In bogs with flowing water, flood plain willow stands, and once on bare soil in spotty tundra. Male and female plants occur rather often.

#### ALLISONIACEAE (Schust. ex Grolle) Schljak.

##### CALYCVULARIA Mitt.

##### *Calycularia laxa* Lindb. et H. Arnell

AT: Belyy I, Khabeiya III, Tambey III, Kharasavey II; NT: Matyuiyaha I, Neromayaha I, Mantyto II, Khakhayayaha I; ST: Khutyaha I, Khevesyo III, Er'yaha II.

On thinly turfed and bare, steep, often nival, slopes; in lichen tundras; on peat outcrops; on spots of bare soil in different types of tundra; occasionally in sedge-moss bogs. Male and female plants frequent but perianths and sporophytes develop rarely. Westernmost reports for Eurasia. The record on Belyy Island is the northernmost on the globe.

Sterile and female plants of *Calycularia laxa* are sometimes confused with *Pellia*. They differ from all species of *Pellia* by ventral scales, which are 2 - 4(5) cells wide at base and to 10 cells long. Among the regional species of *Pellia* only *P. endiviifolia* (Dicks.) Dum. develops rather long ventral slime hairs but they are uniseriate and shorter than ventral scales of *Calycularia*. Moreover *C. laxa* and *P. endiviifolia* are very different in ecological behaviour: the former is

acidophilous, while the latter is basiphilous. Confusing of female plants of *C. laxa* with *Pellia* is sometimes possible, because of female scales are very thin, hair-like and inconspicuous, having similar with thallus pigmentation (see also Potemkin 1990a).

#### PALLAVICINIACEAE Migula

##### MOERCKIA Gott.

##### *Moerckia blyttii* (Moerck) Brockm.

ST: Khutyaha I (Andrejeva 1981) (!).

In moss-lichen tundra, small groups of plants among lichens.

#### BLASIACEAE Klinggr.

##### BLASIA L.

##### *Blasia pusilla* L.

NT: Saletayaha I, Khakhayayaha I; ST: Khytyyaha II, Khevesyo II, Er'yaha II.

On bare wet loamy soil on banks of brooklets, rivers and lakes. Reproduction mostly by scale-like gemmae, very rarely by discoid gemmae in "bottles".

Plants of exposed sites often develop purplish pigmentation and conspicuous white lines along the midrib and its branches which give them a very peculiar appearance. The white lines are caused, according to Macvicar (1926:77), by a deposit of calcium oxalate. At the base of robust plants there are numerous white lines going from the branches. Cross section of old parts of such plants looks septate, i.e. with thick parts with canals filled up by calcium oxalate and thin ones without them. The purplish pigmented phases often develop purplish scale-like gemmae. Secondary pigmentation, however, has not been reported before for the gemmae of *Blasia*. Schuster (1988: 235) stressed that even in purplish plants the gemmae are always bright green.

#### ANEURACEAE Klinggr.

##### ANEURA Dum.

##### *Aneura pinguis* (L.) Dum. var. *pinguis*

AT: Belyy I, Khabelyaha I; NT: Matyulyaha I, Bovanenkovo 2, Neromayaha I, Khakhayayaha I; ST: Khutyaha II, Khevesyo II, Er'yaha II.

On spots in different types of spotty moss tundras, on loamy slopes, occasionally in bogs. Male and female plants frequent, but

plants with mature capsules rare.

##### *Aneura pinguis* var. *denticulata* Nees

ST: Khutyaha & Er'yaha (Andrejeva 1981).

In homogenous sedge (*Carex stans*) bogs with flowing water.

##### RICCARDIA S. Gray

Since all specimens of *Riccardia* have been studied in a dead state, i.e. without any data on their oil-bodies, it is difficult or impossible to identify taxa of this genus correctly (Potemkin 1991). As a consequence, all species are listed under the sign "cf.".

##### *Riccardia* cf. *chamaedrifolia* (With.) Grolle

ST: Khutyaha I.

In sedge-*Sphagnum* tussock-pool bog, on tussock among *Sphagnum*. Plants monoicous, with immature calyptral perigynia.

In the Arctic this species is inseparable from the recently described *Riccardia latifrons* subsp. *arctica* Schust. & Damsh. This arctic subspecies of *R. latifrons* is characterized by the same morphological variability and ecological behaviour and differs from *R. chamaedrifolia* only in the absence of oil-bodies (Schuster 1987).

It is thus possible that the collections seen are *R. latifrons* subsp. *arctica* (which has not been reported for Eurasia before).

##### *Riccardia* cf. *latifrons* (Lindb.) Lindb.

NT: Tomboitosyo I, Khakhayayaha I; ST: Khutyaha I, Khevesyo I.

In moss tundras and sedge-*Sphagnum* willow stand, at base of willow on mineral soil.

#### ORDER JUNGERMANNIALES Klinggr.

##### TRICHOCOLEACEAE Nakai

##### Subfam. TEMNOMOIDEAE Schust.

##### PSEUDOLEPICOLEA Fulf. & J. Tayl.

##### *Pseudolepicolea fryei* (H. Perss.) Grolle & Ando

AT: Belyy II, Tambey II; NT: Matyulyaha II, Bovanenkovo I, Khakhayayaha I; ST: Er'yaha II, near Khadytayaha (Ladyzhenskaja 1971).

On *Sphagnum* tussocks in bogs, associated mostly with *Blepharostoma trichophyllum* var. *brevirete*.

The species is usually represented by mod. *densifolia-colorata*. Mod. *parvifolia-laxifolia-viridis* was found only once (Belyy).

Subfam. *BLEPHAROSTOMATOIDEAE* Grolle*BLEPHAROSTOMA* (Dum.) Dum.*Blepharostoma trichophyllum* (L.) Dum.  
var. *trichophyllum*

NT: Neromayaha II, Khakhayaha I.

In nival tundra (with perianths), on top of watershed among lichens, on willow trunk.

*Blepharostoma trichophyllum* var. *brevirete* Bryhn & Kaal. (*B. trichophyllum* var. *trichophyllum* auct. non (L.) Dum. - Andrejeva 1981).

AT V; NT: Matyuiyaha IV, Tiutey 6, Venuieuo 2, Bovanenkovo 5, Tomboitosyo V, Neromayaha V, Mantyto V, Marre Sale 11, Yuribeitoyaha V, Sebayaha 3, Khakhayaha IV, Lyakkotosyo III; ST: Khutyaha IV, Khevesyo V, Yuribey 4, Laptayaha V, Kharangyneto 2, Er'yaha III, Khadytayaha 2.

Most common in diverse wet tundras with comparatively rich soils. Rarely with perianth and mature capsules. Plants are usually monoicous, only exceptionally dioicous (in Lyakkotosyo male plants were found).

Plants of this variety vary considerably in size, density of leaves, width of cortical cells (20 - 31(40) mkm), width/length ratio of leaf cells, shape and size of apical cells of leaf segments. On spots in spotty tundra the phenotypes with short leaf segments composed of isodiametric cells occur. Sporadically plants with 4 - 5 - lobed leaves and 4 - lobed underleaves were found. Individual leaf segments of such plants are branched. Despite great malleability, var. *brevirete* in Yamal is almost always distinguished from the typical variety by its not bulging septae, separating the cells of leaf segments.

## ANTHELIACEAE Schust.

*ANTHELIA* (Dum.) Dum.*Anthelia juratzkana* (Limpr.) Trev. f. *juratzkana*

AT: Belyy IV, Khabeiya III, Tambey III, Kharasavey III; NT: Matyuiyaha III, Tiutey 1, Tomboitosyo I, Neromayaha IV, Mantyto I, Saletayaha 4, Yuribeitoyaha I, Khakhayaha III, Lyakkotosyo I; ST: Khutyaha III, Khevesyo V, Laptayaha IV, Er'yaha III, Khadytayaha 1.

In wet spotty tundras, on nival slopes. Often with perianths and mature capsules.

*Anthelia juratzkana* f. *elongata* Joerg.

AT: Belyy I; NT: Neromayaha I.

In spotty tundras on sandy soil, occasionally together with f. *juratzkana*.

## JUNGERMANNIACEAE Reichenb.

Subfam. *LOPHOZIOIDEAE* Macv.*TETRALOPHOZIA* (Schust.) Schljak.*Tetralophozia setiformis* (Ehrh.) Schljak.

AT: Belyy I, Khabeiya I, Tambey III; NT: Matyuiyaha II, Khakhayaha I; ST: Laptayaha I.

In diverse tundras on sandy soil.

In Belyy and Matyuiyaha the plants of mod. *parvifolia-densifolia-(subdensifolia)-viridis (subcolorata)* were found. They have (2)3 - lobed leaves with smaller median and especially ventral lobes and larger dorsal ones. In leaf form these plants resemble *Chandonanthus birmensis* Steph., differing from it in subtransverse leaf insertion, cell net, etc. They may be confused also with *Barbilophozia quadriloba*, which have, however, more symmetric, less deeply divided leaves and a rough cuticle.*BARBILOPHOZIA* Loeske sensu latoSubgen. *ORTHOCAULIS* (Buch) Buch*Barbilophozia quadriloba* (Lindb.) Loeske f. *quadriloba*

AT: Belyy I, Khabeiya I, Tambey II, Kharasavey I; NT: Matyuiyaha I, Tomboitosyo I, Marre Sale 1, Saletayaha 2, Yuribeitoyaha III, Lyakkotosyo I; ST: Laptayaha I, Er'yaha I.

In diverse tundras with comparatively rich soils.

*Barbilophozia quadriloba* f. *glareosa* (Joerg.) Potemk. [Bot. Zhurn. 75(12):1744, 1990]

AT: Belyy II, Tambey I, Kharasavey II; NT: Bovanenkovo 1, Neromayaha II, Yuribeitoyaha II, Khakhayaha I; ST: Khevesyo III.

In diverse tundras, probably in less favorable conditions than the type form.

*Barbilophozia quadriloba* f. *cephalozieloides* (Schust.) Potemk. [Novosti Sist. Nizsh. Rast. 28:150, 1992]

AT: Belyy I.

In herb-grass-willow-moss tundra, on bare soil, individual shoots in association with *Scapania zemljae*, *Lophozia heterocolpos* var. *harpanthoides*, *Barbilophozia quadriloba* f. *glareosa*, *Odontoschisma macounii*, *Jungermannia polaris*, *Cephalozia pleniceps*, *Cephalozia arctica*, *Blepharostoma trichophyllum* var. *brevirete*, etc.

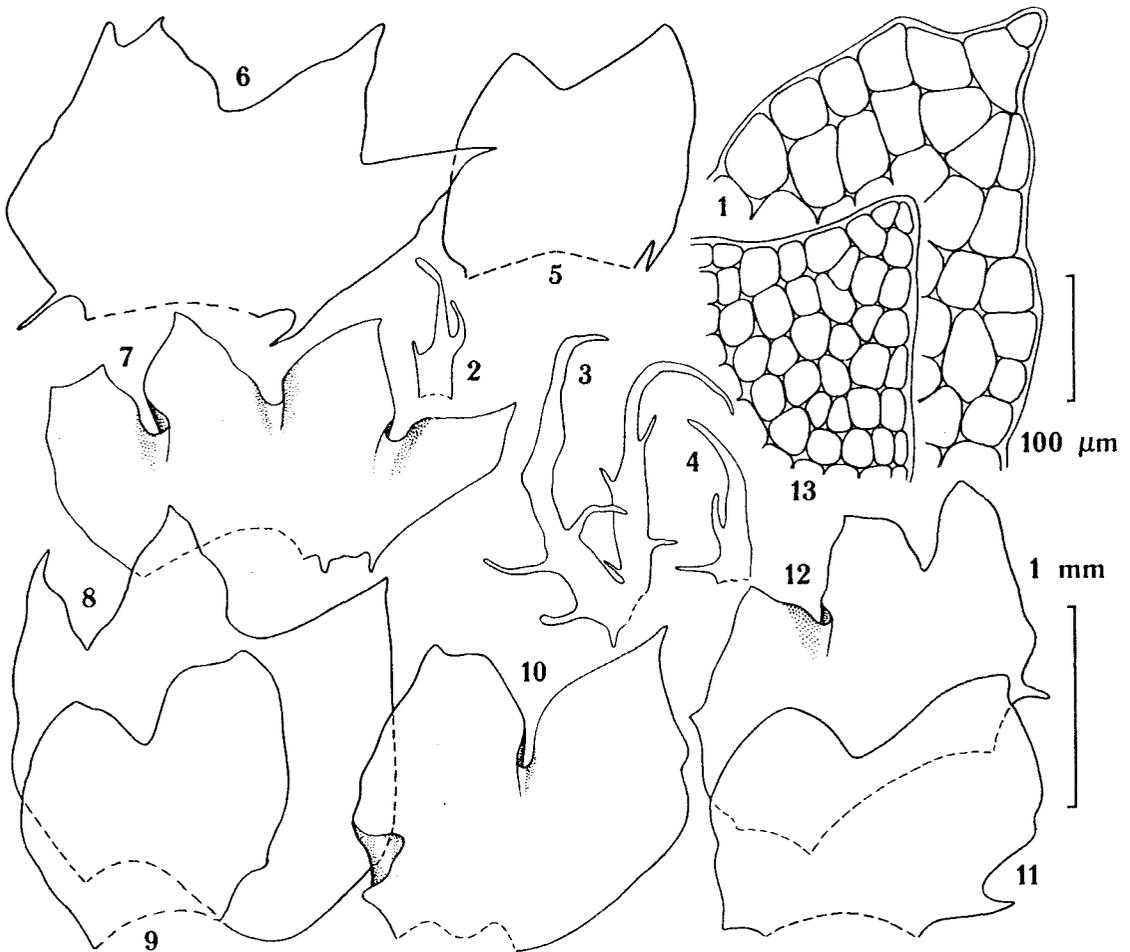


Fig. 2. *Barbilophozia hyperborea* (1-12) and *B. quadriloba* (13). 1, 13 - Apexes of lobes; 2-4 - Underleaves; 5-12 - Leaves. Scale bars: 100 mkm - for 1, 13; 1 mm - for 2-12. All from Khutyayaha (After Potemkin 1992a).

***Barbilophozia hyperborea* (Schust.) R. Stotl. & B. Stotl. ex Potemk. [Novosti Sist. Nizsh. Rast. 28: 148, 1992] (Fig. 2).**

AT: Kharsavey I; NT: Matyuiyaha I, Tiutey I, Neromayaha III, Saletayaha 2, Khakhayayaha II; ST: Khutyayaha I, Khevesyo I.

In dwarf shrub-(herb-) moss and sedge-moss tundras, on brook banks, mostly on weakly turfed soil. Once (Neromayaha) with perianths. For details and differentiation see Potemkin (1992a).

***Barbilophozia kunzeana* (Hueb.) K. Muell. f. *kunzeana***

AT: Belyy I, Khabeiayaha I, Tambey II, Kharasavey II; NT: Matyuiyaha V, Tiutey 3, Venuieuo I, Bovanenkovo 3, Tomboitosyo V, Neromayaha III, Marre Sale 2, Saletayaha I, Yuribeitoyaha II, Sebayaha 2, Khakhayayaha

II, Lyakkotosyo II; ST: Khutyayaha V, Khevesyo V, Yuribey 3, Laptayaha IV, Kharangyneto 5, Er'yaha IV, Khadytayaha 3.

In diverse moss tundras, bogs, peat outcrops, occasionally in late snow areas. Very rarely with perianths and mature capsules, sometimes with gemmae. Gemmae predominantly rhombic, 10 - 17 x 18 - 23 (31) mkm, varying in color from green and yellowish to brown, red brown and, occasionally, deep purple (found in plants of mod. *parvifolia-colorata*, Matyuiyaha). Leaf cells of gemmiferous shoots contain (6)8 - 13(15) oil-bodies and of shoots, not developing gemmae, (3)4 - 6 oil-bodies (found in plants from Khevesyo). Occasionally, gemmiparous leaves have a very rough, *Barbilophozia quadriloba*-like

cuticle (as in plants from Mantyto).

The variability of the species was described in detail by Schuster (1969). Some phenotypes, however, have not been found before. Among them: 1) plants with flat, comparatively narrow, not folded, appressed to stem leaves with not reflexed sinus and small lanceolate underleaves; 2) plants similar to "f. *plicata*", differing in the absence or very weak development of amphigastria.

*Barbilophozia kunzeana* f. *acuta* (Schust.) Potemk. comb. nov. (*Lophozia kunzeana* f. *acuta* Schust. Hep. Anth. N. Am. 2:299, 1969)

NT: Neromayaha I.

In dwarf shrub moss-lichen tundra, in *Polytrichum*-lichen mat.

*Barbilophozia kunzeana* f. *rotundiloba* (Schust.) Potemk. comb. nov. (*Lophozia kunzeana* var. *rotundiloba* Schust., in Schuster & al., Natl. Mus. Canada Bull. 164:24, 1959)

AT: Kharasvey I.

In moss-sedge bog, among *Sphagnum*.

Plants green, very large, 10 - 15 mm long and 1 - 1.5 mm wide, with oblique inserted, distinctly dorsally decurrent 2 - 3 - lobed wide leaves (2 - lobed leaves 840 - 1340 mkm wide and 730 - 1000 mkm long; 3 - lobed leaves 1060 - 1400 mkm wide and 810 - 950 mkm long), near ventral and occasionally dorsal base with 1 - 2 teeth or short cilia; sinuses acute, gamma-like, with strongly reflexed margins, descending 0.37 - 0.50 to 0.57 - 0.62(0.64); lobes mostly more or less divergent, wide ovate, rotund, obtuse, rarely acute; underleaves very large, 500 - 600(890) mkm long, bifid almost to the base, often with 1 - 2 cilia on outer margins and, occasionally, 1 cilium per inner margin; underleaf sinus often reflexed; marginal leaf cells 14 - 20 mkm, median - 20 - 25(28) x 19 - 23 mkm; cuticle from faintly to distinctly striolate-papillose, occasionally with rather large flat papillae.

Yamal plants of f. *rotundiloba* differ from American ones in the more lax leaf position and predominantly bilobed very large underleaves with cilia on outer and inner margins. In the deeply bifid leaves, large bifid underleaves and sporadically coarsely papil-

lose cuticle these plants resemble *Barbilophozia quadriloba*, differing in the wide ovate lobes with mostly obtuse apex, pure green color and larger size. On the other hand they may be confused with *B. floerkei* (F. Web. & Mohr) Loeske, which has the same pigmentation, size, very large underleaves with cilia on inner margins of lobes and gibbous leaf sinuses. *B. kunzeana* f. *rotundiloba* is distinguished from this species in the predominantly bilobed leaves with considerably deeper sinuses and mostly obtuse lobes.

*Barbilophozia kunzeana* f. *wenzelioides* (Schust.) Potemk. [Novosti Sist. Nizsh. Rast. 29:167, 1993]

NT: Bovanenkovo I.

In weakly polygonal dwarf shrub lichen-moss tundra, among *Sphagnum*. With gemmae.

*Barbilophozia binsteadii* (Kaal.) Loeske (*Orthocaulis attenuatus* auct. non (Mart.) Evans - Andrejeva 1981; Zhukova & Rebristaya 1986)

AT IV - V; NT IV - V; ST V.

In diverse wet moss tundras and bogs, usually among *Sphagnum*, *Dicranum*, *Aulacomnium*, *Polytrichum*, considerably more rarely among lichens, sporadically individual shoots on bare soil. Occasionally with gemmae which, as a rule, develop on plants of mod. *densifolia-colorata*, only once on plants of mod. *laxifolia-viridis*. Male and perianth bearing plants occur rarely.

The species is very malleable ecologically and morphologically. Occasionally it resembles very much in some important diagnostic features *Barbilophozia attenuata* (Mart.) Loeske and *B. atlantica*. In such cases only complex analysis of all diagnostic criteria makes it possible to positively identify the species (cf. Schuster 1969).

In the course of investigation of the species in Yamal some paradoxical manifestations of its variability were found: 1) not only neighbour plants (Schuster 1969) but different leaves of the same shoot may have cell net of *Barbilophozia attenuata*- and *B. binsteadii*-types, i.e. with marginal cells (13)14 -

.17(18) mkm and median 16 - 18 x 17 - 23 mkm with small concave-sided trigones or with marginal cells 19 - 21 mkm and median - 18 - 20 x 20 - 23 mkm with large nodulose often confluent in lobes trigones; 2) leaves are not always with 3 narrow lobes, occasionally the plants with subtransverse inserted wide 3(4) - lobed *B. atlantica*-like leaves with shallow sinuses (to 0.35 - 0.25 of the length) occur. They differ from *B. atlantica* in smaller cells with often confluent trigones in lobes and in the absence of underleaves.

In this species, as in some others (*Anastrophyllum minutum*, *Barbilophozia hatcheri*, *Cephalozia bicuspidata*, etc.), the plants affected by small nematodes (15 - 25 mkm in diam. and 300 - 1000 mkm long) were found. Their apical leaves become coarser, develop unusual for the species purplish, blackish fuscous, or blackish purple pigmentation and form the characteristic "head" covering the nematodes.

#### *Barbilophozia atlantica* (Kaal.) K. Muell.

NT: Tomboitosyo I; ST: Khutyaha I.

In dwarf shrub-sedge tundra and *Sphagnum* willow stand in flood plain, associated with *Lophozia ventricosa*, *L. incisa* and *Ptilidium ciliare*.

The plants from Tomboitosyo are mostly quite typical. They are characterized by wide leaves (width/length ratio of 3-lobed leaves - 1.42 - 1.67:1) divided in 0.25 - 0.45 their length in (2)3 wide obtuse to apiculate (with 1 - celled apiculus) lobes; large cells, marginal - 21 - 26 mkm, median - 25 - 32(35) x (21)24 - 28 mkm, with weakly convex, never confluent trigones; underleaves near shoot apexes; sporadic occurrence of stalked slime papillae near the base of ventral leaf margin. Together with plants characterized above, several shoots with predominantly bilobed leaves were mentioned. The distinctive feature of the plants from Khutyaha is an absence of amphigastria. In the other respects they are quite typical. All Yamal plants of *Barbilophozia atlantica* have gamma-like, somewhat reflexed sinuses, giving them a peculiar appearance.

#### Subgen. *BARBILOPHOZIA*

##### *Barbilophozia hatcheri* (Evans) Loeske

AT: Tambey III, Kharasavey III; NT: Matyuiyaha I, Tutey I, Neromayaha I, Mantyto II, Marre Sale 6, Sebayaha I, Khakhayayaha II, Lyakkotosyo II; ST: Khutyaha II, Khevesyo I.

In diverse herb communities on sandy and loamy sand soils situated mostly on steep, occasionally nival, slopes; in diverse lichen tundras on sandy soil. Almost always with gemmae.

Together with quite typical plants the plants of mod. *parvifolia-colorata-eciliata-gemmipara* occur often. They have small size, to 2 - 4 mm long and 0.5 mm wide, deep brown pigmentation, (2)3 - lobed or predominantly bilobed leaves with obtuse or briefly apiculate lobes and mostly without cilia near ventral leaf base (only on individual leaves solitary, short cilia composed of 2 - 4 cells can be found). The plants of this modification may be confused with small forms of *Barbilophozia barbata*. They differ from it, however, in considerably smaller size, sporadic occurrence of cilia near ventral leaf base, underleaf structure, and constant presence of gemmae.

Occasionally *Barbilophozia hatcheri* is associated with *B. lycopodioides*. In Lyakkotosyo transitional forms of the both species from mod. *parvifolia-colorata* to mod. *megafolia-viridis* were found in one specimen. In this case *B. hatcheri* differed from *B. lycopodioides* in constant presence of gemmae (even small plants of mod. *parvifolia-colorata* of *B. lycopodioides* with 2 - 3 - lobed leaves do not develop gemmae), shorter cilia and lobe apiculi composed of shorter cells and almost straight, not distinctly convex lobe sides. These observations confirm the taxonomic status of *B. hatcheri* as a species, not a variety of *B. lycopodioides* (cf. Schljakov 1980).

##### *Barbilophozia rubescens* (Schust. & Damsh.) Karttunen & Soederstroem (*B. hatcheri* var. *grandiretis* Lammes)

AT: Tambey I, Kharasavey II; NT: Bovanenkovo I, Marre Sale I, Khakhayayaha II.

In moss tundras and herb communities on nival slopes, associated with *Ptilidium ciliare*, *Barbilophozia hatcheri*, *B. lycopodioides* and *Tritomaria quinquedentata*. Once

(Kharasavey) with few gemmae, 25 - 36 x 23 - 34 mkm, deep purple or reddish brown, mostly 2 - celled, 3 - 4 - angular to polygonal, with feebly projecting angles (cf. Schuster 1988).

*Barbilophozia rubescens*, for comparison with *B. hatcheri* and *B. lycopodioides* is characterized by robust size contrasting with usually small underleaves occurring only near shoot apices; fewer cilia (1 - 3) sporadically developing near ventral leaf base and composed of not strongly elongated rectangular cells (30 - 60 x 14 - 20 mkm, width/length ratio 1:1.5 - 3.0), larger cells with numerous oil-bodies (5)8 - 16(18) per cell, etc. (see also Schuster 1988).

*Barbilophozia lycopodioides* (Wallr.) Loeske

AT: Kharasavey I; NT: Matyuyaha I, Marre Sale 3, Saletayaha 3, Khakhayaha III, Lyakkotosyo I; ST: Khutyaha I, Yuribey 2.

In herb communities at the foot of steep slopes and wet herb-grass tundra, associated with *Barbilophozia hatcheri*, *B. rubescens*, *Tritomaria quinquedentata*, *Ptilidium ciliare*, and *Lophozia heterocolpos*. Almost always without gemmae, occasionally with perianths.

*Barbilophozia barbata* (Schmid. ex Schreb.) Loeske var. *barbata*

NT: Matyuyaha I, Bovanenkovo I, Neromayaha I, Marre Sale I, Lyakkotosyo I.

In moss willow stands and lichen-moss tundras.

*Barbilophozia barbata* var. *amphigastriata* K. Muell.

NT: Neromayaha I, Marre Sale I.

In herb-willow-moss tundra and flood plain willow stand, with *B. barbata* var. *barbata* and *Ptilidium ciliare*.

The varietal status of var. *amphigastriata* is doubtful. Possibly it is only a modification of the polymorphous *Barbilophozia barbata*.

LOPHOZIA (Dum.) Dum.

Subgen. *PROTOLOPHOZIA* Schust.

*Lophozia debiliformis* Schust. & Damsh.

NT: Khakhayaha I, Sebayaha I; ST: Er'yaha I.

In willow stands on slope, late snow area and bank of brook, usually on fine-grained soil with *Tritomaria quinquedentata* f. *gra-*

*cilis*, *Lophozia excisa*, *L. ventricosa* s.l., *Scapania curta* var. *grandiretis*, *Barbilophozia hyperborea*, *B. lycopodioides* and *Pleurocladula albescens*, or in pure mats. In Khakhayaha with gemmae.

Subgen. *LEIOCOLEA* K. Muell.

The species of *Leiocolea* are basiphilous and, consequently, very rare in Yamal occurring only in sites with comparatively rich soils. The only acid-tolerant species of the subgenus, *Lophozia heterocolpos*, is not uncommon on the peninsula.

*Lophozia rutheana* (Limpr.) M.A. Howe

NT: Bovanenkovo I.

In cotton grass-sedge-hypnum moss bog, among *Calliergon sarmentosum*, *Scapania irrigua* var. *rufescens*, *Barbilophozia quadriloba* f. *glareosa*, *Tritomaria quinquedentata*, etc.

*Lophozia gillmanii* (Aust.) Schust.

NT: Bovanenkovo 2; ST: Khutyaha I.

In *Equisetum* and *Sphagnum* willow stands with *Plagiöchila asplenioides* subsp. *porelloides*, *Aneura pinguis*, *Lophozia heterocolpos* var. *arctica*, *Chiloscyphus fragilis*, *Mesoptychia*, *Blepharostoma*, etc.

*Lophozia collaris* (Nees) Dum.

AT: Belyy I (Zhukova & Rebristaya 1987); ST: Laptayaha I.

In spotty herb-willow *Racomitrium* - *Gymnomitrium* tundra and in tundra shortgrass meadow; individual plants and small tufts in association with *Nardia geoscyphus*, *Cephalozia pleniceps*, and *Lophozia* sp.

*Lophozia heterocolpos* (Thed. ex Hartm.) M.A. Howe var. *heterocolpos*

AT: Belyy (Arnell 1918), Khabeiya I, Kharasavey I; NT: Matyuyaha I, Tiutey 2, Bovanenkovo I, Tomboitosyo I, Neromayaha II, Saletayaha I, Yuribeitoyaha IV, Lyakkotosyo I; ST: Khevesyo I, Laptayaha II.

In diverse wet tundras, occasionally in late snow areas, once in fire place. Often with gemmae, once with perianths.

*Lophozia heterocolpos* var. *arctica* (S. Arn.) Schust. & Damsh.

AT: Kharasavey I; NT: Neromayaha III; Yuribeitoyaha II, Khakhayaha I, Lyakkotosyo I; ST: Khutyaha I, Khevesyo I.

In *Equisetum*-herb, herb-dwarf shrub-moss and willow-sedge-moss tundras, at the foot of

steep slopes, associated with *Blepharostoma trichophyllum* var. *brevirete*, *Lophozia heterocolpos* var. *heterocolpos*, *L. excisa*, *Ptilidium ciliare*, *Tritomaria quinquedentata*, *T. scitula*, *Barbilophozia* spp., *Odontoschisma macounii*, *Scapania cuspiduligera*, *Preissia*, etc. Sporadically with gemmae and perianths. The gemmae often develop on rather stout flagellae with reduced leaves, similar to those of var. *heterocolpos*. The perianth in var. *arctica* lacks a beak and is more or less plicate, at least with one plica in dorsal part when immature and smooth when mature (only one mature perianth has been seen). The mouth of the perianth varies from faintly crenulate to sparsely dentate and the teeth are composed of 1 - 3 subsodiametric cells.

The degree of manifestation of the perianth beak in the type variety of the species varies greatly - from undetectable or rudimentary to rather long and narrow. A plicate perianth surface occurs in var. *heterocolpos* also (cf. Schuster 1974, Fig. 163: 8, 9). Consequently, the presence of beak and plicae considered as significant generic or infrageneric criteria (cf. Mueller 1951 - 1958; Inoue 1957, 1961; Schuster 1974; Schljakov 1980, etc.) has only a little infraspecific value.

This comparatively poorly known taxon is rather common, not only in Yamal but in the Asian Arctic as a whole. It differs from the type variety of the species by larger cells (marginal - 20 - 30(34) x 23 - 35(40) mkm, median - 23 - 35 x 24 - 42 mkm) and gemmae (18 - 23 x 24 - 38 mkm), a mostly smooth or faintly papillose cuticle, more numerous oil-bodies ((3)4 - 11(16) per cell), *Barbilophozia barbata*-like leaves that are 2(3) - lobed, exceptionally 4 - lobed, often developing purplish pigmentation, etc.

*Lophozia heterocolpos* var. *harpanthoides* (Bryhn & Kaal.) Schust.

AT: Belyy II.

In herb-willow-moss tundras with *Blepharostoma trichophyllum* var. *brevirete*, *Tritomaria quinquedentata*, *Odontoschisma macounii*, *Scapania zemljae*, *Jungermannia polaris*, *Cephaloziella arctica*, etc.

The investigated plants are mod. *mesoderma-colorata* of the variety with straight-

sided, rarely weakly convex, never confluent trigones. Small-leaved phenotypes often develop purplish violet pigmentation in distal parts of leaves. One shoot with a ventral-intercalary branch originating from the under-leaf axil was found also. Otherwise the material is quite typical. It has narrow and shallow sinuses with convex sides, usually rotund lobes, often bilobed amphigastria, and comparatively small, subsodiametric basal and median leaf cells (median ca. 20 - 31 x 17 - 24 mkm).

*Lophozia badensis* (Gott. ex Rabenh.) Schiffn. ex Dalla Torre & Sarnth.

AT: Kharasavey I; NT: Yuribeitoyaha I.

In hillock tundra on brooklet bank and in dwarf shrub spotty tundra on bare soil, associated with *Jungermannia polaris*, *Arnellia fennica*, *Scapania gymnostomophila* f. *incurva*, *Tritomaria scitula*, *Lophozia heterocolpos*, and *Barbilophozia quadriloba* f. *glareosa*.

In Kharasavey plants of mod. *parvifoliamesoderma-colorata* were found. The smallest plants of this modification have subtransversely oriented, more or less concave and fuscous leaves and resemble small species of *Marsupella*. In the sterile state they differ from *Marsupella* by stem anatomy and comparatively large cells.

Subgen. *SCHISTOCHILOPSIS* Kitag.

*Lophozia grandiretis* (Lindb. ex Kaal.) Schiffn.

ST: Khevesyo III, Laptayaha II, Er'yaha I.

On spots in spotty moss and lichen-moss tundras, bare loamy soil near temporary water course and peat outcrop, associated with *Cephalozia pleniceps*, *Blepharostoma trichophyllum* var. *brevirete*, *Anthelia juratzkana*, *Nardia geoscyphus*, *Tritomaria heterophylla*, *T. quinquedentata*, *Aneura pinguis*, *Odontoschisma macounii*, etc. Gemmae usually develop in small quantity. Male plants were found once. Antheridia vary from green to yellow and purplish. The stalks are 2 - or, at least partly, 3 - seriate.

The color varies from green to deep purple. Plasmolysis, resembling that of *Lophozia opacifolia*, occurs exceptionally in plants of mod. *viridis*. Such plants differ from *L.*

*opacifolia* in their dirty green, not bluish green coloration, as well as the size of cells and gemmae.

*Lopozia incisa* (Schrad.) Dum. *s.str.*

AT: Tambey I, Khabeiyaha II, Kharasavey II; NT: Matyuyaha I, Bovanenkovo I, Tomboitosyo I, Neromayaha III, Mantyo I, Saletayaha I, Yuribeitoyaha I, Khakhayayaha II, Lyakkotosyo I; ST: Khutyayaha II, Khevesyo III, Laptayaha I, Er'yaha I, Khadytayaha I.

In diverse wet moss tundras, bogs, peat outcrops, often among *Sphagnum*. Usually with gemmae. Male plants were found only once.

Among *Sphagnum* the plants of mod. *laxifolia-integrifolia*, resembling *Lophozia laxa* (Lindb.) Grolle, sporadically occur. They differ from this species by opaque bluish green coloration, absence of purplish pigment, character of gemmae, etc. Moreover *L. laxa* is an amphi-oceanic species apparently unknown from continental regions of Eurasia (Konstantinova & al., 1992).

When sterile differentiation of *L. incisa* from *L. opacifolia* is problematic on account of considerable overlapping of their variability (cf. Schuster 1969, 1988, etc.). Usually plants of *L. incisa* are smaller, with thinner stems, and narrower, deeper divided leaves, 2 - 3 - stratose only near the base. Moreover, *L. incisa* is associated with acidophilous species, while *L. opacifolia* occurs on enriched soils.

*Lophozia incisa* var. *inermis* K. Muell.

AT: Tirvyayaha I.

In wet willow-moss tundra among *Sphagnum* sp., *Barbilophozia binsteadii*, *Ptilidium ciliare*, *Blepharostoma trichophyllum* var. *brevirete*. In my opinion, the most characteristic feature of this rare variety, which is unknown for the other taxa of the subgenus, is the prominent bulging trigones.

*Lophozia opacifolia* Culm. ex Meyl.

AT: Belyy II, Khabeiyaha III, Tambey III, Kharasavey II; NT: Matyuyaha I, Bovanenkovo I, Tomboitosyo I, Neromayaha III, Mantyo I, Yuribeitoyaha II, Khakhayayaha II; ST: Khutyayaha I, Khevesyo III, Yuribey 2, Er'yaha I.

On spots of bare soils in diverse tundras, late snow areas at the foot of slopes and peat outcrops, and on brooklet banks. Usually with gemmae. Male plants and plants with

perianths and mature capsules rare.

Some phenotypes of *Lophozia opacifolia* resemble *L. hyperarctica* Schust. They have very thick, fleshy and flattened, elliptical in cross section, blackish brown pigmented with age stems; predominantly bilobed, very wide, almost transversely inserted dorsally leaves, with shallow crescentic sinus and entire or faintly denticulate (on gemmiparous shoots) margins; and large gemmae, 20 - 34(40) x 20 - 31 mkm. They differ from *L. hyperarctica* in opaque, whitish green coloration; characteristically plasmolysed cell contents; absence of black pigmentation of cell walls in old parts of ventral sector of stem (brownish black coloration of old part of stem of *L. opacifolia* connected with destruction of the cell walls, not with black pigmentation); presence of diffuse mycorrhiza in ventral part of stem.

Subgen. *ISOPACHES* (Buch) Schust.

For a description of *Lophozia alboviridis* and *L. decolorans* in Yamal and differentiation of the species of the subgenus see Potemkin (1990c). I would like to note here only the most important distinctive criteria of the species of the subgenus in the key given below and to stress that sex distribution is not constant in arctic populations of *Isopaches* species: *L. alboviridis* in Yamal, as well as in Greenland (Schuster & Damsholt 1974) is mostly dioicous but sporadically paroicous; *L. decolorans* in Yamal is paroicous, but in the other localities dioicous; in *L. bicrenata* male plants occur sporadically, while as a rule this species is paroicous.

KEY TO SPECIES OF *ISOPACHES*

1. Marginal leaf cells considerably smaller than median, 11 - 18(20) mkm; leaf lobes more or less unequal, ventral lobe longer and wider than dorsal, ending in sharp tips formed by (1)2 - 3(4) superimposed cells with distinctly elongated apical cell; gemmae with strongly projected and very thick angles, mostly regulary stellate, 19 - 25(26) x 16 - 24 mkm.....*L. alboviridis*

1. Marginal cells not distinctly different from median, larger than 20 mkm; leaf lobes usually almost equal, ending in obtuse to

sharp apiculi formed by 1(2) superimposed subisodiametric cells; gemmae variable, from mostly irregularly polygonal to rectangular and triangular, with feebly to rather strongly projecting and thickened angles, as an exception - oval, 17 - 25 x 23 - 31 mkm (*Lophozia bicrenata*) or 17 - 30(34) x 23 - 45(56) mkm (*L. decolorans*).....2

2. Leaves usually densely imbricate, wide (width/length ratio usually considerably more than 1:1.2), trapezium-like, with mostly shallow wide crescentic sinus, 0.05 - 0.15 of the leaf length (sterile plants resemble *Prasanthus suecicus*); male bracts with antical tooth; perianth mouth shortly ciliate, cilia 1 - 2(3) - celled; often with stolons.

.....*L. decolorans*

2. Leaves not densely imbricate, their width not obviously exceeding their length (width/length ratio ca. 1:0.9 - 1.2); sinus deeper, 0.2 - 0.3 of the leaf length, mostly U-shaped, occasionally crescentic (plants essentially different from *Prasanthus suecicus*); male bracts usually without antical tooth; perianth mouth spinose-ciliate, cilia 2 - 4 - celled; stolons absent.....*L. bicrenata*

Working with this key, the following correlation should be taken into account: gemmae are more angulate and thick-angled but cilia of perianth mouth and apiculi of leaf lobes are shorter and leaves are denser in plants of exposed sites and just the opposite for plants of shade sites.

*Lophozia bicrenata* (Schmid. ex Hoffm.) Dum.

ST: Khutyaha I.

On thinly turfed sandy soil in dwarf shrub-herb moss tundra on steep slope, in association with *L. alboviridis*, *Gymnomitrium corallioides*, *Lophozia excisa* and *Cephalozia arctica*. With perianths and gemmae.

*Lophozia alboviridis* Schust.

AT: Kharasavey I; NT: Matyuyaha I, Neromayaha III, Mantyo I, Saletayaha 2, Khakhayaha II, Lyakkotosyo I; ST: Khutyaha III, Khevesyo I, Laptayaha I, Er'yaha I.

On weakly turfed sandy and loamy sand soils, sometimes with the other species of the subgenus. Always with gemmae; male plants and plants with perianths occur rarely; seen

once with mature capsules. Potemkin (1990c, fig. 1) provides illustrations of this species by material from Yamal.

*Lophozia decolorans* (Limpr.) Steph.

AT: Tambey II; NT: Lyakkotosyo I; ST: Khutyaha I.

On steep herb sandy slopes, associated with *Barbilophozia hatcheri*, *Gymnomitrium corallioides*, *Lophozia excisa*, *L. alboviridis*, *Scapania praetervis*, *Anastrophyllum minutum*, etc. With gemmae and perianths. Potemkin (1990c, fig. 2) provides illustrations of this species by material from Yamal.

Subgen. *LOPHOZIA*

*Lophozia heteromorpha* Schust. & Damsh. (Fig. 3)

NT: Bovanenkovo I, Neromayaha I; ST: Khevesyo I.

In spotty dwarf shrub formation with *Betula nana*, among *Dicranum elongatum* with *Lophozia excisa* var. *infusca*, *L. major*, *L. heterocolpos*, *Blepharostoma trichophyllum* var. *trichophyllum*; in lichen-moss-dwarf shrub tundra, among *Sphagnum* with *Barbilophozia kunzeana*; at the foot of steep herb slope near margin of sedge bog with *Pellia neesiana*, *Chiloscyphus fragilis*, *Scapania irrigua*, *Cephalozia pleniceps*, and *Jungermannia hyalina*. With gemmae.

*Lophozia heteromorpha* is a polymorphous species with unclear limits of variability. The most important features, differentiating it from the other taxa of *Lophozia*, are: polymorphous leaf form; violetish pigmentation of mature gemmae; violet pigmentation of young leaf margins in distal parts, replaced by fuscous pigment with age; frequent presence of amphigastria; and weak dorsiventral differentiation of stem tissue. All these characters are not constant, however, and only a complex analysis of them all permits sure identification of the species (see also Potemkin 1990a).

*Lophozia jurensis* Meyl. ex K. Muell. (*L. latifolia* Schust.; *L. sudetica* auct. non (Nees ex Hueb.) Grolle p.p. - Potemkin 1989; *L. pellucida* var. *minor* auct. non Schust. - Potemkin 1988, 1989)

AT: Belyy II, Tambey II, Kharasavey II; NT: Matyuyaha II, Tiutey 2, Bovanenkovo I, Neromayaha III, Yuribetoyaha I, Khakhayaha I, Lyakkotosyo II; ST: Khutyaha I, Khevesyo II, Laptayaha II, Kharangy-neto 4, Er'yaha I, Khadytayaha 3.

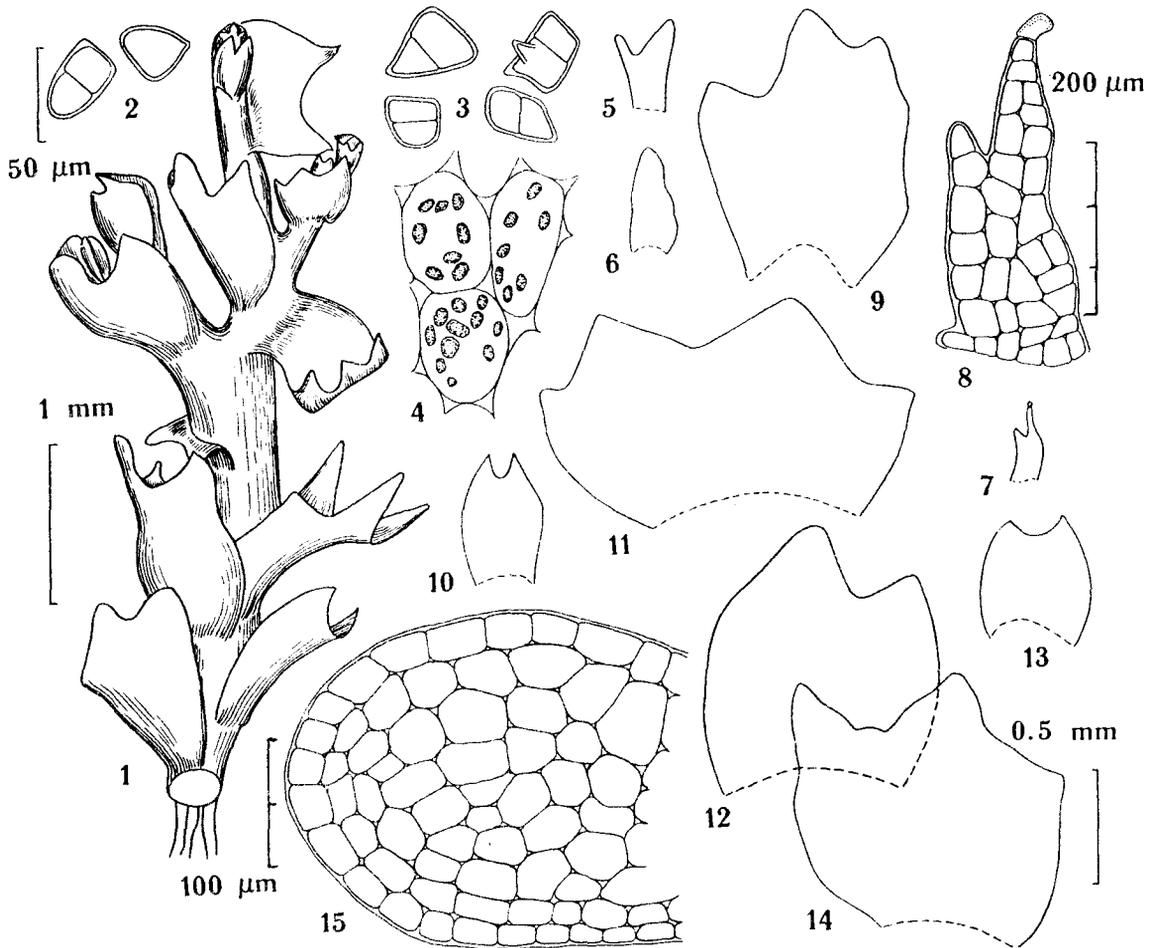


Fig. 3. *Lophozia heteromorpha*. 1 - Sterile shoot; 2, 3 - Gemmae; 4 - Median cells with oil-bodies; 5-7 - Underleaves; 8 - Magnified underleaf from Fig. 7; 9-14 - Leaves; 15 - Cross section of stem. Scale bars: 1 mm - for 1; 0.5 mm - for 5 - 7, 9 - 14; 200 mkm - for 8; 100 mkm - for 15; 50 mkm - for 2 - 4. All from Khevesyo (After Potemkin 1990a).

In diverse moss tundras. Often with perianths, rarely with gemmae and mature capsules.

Yamal plants are mostly paroicous. Individual monoicous shoots were found only in Yuribeitoyaha, Lyakkotosyo and Laptayaha. The species varies from mod. *laxifolia-viridis* to mod. *densifolia-colorata*. Secondary pigmentation is usually purplish red. Plants of mod. *laxifolia-viridis* often represent phenocopies of *Lophozia pellucida* var. *minor* (cf. Schuster 1969, Fig. 220:11). They differ from this species in: 1) almost constant absence of gemmae (if gemmae present, they are reddish brown or reddish, with faintly projecting angles (vs strongly angulate, colourless to yellow and yellowish brown

gemmae of *L. pellucida*); 2) male bracts with antical teeth; 3) ecological behaviour - *L. jurensis* associated with acidophilous species while *L. pellucida* with basiphilous ones.

*Lophozia excisa* (Dicks.) Dum. (? *L. uncinata* Schljak. syn. nov.).

In Yamal three varieties of *L. excisa*, representing apparently more or less distinct entities of this genetically highly complicated species are distinguished. My approaches to their differentiation are given in the key.

KEY TO YAMAL VARIETIES OF *LOPHOZIA EXCISA*

1. Perianth mouth crenulate or dentate, composed of more or less regular projecting, oriented perpendicularly to margin, elon-

gated, finger-like cells. Mature gemmae reddish brown to dull purplish. ....2

1. Perianth mouth with smooth margin, composed of mostly tangentially oriented cells, and scattered 1 - 2(3) - celled firm teeth formed by mostly subisodiametric cells. Mature gemmae colourless to violetish .....*L. excisa* cf. var. *succulenta*

2. Perianth mouth crenulate; marginal cells, in lobes, 17 - 30 mkm (tangentially measured).....*L. excisa* var. *excisa*

2. Perianth mouth dentate, with free teeth 0.5 - 2(3 - 4) cells long; marginal cells, in lobes, (25)30 - 40(42) mkm (tangentially measured).....*L. excisa*.var. *infuscata*

*Lophozia excisa* var. *excisa* (*L. sudetica* auct. non (Nees ex Hueb.) Grolle p.p. - Potemkin 1989)

AT: Belyy II, Khabeyaha III, Tambey III, Kharasavey II; NT: Matiyaha I, Tiutey I, Bovanenkovo I, Tomboitosyo II, Neromayaha IV, Mantyto I, Marre Sale I, Saletayaha 7, Yuribeitoyaha II, Khakhayayaha III, Lyakkotosyo III; ST: Khutyaha III, Khevesyo III, Yuribey I, Laptyaha II, Kharangyneto I, Er'yaha II.

In diverse moss and spotty tundras, on herb slopes, late snow areas, peat outcrops, moss bogs, banks of water courses and lakes. Often with perianths and gemmae, sporadically with mature capsules.

An euritopic, extremely malleable taxon, varying from mod. *laxifolia-viridis-egemmi-para*, occurring in wet sites among mosses, to mod. *parvifolia-densifolia-colorata-gemmi-para*, which is characteristic for habitats on bare soil. The smallest plants of the last modification are only 0.8 - 0.9 mm long and 0.2 - 0.35 mm wide. They usually have a thick, fleshy stem and comparatively small leaves as well as comparatively small cells, (17)22 - 30 x (17)20 - 25(28) mkm, with small trigones. Their gemmae are 2 - celled, 21 - 31(36) x 17 - 25(28) mkm, and from brown and brownish red to deep purple.

Yamal plants of *Lophozia excisa* var. *excisa* develop brown pigmentation more often than red or purplish. This may lead to confusing *L. excisa* and *L. major*. Such forms of *L. excise*, however, have leaves not so strongly narrowed in upper part, as in *L. major*, with the maximal width between the middle and

lower thirds or in the middle, not near the base, and almost triangular, not horn-like lobes (if the maximal width of leaves of *L. major* is in the middle, their ventral margin is very convex but the dorsal is almost straight, i.e. the leaves of this species are usually considerably more asymmetric than in *L. excisa*).

Small gemmiparous plants of *Lophozia excisa* are confused also with *L. sudetica*. They differ from this species in their wide ventral merophytes, unmodified gemmiparous leaves, also often in larger cells as well as size, shape and coloration of gemmae, etc. Moreover *L. excisa* differs from all other regional species of the subgenus, excepting *L. jurensis*, in paroecia and, as a consequence, in often developing perianths.

*Lophozia excisa* var. *infuscata* Schust & Damsh.

AT: Khabeyaha I; NT: Neromayaha II, Lyakkotosyo I; ST: Er'yaha I.

In willow stands on humused soil with *Barbilophozia binsteadii*, *B. kunzeana*, *B. quadriloba*, *Anastrophyllum minutum*, *Cephalozia pleniceps*, *Tritomaria quinque-dentata*, *Blepharostoma*, etc.; in wet moss tundra among *Aulacomnium palustre*, with *Tritomaria quinque-dentata* and *Lophozia major*. With gemmae, perianths and mature capsules.

The differentiation of this variety, recently described by Schuster and Damsholt (1974) and known before this report only from Greenland, is sometimes rather problematic. Its distinctive criteria, mentioned by the authors - larger cells (marginal in lobes - (26 - 29)30 - 38(40) mkm, median - (32 - 35)36 - 45(48) x (36)40 - 55(60) mkm) and gemmae, (28)30 - 37 x 33 - 38(48) mkm; more numerous oil-bodies, (12 - 18)20 - 36(40 - 45) per cell; fuscous secondary pigmentation; dentate perianth mouth with free teeth 0.5 - 2 (3 - 4) cells long and terminal cells (where free) ca. 56 - 68(75 - 80) x 16.5 - 22 mkm - are mainly quantitative. Their variability overlaps with that of the type variety. The most reliable of these criteria, for separation of the Yamal plants of the variety, are character of perianth mouth and size of marginal cells of leaf lobes.

*Lophozia excisa* cf. var. *succulenta* Schust. & Damsh.

AT: Belyy II, Khabelyaha II, Tambej I, Kharasavey I; NT: Neromayaha I; ST: Khutyyaha I, Kheveyso I.

On bare fine-grained soil in late snow areas and diverse spotty tundras; mostly individual shoots among *Prasanthus suecicus*, *Gymnomitrium corallioides*, *G. concinatum*, *Nardia geoscyphus*, *Scapania scandica*, *Tritomaria quinquedentata* f. *gracilis*, *Lophozia ventricosa* s.l., *Cephalozia bicuspidata*, *Anthelia juratzkana*, *Cephaloziella arctica*, *Anastrophyllum minutum*, *Jungermannia sphaerocarpa* var. *nana*, etc. Often with perianths, gemmae and mature capsules.

The variety was described from West Greenland by Schuster and Damsholt (1974) on the base of "sparing type material", which was unavailable for critical study. It is obvious that this material can not reflect the phenetic variability of the taxon completely. It gives me the basis to attribute to the cf. var. *succulenta* the Yamal plants that differ somewhat from the type until an investigation of the type is possible. Because of the tentative identification of these plants, their description and differences from the type are listed.

Plants minute to small, 1 - 10 mm long and (0.2)0.5 - 1.1 mm wide, resembling small compact soil forms of *Lophozia excisa* var. *excisa*. Stem more or less fleshy, thick, conspicuously mycorrhizal throughout much of the medulla. Leaves usually subrotund, broader than long, imbricate, subvertical, often 2(3) - stratose at base; sinus mostly crescentic, occasionally gibbous, ca. 1/5 - 2/5 of the leaf length; lobes acute; distal parts, especially margins, of young leaves bright red to deep purple and violet, of mature and old leaves - fuscous (brown pigment replaces red pigment with age), unpigmented parts of leaves and stem in dead material opalescent. Cells of leaves thin-walled, except for small to sporadically rather pronounced trigones; marginal cells in lobes, 17 - 28 mkm (measured tangentially), median from 14 - 17 x 17 - 23 mkm to 20 - 25(28) x 25 - 30(35) mkm; oil-bodies small, 3 - 5(6) mkm, 4 - 12(14) per cell, according to Schuster and Damsholt (l.c.) occasionally 18 - 20 per cell.

Gemmae green to violetish (only individual "overmatured" gemmae deep violet), 1 - 2 celled, usually thin-walled, almost oval to triangular and polygonal, with weakly projected angles, 20 - 23 x 23 - 34 mkm.

Paroicous. Male bracts leaf-like, often with somewhat gibbous base, 1 - 2 - androus, with or without distinct antical tooth. Female bracts 2 - 3 - fid; lobes acute to apiculate (apiculus 1 - 3(5) cells long) often with strongly reflexed margins; sinuses rather deep, angulate, gibbous. Perianth 2 - 5(10) - stratose at base, usually bistratose up to middle or higher, at mouth usually bleached, weakly lobulate, occasionally formed of rather thick-walled collenchymatous cells; the mouth margin smooth, composed of mostly tangentially oriented cells, with scattered 1 - 2(3) - celled firm teeth formed by mostly subisodiametric, only as an exception by elongated cells. Capsule wall 3 - 4 - stratose with epidermal layer usually considerably thicker than any of inner ones (the thicknesses ratio ca. 1.5 - 2.0:1). Spores 16 - 18(20) mkm. Elaters 2 - spiral, (7)8 - 9(11) mkm thick.

In their description of this variety Schuster and Damsholt (l.c.) stressed that "the combination of denticulate, firm-celled perianth mouth, the polystratose perianth base, and edentate bases of male bracts isolate these plants from any other variety of *L. excisa*". In my opinion, the most important of these criteria is the character of perianth mouth - the combination of scattered teeth and smooth margin, composed of tangentially elongated cells (a firm-celled perianth mouth is not constant for the Yamal plants of var. *succulenta* and it has been seen in var. *infuscata* also). The character of the perianth base as well as the leaf base (the authors note unistratose leaf base for the variety) is not a very reliable feature. According to my personal observations a 2 - 3 - stratose perianth base is not a rarity for the typical variety of the species. A bistratose leaf base and edentate male bracts occur exceptionally in var. *excisa* also. On the other hand, "sparing type material" cannot show the degree of constancy of these characters and the constancy of the absence of gemmae

stressed in the description.

*Lophozia* cf. *longidens* (Lindb.) Macoun

AT: Khabelyaha II, Tambey I.

In lichen and lichen-moss tundras, individual plants among lichens with *Anastrophylum minutum*, *Tritomaria quinquedentata*, *Ptilidium ciliare*, *Gymnomitrium concinatum*, etc. With gemmae.

Because some species of *Lophozia* in certain conditions may develop phenocopies of *L. longidens* and collections of the species in Yamal are sparing and insufficient for its sure identification it listed under the sign "cf."

*Lophozia* cf. *savicziae* Schljak. (*L. wenzelii* auct. non (Nees) Steph. - Zhukova & Rebristaya 1986, 1987)

AT III; NT: Matyuiyaha II, Bovanenkovo 8, Tomboitosyo II, Neromayaha IV, Mantiyo II, Khakhayayaha II, Lyakkotosyo I; ST: Khutyayaha III, Khevesyo V, Laptayaha II, Kharangyneto 2, Khadytayaha 4.

In diverse wet moss, moss-lichen and lichen tundras, late snow areas, on spots in spotty tundras, steep slopes and in bog communities. Often with gemmae; male plants rare.

The most characteristic features of the species are concave, trapezium-like, rather rigid leaves, spread away from the stem from their bases, with a rather shallow, usually lunate sinus and mostly apiculate lobes; often deep purple ventral sector of stem as well as ventral leaf bases; polygonal to stellate gemmae with strongly thickened and projecting angles; usually large cells.

In original description of the species Schljakov (1973) noted two types of oil-bodies - small, 2 - 4 mkm, homogenous, drop-like, 15 - 30 and more per cell, or, if they are larger, they are less numerous, granulate, with central droplet. Later (Schljakov 1980) he listed granulate oil-bodies without central droplet for the species also, interpreting the polymorphism of oil-bodies as a feature of its antiquity. Oil-bodies with central droplet, ca. (5)8 - 18(20) to 15 - 30 per cell, 3 - 7 mkm in diam., were found in most collections of the species studied in a living state (mainly from Bovanenkovo, Neromayaha, Khevesyo). In some specimens of the species from the

same localities granulate oil-bodies without central droplet were found. The differentiation of (?) forms of the species with granulate oil-bodies and oil-bodies with central droplet from the other large-celled *Lophozia*, namely *L. ventricosa* var. *grandiretis* (Buch & S. Arn.) Schust. & Damsh., *L. ventricosa* var. *rigida* Schust. as well as *L. wenzelii* var. *lapponica* Buch & S. Arn. sensu Schust. remains unclear. As a consequence, the conception of the species, particularly in respect of oil-body polymorphism, remains unclear also.

*Lophozia ventricosa* (Dicks.) Dum. s.l. (incl. *L. groenlandica* (Nees) Macoun sensu Schljak. 1975, non sensu Schust. 1969, excl. syn. *L. heteromorpha* Schust. & Damsh., )

AT: Belyy I, Khabelyaha III, Tambey III, Kharasavey II; NT: Matyuiyaha V, Tiutey I, Venuleuo I, Bovanenkovo 4, Tomboitosyo III, Neromayaha III, Mantiyo II, Marre Sale I, Saletayaha I, Yuribeitoyaha II, Khakhayayaha V, Lyakkotosyo III; ST: Khutyayaha V, Khevesyo V, Laptayaha III, Kharangyneto 4, Er'yaha III, Khadytayaha 5.

In diverse moss and lichen tundras, herb communities, late snow areas, moss bogs. Usually with gemmae; perianth bearing and male plants rare.

*Lophozia ventricosa* var. *longiflora* (Nees) Macoun ( *L. longiflora* (Nees) Schiffn. s.l., incl. *L. porphyroleuca* auct. non Schiffn.; *L. ventricosa* auct. non (Dicks.) Dum. p.p. - Zhukova & Rebristaya 1986)

AT: Belyy I, Khabelyaha IV, Tambey III, Kharasavey II; NT: Matyuiyaha III, Tiutey 2, Venuleuo I, Bovanenkovo I, Neromayaha III, Mantiyo V, Marre Sale 7, Saletayaha 7, Yuribeitoyaha IV, Khakhayayaha II, Lyakkotosyo IV; ST: Khutyayaha V, Khevesyo V, Yuribeitoyaha 2, Laptayaha V, Kharangyneto 5, Er'yaha III.

In diverse moss and lichen tundras, moss bogs, occasionally on spots in spotty tundras. Perianth bearing and male plants rather frequent; occasionally with gemmae and mature capsules.

*Lophozia wenzelii* (Nees) Steph.

AT: Kharasavey I; NT: Matyuiyaha I, Bovanenkovo I, Neromayaha II, Sebayaha I, Khakhayayaha I; ST: Khutyayaha II, Khevesyo I, Laptayaha II, Er'yaha II.

In wet dwarf shrub-moss tundras, once in herb-moss nival tundra. Perianth bearing, male and gemmiparous plants occur sporadically.

*Lophozia sudetica* (Nees ex Hueb.) Grolle (*L. rufescens* auct. non Schljak. - Potemkin 1989)

AT: Tambey II, Kharasavey I; ST: Khutyayaha I, Laptayaha I.

In diverse lichen tundras and spotty *Gymnomitrium* tundra, on steep slope; individual shoots on fine-grained soil. With gemmae.

*Lophozia sudetica* is a rare species in Yamal. It is represented by small forms like "*Lophozia alpestris* var. *gelida* (Tayl.) K.Muell." A part of the earlier reports of the species from Yamal (Arnell 1918 (?); Zhukova & Rebristaya 1986, 1987; Potemkin 1989) must be attributed to mod. *parvifolia-colorata-parviretis-gemmipara* of *L. excisa*, *L. major* and *L. jurensis*, which may develop similar small cells and pigmentation. *L. sudetica* differs from them, however, in considerably more symmetrical leaves, which usually become dentate from gemmae production; narrow ventral merophyte and usually purplish pigmented ventral part of the stem and ventral leaf base.

My attempts to use the leaf cell rows criterion (Schljakov 1980) for separation of this species and *Lophozia rufescens* Schljak. were resultless. Other criteria for differentiation of small forms of the both species with pigmented gemmae are absent. In my opinion the cell row directions in specimens of *L. sudetica* determined by Schljakov (LE) vary principally from "in lobes" to "to sinus". I am sceptical about this criterion for differentiation of *Lophozia* species.

*Lophozia major* (C. Jens.) Schljak. (*L. polaris* (Schust.) Schust. & Damsh.; *L. alpestris* auct. non (Schleich.) Evans. - Zhukova & Rebristaya 1987)

AT: Belyy II, Khabeiyaha II, Tambey III, Tirvyayaha I, Kharasavey II; NT: Matyuyaha II, Tiutey 2, Venuieuo I, Bohavenkovo 8, Tomboitosyo I, Neromayaha IV, Marre Sale I, Yuribeitoyaha V, Khakhayayaha II, Lyakkotosyo I; ST: Khutyayaha I, Khevesyo III, Laptayaha II, Er'yaha II, Khadytayaha I.

In herb-willow-moss, moss-lichen and diverse swampy tundras, herb willow stands, on brook and lake banks. While *L. major* prefers comparatively rich soils, it is often associated with acidophilous species. Always with gemmae; male and female plants very rare.

In Yamal the species is very malleable in

its sinus, which varies from usually crescentic to angulate with concave or convex sides; lobe form, which is often horn-like but sometimes - obtuse- or acute-angled; position of maximal width of the leaf (mostly in the lower third, occasionally in the middle); leaf symmetry (usually the leaves are asymmetric - with strongly convex ventral and stright dorsal margin, but some, mainly small forms of the species have more or less symmetric leaves); cell size, which ranges for median cells from 17 - 20 x 23 - 25 mkm to 28 - 35 x 30 - 42 mkm, etc. There is a certain overlapping of the variability ranges of *Lophozia major* with *L. excisa*, *L. sudetica* and *L. rubrigemma* (for differentiation see characteristics of these species).

*Lophozia* cf. *rubrigemma* Schust. (Fig.4:1-4)

AT: Tambey I; NT: Neromayaha I, Marre Sale I.

In *Cassiope* tundra on bare soil with *Anthelia juratzkana*, *Anastrophyllum minutum* and *Blepharostoma*; in willow stand on bare soil among crustose lichens, individual stem with *Lophozia major* and *Scapania hyperborea* mod. *parvifolia-gemmipara*; in willow-moss tundra among with *Tritomaria quinquedentata*, *Ptilidium ciliare*, *Scapania scandica*. With gemmae. The scant Yamal material of the species and rather poor our knowledge of it on the whole as well as the overlapping of variability ranges with *Lophozia major* cause serious difficulties with identification of *L. rubrigemma* and some problems remain insoluble.

The plants from Tambey share with typical *L. rubrigemma* leaf form and leaf position on the stem but differ in comparatively small cells and gemmae (Potemkin 1990a). The plants from Neromayaha are very similar to the type (RMS 45961c), which was investigated for comparison. They have the same leaf form, large cells (marginal 23 - 38 x 20 - 34 mkm, median 28 - 37(45) x 23 - 31 mkm) and gemmae, 23 - 31 x 17 - 28 mkm to 34 - 41 x 2028 mkm, but material is very sparing. The last specimen, from Marre Sale, is also problematic. The plants are large-celled with pellucid leaves, resembling *L. excisa* more rather than *L. rubrigemma*. Cells, however, often develop

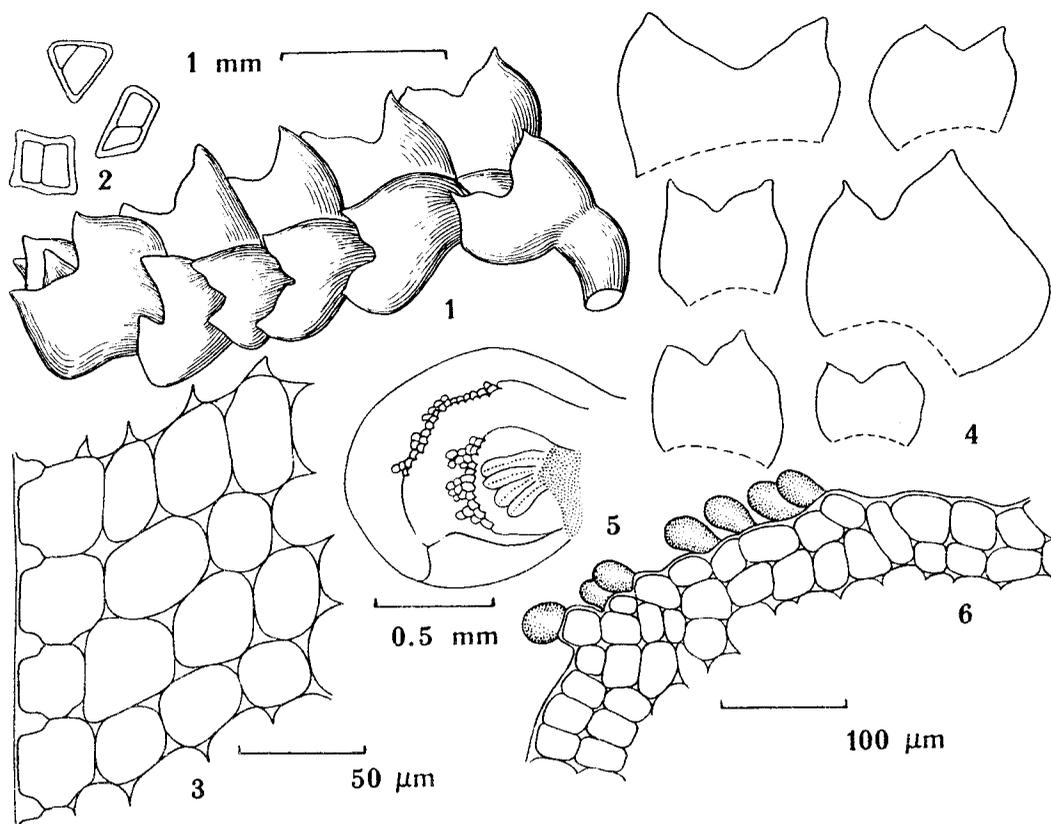


Fig. 4. *Lophozia* cf. *rubrigemma* (1 - 4) and *Cryptocolea imbricata* (5, 6). 1 - Shoot, lateral aspect; 2 - Gemmae; 3 - Cells of leaf margin; 4 - Leaves; 5 - Longisection through gynoecium; 6 - Margin of inner bract with slime papillae. Scale bars: 1 mm - for 1, 4; 0.5 mm - for 5; 100 mkm - for 6; 50 mkm - for 2, 3. 1 - 4 - from Tambey; 5 - 6 - from Khevesyo (After Potemkin 1990a).

somewhat bulging trigones as in *L. rubrigemma*, which do not occur in *L. excisa*.

*Lophozia pellucida* Schust. var. *minor* Schust.

NT: Neromayaha II, Khakhayayaha I; ST: Khutyayaha I.

It is a true basiphilous species of "difficult sites", growing usually on nival clay and loamy slopes on bare soil with *Nardia geoscyphus*, *Barbilophozia quadriloba*, *Cephalozia plenceps*, *Tritomaria quinque-dentata*, *Lophozia excisa*, *L. major*, *L. heterocolpos* var. *arctica*, *Jungermannia polaris*, *J. obovata* s.l., etc.

*Lophozia pellucida* var. *minor* is represented in Yamal mostly by very small forms (*mod. angusifolia-paivifolia-fusca vel viridis*),

which are often only 0.3 - 0.4 mm wide and 1 - 3 mm long. They have subsidiametric to rectangular, not strongly elongated cortical cells, 14 - 25 x 25 - 70 mkm, and small leaf cells, often 17 - 23 mkm only. Such forms are easily distinguished due to large, 25 - 36(42) x 20 - 31 mkm, polygonal, angulate, colourless to yellow and brownish, gemmae, exceptionally with the traces of violet pigmentation; thin-walled cells almost without trigones; stem about 10 cells high with very weak dorsiventral differentiation of the medulla, often blackish ventrally; violetish fuscous bases of rhizoids. Such small forms of the species may be easily missed when they grow in small quantity among other hepatics.

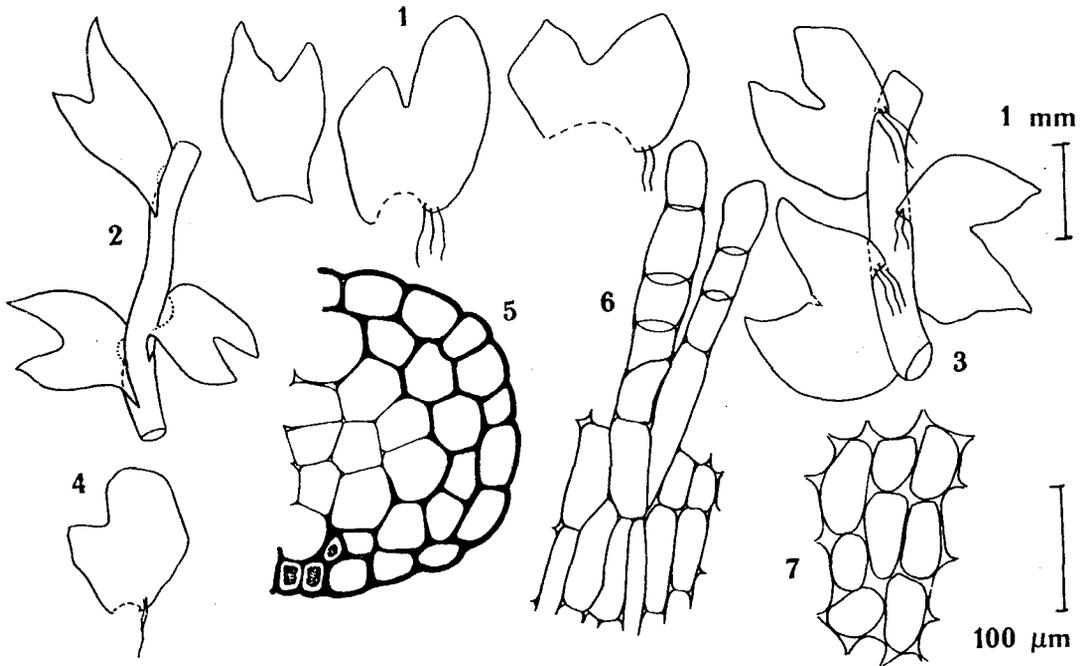


Fig. 5. *Gymnocolea fascinifera*. 1 - Leaves; 2 - Sector of shoot of mod. *angustifolia*, antical aspect; 3 - Sector of shoot of mod. *latifolia*, postical aspect; 4 - Male bract; 5 - Cross section of stem with unusually thick-walled cortical cells; 6 - Underleaf on stem; 7 - Median cells. Scale bars: 1 mm - for 1 - 4; 100 mkm - for 5 - 7. 1-3, 5-7 - from Kharasavey; 4 - from Belyy.

#### GYMNOCOLEA (Dum.) Dum.

*Gymnocolea fascinifera* Potemk. sp. nov. (*Cladopodiella fluitans* auct. non (Nees) Buch p. p. - Zhukova & Rebristaya 1986) (Figs. 5, 6).

*Species Gymnocoleae boreali* (Frisv. & Moen) Schust. *pigmentationis secundariae magnitudine ac caractere similis est, a qua rhizoidibus fasciculatis a basibus ventralibus foliorum et partibus caulis adjantibus abeuntibus, foliis manifeste inaequilobatis integerrimis, papillis mucosis dentibusque marginalibus destitutis, haud inunctis, guttis oleosis numerosioribus minoribus, plerumque 4 - 6 mkm in diam, (2)5 - 12(16) in quavis cellula locatis, caule pro more tenuiore (cellulis (5)6 - 8(11) in diam.), cellulis cor-*

*ticalibus leptodermaticis latioribus (20)23 - 28 (30) x (45)55 - 110(145) mkm ad (28)30 - 34(38) x 30 - 40 mkm in parte caulis dorsali sitis differt.*

Plants green to brown, not glistening, 1 - 2.5 mm wide and 5 - 15 mm long, often furcate terminal and rarely ventral and lateral intercalary branched. Stem (5)6 - 8(11) cells high; cortical cells weakly differentiated from cells of medulla, rather thin-walled, usually strongly elongated, dorsally (20)23 - 28(30) x (45)55 - 110(145) mkm, but sporadically subisodiametric and then wider, (28)30 - 34(38) x 30 - 40 mkm. Rhizoids sparse, in more or less distinct fascicles from ventral leaf base and adjacent part of stem (leaves detach with rhizoids). Leaves usually asymmetric with shorter and narrower antical

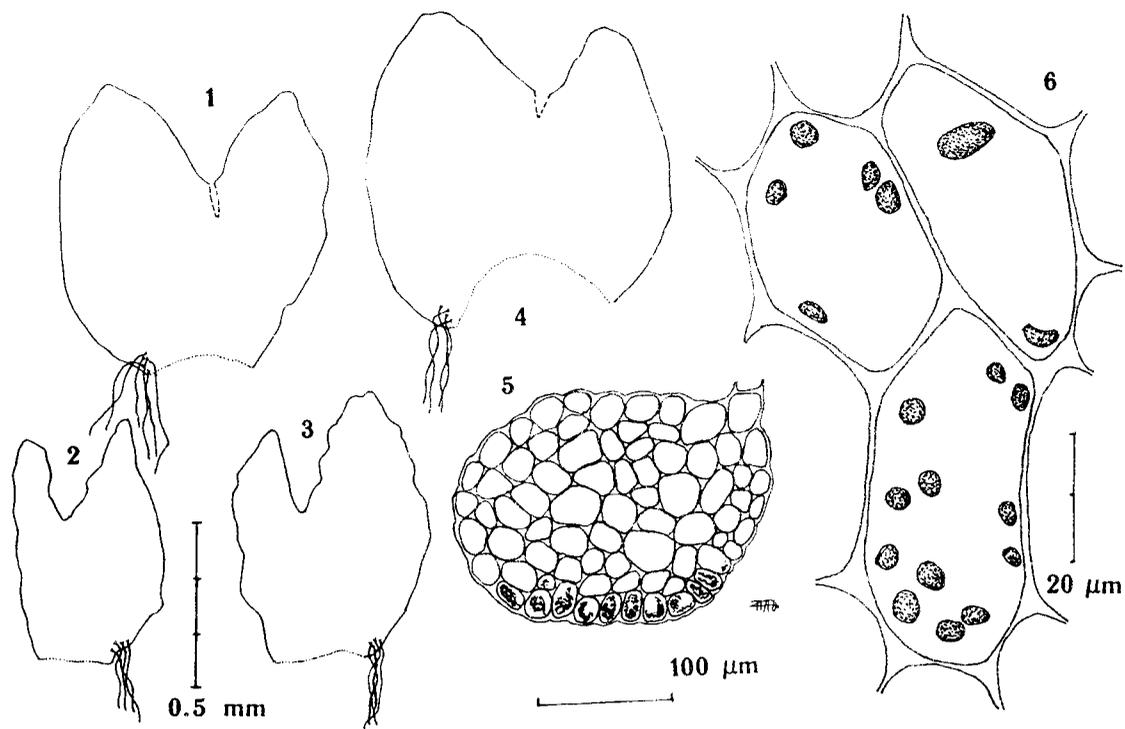


Fig. 6. *Gymnocolea fascinifera*. 1-4 - Leaves; 5 - Cross section of stem; 6 - Median cells with oil-bodies. Scale bars: 0.5 mm - for 1 - 4; 100 mkm - for 5; 20 mkm - for 6. All from the holotype.

lobe, widest in the middle third, more often a little longer than broad, but in general very malleable in respect of width/length ratio, which is ca. 1:0.7 - 2.0; sinus wide, V- or U-shaped, ca. 1/3 - 1/2 the leaf length; lobes from acute to apiculate, with 1-celled apiculus formed by subisodiametric cell, to obtuse and rotund; margins entire, occasionally more or less crooked, without any teeth or slime papillae. Amphigastria small, only occasionally discernible, mainly when purple pigmentation developed, formed of two stalked slime papillae. Cells more or less thin-walled, with small concave-sided to conspicuously bulging trigones, variable in size: marginal (tangentially measured in distal half of leaf) 17 - 31 mkm, median and basal 18 - 36 x 23 - 45 (55 - 70) mkm. Oil-bodies small, granulate, spherical, 4 - 6 (7.5) mkm in diam., exceptional individuals oval, up to 7 - 9 x 5 - 6 mkm, (2)5 - 12 (16) per cell. Cuticle smooth to usually striolate.

Diocious. Androecia long, spicate. Male bracts strongly concave, very asymmetric,

with small antical lobe, 1 - 2 - androus. Female plants unknown.

Holotype: USA, Alaska, Seward Peninsula, south Killeak Lake, in well developed troughs of high centered polygon, with *Scapania paludicola*, July 28, 1992 A. D. Potemkin, coll. N<sup>o</sup> 92 - 97 01 (LE).

Besides the type locality where the species was collected at first in fresh state, with oil-bodies, it is known from one more locality in Alaska, north of the Seward Peninsula, neighbourhood of Kotzebue (with androecia) (Potemkin 92 - 132 03) and from the following places in Yamal:

AT: Belyy I, Kharasavey II; NT: Matyuyaha I; ST: Khutyaha I, Er'yaha I.

In *Sphagnum* tussock bog and bogs with flowing water, in herb-willow, grass-cotton grass and sedge-lichen-moss tundras, often among *Drepanocladus* and *Sphagnum*, with *Scapania paludicola* var. *rotundiloba*, *Ptilidium ciliare*, *Pseudolepicolea fryei*, *Barbilophozia kunzeana*, *B. binsteadii*, *Gymnocolea inflata*, *Odontoschisma elongatum*, *Ble-*

*pharostoma*, etc. Once with androecia (Belyy).

*Gymnocolea fascinifera* may be confused with the other species of the genus and with *Cladopodiella fluitans*. It differs from all of them in rhizoid position in the ventral leaf base area - a unique feature, not found in the other northern species of Lophozioideae (even if only few rhizoids present at least some of them detach with the leaf base). The rhizoids, detaching with the leaf base, are absolutely noncharacteristic for *G. inflata* and *C. fluitans* and only individual rhizoids occasionally may be detached with the leaf base of *G. borealis*. Besides this character *G. fascinifera* differs from *G. inflata* in its leaf cells with more numerous oil-bodies, mostly yellowish brown coloration of pigmented forms (never fuscous black), leaves usually with distinctly unequal, sometimes apiculate lobes and the often larger size of plants; from *G. borealis* - in leaves with distinctly unequal lobes and entire margins without slime papillae and teeth, not glistening appearance, numerous oil-bodies ((2)5 - 12(16) vs 1 - 6(8) per cell), often thinner stem and thin-walled wider cortical cells, and ecological behaviour. The principal feature, differing *G. fascinifera* as well as the other species of the genus from *Cladopodiella fluitans* is the presence of terminal furcate branching. Moreover the species under consideration has usually smaller, collenchymatous cells and only sporadic small amphigastria.

*Gymnocolea inflata* (Huds.) Dum. var. *inflata* (*G. inflata* var. *heterostipa* (Carr. & Spruce) K. Muell., *Cladopodiella fluitans* auct. non (Nees) Buch p.p. - Zhukova & Rebristaya 1986; Andrejeva 1981)

AT: Belyy II, Tambej I, Kharasavey I; NT: Matyuyaha II, Bovanenkov 3, Tomboitosyo III, Mantyto III, Yuribetoyaha I, Khakhayayaha I; ST: Khutyayaha IV, Khevesyo III, Laptayaha I, Kharangyneto 4, Er'yaha II, Khadytayaha 6.

In sedge, cotton grass and sedge-moss bogs, sedge-lichen, cotton grass and diverse moss tundras, late snow areas. Plants with caducous perianth and androecia rather frequent.

The speccis is malleable. On bare exposed soil it develops mod. *latifolia-densifolia-col-*

*orata*, or more rarely - mod. *parvifolia-laxifolia-colorata* and mod. *angustifolia-laxifolia-colorata*; growing in moss tufts - mod. *laxifolia-angustifolia-viridis* and mod. *parvifolia-laxifolia-viridis*.

*Gymnocolea inflata* var. *acutiloba* (Kaal.) S. Arn.

NT: Tomboitosyo I, Sebayaha I; ST: Khutyayaha II.

Usually on thinly turfed ground or on peat in pools of diverse, mostly sedge and cotton grass bogs and wet tundras, once in sedge-lichen nival tundra, associated with *Cephalozia bicuspidata*, *Lophozia ventricosa* s.l., *Nardia insecta*, *Odontoschisma elongatum*, *Scapania hyperborea*, *S. tundrae*, *Gymnomitron apiculatum*, etc. Sporadically with sterile perianths, once with traces of gemmae.

After investigation of Yamal and South Greenland material (Schuster & Damsholt 82 - 1047, 82 - 1118, 82 - 1203, 82 - 1505, 82 - 1817, 82 - 2016, etc.) I have accepted Schuster's and Damsholt's interpretation of "*Gymnocolea acutiloba*" (Schuster 1988) but treat it here as a variety because we have not enough data on its distribution to say about subspecies. Their interpretation gave a set of new characters of this taxon in the Arctic (distinctive as well as shared with var. *inflata*): often purplish pigmentation; caducous perianth, pluristratose in basal half with longer teeth of the mouth, 1 - 2(3) cells long; leaves usually widest below the middle; leaf bases sporadically with tooth; ca. 5% of cells with 1 - 2 large oil-bodies, 50 - 70% of cells with 3 - 7 oil-bodies. Moreover *G. inflata* var. *acutiloba* may develop rather thick-walled leaf cells with distinct, sometimes bulging trigones and reproduce via gemmae. Unfortunately most of these criteria are not constant, occur in diverse combinations and often it is not easy to separate var. *acutiloba* from var. *inflata* because of the overlapping of their variability ranges. Nevertheless typical *G. inflata* var. *acutiloba* may grow on bare soil and in helophytic condition, among *Sphagnum* for instance (Schuster 1988), that means it is a distinct genetic entity.

It is necessary to stress that the Arctic

phases of var. *acutiloba* are more plastic in cell size, which in the middle of the leaf is (17)20 - 28 x 23-31(35) mkm usually, and, consequently, often have cells larger than the plants described from temperate regions.

Somewhat tentatively I assign to var. *acutiloba* the plants from Sebayaha. They share with this taxon size, leaf shape, character of pigmentation, smooth cuticle, but differ from it in larger cells (median leaf cells 28 - 35 mkm wide, cortical - 21 - 30 mkm wide) and lustrous appearance, sporadic stalked slime papillae near leaf and particularly bract base (in typical plants - teeth), longer teeth of perianth mouth composed of 2 - 4 superimposed cells. I think it may be a polyploid derivative of var. *acutiloba*. For clarification of the true taxonomic position of these plants an additional material is necessary.

Because of the presence of slime papillae near the leaf base, the long teeth of the perianth mouth, and large cells and lustrous appearance, these plants may be confused with *Gymnocolea borealis*. They differ from this species in fuscous black pigmentation often with traces of purple pigment, smaller size, smooth cuticle, caducous perianth and ecological behaviour.

#### TRITOMARIA Schiffn. ex Loeske

For characteristics and differentiation of the taxa of *Tritomaria* in Yamal, grounds for rejection of sectio *Tritomaria* and sectio *Trilophozia* (Schust.) Schust. and *T. exsectiformis* subsp. *arctica* Schust. as well as for description of sporophytes of *T. heterophylla* and androecia of *T. quinquedentata* f. *gracilis* see Potemkin (1990d).

*Tritomaria exsectiformis* (Breidl.) Schiffn. ex Loeske s.l. (incl. subsp. *arctica* Schust.)

NT: Matyuiyaha I, Tomboitosyo I, Neromayaha I, Lyakkotosyo II; ST: Khevesyo I, Er'yaha I.

In diverse moss and moss-lichen tundras, individual shoots and tufts among mosses, as an exception on bare soil among lichens, with *Barbilophozia binsteadii*, *Anastrophyllum minutum*, *Lophozia ventricosa* s.l., *Ptilidium ciliare*, *Tritomaria quinquedentata* and *Blepharostoma*. Always with gemmae

*Tritomaria scitula* (Tayl.) Joerg.

AT: Belyy II (Zhukova & Rebristaya 1987), Khabeiyaha I; NT: Neromayaha I, Yuribeitoyaha III.

In willow-Dryas tundras and horse-tail willow stands with *Lophozia heterocolpos*, *Blepharostoma*, *Scapania cuspiduligera*, *S. gymnostomophila*, *Barbilophozia quadriloba*, *Tritomaria quinquedentata*, *Arnellia fennica*, etc. Always with gemmae.

*Tritomaria heterophylla* Schust. f. *heterophylla*

NT: Khakhayayaha I; ST: Khevesyo III, Laptayaha III.

Usually on spots in wet moss spotty tundras with *Blepharostoma*, *Nardia geoscyphus*, *Cephalozia pleniceps*, *Barbilophozia quadriloba*, *Arnellia fennica*, *Lophozia grandiretis*, *Jungermannia polaris*, *J. obovata*, *Anastrophyllum minutum*, *Tritomaria quinquedentata*, etc. Almost always with gemmae; male and perianth bearing plants rather frequent; seen twice with mature capsules. Potemkin (1990d, fig. 1) provides the illustration of this form by material from Yamal.

*Tritomaria heterophylla* f. *anomala* Potemk. (Bot. Zhurn. 75(12): 1746, 1990)

ST: Khevesyo II.

On spots in sedge-lichen dwarf shrub-moss, grass-moss and lichen-moss tundras. The set of associated species is similar to that of type form. Once f. *heterophylla* and f. *anomala* were found near each other, but in somewhat different microhabitats. With gemmae, perianths and androecia.

The most characteristic features of this form are fuscous black secondary pigmentation; often obtuse to rotund leaf lobes; non gibbous sinuses; comparatively small trigones; female bracts with entire margin and obtuse to shortly apiculate lobes; subentire perianth mouth with obtuse apices of marginal cells; fuscous to violet fuscous, often strongly angulate and then larger gemmae, (20)25 - 40(48) x 17 - 40 mkm. Potemkin (1990d, fig. 1) provides the illustration of this form by material from Yamal.

*Tritomaria quinquedentata* (Huds.) Buch Damsholt (1982) and Schuster (1988) distinguish, on the base of perianth characters, two Holarctic subspecies of *Tritomaria quin-*

*quedentata* - subsp. *quinquedentata* and subsp. *turgida* (Lindb.) Damsh. Analysis of Siberian material of the species shows, however, that proposed distinctive characters, i.e. perianth mouth ciliate vs shortly dentate; perianth unistratose and plicate on the most of its length vs bistratose at least to the middle and weakly plicate in upper part; purplish pigmentation absent vs present; cells small vs large, etc. occur in diverse combinations and do not provide a foundation for separating "subsp." *turgida* from "subsp." *quinquedentata* (see for instance the description of the perianth of *T. quinquedentata* var. *quinquedentata* f. *gracilis* below). Therefore, following Schljakov (1980) I do not distinguish var. or subsp. *turgida* and include it in var. *quinquedentata*.

*Tritomaria quinquedentata* var. *quinquedentata* f. *quinquedentata* (*T. heterophylla* auct. non Schust. - Zhukova & Rebristaya 1986; Gribova & Potemkin 1988)

AT V; NT IV - V; ST: IV - V.

In wet, mainly moss, tundras, moss bogs, occasionally in late snow areas. Male and perianth bearing plants sporadic; seen once with mature capsules.

*Tritomaria quinquedentata* var. *quinquedentata* f. *gracilis* Schust.

AT: Belyy I, Khabeiya II, Tambey II; NT: Tiutey I, Bovanenkovo I, Neromayaha IV, Mantyto I, Marre Sale I, Saleteyaha 5, Yuribelttoyaha II, Khakhayayaha II, Lyakkotsoyo II; ST: Khutyayaha I, Khevesyo II, Laptayaha I.

On steep herb slopes, in spotty tundras, occasionally in moss bogs. Perianths and androecia very rare. Androecia from shortly to longly spicate, composed of 3 to 12 pairs of 1 - 2 - androus bracts; antheridia on 1 - seriate stalk (17)20 mkm in diam. Only one plant with perianth has been seen. Female bracts similar to sterile leaves but a little broader than long. Bracteole equal to bracts in length, lingulate, apiculate, coherent with them at base. Perianth pluriplicate, 2 - 3 - stratose at base, unistratose on the most of its length; its mouth lobulate, crenulate with solitary 1 - 2(3) - celled teeth ("var. *turgida*" type!).

This form of the species is most characteristic for "difficult sites". Smallest phases of it

may develop the individual bilobed leaves, which are not typical for the species. Potemkin (1990d, fig. 2) provides the illustration of this form by material from Yamal.

*Tritomaria quinquedentata* var. *grandigemma* Potemk.

[*T. quinquedentata* var. *grandigemma* Potemk. Bot. Zhurn. 75(12):1748, 1990, nom. invalid. (sine holotypo). Holotypus: Paeninsula Jamal, regio ripae sinistralis fl. Laptajaha adjacens (68° 20' lat. bor., 73° 15' long. orient.) in tundra Nanobetulosocaricosa muscosa, paludosa tumulis et demissionibus tecta, 23.VII.1979, O.V. Rebristaja (LE)] (*Tritomaria quinquedentata* auct. non (Huds.) Buch - Zhukova & Rebristaya 1986).

AT: Kharasavey I; NT: Matyuyaha I, Tiutey I, Bovanenkovo I, Sebayaha I, Khakhayayaha II; ST: Khutyayaha II, Khevesyo II, Laptayaha II, Er'yaha I.

In diverse moss, moss-lichen and dwarf shrub tundras. Often with gemmae; perianths and androecia rather rare.

The taxonomic status of var. *grandigemma* remains somewhat problematic. This variety is characterized by frequent production of comparatively large, ca. (17)22 - 29(31 - 34) x 16 - 20(25) mkm, 1 - 2(3 - 4) - celled gemmae and leaves with strongly gibbous sinuses. On the other hand the plants are usually subpellucid with cell size and oil-body number a little larger than in the type variety sensu stricto and somewhat resemble in this respect "var. *turgida*", the gemmae of which have never been described. I have, however, also never seen the gemmae of var. *quinquedentata* and, consequently, certain doubts arise about the constancy of their size, 15 - 20 mkm, which listed in all known literature.

This taxon as well as the type variety is polymorphous and varies from mod. *grandifolia-laxifolia-viridis* to mod. *parvifolia-subangustifolia-subaequiloba-colorata*. Plants of mod. *parvifolia-densifolia-subaequiloba-colorata-gemmipara* resemble very much *Tritomaria heterophylla*. They differ from this species in gemmae with usually round, weakly projecting angles (if the gemmae have acute, strongly projecting angles then cell walls in angles are weakly thickened);

smaller cells in leaf lobes (excepting the leaves with reduced lobes, resulting from intensive gemma production); somewhat less symmetric leaves; different type of the perianth mouth (ciliate-dentate vs crenulate-dentate). Potemkin (1990d, fig. 2) provides the illustration of this variety by material from Yamal.

#### ANASTROPHYLLUM (Spruce) Steph.

##### *Anastrophyllum saxicola* (Schrad.) Schust.

AT: Tambey II; NT: Matyuiyaha I, Mantyto I; ST: Khevesyo I, Kharangyneto 2.

In sedge-lichen, often wet tundras and in frost clefts and depressions of polygonal-frost cleft tundra, associated with *Barbilophozia binsteadii*, *B. kunzeana*, *Ptilidium ciliare*, *Tetralophozia setiformis*, etc. See also Potemkin (1990a).

##### *Anastrophyllum sphenoloboides* Schust.

NT: Matyuiyaha I, Neromayaha I, Mantyto I, Lyakkotosyo I; ST: Khutyaha I, Laptayaha I.

In wet moss and dwarf shrub-lichen nival tundras, on steep slope; growing in moss tufts associated with *Anastrophyllum minutum*, *Barbilophozia binsteadii*, *Lophozia ventricosa* s.l., *Ptilidium ciliare*, etc., but on thinly turfed soil - with *Cephalozia bicuspidata*, *Pleurocladula albescens*, *Anthelia juratzkana*, *Calycularia laxa* and *Gymnocolea inflata*. With gemmae, perianths and mature capsules.

The species rather often occurs on thinly turfed soil as mod. *parvifolia-colorata-gemmipara*. The plants of this modification are very small, 0.2 - 0.4 mm wide and 2 - 4 mm long, with thinner stem, 6 - 7 cells high; scattered and short teeth of perianth mouth, 1(2) cells long; antheridia on 1 - or 2 - seriate stalk; gemmae 1(2) - celled, 14 - 20 (23) x 12 - 17 mkm, from round to 3 - 4 - angulate, mostly with weakly projected angles, from faintly to deep purple; gemmiparous leaves usually strongly modified, dentate, as in *Lophozia bicrenata* (see Potemkin 1993b). Deviations from the description of the species by its author (Schuster 1969; Schuster & Damsholt 1974) that are mentioned above result mainly from the unfavorable conditions for growth on bare soil. Predominantly 1 - celled gemmae and

modified gemmiparous leaves result apparently from very abundant gemma production.

*Anastrophyllum sphenoloboides* may be confused with some forms of *A. minutum* developing purplish pigmentation. Such forms, however, have features typical of *A. minutum*: wide leaves, usually not longer than broad, with wide sinus; small, not prominent trigones and marginal cells considerably smaller than median.

##### *Anastrophyllum minutum* (Schreb.) Schust. var. *minutum* f. *minutum*

AT V; NT V; ST V.

The most common Yamal hepatic, occurring in diverse moss tundras, where it is more frequent among *Dicranum*, rarer in lichen and spotty tundras, and exceptionally on steep slopes. Sporadically with gemmae, perianth and androecia.

A polymorphous taxon. The most paradoxical deviations from phenotypes described earlier are phases from dry sites with *Anastrophyllum michauxii*-like squarrose antical lobes, that resemble very much *A. japonicum* Steph. phenotypes of *A. michauxii*. There are numerous transitional forms between these phases and typical *A. minutum*, however. The smallest phenotypes were found on exposed bare soil. They are only 0.25 mm wide and 2 - 3 mm long. Plants of mod. *parvifolia-sublaxifolia-colorata* somewhat resemble *Cephalozia arctica*, of mod. *parvifolia-densifolia-colorata* - *Gymnomitrium*.

##### *Anastrophyllum minutum* var. *minutum* f. *cuspidata* (Kaal.) Schust.

AT: Belyy I; NT: Matyuiyaha II, Bovanenkovo I, Neromayaha III, Mantyto I, Marre Sale I, Yuribeitoyaha I, Khakhayayaha I, Lyakkotosyo II; ST: Khutyaha III.

In wet and shade sites among mosses and lichens in diverse communities characteristic for the type form.

##### *Anastrophyllum minutum* var. *grandis* (Lindb.) Schust.

AT: Khabeiyaha I, Tambey II; NT: Matyuiyaha I, Tomboitosyo II, Neromayaha II, Mantyto I, Marre Sale II, Yuribeitoyaha III, Khakhayayaha II; ST: Khevesyo II, Laptayaha II, Kharangyneto 2, Er'yaha II.

In diverse tundras characteristic for the type variety, occasionally together with it. Schljakov (1980) noted that it is a form of

wet sites with comparatively poor nourishment. In Yamal, however, var. *grandis* is often associated with basiphilous taxa. For instance, in Yuribeitoyaha it was collected with *Scapania cuspiduligera*, *S. praetervisa*, *Tritomaria scitula*, *Lophozia heterocolpos*, *L. major*, *Odontoschisma macounii*, etc. Once (Laptayaha) with gemmae. Gemmae 3-angled to polygonal, brownish red and colourless mixed, 16 - 20(23) x 14 - 17(20) mkm.

This variety may be easily confused with *Anastrophyllum cavifolium*. It differs from this species in its small marginal leaf cells, which usually considerably smaller than median and often form a discrete border; more narrow cortical cells; rather regular, in crescentic rows, cell position in leaf lobes; not distinct, smaller trigones; fewer oil-bodies, etc. Unfortunately the separation of both taxa is complicated by occurrence of transitional forms with features of both taxa (cf. Zinovjeva 1969). So var. *grandis* may develop very concave and individual 3-lobed leaves as well as very thick stems, to 14 cells high, etc.

*Anastrophyllum cavifolium* (Buch & S. Arn.) Lammes

AT: Kharasvey I; NT: Neromayaha I, Mantyto I.

In moss (*Dicranum*) tundras, on tussock in yernik-sedge tussock bog with *Ptilidium ciliare*, *Anastrophyllum minutum*, *Tritomaria quinqueidentata*, *Barbilophozia kunzeana*, *Blepharostoma*, etc.

Subfam. MESOPTYCHIOIDEAE Schust.

MESOPTYCHIA (Lindb.) Evans

*Mesoptychia sahlbergii* (Lindb. & H. Arn.) Evans

ST: Khutyaha I.

In moss willow stand among *Drepanocladus* sp. and *Paludella squarrosa* with *Lophozia gillmanii*, *L. heterocolpos* var. *arctica*, *Plagiogochila porelloides*, *Aneura pinguis*, etc.

Subfam. JUNGERMANNIOIDEAE

JUNGERMANNIA L.

Subgen. JUNGERMANNIA

*Jungermannia pumila* With.

ST: Khevesyo I.

In moist dwarf shrub-sedge-moss tundra on

bare soil with *Cephalozia bicuspidata* and *Nardia geoscyphus*.

*Jungermannia polaris* Lindb.

AT: Belyy I, Khabeliyaha I, Tambey II, Kharasvey I; NT: Tiutey I, Yuribeitoyaha I, Khakhayayaha I; ST: Khevesyo I, Laptayaha II, Er'yaha I.

On spots in spotty tundras, rarely on bare soil on herb and nival slopes. Often with perianths, occasionally with mature capsules.

Subgen. SOLENOSTOMA (Mitt.) Amak.

*Jungermannia confertissima* Nees

AT: Tambey I; NT: Tomboitosyo I, Neromayaha I, Khakhayayaha I; ST: Khevesyo II, Laptayaha II, Er'yaha I.

On bare and thinly turfed soil in spotty lichen-moss tundras, wet herb-moss willow stands, on nival slope; associated with *Nardia geoscyphus*, *Cephalozia bicuspidata*, *C. pleniceps*, *Aneura pinguis*, *Blepharostoma*, *Lophozia grandiretis*, *Odontoschisma macounii*, *Tritomaria heterophylla*, *Cryptocolea imbricata*, *Anthelia juratzkana*, etc. Often with perianths, once with mature capsules.

*Jungermannia jenseniana* Grolle

NT: Khakhayayaha I; ST: Khevesyo II.

On spots of bare sandy ground in spotty dwarf shrub tundras with *Anthelia juratzkana*, *Marsupella sprucei*, *Prasanthus suecicus*, *Cephalozia bicuspidata*, *Nardia geoscyphus*, etc. Twice (Khevesyo) with perianths.

Yamal material of *Jungermannia jenseniana* is too sparse to form a true notion on this species. Phases without distinct red pigmentation are difficult to separate from *J. sphaerocarpa* var. *nana* also developing a perigynium. Differentiation from *J. confertissima* is more problematic. The main distinctive feature of the last species is rhizoid position. This character, however, is not very constant - rhizoids may migrate to ventral leaf base and perigynium in some forms of *J. sphaerocarpa* var. *nana* (Schuster & Damsholt 1974) and, moreover, in *J. jenseniana* itself - in an isotype of the species from JE (V. Schiffner. Hepaticae eur. exs. 1380. *Aplozia pusilla* C.Jens. Orig. Ex.!) leaves often detach with rhizoids. As a consequence, the problem of taxonomic status of *J. jenseniana* is critical.

***Jungermannia sphaerocarpa* Hook. var. *sphaerocarpa***

AT: Beiyi I; ST: Khevesyo III, Laptayaha I.

On bare ground of creek, river and lake banks with *Pleurocladula albescens*, *Cephalozia bicuspidata*, *Nardia geoscyphus*, *Lophozia* cf. *savicziae*, *L. opacifolia*, *Anthelia juratzkana*, *Blasia pusilla*, etc. Almost always with perianths, once with mature capsules.

***Jungermannia sphaerocarpa* var. *nana* (Nees) Frye & Clark (*Solenostoma pumilum* subsp. *polaris* auct. non (Lindb.) Schust. - Zhukova & Rebristaya 1986)**

AT: Belyi I, Tambey II, Kharasavey II; NT: Matyuiyaha II, Neromayaha I, Yuribetoyaha I, Khakhayayaha II; ST: Khevesyo IV, Laptayaha I.

On spots of bare ground in wet spotty tundras, rarer at the foot of steep herb and nival slopes and on banks of creeks and lakes. Almost always with perianths, often with mature capsules.

Small forms of *Jungermannia sphaerocarpa* var. *nana* are sometimes confused with *J. polaris*. They differ from the last species in their larger cells, especially marginal, which near leaf apex are at least 20 - 23(25) mkm (vs 15 - 17, rarely 21 mkm long in *J. polaris*); subrotund, plane or slightly concave, or, occasionally, weakly deflexed backward leaves, briefly decurrent dorsally and ventrally, oriented in parallel to stem and, consequently, jugged out of the ventral surface of the stem (in *J. polaris* leaves mostly ovate, widest at base, nondecurrent, concave, oriented distinctly at the angle to stem and never jugged out of the ventral surface of the stem).

*Jungermannia sphaerocarpa* var. *nana* in Yamal often develops a distinct low perigynium and the gametophyte lacks red or purplish pigmentation while capsules and spores are usually purplish or purplish brown.

The taxonomic status of *Jungermannia sphaerocarpa* var. *nana* is rather problematic. Quite possibly it is mainly an ecologically determined form of tundra and alpine regions (cf. Schuster 1969; Koponen et al. 1977).

Subgen. *PLECTOCOLEA* (Mitt.) Amak.***Jungermannia hyalina* Lyell (*Solenostoma******pumilum* auct. non (With.) K. Muell. - Zhukova & Rebristaya 1986)**

AT: Khabeliyaha I, Kharasavey I; NT: Matyuiyaha II, Saletayaha I, Khakhayayaha II; ST: Khutyayaha II, Khevesyo II, Er'yaha I.

In herb-moss, herb-horse-tail and sedge willow stands, at the foot of steep herb slope at margin of swampy sedge depression, on sandy bank, on degraded *Sphagnum*. Androecia, perianths and mature capsules rare. Reports of the species from the arctic tundra are northernmost known.

In Yamal *Jungermannia hyalina* occurs as mod. *laxifolia-leptoderma-iridis*, more rarely - mod. *laxifolia-mesoderma-subcolorata vel iridis*. The plants have pellucid, often strongly asymmetric leaves, longly decurrent dorsally; mostly colourless rhizoids, not rarely in distinct fascicles from ventral leaf bases; thin-walled medulla of stem; and sporadically rather low perigynium. While these characters are usually not mentioned for the species, they often occur in *J. hyalina* throughout its range (as was found in the course of investigation of numerous collections of the species in LE).

***Jungermannia obovata* Nees s.l. (*Jungermannia subelliptica* (Lindb. ex Kaal.) Lev.)**

AT: Khabeliyaha II, Kharasavey II; NT: Neromayaha I; ST: Khutyayaha I, Khevesyo III, Laptayaha II, Er'yaha I.

In dwarf shrub sedge-(cotton grass)-moss sedge-lichen-moss and diverse spotty tundras, on wet thinly turfed loamy soil near temporary water courses, in late snow areas, usually on thinly turfed soil, associated with *Anthelia juratzkana*, *Nardia geoscyphus*, *Jungermannia polaris*, *J. sphaerocarpa* var. *nana*, *Cephalozia bicuspidata*, *C. pleniceps*, *Scapania obcordata*, *Tritomaria heterophylla*, etc. Almost always with perianths, often with mature capsules.

**NARDIA S.Gray*****Nardia japonica* Steph.**

ST: Khutyayaha I.

In dwarf shrub-cotton grass moss tundra and on high-centered polygon, on bare loamy sandy soil with humus, associated with *Cephalozia bicuspidata*, *Gymnocolea inflata*

var. *acutiloba*, *Calycularia laxa* and *Nardia insecta*. Only male plants were found.

When the species grows with *Nardia insecta* it distinctly differs in smaller size (0.2 - 0.5 mm vs 0.5 - 1.6 mm wide); underleaves, which longer than the half of leaf length vs considerably shorter than the half of leaf length; and sex distribution (dioicous vs paroecious).

***Nardia geoscyphus* (De Not.) Lindb. var. *geoscyphus***

AT: Belyy II, Khabelyaha II, Tambey II, Kharasavey III; NT: Matyuyaha I, Tlutey I, Neromayaha IV, Sale-tayaha 4, Yuribetoyaha I, Khakhayayaha III, Lyakkot-syo I; ST: Khutyayaha III, Khevesyo V, Laptayaha V, Eryaha I.

In moist, more rarely in comparatively dry spotty tundras, on steep herb and nival slopes, on banks of diverse water courses and lakes, in bog communities; on sandy, loamy and peaty ground. The most common species of *Jungermannioideae* on the peninsula. Often with perianths and mature capsules.

***Nardia geoscyphus* var. *bifida* Schust.**

NT: Neromayaha I.

On loamy sand landslip nival slope with *Anastrophyllum minutum*.

***Nardia insecta* Lindb.**

NT: Mantyto I; ST: Khutyayaha II.

On high-centered polygon, yernik *Sphagnum* hummock and polygonal spotty-hummock dwarf shrub lichen tundra; on loamy and loamy sandy soil with humus, with *Cephalozia bicuspidata*, *Anthelia juratzkana*, *Gymnocolea inflata* var. *acutiloba*, *Jungermannia jenseniana*, *Gymnomitrium apiculatum*, *Marsupella sprucei*, *Nardia japonica* and *Lophozia ventricosa* s.l. With perianths and mature capsules.

Yamal phenotypes of the species are not typical. They usually have oval, rotund to reniform, strongly concave, entire or mostly retuse leaves; very deep pigmentation, from purplish brown to fuscous or purplish black. They share with typical plants paroecia; colenchymatous large cells with granulate oil-bodies; distinct squarrose underleaves with rhizoids in fascicles at base, frequently narrowly united with leaf bases on one side of stem; and sporophyte characteristics. Such

forms of the species may be confused with *Nardia scalaris*. They differ from it in sex distribution; granulate, not glistening oil-bodies; underleaves mostly connate with leaves bases on one side of stem; often somewhat larger cells. Moreover *Nardia scalaris* is principally an amphioceanic species. Individual reports of it from continental regions are apparently based on phenotypes of *N. insecta* with entire leaves.

**CRYPTOCOLEA Schust.**

***Cryptocolea imbricata* Schust. (Fig. 4: 5-6)**

AT: Khabelyaha I; ST: Khutyayaha I, Khevesyo II, Laptayaha II.

On bare ground in spotty tundras and on herb slopes, usually with *Tritomaria heterophylla*, *Nardia geoscyphus*, *Jungermannia confertissima*, *J. obovata*, *Cephalozia pleniceps*, more rarely with *Arnellia fennica*, *Jungermannia sphaerocarpa* var. *nana*, *Blepharostoma*, *Odontoschisma macounii*, *Tritomaria quinquentata*, *Prasanthus suecicus*, *Gymnomitrium corallioides*, and *Anthelia juratzkana*. Male and female plants not rare. For details see Potemkin (1990a).

**Subfam. MYLIOIDEAE Grolle**

**MYLIA S. Gray**

***Mylia anomala* (Hook.) S. Gray**

NT: Mantyto I; ST: Khutyayaha III, Khevesyo I.

In sedge-*Sphagnum* tussock-pool swampy tundras, on peat outcrop and on steep herb-dwarf shrub nival slope. Usually with *Barbilophozia binsteadii*, *B. kunzeana*, *Ptilidium ciliare*, *Cephalozia lunulifolia*, *C. bicuspidata*, *Scapania irrigua*, *Sphagnum* spp., etc. Twice with gemmae (Khutyayaha).

In Mantyto individual plants of mod. *parvifolia-densifolia-colorata* were collected on a nival steep slope on bare soil with *Pleurocladula albescens*, *Gymnomitrium concinatum*, *Cephalozia bicuspidata*, *C. pleniceps*, *Anastrophyllum minutum*, and *Lophozia* cf. *savicziae*. The plants are only 0.8 - 1.0 mm wide and about 3 mm long. They resemble *Nardia scalaris* rather than *Mylia*. Such unusual phases of the species differ from *Nardia scalaris* in the character of cross section of stem with regularly distinctly projecting, larger cortical cells, 60 - 80 x 45 - 60 mkm

(Schuster 1969, Figs. 260:8, 299:8); larger leaf cells, 48 - 56 x 28 - 46 mkm, and underleaves; and not persistent, more numerous oil-bodies of different structure.

### GYMNOMITRIACEAE Klinggr.

#### PRASANTHUS (Lindb.) Lindb.

After description of *Prasanthus jamalicus* (Potemkin 1992b) two species of the genus became known. They differ as follows:

#### KEY TO SPECIES OF *PRASANTHUS*

1. Minute (width of sterile shoots 200 - 350 mkm), purplish brown to purplish black, unglistering, with distant leaves on sterile shoots, resembling small species of *Nardia*; stolons rare; cell walls of sterile leaves thin; basal leaf cells mostly subisodiametric (length : width ratio - 1 : 1.5(2)), undifferentiated from median cells; thickenings of inner capsule wall layer nodular, often with semiannular bands in basal parts of valves; elaters 3(4) - spiral, exceptionally 2 - and 5 - spiral

...sectio *PSEUDONARDIA* Potemk., *P. jamalicus*

1. Small (width of sterile shoots 350 - 700 mkm), yellow to brown, very rarely the ventral part of the perigynium purplish; glistening, with imbricate, rarely subimbricate leaves; stolons common; cell walls of leaves thick; basal leaf cells mostly elongated (length : width ratio - 1 : 2 - 3), distinctly differentiated from subisodiametric median cells; thickenings of inner capsule wall layer semiannular; elaters 2 - spiral, exceptionally 3 - spiral.....sectio *PRASANTHUS*, *P. suecicus*

*Prasanthus jamalicus* Potemk. [Ann. Bot. Fennici 29:319, 1992]

NT: Khakhayaha I; ST: Khutyaha I.

In pure patches on exposed windswept sandy soil, in Khutyaha (Holotype) with small admixture of *Scapania* sp., *Prasanthus suecicus*, *Marsupella sprucei*, *Anthelia juratzkana*. With mature capsules.

#### *Prasanthus suecicus* (Gott.) Lindb.

AT: Belyy II, Khabeiyaha III, Tambey II, Kharasavey II; NT: Matyuyaha II, Neromayaha III, Saletayaha 4, Yuribeitoyaha I, Khakhayaha III, Lyakkotosyo I; ST: Khutyaha III, Khevesyo IV, Laptayaha III, Kharangneto I, Er'yaha II, Khadytayah 2.

In spotty and lichen tundras, steep thinly

turfed slopes, on exposed windswept sandy soil. Usually fertile, often with mature capsules.

#### MARSUPELLA Dum.

#### *Marsupella sprucei* (Limpr.) H. Bern.

AT: Khabeyaha I, Tambey I; NT: Matyuyaha I, Neromayaha II, Saletayaha 5, Khakhayaha II, Lyakkotosyo I; ST: Khutyaha II, Khevesyo III, Laptayaha I, Er'yaha I, Khadytayah 2.

Usually individual plants on windswept sandy soil in spotty tundras, steep slopes, and other similar sites, associated mostly with *Prasanthus suecicus* and *Gymnomitrium corallioides*. Almost always fertile, sporadically with mature capsules.

#### GYMNOMITRION Corda

*Gymnomitrium apiculatum* (Schiffn.) K. Muell. (*G. corallioides* auct. non Nees - Gribova & Potemkin 1988)

AT: Belyy I, Tambey I; NT: Matyuyaha II, Tombotosyo I, Saletayaha I; ST: Khutyaha I, Khevesyo I, Laptayaha I.

On nival north-facing sandy slopes, in herb-willow *Gymnomitrium* and dwarf shrub-lichen tundras on sandy soil, associated with the other regional Gymnomitriaceae, *Anthelia juratzkana*, *Lophozia* cf. *savicziae*, *L. opacifolia*, *Cephalozia bicuspidata*, *Pleurocladula albescens*, and *Diplophyllum taxifolium*. Once (*Matyuyaha*) with perianth.

The species occurs in Yamal in two phases: *Gymnomitrium corallioides*-like, dorsiventrally compressed, with very dense, often hardly discernible leaves and the other phase, resembling more *Gymnomitrium concinatum*, almost not dorsiventrally compressed, with more distant, distinctly discernible leaves. As a consequence it often difficult to identify the species for sure in the course of superficial investigation of specimens under a dissecting microscope, especially because it very rarely develops red pigmentatioin in Yamal. *G. apiculatum* differs from *G. concinatum*, when sterile, in the shallower and wider, obtuse-angled sinus; thin-walled marginal cells, erose at least on old leaves; smooth cuticle; apiculate lobes, with thin-walled, quickly erose, not permanent apiculi of 2 superimposed cells (in *G. concinatum* they are thick-walled, not erose, permanent, while

sometimes very similar in form), etc. The main distinctive features from *G. corallioides* are the following: apiculate leaf lobes (discernible on young leaves); wide sinus; thinner-walled leaf cells.

*Gymnomitrium concinatum* (Lightf.) Corda

AT: Belyy III, Khabeiyaha I, Tambey II; NT: Matyuyaha II, Tlutey I, Mantyo I, Khakhayayaha I; ST: Khutyayaha II, Khevesyo II, Kharangyneto I, Er'yaha I, Khadytayaha 3.

In spotty (often *Gymnomitrium*) tundras, on steep slopes, late snow areas, etc., on sandy and loamy ground. Male plants and plants with mature capsules sporadic.

*Gymnomitrium concinatum* differs from the two other regional representatives of the genus in its narrow and more deep sinus; faintly but distinctly papillose cuticle; and not erose while often decolorate leaf margins. The species varies from mod. *subdensifolia-viridis* to mod. *densifolia-fusca*.

*Gymnomitrium corallioides* Nees

AT: Belyy IV, Khabeiyaha IV, Tambey IV, Kharasavey III; NT: Matyuyaha II, Tlutey 2, Neromayaha IV, Marre Sale I, Saletayaha 10, Yuribeitoyaha I, Khakhayayaha III, Lyakkotosyo I; ST: Khutyayaha IV, Khevesyo III, Laptayaha II, Kharangyneto 3, Er'yaha II, Khadytayaha 3.

Usually in spotty sedge-lichen and sedge-*Racomitrium*-lichen tundras, where it is a dominant taxon on spots (in this connection these tundras are named *Gymnomitrium* or *Gymnomitrium-Racomitrium* tundras). Male plants and plants with mature capsules are sporadic. The species varies from mod. *densifolia-colorata* (on exposed sites) to mod. *subdensifolia-viridis* (in shade).

SCAPANIACEAE Migula

SCAPANIA (Dum.) Dum.

Subgen. *JENSENIA* S. Arn.

*Scapania obcordata* (Berggr.) S. Arn.

AT: Belyy III, Khabeiyaha II, Tambey II; NT: Matyuyaha I, Bovanenkovo I, Neromayaha II, Yuribeitoyaha II, Khakhayayaha II; ST: Khutyayaha II, Khevesyo III.

In diverse moist moss tundras, near temporary water courses, on steep herb and nival slopes, in sedge-moss bogs with flowing water, and on peat outcrop. Usually with gemmae or with traces of gemmae on modified leaves, sporadically with androecia and perianths.

*Scapania obcordata* is an extremely variable species, which, when growing on exposed bare soil usually develops mod. *parvifolia-subaequiloba-colorata* but in shade and moist conditions produces the phenocopies of *S. irrigua*. The latter phenotypes differ from *S. irrigua* in stem anatomy, character of the cell net at base and near apexes of leaves (see Schuster 1974; Schljakov 1981), peculiar modification of gemmiparous leaves, and gemmae and oil-bodies characteristics. Oil-bodies in *S. obcordata* are often with a more or less distinct central droplet (Schuster 1974, Fig. 346: 2).

Subgen. *KAALAASIA* Buch

*Scapania gymnostomophila* Kaal. f. *gymnostomophila*

NT: Yuribeitoyaha I.

In cleft on spot in spotty-cleft tundra with *Lophozia heterocolpos*, *L. major*, *Barbilophozia quadriloba* f. *glareosa*, *Tritomaria quinquedentata* f. *gracilis*. With gemmae.

Transitional forms to *Scapania gymnostomophila* f. *incurva* were found. It confirms the supposition of H. Persson (1946) and Schuster (Schuster et al. 1959) that "*Diplophyllum incurvum* Bryhn & Kaal." is a peculiar form of *Scapania gymnostomophila* characteristic for exposed sites.

*Scapania gymnostomophila* f. *incurva* (Bryhn & Kaal.) Schust.

NT: Yuribeitoyaha II.

On bare soil in willow-*Dryas* spotty tundra with *Arnellia fennica*, *Tritomaria scitula*, *Lophozia heterocolpos*, *L. badensis*, and *Barbilophozia quadriloba* f. *glareosa*.

*Scapania gymnostomophila* f. *incurva* resembles very much *S. calcicola* (H. Arn. & Perss.) Ingh. subsp. *ligulifolia* (Schust.) Damsh. & Long, differing from this taxon in its smaller gemmae and number of oil-bodies which are usually 1 - 2 per median cell.

Subgen. *BUCHIELLA* Schust.

*Scapania zemljae* S. Arn (? *S. invis*a Schust.)

AT: Belyy I; NT: Tomboitosyo I, Neromayaha III, Khakhayayaha II; ST: Khutyayaha II, Khevesyo II, Laptayaha II.

Usually on spots in spotty tundras, occasionally on thinly turfed sandy soil, associated mostly with *Gymnomitrium coralloides*, *Prasanthus suecicus*, *Cephaloziella arctica*, *Anthelia juratzkana*, *Lophozia alboviridis*, *L. excisa*, *Marsupella sprucei*, *Nardia geoscyphus*, etc. In Belyy the species was collected, however, in association with mainly basiphilous hepatics: *Lophozia heterocolpos* var. *harpanthoides*, *Barbilophozia quadriloba*, *Jungermannia polaris*, *Cephaloziella arctica*, and *Odontoschisma macounii*. Always with gemmae, occasionally with androecia, once with perianth (Khakhayayaha). For descriptions of male plants and characteristic of gemmae see Potemkin (1993b).

The species is assigned here to subgenus *Buchiella* rather tentatively. Sterile plants of *Scapania zemljae* have much in common with the type species of the subgenus - *S. cuspiduligera*: erect and sheathing, often widely 2(3) - stratose leaf base; ability to develop a border of smaller thick-walled marginal cells; colourless to red and brown, 2 - celled gemmae; not persistent oil-bodies; decurrent ventral leaf margin, etc. (Widely 2(3) - stratose leaf bases have not been noted previously for the species; this character was found during investigation of original collections of O. Ekstam from Novaya Zemlya, including the type of the species (Novaya Zemlya, S. Island, Sinus Karmakulski, O. Ekstam, 3.09. 1901) and of Yamal materials). The structure of the perianth (which has been seen only once) is different from that of *S. cuspiduligera*, however. The perianth is pluriplicate in its upper part, with (3)4 deep plicae descending to the base. The mouth is bleached, dentate, with bluntish to triangular teeth with a uniseriate apiculus of 1 - 2(3) subsodiametric cells; the larger teeth arise from a base 3 - 4(5) cells broad. The perianth characteristics separate *S. zemljae* from *S. cuspiduligera*. But these differences cannot be evaluated firmly on the basis of only one collection. Additional collections of plants with perianths are needed for the elucidation of the taxonomic position of this species.

*Scapania cuspiduligera* (Nees) K.Muell.  
var. *cuspiduligera*

AT: Khabelyaha I; NT: Matyuiyaha I (Zhukova & Rebristaya 1986), Marre Sale 2, Yuribeitoyaha III; ST: Laptayaha I.

In herb-moss and horse-tail willow stands, sedge-yernik-willow tundra, associated with *Blepharostoma*, *Tritomaria quinquedentata*, *T. scitula*, *Lophozia heterocolpos*, *L. major*, *Barbilophozia quadriloba* f. *glareosa*, *Anastrophyllum minutum* var. *grandis*. Always with gemmae, which are 2 - celled and almost invariably yellowish brown with a deeper pigmented septum.

Comparative abundance of the species was mentioned only in Yuribeitoyaha where the manifestations of its variability from common mod. *laxifolia-viridis* (plants to 10 mm long and 3 mm wide) to mod. *parvifolia*-(*densifolia*)-*colorata* (plants about 2 mm long and 0.7 mm wide) were observed. Plants of the last modification differ considerably from typical forms as was noted by Schuster also (Schuster et al. 1959). They have deep fuscous (rarely brown) pigmentation; leaves with unequal, occasionally shortly apiculate lobes, sporadically with individual obtuse teeth formed mostly by projecting angles of marginal cells. The border is present only when marginal cells are bleached. Its absence correlates with development of deep fuscous pigmentation. Cells are considerably smaller, median 14 - 17 mkm, marginal 10 - 17 mkm, occasionally with rough striolate cuticle (elongated papillae to 3 - 4 mkm wide and 10 - 15 mkm long). Sheathing of the stem by leaf bases as well as long ventral decurrence are not distinct, especially in mod. *densifolia*. Such phenotypes are usually connected with typical ones by transitional forms. They have characteristic bleached ventral leaf bases and modified apexes of gemmiparous leaves, brown, 2 - celled gemmae and, according to Schuster & al. (1959), brown, big oil-bodies, (1)2 - 4(5 - 6) per cell.

*Scapania cuspiduligera* var. *diplophyllopsis*  
Schust.

NT: Neromayaha II.

In yernik-willow and lichen tundras, on loamy soil with humus, associated with *Jungermannia obovata*, *Nardia geoscyphus*,

*Anthelia juratzkana*, *Lophozia jurensis*, *L. major*, *L. heterocolpos*, *Ptilidium ciliare*, *Blepharostoma*, *Barbilophozia hyperborea*, *B. quadriloba*, *Tritomaria quinquedentata*, *T. exsectiformis*, *Cephaloziella rubella* subsp. *arctogena*. Always with gemmae, once with androecia (for description of androecia see Potemkin (1993b)).

Until now the range of variability and distinctive features of this variety remain not quite clear. A *Diplophyllum taxifolium* - like ventral lobe is not a constant character. Gemma production often leads to reduction of the ventral lobe, resulting occasionally in leaves with almost equal lobes. I think, the most important criteria, differentiating this variety from var. *cuspiduligera*, is the gemmae, green until near maturity, then becoming brown, and leaf lobes often with few, small sharp denticulations and a 1-celled mucro.

#### Subgen. SCAPANIA

##### *Scapania curta* (Mart.) Dum. var. *curta*

AT: Belyy I (Zhukova & Rebristaya 1987), Khabelyaha I, Tambej I, Kharasavey I; NT: Neromayaha II, Mantyto I, Yuribeitoyaha I, Khakhayayaha I; ST: Khutyayaha I, Khevesyo II, Laptayaha II, Er'yaha I.

In dwarf shrub-moss and spotty tundras, at the foot of herb and nival slopes, in flat-polygon and sedge-moss bogs, on peat outcrop. Occasionally with gemmae, once with perianth (Er'yaha).

##### *Scapania curta* var. *grandiretis* Schust.

NT: Khakhayayaha II; ST: Khutyayaha II.

In late snow areas, tussock bog, tussock moss tundra, associated with *Tritomaria quinquedentata* f. *gracilis*, *Nardia geoscyphus*, *Jungermannia confertissima*, *Lophozia opacifolia*, *L. cf. savicziae*, *Anthelia juratzkana*, *Cephalozia bicuspidata*, *Scapania curta* var. *curta*, etc. Usually with gemmae, once with perianths (Khakhayayaha).

##### *Scapania scandica* (H. Arn. & Buch) Macv. var. *scandica* (*S. parvifolia* Warnst.; *S. mucronata* auct. non Buch - Potemkin 1989)

AT: Belyy II, Khabelyaha II, Tambej III, Kharasavey II; NT: Matyuyaha II, Tomboitosyo I, Neromayaha III, Mantyto I, Marre Sale I, Saletayaha I, Yuribeitoyaha I, Khakhayayaha II; ST: Khutyayaha V, Khevesyo V, Laptayaha III, Kharangyneto 2, Er'yaha II, Khadytayaha I.

In diverse tundra communities formed by mosses, lichens, sedges, grasses and dwarf shrubs, on spots in spotty tundras, in late snow areas, occasionally in bogs composed of sedge, cotton grass and mosses (mainly by species of *Drepanocladus*, *Hypnum*, *Sphagnum*). It is the most widespread taxon of the genus in Yamal. Often with gemmae, sporadically with androecia and perianths. For details on this and the other varieties of the species see Potemkin (1993a).

##### *Scapania scandica* var. *argutedentata* Buch ST: Khevesyo I.

At base of steep herb slope and on moist loamy scarp with *Lophozia opacifolia*, *L. cf. savicziae*, *Blasia pusilla*, *Nardia geoscyphus*, *Jungermannia sphaerocarpa*, *Anthelia juratzkana*, *Cephalozia bicuspidata*, *C. pleniceps*, *Pleurocladula albescens*. With gemmae, androecia, perianths and mature capsules. Illustrations in Potemkin (1993a).

##### *Scapania scandica* var. *grandiretis* (Schljak.) Schljak.

AT: Kharasavey I; NT: Neromayaha I, Khakhayayaha I.

On spots in spotty tundras, on margin of lake and in nival tundra shortgrass meadow; associated with *Scapania scandica* var. *scandica*, *S. curta*, *Cephalozia bicuspidata*, *Lophozia ventricosa* s.l., *L. excisa*, *L. wenzelii*, *L. major*, *Anastrophyllum minutum*, *Nardia geoscyphus*, etc. With gemmae and androecia.

##### *Scapania mucronata* Buch

NT: Khakhayayaha I.

On bare loamy sandy ground in spotty hillock yernik tundra with *Cephaloziella arctica*, *Cephalozia bicuspidata*, *Odontoschisma macounii*, *Anthelia juratzkana*, *Scapania cf. obcordata*. With gemmae. This report is based on sparse material. The species is represented by mod. *parvifolia-colorata-gemmipara*. Nevertheless the plants are quite typical: brownish, without any traces of red or purplish pigment, with undifferentiated marginal leaf cells and rather short keel, < 0.5 the ventral lobe in length. In spite of intensive gemma formation the leaf margins are entire.

**Scapania praetervis** Meyl.

AT: Belyy I, Khabelyaha I, Tambey I, Kharasavey II; NT: Matyuyaha I, Tomboitosyo II, Neromayaha II, Lyakkotosyo II; ST: Khutyaha I, Laptayaha I.

In diverse moss, dwarf willow-moss tundras, polygonal dwarf shrub-lichen-*Gymnomitrium* and dwarf shrub-moss-lichen tundras, high-centered polygon and in grass-sedge tundra. Often with gemmae, once with androecia and juvenile perianths.

**Scapania irrigua** (Nees) Nees var. *irrigua* f. *irrigua*

AT: Belyy III (Zhukova & Rebristaya 1987), Khabelyaha I, Kharasavey I; NT: Matyuyaha II, Bovanenkovo I, Tomboitosyo I, Neromayaha I, Saletayaha I, Khakhayaha I; ST: Khutyaha III, Khevesyo III, Laptayaha III, Khadytayah I.

In diverse moist sedge-moss tundras, moss-cotton grass and sedge bogs, near banks of water courses and lakes, etc. Gemmae, androecia and perianths rare.

**Scapania irrigua** var. *irrigua* f. *rubescens* (Buch) Schust.

NT: Mantyto I.

In sedge bog. With androecia.

**Scapania irrigua** var. *rufescens* (Loeske) Loeske

NT: Bovanenkovo I.

In cotton grass-sedge-hypnum bog, among *Calliargon sarmentosum*.

**Scapania degenii** Schiffn. ex K. Muell. (*S. hyperborea* auct. non Joerg. p.p. - Potemkin 1989)

NT: Khakhayaha II.

In willow-sedge lichen-moss and sedge-*Hylocomium* tundras, associated with *Ptilidium ciliare*, *Tritomaria quinquedentata*, *Blepharostoma*, *Cephaloziella arctica*, *Lophozia heterocolpos*, *Scapania cuspiduligera*, and *Anastrophyllum minutum*.

Yamal plants represent mod. *grandifolia-integrifolia* - *colorata* - *egemmipara*. Potemkin (1989) attributed them to *Scapania hyperborea* because of the absence of gemmae, occasionally dorsally arched leaves with entire margins and usually not apiculate lobes of which the dorsal is comparatively large. An analysis of the Yamal specimens of *S. degenii* and the specimen from Arctic Alaska determined by W. C. Steere July 22,

1951, which contains plants without gemmae, with dorsally arched, entire margined leaves as well as rather typical plants with gemmae and dentate leaf margins, showed that leaf teeth formation in the species correlates with gemma formation, resulting in apiculate leaf lobes, of which the ventral often becomes more narrow.

Phenotypes of *Scapania degenii* without gemmae differ from *S. hyperborea* in the following features: 1) oil-bodies usually persistent in drying; 2) keel distinctly shortly winged (a winged keel is an exception in *S. hyperborea* - I have never seen it in arctic plants of the species, while K. Mueller (1951 - 58) mentioned it); 3) semicircular (vs irregular) cell position in leaf lobes; 4) the often 3 - stratose cortex (vs 1 - 2 - stratose, only exceptionally 3 - stratose) (for evaluation of the last character it is necessary to take into account habitat conditions).

**Scapania hyperborea** Joerg. (incl. f. *subaequalis* Schust.; ? *S. brevicaulis* auct. non Tayl. - Zhukova & Rebristaya 1986)

AT: Belyy I, Khabelyaha II, Kharasavey I; NT: Matyuyaha I, Bovanenkovo I, Tomboitosyo I, Neromayaha I, Mantyto I, Yuribetoyaha I; ST: Khutyaha II, Khevesyo I.

In sedge bogs and tundras (often of nival type), herb nival communities, in moss (*Hylocomium*, *Dicranum*) and moss-lichen tundras, on sandy margin of lake; often on sandy ground. Sporadically with gemmae, which vary in coloration from pink, purple and violet to fuscous, reddish fuscous and purple blackish fuscous; once with androecia. For characteristics of reproduction of the species by gemmae and for consideration of status of f. *subaequalis* see Potemkin (1993b).

*Scapania hyperborea* is an extremely malleable species represented in the Arctic by numerous phenotypes which in details were described by Schuster (1974) and Schuster and Damsholt (1974). Most paradoxical of them is the *Scapania helvetica*-phenotype. The plants reported from Yamal as *S. brevicaulis* Tayl. (Zhukova & Rebristaya 1986) apparently should be attributed to this phenotype. They are very small, brownish pigmented with bistratose

keel at least in basal half of leaves and very characteristic for the species broadly oval to almost spheric pinkish to purple 2-celled gemmae.

*Scapania tundrae* (H. Arn.) Buch (*S. pulcherrima* Schust. syn. nov.)

AT: Belyy I, Kharasavey I; NT: Matyuyaha II, Bovanenkovo I, Tomboitosyo I, Neromayaha III, Mantiyo II, Saletayaha I, Khakhayayaha II; ST: Khutyayaha IV, Khevesyo II.

In sedge, sedge-moss and moss-cotton grass bogs, late snow areas, hummock dwarf shrub sedge-lichen-moss and tussock dwarf shrub *Dicranum* tundras, on sandy margin of lake, at the foot of *Sphagnum* tussocks on margin of lake, usually on sandy soil, often with *Scapania hyperborea*. Sporadically with gemmae. For information about leaf modifications that result from gemma formation see Potemkin (1993b).

After investigation of Yamal collections of *Scapania tundrae*, including some *S. pulcherrima*-like phenotypes (mainly from Khutyayaha, sedge-*Sphagnum* tussock bog, July 30, 1977, E. N. Andrejeva, N 49) and numerous transitional forms to *S. tundrae* phenotypes, I think that *S. pulcherrima*, described from West Greenland (Schuster 1974), represents a form of *S. tundrae*, developing in peculiar ecological conditions.

While Schuster (1974) considers that *Scapania pulcherrima* "exhibits the same relationships to *S. degenii* as does *S. tundrae* to the *S. irrigua-hyperborea* complex", I can not agree with this statement. *S. pulcherrima* differs from *S. degenii* in its not persistent and smaller oil-bodies; pigmentation and broadly oval shape of its 2-celled gemmae; presence of coarse, irregular broad-based teeth; ecological behaviour; etc. On the other hand, all distinctive features of *S. pulcherrima* or tendencies for their manifestation occur in diverse phenotypes of *S. tundrae*. *S. pulcherrima* shares with *S. tundrae* cell size, oil-body and gemma characteristics, and ecological behaviour. Such features as short, winged and semicircular curved keel, minutely papillose-verruculose cuticle and vinaceous pigmentation of ventral leaf bases occur more or less often also in Siberian plants of *S.*

*tundrae* (cf. Mueller 1951 - 58, Fig. 347: a, b). Schuster (l.c.) characterizes the leaves of *S. tundrae* as entire-margined or bearing scattered small teeth associated with gemma formation. However, the tendency to develop the crooked margin with solitary obscure broad-based teeth or marginal projections not associated with gemma formation is clear from his Fig. 407. This feature is rather common for Siberian plants of the species and gives them a rather peculiar appearance. It is not difficult to imagine the transformation of such marginal projections into irregular broad-based teeth of *S. pulcherrima*.

*Scapania paludicola* Loeske & K. Muell. var. *rotundiloba* Schust. (*S. paludicola* var. *paludicola* auct. non Loeske & K. Muell. - Gribova & Potemkin 1988)

AT: Belyy I, Tambey I, Kharasavey II; NT: Matyuyaha II, Bovanenkovo I, Tomboitosyo II, Neromayaha III, Mantiyo I, Marre Sale 3, Khakhayayaha II, Lyakkotosyo I; ST: Khutyayaha II, Khevesyo IV, Laptayaha I, Kharangyneto 2, Er'yaha II, Khadytayaha I.

In sedge, *Sphagnum*, sedge-*Sphagnum* and moss-cotton grass bogs, in moist dwarf shrub-sedge-moss, grass-sedge, cotton grass and dwarf shrub-*Sphagnum*-cotton grass tundras, near water courses and lakes, etc. Rarely with androecia and gemmae, once with perianth. Modifications of gemmiparous leaves are like those in *S. hyperborea* (Potemkin 1993b).

Variety *rotundiloba* is characterized by obtuse to rotund edentate leaf lobes and reddish gemmae. Vinaceous red pigmentation of ventral leaf bases is usually absent in Yamal plants. Only a few collections of the variety were investigated in a fresh state, and oil-bodies were usually (5)6 - 8(10) per cell and 3 - 7 mkm in diam. The level of genetic separation of var. *rotundiloba* from the type variety is not clear and its taxonomic status needs investigation.

*Scapania* cf. *kaurinii* Ryan.

ST: Khevesyo I.

At the foot of peat outcrop in flat-centered polygon with *Calycularia laxa*, *Scapania scandica*, and *Marchantia polymorpha*.

This report is based on sparse sterile material. The plants are mod. *parvifolia-colorata* of the species. They are assigned to *Scapania kaurinii* on the following criteria: 1) leaf lobes subequal, characteristically dorsally arched and adaxially concave in better developed plants; 2) keel distinct, stiff, 2(3) - stratose throughout; 3) cortex 1 - 2 - stratose, distinctly differentiated, of very thick-walled cells; 4) trigones moderate, straight-sided to faintly bulging. These characters separate the plants under consideration from all small phases of the extremely variable *S. hyperborea* and from other species of section *Irrigua* (K. Muell.) Buch that sometimes resemble *S. kaurinii*.

*Scapania uliginosa* (Lindenb.) Dum. s. str.

AT: Belyy I; NT: Neromayaha I; ST: Khutyaha I, Khevesyo I.

In grass-sedge, sedge-moss and cotton grass sedge bogs usually with flowing water, among species of *Drepanocladus*, *Calliergon*, *Sphagnum*, *Meesia*, *Paludella squarrosa*, *Aulacomnium turgidum* and associated with *Chiloscyphus fragilis*, *Gymnocolea inflata*, *G. fasciniifera*, *Cladopodiella fluitans*, *Scapania hyperborea*, etc. Once with androecia.

Yamal plants are not quite typical. Leaf cells often develop prominent trigones and a punctate-papillose to striolate cuticle at the leaf base. Purple pigmentation occurs usually only near the ventral leaf base.

*Scapania subalpina* (Nees ex Lindenb.) Dum.

AT: Belyy I (Zhukova & Rebristaya 1987).

In pool of sedge-moss bog.

*Scapania crassiretis* Bryhn

AT: Kharasavey I; NT: Lyakkotosyo I; ST: Khevesyo III.

In moist grass-sedge-dwarf shrub-moss, dwarf shrub-lichen-moss, grass-cotton grass and grass spotty tundras, more often on moist bare ground, associated with *Tritomaria quinquedentata*, *Anastrophyllum minutum*, *Barbilophozia kunzeana*, *B. binsteadii*, *Ptilidium ciliare*, *Cephalozia bicuspidata*, *Scapania paludicola* var. *rotundiloba*, *S. scandica*, *Odontoschisma ma-*

*counii*, *Lophozia ventricosa* s.l., etc. Often with gemmae. On bare soil *Scapania crassiretis* often develops mod. *densifolia-colorata* with leaves often rather briefly decurrent ventrally. These plants can be confused with *S. degenii*. A principal difference of these species is different keel-stem angles in the same insolation conditions: in forms of *S. crassiretis* from exposed sites the keel-stem angle in the distal part of the keel does not exceed 110°, but in *S. degenii* it is up to 160 - 185°; in shade they are 80 - 90° and 100 - 120° respectively (cf. Schuster 1974). Moreover the keel of *S. crassiretis* is usually almost straight in distal part vs more or less arched in *S. degenii*; marginal teeth of *S. crassiretis* are mostly uniseriate with a strongly elongated apical cell (excepting the mod. *subintegrifolia-egemmipara* which has weakly developed, solitary, 1 - celled, slightly elongated teeth) vs with slightly elongated apical cell, often with two cells at base; cells with coarse nodulose trigones in *S. crassiretis* vs moderate, more or less bulging trigones in *S. degenii*.

*Scapania simmonsii* Bryhn & Kaal.

NT: Yuribeitoyaha II.

On bare ground in herb-dwarf shrub moss tundra, on hummock in sedge-willow-moss hummock tundra, in moist depression in hummock-pool sedge-yernik-willow tundra, associated with *Ptilidium ciliare*, *Blepharostoma*, *Odontoschisma macounii*, *Anastrophyllum minutum*, *Barbilophozia quadriloba* f. *glareosa*, and *Tritomaria quinquedentata*.

Together with typical plants some weakly developed shoots were found. They represent mod. *laxifolia-parvifolia-integrifolia-subcolorata* and mod. *parvifolia-angustifolia-integrifolia-colorata*. Plants of the last modification are only 0.6 mm wide and 2 mm long and resemble very much the species of the sectio *Curtae* (K. Muell) Buch. They have plane leaves; cells with moderate, only sporadically nodulose trigones; a comparatively weakly papillose cuticle; and stem with a distinctly differentiated, 1(2) - stratose, blackish cortex of thick-walled cells.

## DIPLOPHYLLUM (Dum.) Dum.

*Diplophyllum taxifolium* (Wahlenb.) Dum.  
var. *macrosticta* Buch

AT: Belyy V, Kharasavey II; NT: Mantyo II; ST: Khutyaha I, Laptayaha III.

Predominantly in late snow areas mostly on sandy, exceptionally on loamy, ground, sporadic in some moss, moss-lichen, herb, sedge and cotton grass tundras. According to Zhukova & Rebristaya (1987) in Belyy the species occurs in communities on sandy, loamy and peaty ground. Gemmae rare.

The distribution of the species in Yamal is not uniform: in many localities it is absent or rare, but in Belyy it is common species with rather wide ecological amplitude.

## GEOCALYCACEAE Klinggr.

Subfam. *LOPHOCOLEOIDEAE* Rodway

## CHILOSCYPHUS Corda

Subgen. *LOPHOCOLEA* (Dum.) ?Engel & Schust.

*Chiloscyphus minor* (Nees) Engel & Schust. (*Lophocolea minor* Nees)

NT: Neromayaha I; ST: Khytyyaha I.

In *Sphagnum*-sedge, herb-moss and lichen willow stands on humus, associated with *Scapania curta*, *Cephalozia bicuspidata*, *C. pleniceps*, *Blepharostoma*, etc. With gemmae.

Plants from Neromayaha (lichen willow stand) are very small to medium in size, from 130 mkm to 1000-1500 mkm wide. The smallest phases have an almost transverse leaf orientation on the stem. Gemmae occur in small quantity only on occasional plants. They become free 2-celled, more rarely in 3- or 4-celled more or less globose bodies.

Subgen. *CHILOSCYPHUS*

Although *Chiloscyphus pallescens* (Ehrh. ex Hoffm.) Dum. was reported previously for the peninsula (Andrejeva 1981; Zhukova & Rebristaya 1986, 1987; Gribova & Potemkin 1988) I have found no typical plants of this species in investigated specimens. I consider all earlier reports doubtful also because of the chromosome investigation of arctic *Chiloscyphus* (Steere & Inoue 1978), that showed that large-celled *Ch. pallescens*-like arctic phenotypes have 9, not 18 chromosomes and should be attributed to *Ch.*

*polyanthos* rather than to *Ch. pallescens*.

For differentiation of *Chiloscyphus pallescens* s.l. and *Ch. polyanthos* s.l. oil-body characteristics may be useful. According to Schuster (1980) oil-bodies of *Ch. polyanthos* are (1)2, more rarely 3-4(5) per cell, large: 4-5 x 7-12 mkm to 6-7 x 8-12(18) mkm vs in *Ch. pallescens* mostly 3)4-6(10-12) to 8-12 per cell, smaller: spherical 4-5.5 mkm, oval 4-4.5(5) x 8-9(10-11) mkm.

Unfortunately all Yamal specimens of *Chiloscyphus* were studied without oil-bodies. I retain *Ch. fragilis* as a species because most Yamal specimens very good fit to it and consequently almost no doubts were arisen during the investigation of the Yamal materials. Nevertheless the status of this species should be revised in the future on the basis of not only morphological but biochemical and chromosome characters.

*Chiloscyphus fragilis* (A.Roth) Schiffn. (*Ch. pallescens* auct. non (Ehrh. ex Hoffm.) Dum. - Andrejeva 1981; Zhukova & Rebristaya 1986, 1987; Gribova & Potemkin 1988)

AT: Belyy I, Khabeiya II, Tambey II, Tirvyaha I, Kharasavey II; NT: Matyuyaha I, Bovanenkovo I, Tomboitosyo II, Neromayaha III, Marre Sale II, Yuribetoyaha II, Khakhayaha II; ST: Khutyaha I, Khevesyo II, Er'yaha I.

Usually in sedge and cotton grass bogs, moist sedge and cotton grass tundras, moss willow stands, etc. Once with mature capsules.

## PLAGIOCHILACEAE (Joerg.) K. Muell.

PLAGIOCHILA (Dum.) Dum.

*Plagiochila asplenioides* (L.) Dum. subsp. *porelloides* (Torrey ex Nees) Schust. (incl. f. *subarctica* (Joerg.) Schust.; *P. arctica* auct. non Bryhn & Kaal. - Andrejeva 1981)

NT: Bovanenkovo 2; ST: Khutyaha II.

In *Equisetum*-moss, moss and flood plain willow stands, hummock moss-dwarf shrub tundra, sedge bog; associated with *Drepanocladus uncinatus*, *Mesoptychia*, *Lophozia gillmanii*, *Aneura pinguis*, *Pellia neesiana*, etc.

## ARNELLIACEAE Nakai

ARNELLIA Lindb.

**Arnellia fennica** (Gott.) Lindb.

NT: Matyuyaha I, Yuribeitoyaha III; ST: Khevesyo I, Laptayaha III, Kharangneto I.

In diverse spotty tundras, herb-*Equisetum* willow stands, old fire place, late snow area; on bare and thinly turfed soil, associated with *Barbilophozia quadriloba*, *Lophozia heterocolpos*, *L. grandiretis*, *Tritomaria scitula*, *T. heterophylla*, *T. quinquedentata*, *Scapania gymnostomophila*, *Jungermannia polaris*, *Odontoschisma macounii*, *Cryptocolea*, *Blepharostoma*, *Nardia geoscyphus*, etc. The species varies from mod. *densifolia-colorata* to mod. *laxifolia-viridis*.

## CALYPOGEIACEAE (K. Muell.) H. Arn.

## CALYPOGEIA Raddi

**Calypogeia sphagnicola** (H. Arn & J. Perss.) Warnst. & Loeske

ST: Laptayaha I.

In tussock swampy *Dicranum-Sphagnum* tundra on tussock among *Sphagnum* with *Barbilophozia binsteadii*.

**Calypogeia muelleriana** (Schiffn.) K. Muell.

NT: Lyakkotosyo I; ST: Khevesyo I, Laptayaha I, Er'yaha II.

In cotton grass and *Ledum* tundras, high-centered polygon, moss-cotton grass bog, associated mostly with *Barbilophozia binsteadii*, *Anastrophyllum minutum*, *Lophozia ventricosa* var. *longiflora*, *Cephalozia bicuspidata*. Once (Er'yaha) with gemmae.

## CEPHALOZIACEAE Migula

## Subfam. CEPHALOZIOIDEAE

## PLEUROCLADULA Grolle

**Pleurocladula albescens** (Hook.) Grolle. s.l.

AT: Belyy III, Khabelyaha II, Tambey I, Kharasavey I; NT: Matyuyaha II, Tiutey 4, Mantiyo III, Khakhayayaha III; ST: Khutyayaha III, Khevesyo IV, Laptayaha II, Er'yaha II, Khadytayaha I.

Usually in late snow areas, rarely on spots in spotty tundras. Once (Tiutey) with gemmae (see Potemkin 1993b).

## CEPHALOZIA (Dum.) Dum.

**Cephalozia bicuspidata** (L.) Dum. subsp. *ambigua* (C. Mass.) Schust.

AT: Belyy II (Zhukova & Rebristaya 1987), Khabelyaha I, Tambey I, Kharasavey I; NT: Tiutey I, Tomboitosyo I; ST: Khevesyo II, Laptayaha I, Er'yaha I.

In late snow areas and on spots in spotty tundras. Sporadically with perianths, twice with gemmae.

The overlapping of the variability ranges of *Cephalozia bicuspidata* subsp. *ambigua* and subsp. *bicuspidata* is considerable. Most difficult and sometimes impossible to separate is mod. *parvifolia* of the both subspecies. All doubtful phenotypes of *C. bicuspidata* s.l. were attributed to subsp. *bicuspidata*. Schuster's (1988:180) arguments for distinguishing this taxon as a subspecies rather than a species seem well founded.

**Cephalozia bicuspidata** subsp. *bicuspidata*

AT: Belyy III, Khabelyaha V, Tambey V, Kharasavey III; NT: Matyuyaha III, Tiutey 2, Bovanenkovo 3, Tomboitosyo III, Neromayaha V, Mantiyo III, Saletayaha 3, Yuribeitoyaha I, Khakhayayaha V, Lyakkotosyo II; ST: Khutyayaha V, Khevesyo V, Laptayaha III, Kharangneto 4, Er'yaha III, Khadytayaha 4.

In diverse moss, lichen, and spotty tundras, late snow areas, herb formations on sand, sedge-moss bogs, etc. Perianths and mature capsules rather frequent, gemmae rare.

**Cephalozia leucantha** Spruce

NT: Neromayaha I.

On humus-rich soil among crustose lichens with *Anastrophyllum minutum*, *Lophozia* sp., in willow stand on loamy soil.

**Cephalozia pleniceps** (Aust.) Lindb.

AT: Belyy I, Khabelyaha III, Tambey III, Kharasavey I; NT: Matyuyaha I, Bovanenkovo 2, Tomboitosyo I, Neromayaha III, Mantiyo II, Saletayaha 3, Yuribeitoyaha II, Khakhayayaha III, Lyakkotosyo I; ST: Khutyayaha III, Khevesyo V, Laptayaha III, Er'yaha III.

On steep herb and nival slopes, in spotty, mostly lichen-moss and sedge-moss, and dwarf shrub sedge-(grass)-moss tundras, on peat outcrops, edges of lakes and water courses, in sedge-moss and moss bogs. Often with perianths and mature capsules.

The species is very malleable. On exposed bare soil it is represented by small, 1.5 - 4 mm long, very fleshy whitish phenotypes with dense leaves and lobes terminated by one obtuse not elongated cell. Perianths are 4 - 5 - stratose at the base and unistratose only in upper half, occasionally only near the mouth. In wet moss tufts comparatively large, up to 27 mm long, phases of the species occur. They are greenish, not fleshy, with

distant leaves with apiculate lobes of 1 - 2 cells.

*Cephalozia lunulifolia* (Dum.) Dum. (? *C. affinis* auct. non Steph. - Zhukova & Rebristaya 1987 (the species was identified in sterile state that is actually impossible (cf. Schuster 1974)))

AT: Belyy I (Zhukova & Rebristaya 1987), Kharasavey I; NT: Tomboitosyo I, Neromayaha I; ST: Khutyaha III, Khevesyo III, Khadytayahya I.

In moist tussock moss tundras, *Sphagnum* yerniks, peat outcrops, moss-lichen and herb-moss tundras, sedge bog and willow lichen nival tundra. Once (Khutyaha) with gemmae. Gemma formation leads to development of reduced and multilobed leaves as well as large underleaves (Potemkin 1993b).

The species is usually represented by forms with distant, longly decurrent leaves. Most vigorous plants may be to 40 mm long and 1 mm wide. In Kharasavey mod. *densifolia* was found. The plants resemble *Cephalozia pleniceps*. They have subtransverse oriented shortly decurrent leaves with not connivent lobes terminated usually by 1 cell. They differ from *C. pleniceps* in the following distinctive features: 1) antical leaf margin decurrent in parallel to stem vs subtransverse in *C. pleniceps*; 2) rhizoids often copiously branched near the ends vs nonbranched, dilated near the ends; 3) basal cell of uniseriate lobe apiculus comparatively narrow, ca. 28 - 35 mkm wide at the base vs usually more than 33 mkm wide; 4) dorsal cortical cells more than 3 times wider than medullary cell diameter vs less than 3 times wider in *C. pleniceps*; 5) ventral, stolon-like branches heliotropic vs geotropic; 6) all plants sterile that is a characteristic feature of the dioicous *C. lunulifolia*, not of the autoicous *C. pleniceps*.

Some phases of *Cephalozia lunulifolia* resemble the amphiatlantic species *C. macrostachya* Kaal. They may develop comparatively small cells in lobe bases; leaves to 17 - 19 cells broad with nonconnivent lobes; and similar stem anatomy. They differ in the almost entire perianth mouth and bract margins as well as in thin-walled cells which are, at least partly,

more than 25 mkm wide in lobe bases.

*Cephalozia connivens* (Dicks.) Lindb.

NT: Neromayaha I.

In nival willow stand on bare slightly humusy loamy sandy soil among *Cephalozia bicuspidata* and *C. pleniceps*. Northernmost report of the species.

Investigated plants differ distinctly from admixed *Cephalozia pleniceps* in leaf insertion; cell size (dorsal cortical cells 40 - 70 x 50 - 85 mkm vs 30(50) mkm wide; cells of leaf lobe base 40 - 50 x 40 - 56 mkm vs 30, rarely 35 - 40 mkm in diam.); leaves only 9 - 14 cells wide with dorsal lobe 3 - 5 cells wide and ventral (3)4 - 5(6) cells wide vs (14)16 - 23 cells wide with wider lobes respectively; absence vs presence of stolons; stem of 12 - 13 rows of cortical cells (5 dorsal rows and 7 - 8 lateral and ventral rows) and 16 - 17 rows of medullary cells vs 24 rows of cortical and 32 rows of medullary cells, etc. The main difference from plants of the temperate region is thin-walled medullary cells. Comparative study of temperate and arctic species of *Cephalozia* as well as of *Jungermannia* subgen. *Plectocolea* showed, however, that development of thick-walled medullary cells is characteristic only for temperate populations and is considerably rarer and more weakly expressed in the Arctic.

Subfam. ODONTOSCHISMATOIDEAE Buch ex Grolle

CLADOPODIELLA Buch

*Cladopodiella fluitans* (Nees) Buch

ST: Khutyaha II.

In bogs with flowing water among *Drepanocladus exannulatus*, *D. fluitans* f. *pseudostramineum*, *Calliargon sarmentosum*, with *Scapania uliginosa*, *S. hyperborea*, *Gymnocolea fascinifera* and among *Sphagnum* with *Gymnocolea fascinifera* and *G. inflata* var. *acutiloba*; in high-centered polygon among *Gymnocolea inflata* var. *acutiloba*.

The plants collected in bogs with flowing water are quite typical but in the polygon they are represented by mod. *parvifolia-fusca*. They have a stem only 5 cells high,

with distinct underleaves and cortical cells 28 - 32 mkm wide and median leaf cells ca. 28 x 30 - 38 mkm.

*Cladopodiella francisci* (Hook.) Buch ex Joerg.

ST: Khutyayaha I, Khadytayaha 3.

In tussock tundras, on upland in bog and on the margin of loamy landslip, associated with *Lophozia* cf. *savicziae*, *Gymnocolea inflata*, *Cephalozia bicuspidata*, *Gymnomitrium corallioides*, *Scapania scandica*, and *Marsupella sprucei*. Often with gemmae, perianths and mature capsules. Gemmae more or less angulate, 1 - 2 - celled, colourless to violetish, 23 - 25(39) mkm. Spores from 11 - 13 to 15 - 16 mkm in diam. Elaters 9 - 13 mkm in diam., with 2 brown spirals 2.5 mkm wide. Two capsules found in collection from Khutyayaha, margin of loamy landslip, are not typical: valves coherent in apical part of capsule; epidermal layer with nodular thickenings on alternating longitudinal walls; and inner layer with mostly complete semiannular bands.

ODONTOSCHISMA (Dum.) Dum.

*Odontoschisma elongatum* (Lindb.) Evans

NT: Matyuyaha II, Mantyto II, Sebayaha I, Khakhayayaha II; ST: Er'yaha I.

In diverse bogs, dwarf shrub sedge-lichen-moss and dwarf shrub-lichen tundras, on steep slope, associated usually with *Ptilidium ciliare*, *Blepharostoma*, *Cephalozia bicuspidata*, *Gymnocolea inflata*, *Barbilophozia binsteadii*, *B. kunzeana*, *Lophozia ventricosa* var. *longiflora* and *Scapania irrigua*, but on steep slope also with *Anthelia juratzkana*, *Pleurocladula albescens*, *Calycularia laxa* and *Anastrophyllum sphenoloboides*.

The species varies from mod. *densifolia-colorata* to mod. *laxifolia-colorata* vel *subcolorata*, mod. *viridis* occurs very rarely.

*Odontoschisma macounii* (Aust.) Und.

AT: Belyy III, Khabelyaha I, Kharasavey I; NT: Marre Sale I, Yuribetoyaha II, Khakhayayaha I, Lyakkotosyo I; ST: Khevesyo III, Laptayaha II, Er'yaha I, Kharangyneto I.

On bare and thinly turfed soil in diverse tundras, in flat centered polygons, moist horse-tail nival and sedge willow stands, apparently only in sites with comparatively

rich soils.

CEPHALOZIELLACEAE Douin

CEPHALOZIELLA (Spruce) Schiffn.

*Cephaloziella subdentata* Warnst.

NT: Bovanenkovo I, Tomboitosyo I, Neromayaha I, Yuribetoyaha I; ST: Khutyayaha II, Er'yaha I, Khadytayaha I.

In willow-yernik sedge and sedge-*Dryas*-lichen tundras, sedge-moss and polygonal bogs, associated with *Sphagnum*, *Dicranum elongatum*, *Meesia*, *Blepharostoma*, *Cephaloziella rubella* subsp. *arctogena*, *Aneura* cf. *pinguis*, etc. Often with perianths, once with mature capsules and gemmae.

This species is often confused in the Arctic with *Cephaloziella rubella* subsp. *arctogena*. It differs from this taxon in sex distribution (auticous vs paroicous), ability of hygric forms to produce spinose teeth at leaf base as in *C. elachista* (Jack ex Gott. & Rabenh.) Schiffn., and in perianth mouth, bract, and capsule wall characters (see Potemkin 1992a).

*Cephaloziella divaricata* (Sm.) Schiffn. var. *divaricata*

AT: Khabelyaha I, Tambey I, Kharasavey I; NT: Matyuyaha I, Tiutey I, Bovanenkovo I, Tomboitosyo II, Neromayaha II, Mantyto I, Marre Sale I, Yuribetoyaha II, Khakhayayaha I, Lyakkotosyo I; ST: Khutyayaha II, Khevesyo II, Laptayaha II, Kharangyneto 3, Er'yaha I.

In diverse moss, sedge, sedge-moss, dwarf shrub and sedge-lichen tundras, cotton grass-sedge-*Sphagnum* bog, on peat outcrop, on bare loamy ground on edge of temporary water course. Often with gemmae, rare with perianths.

*Cephaloziella divaricata* var. *scabra* (M. A. Howe) S. Arn.

NT: Tomboitosyo I, Lyakkotosyo I; ST: Khevesyo I.

In sedge-moss and moss-herb willow stands, hummock sedge-yernik moss tundra, associated with *Lophozia jurensis*, *L. ventricosa*, *Ptilidium ciliare*, *Anastrophyllum minutum*, etc. Once with gemmae.

*Cephaloziella divaricata* var. *polystratosa* (Schust. & Damsh.) Potemk. comb. nov. (*Cephaloziella byssacea* (A. Roth) Warnst. var. *polystratosa* Schust. & Damsh.,

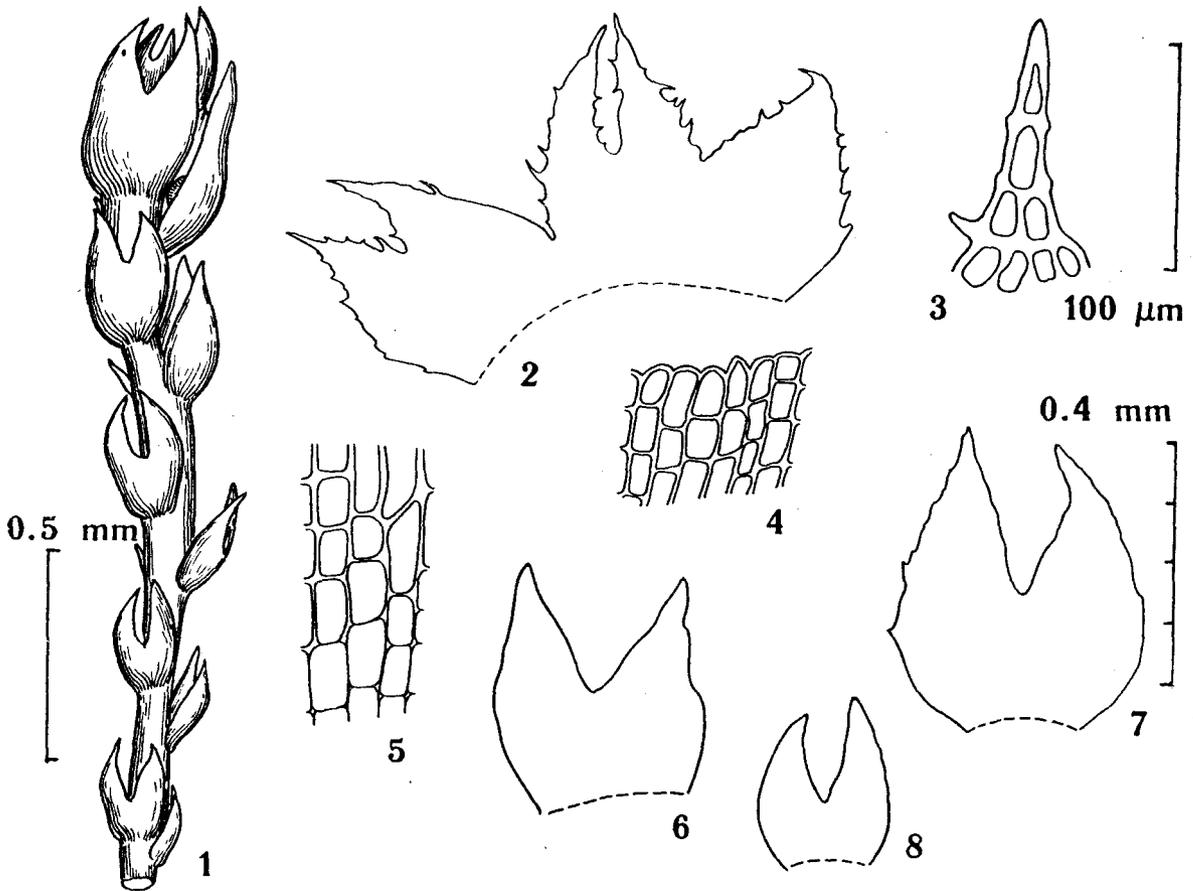


Fig. 7. *Cephaloziella rubella* subsp. *arctogena*. (1) Young fertile shoot (x56). (2) Female bracts and bracteole (x80). (3) Apex of female bract (x300). (4) Sector of perianth mouth (x300). (5) Median and basal cells of female bract (x80). (6,7) Male bracts (x80). (8) Leaf (x80). Scale bars: 0.5 mm - for 1; 0.4 mm - for 2, 6 - 8; 100 mkm - for 3 - 5. All from Khutyayaha (After Potemkin 1992a).

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NT: Neromayaha I, Saletayaha I.

On thinly turfed loamy sandy soil, associated with *Encalypta* sp. With gemmae. First report for Eurasian Arctic. Previously the variety was known from South Greenland and, in Eurasia, from Leningrad (St. Petersburg) Province (for detailed descriptions and illustrations see Schuster 1988, Potemkin & Tcherepanov 1993).

*Cephaloziella rubella* (Nees) Warnst. subsp. *rubella*

NT: Bovanenkovo I, Marre Sale I.

In grass-sedge moss and moss-dwarf shrub tundra. With perianths.

*Cephaloziella rubella* subsp. *arctogena* (Schust.) Schust. & Damsh. (*C. rubella* auct.

non (Nees) Warnst. p.p. - Gribova & Potemkin 1988; *C. subdentata* auct. non Warnst. p.p. - Zhukova & Rebristaya 1986, 1987; Gribova & Potemkin 1988) (Fig. 7)

AT: Belyy I; NT: Matyuyaha I, Bovanenkovo I, Tomboitosyo II, Neromayaha III, Mantlyo I, Saletayaha I, Yuribeitoyaha II, Khakhayaha II, Lyakkotosyo III; ST: Khutyayaha III, Khevesyo I, Kharangyneto I, Khadytayaha 4.

In dwarf shrub-moss and sedge-moss tundras, swampy sedge-(cotton grass)-moss and dwarf shrub-moss (often *Sphagnum*) communities. Often with perianths, sporadically with mature capsules. For differentiation see Potemkin 1992a).

*Cephaloziella rubella* cf. var. *elegans* (Heeg.) Schust.

NT: Tomboitosyo I, Marre Sale I; ST: Khutyayaha I.

In herb willow stands, spotty polygonal and grass-sedge moss tundras, associated with *Cephaloziella rubella* subsp. *rubella* and subsp. *arctogena*, *Scapania scandica*, *Lophozia albobiridis*, *Cephalozia bicuspidata*, *C. pleniceps*, and *Anastrophyllum minutum*. The only one perianth have been seen. All Yamal collections of this variety are poor. The occurrence of Yamal plants together with the other taxa of *C. rubella* leads to certain doubts on their taxonomic isolation (cf. Arnell 1956: 72).

***Cephaloziella hampeana* (Nees) Schiffn. var. *hampeana***

AT: Belyy I; NT: Matyuyaha I, Bovanenkovo I, Tomboitosyo II, Neromayaha II, Mantyto I, Khakhayayaha I; ST: Khevesyo II, Laptayaha II, Khadytayaha I.

In diverse moist sedge- and grass-moss tundras, sedge and sedge-cotton grass bogs, dwarf shrub-sedge-cotton grass and grass-cotton grass tundras, sedge willow stands. Sporadically with perianths and gemmae, once (Khevesyo) with mature capsules.

***Cephaloziella hampeana* var. *sibirica* C. Jens.**

AT: Belyy (Arnell 1918).

***Cephaloziella arctica* Bryhn & Douin (*C. rubella* auct. non (Nees) Warnst. p.p. - Zhukova & Rebristaya 1986; Potemkin 1989)**

AT: Belyy V, Khabelyaha V, Tambej V, Kharasavey III; NT: Matyuyaha II, Tiutey 2, Bovanenkovo I, Tomboitosyo I, Neromayaha III, Yuribeitoyaha I, Khakhayayaha II, Lyakkotosyo II; ST: Khutyaha II, Khevesyo III, Laptayaha II, Er'yaha I, Khadytayaha I.

In spotty, predominantly dwarf shrub-sedge-(lichen)-moss, and swampy sedge-moss tundras, at the foot of nival slopes, in plant communities on weakly stabilized sand. Sporadically with gemmae, perianths and mature capsules.

In Arctic tundras, growing on bare soil, the species usually develops mod. *parvifolia-colorata* with purplish fuscous to purplish black pigmentation; comparatively narrow leaves, a little wider than the stem; and reduced amphigastria, which are only sporadically present near shoot apices. In moist moss tufts mod. *viridis* and mod. *subcolorata* usually occur and often resemble *Cephaloziella hampeana*. They differ from

the last species by the presence at least small underleaves, thick-walled cells of stem and often of leaves, slightly elongated cells of perianth mouth, female bract characters, etc.

***Cephaloziella grimsulana* (Jack ex Gott. & Rabenh.) Lacout.**

NT: Neromayaha II, Saleiyaha 2.

On bare clay and humus clay soil on landslip slopes, on loamy sand on steep slope, associated with *Barbilophozia hyperborea*, *Lophozia excisa*, etc. With gemmae, once with juvenile perianth.

***Cephaloziella uncinata* Schust. (*C. striatula* (C.Jens.) Douin var. *argudentata* S. Arn. syn. nov.; *C. subdentata* auct. non Warnst. p.p. - Andrejeva 1981; Zhukova & Rebristaya 1986, 1987)**

AT I; NT: Matyuyaha III, Tiutey I, Bovanenkovo I, Tomboitosyo I, Neromayaha IV, Mantyto I, Marre Sale I, Yuribeitoyaha II, Khakhayayaha II, Lyakkotosyo II; ST: Khutyaha II, Laptayaha I, Er'yaha II.

In diverse swampy communities of sedge, cotton grass and mosses (often *Sphagnum*), *Sphagnum* yerniks, dwarf shrub-(cotton grass)-moss and herb-dwarf shrub-moss tundras, on margin of lake. Almost always with perianths, sporadically with mature capsules.

The main peculiarity of Yamal plants is a smooth or slightly papillose cuticle characteristic not only for xeromorphic phenotypes (Schuster 1980) but for mesic and hygic forms also. This feature, however, is very malleable in the species. Investigation of Greenland material showed that the character of the cuticle often varies considerably from leaf to leaf on the same shoot and from plant to plant in the same specimen as in RMS 66 - 054, 66 - 306a, 66 - 1285a, 70 - 2128, etc., and, consequently, it is impossible to explain such variability only by factor of moisture. The other features of the species are quite typical. Robust forms of the species may develop solitary teeth, however, not only at leaf base but on sinus sides also.

Investigation of the description, illustrations and specimens of *Cephaloziella striatula* var. *argudentata* from Novaya Zemlya (Arnell 1947), which was assigned later by the author (Arnell 1956) as a synonym of *C. subdentata* var. *spinigera* H. Arn. & C. Jens.,

showed that it is almost identical with Yamal plants of *C. uncinata*. It shares with this species such important features as uncinately leaf apexes of 1 - 5 superimposed cells with strongly elongated terminal one, coarsely dentate female bracts with uncinately leaf apexes of strongly elongated cells and a ciliate-dentate perianth mouth of strongly elongated cells, which are free on most of their length. The only differences, excepting a faintly papillose cuticle, are sporadically more narrow leaf lobes, only 4 - 7 cells broad at base, and longer uniseriate lobe apexes, to 5 cells long.

#### PTILIDIACEAE Klinggr.

##### PTILIDIUM Nees

##### *Ptilidium ciliare* (L.) Hampe

AT V; NT V; ST V.

One of the most widespread Yamal hepatics in diverse plant communities, excepting bogs and dry lichen tundras on sand. Sporadically it is a dominant species, forming large mats about several hundred square metres.

*Ptilidium ciliare* is an extremely malleable species. In Yamal it is mostly represented by mod. *densifolia* of diverse coloration: from green and yellowish green to brown, reddish brown, deep purple and blackish violet. The brown pigmented plants occur most often, however. The number of marginal cilia varies greatly also. There are often rather few cilia in plants, growing on bare exposed soil (mod. *parvifolia* - *densifolia* - *colorata* - *oligociliata*). Sporadically forms with 25 - 40 cilia in the ventral leaf margin occur. Their cilia are composed of strongly elongated cells, 40 - 60 x 11 - 14(20) mkm, and they are sometimes longer than the width of ventral lobe. Cells of these plants are usually larger, than mentioned for the species, to 38 - 48(56) x (28)33 - 39 mkm at lobe base. These differences are not very constant, however, and such forms often grade into typical ones.

#### ORDER MARCHANTIALES Limpr.

#### MARCHANTIACEAE (Bisch.) Lindley

##### MARCHANTIA L.

##### *Marchantia alpestris* (Nees) Burgeff.

NT: Bovanenkovo 1, Saletayaha 1.

On old fire place and on edge of water

course. With gemma receptacles, archegoniophores and antheridiophores.

##### *Marchantia polymorpha* L.

NT: Matyulyaha I, Yuribeltoyaha II; ST: Khutyaha III, Khevesyo III, Er'yaha III.

On edges of water courses, in karst funnels, cotton grass bogs, at the foot of peat outcrops, near and on fire places. Almost always with gemma receptacles, archegoniophores and antheridiophores.

##### *Marchantia aquatica* (Nees) Burgeff.

AT: Kharasavey I.

On margin of lake. With solitary gemma receptacles.

##### PREISSIA Corda

##### *Preissia quadrata* (Scop.) Nees subsp. *hyperborea* Schust.

AT: Kharasavey I; NT: Neromayaha I, Lyakkotosyo I; ST: Khutyaha III, Khevesyo I, Er'yaha I.

In crevices and on vertical surfaces of steep sandy slopes, on river bank. Sporadically with archegoniophores, antheridiophores and mature capsules. Previously it was known only from North America and Greenland (Schuster 1992b).

The main distinctive features of this taxon from the type subspecies, according Schuster (l.c.), are: plants normally autoecious (vs dioecious); subarctic-arctic (vs predominantly temperate-boreal); male receptacles with a wide, thin, chartaceous, nitid flange, usually arched upward (vs without such flange, the margins not conspicuously curved upward); carpocephalum with 2 - 4 sporophytes (vs to 8 - 10 sporophytes); spores smaller (ca. 50 - 70 mkm), with meshes of reticulations lower (vs larger, ca. (62)65 - 80 mkm usually, with meshes of reticulations high), etc.

Yamal plants of the subspecies are quite typical but have smaller thalli, only 3 - 5 mm wide (vs 10 - 15 mkm in original description) that may be explained by unfavorable conditions of soil nourishment (the other basiphilous species in Yamal are smaller also). The spores are a little smaller too, 45 - 60 mkm.

#### RICCIACEAE Reichenb.

##### RICCIA L.

*Riccia sorocarpa* Bisch. subsp. *arctica* Schust. (*R. sorocarpa* auct. non Bisch. -

Andrejeva 1981)

ST. Er'yaha I.

In willow-moss spotty tundra on loam with *Jungermannia polaris*, *J. obovata*, *Fossombronia alaskana*, *Cephaloziella arctica*, *Blepharostoma trichophyllum* var. *brevirete*. With mature capsules. Previously it was known only from Greenland (Schuster 1992b).

This taxon, according to Schuster (l.c.), differs from the type subspecies in arctic distribution, somewhat smaller spore size, usually 65 - 86(91) mkm (in Yamal plants (60)68 - 75(82) mkm); wing margins of spores usually vestigial and locally developed only or lacking; areolae tending to slightly smaller, mostly ca. 5 - 8(10) mkm in diam (in Yamal plants (4)5 - 8(9) mkm), etc.

## EXCLUDED TAXA

## Erroneous identification

*Barbilophozia attenuata* (Mart.) Loeske  
*Cephalozia affinis* Steph.  
*Chiloscyphus pallescens* (Ehrh. ex Eoffm.) Dum.  
*Plagiochila arctica* Bryhn & Kaal.  
*Scapania brevicaulis* Tayl.  
*Scapania lingulata* Buch

## Corrected identification

*B. binsteadii*  
*C. lunulifolia*  
*Ch. fragilis*  
*P. asplenioides* subsp. *porelloides*  
*S. hyperborea* (*S. helvetica* phenotypes)  
 apparently a small form of *Scapania* sect. *Irrigua*

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