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CONTRIBUTION TO THE FLORA OF FRANZ JOSEF LAND ARCHIPELAGO. II. LIVERWORTS (MARCHANTIOPHYTA) OF ALEXANDRA LAND ISLAND

К ФЛОРЕ АРХИПЕЛАГА ЗЕМЛЯ ФРАНЦА ИОСИФА. II. ПЕЧЕНОЧНИКИ (MARCHANTIOPHYTA) ОСТРОВА ЗЕМЛЯ АЛЕКСАНДРЫ

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Abstract

An annotated list of liverworts of the Alexandra Land (Franz Josef Land) was compiled based on identification of 90 specimens collected by one of the authors in various parts of the island. The list counts 23 species, including *Diplophyllum albicans, Marsupella apiculata, M. boeckii, M. sprucei,* and *Prasanthus suecicus,* which are new to the archipelago. The previously published data on the flora of liverworts of the island are analyzed and 12 previously recorded species are excluded. GenBank accession numbers are provided for 3 arctic species (8 samples, 15 accessions). ITS1-2 nrDNA and *trn*L-F cpDNA phylogeny of *Lophoziopsis rubrigemma* revealed its hybrid origin from *Lophoziopsis polaris* and *L. excisa*. The morphological features and distribution of some species in the archipelago are discussed.

Резюме

Аннотированный список печеночников острова Земля Александры (Земля Франца Иосифа), составленный на основе идентификации 90 образцов, собранных одним из авторов в различных частях острова включает 23 вида, в том числе новые для архипелага *Diplophyllum albicans, Marsupella apiculata, M. boeckii, M. sprucei* и *Prasanthus suecicus*. На основе анализа ранее опубликованных данных по флоре острова и литературных данных 12 видов исключены из его флоры. Для 3 видов (8 образцов) приводятся номера 15 последовательностей в ГенБанке. Молекулярно-филогенетический анализ *Lophoziopsis rubrigemma* по данным ITS1-2 ядДНК и *trn*L-F хпДНК показал, что этот вид имеет гибридное происхождение от *Lophoziopsis polaris* и *L. excisa*. Обсуждаются морфологические особенности и распространение на архипелаге ряда видов.

KEYWORDS: liverworts, integrative floristic, morphology, phytogeography, Franz Josef Land Archipelago, Arctic, Russia

INTRODUCTION

This paper is the second one based on the identifications of specimens collected by A.N. Savchenko in the Franz Josef Land archipelago. Alexandra Land, named after Queen Alexandra of Denmark, is one of the largest islands in the archipelago and the most inhabited of all the islands. It is here that both the oldest buildings in the archipelago and modern ones, including the buildings of the "Russian Arctic National Park" created in 2016. Thanks to the support of the staff of the National Park, who helped with transport and carried out security during the gathering, it was possible to study not only the territory near the village, but also several remote areas (Fig. 1).

STUDY AREA

Alexandra Land is the westernmost island in the archipelago (Fig. 1).The island is a fragment of a basalt plate more than 75% covered by ice domes. The northern part of the island, the so-called "Central Land", with an area of approximately 300 sq. km. is a hilly plain with elevation ca. 25–34 m, covered with a quaternary sediments. The rocky base of the island is composed of basalts of Lower Cretaceous age. Large columnar blocks of basalt strata are pronounced on the highlands. Skeletal soils, basalt rock fields and rock fragments predominate the ice-free part of the island. The island is located in the Arctic deserts and permafrost climatic zone. The average annual temperature in this area is negative: –13 °C. Summer is short, cloudy, cold and wet. On average, the air does not warm up above +4° C. The thickness of the active soil layer on the island is usually no more than 40 cm. Most of the water flows on ice-free land areas have mainly glacial nutrition. The streams are weakly embedded, with numerous tributaries and intermittent channels (Ladyzhenskaya & Zhukova, 1972; https://ru.wikipedia.org/wiki/Земля_Александры).

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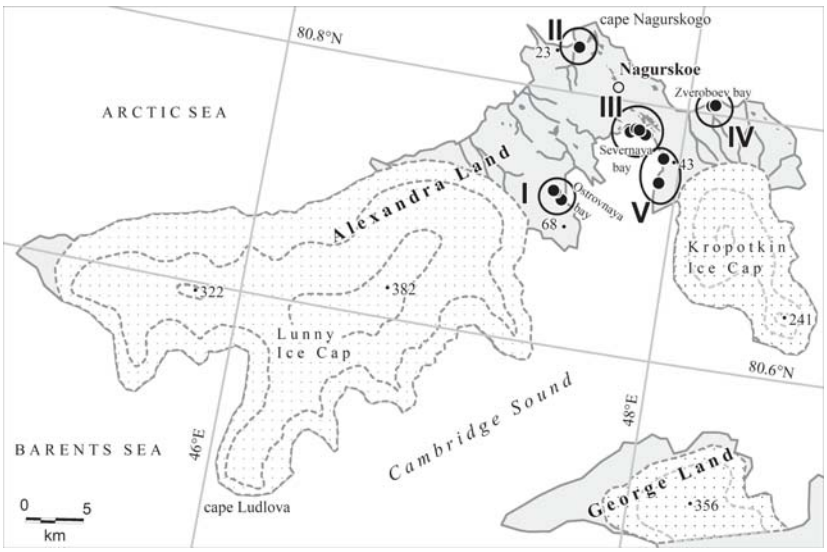

Fig. 1. Collecting localities, shown as five groups. **I.** Coast of Ostrovnay Bay.1. Rubble scree, 80.71570°N – 47.45039°E, 18 m alt. 2. Dry tundra, among rubble, 80.72118°N – 47.41594°E, 23 m alt. 3. A remnants of basalt rocks, on spots among the rubble-block ruins, 80.72188°N – 47.40598°E, 31 m alt.

II. Otmelay Bay, 80.83675° N – 47.41484°E, 7 m alt.

III. Severnaya Bay. 1. Dry tundra, on spots among the rubble-stone ruins and products of frost weathering, 80.77888°N – 47.72354°E, 14 m alt. 2. The shore of the lake, rock field as result of collapse of the basalt cover, 80.77723°N – 47.73079°E, 11 m alt. 3. A remnant of a basalt plateau with a large-columned separateness with prismatic pillars, 80.77684° N – 47.81532°E, 22 m alt. 4. Near the road among the coarse-grained remnants of the basalt plateau, 80.78016°N – 47.75759°E, 16 m alt. 5. Dry tundra, banks of the stream on coast of the bay, 80.77679°N – 47.79979°E, 10 m alt. 6. Remnants of basalt rocks, soil covered ledges, 80.77763°N – 47.80365°E, 23 m alt. 7. Dry tundra, 80.77689°N – 47.80567°E, 14 m alt. 8. The top of remnants of basalt rocks, 80.77972°N – 47.77375°E, 25 m alt.

IV. Zverboev Bay, Eastern Cape. 1. Rubble-block ruins on plane, hollow along coast with moss cover, 80.80817°N – 48.12523°E. 2. Rubble ground near rocks in hollow along coast with moss cover, 80.80728°N – 48.10812°E, 9 m alt.

V. Severnaya Bay near Former German station. 1. Upper part of moraines composed of rubble-block ruins with patches of permafrost microrelief, 80.74021°N – 47.90699° E, 46 m alt. 2. The hollow on a moraine with mats of lichens and bryophytes on gravelly-clay soil among stones, 80.74083°N – 47.90733°E, 44 m alt. 3. Remnant of a basalt plateau, spots among the rubble-block ruins, 80.76022°N – 47.90493°E, 25 m alt. 4. Remnants of basalt rocks, spots among rubble-block ruins near huge rocks, 80.75967°N – 47.90501°E, 19 m alt. 5. Gentle slope to the sea, the rubble-sandy soil, 80.75928°N – 47.90496°E, 15 m alt. 6. Remnants of basalt rocks, rubble-block ruins, 80.76136°N – 47.90833°E, 32 m alt. 7. Remnants of basalt rocks covered by remains of coal warehouse, 80.76021°N – 47.91346°E, 32 m alt. 8. Remnants of basalt rocks, 80.76016°N – 47.90974° E, 28 m alt.

The vegetation of the island was studied by V.D. Alexandrova, who, within the framework of vegetation descriptions, collected a significant number of bryophytes, appearing along with lichens, dominant in the communities of the polar deserts to which Alexandra Land belongs. Alexandrova identified four main types of habitats on the island: basalt rocks and boulders, rocky streams (or fields), a stone network, and polygonal soils (Zhukova, 1972). Liverworts from Alexandrova's collection were identified by K.I. Ladyzhenskaya and A.L. Zhukova. The results were published in two papers (Ladyzhenskaya & Zhukova, 1972; Zhukova, 1973), in which the lists of species differ somewhat. In particular, the later publication lists such species as *Cephaloziella pearsonii* (Spruce) Douin, *Gymnomitrion obtusum* Lindb., etc. that were not recorded in the first one (Ladyzhenskaya & Zhukova, 1972). In total, Zhukova (1973) recorded 26 species (35 taxa) for Alexandra Land. A number of species were subsequently changed during the revision and the analysis of collections (Konstantinova & Potemkin, 1997, Potemkin & Matveyeva, 2015; see discussion).

Material and methods

Alexandra Land is the only island in the Franz Josef Land archipelago where Anatoliy Savchenko was able to collect liverworts for several days. As a result five remote areas were studied (Fig.1). Due to the transportation difficulties and danger from polar bears the collecting time in each area was extremely limited. In total, 90 specimens were collected from 24 sites. For all collecting sites the coordinates and elevations were measured using GPS. Collecting localities are grouped into 5 locations (Fig.1, 2).

As in our first paper on the liverworts of the archipelago (Konstantinova *et al.*, 2020a), we give comments on the morphological features of a number of species or varieties, and also provide GenBank data for a number of sequenced specimens.

Fig. 2. Main habitats in the study area. A: coast of Ostrovnaya Bay, rubble scree (locality I:1); B: Severnaya Bay, bank of stream on slope to the sea (locality III: 5); C: Severnaya Bay, a remnant of a basalt plateu with a large-columned separateness with pismatic pillars (locality III: 3); D: Severnaya Bay, the top of a remnant of a basalt plateu (locality III: 7); E: Zveroboev Bay, Eastern Cape, rubble ground slope with hollows (locality IV); F: Severnaya Bay, near former German Station, gentle slope to the sea with remnants of basalt rocks (locality V).

As in some our previous papers (Konstantinova *et al*., 2020a, 2021) we used an approach now called integrative floristics (Fedosov *et al*., 2022). This approach includes sequencing specimens of poorly-known species or specimens represented by a small number of shoots without the structures (perianthia, androecia, gemmae) necessary for satisfactory identification to confirm or clarify their identification. This approach is especially pronounced in the high Arctic, where many species are represented by unusual forms, the interpretation of which causes serious difficulties. However, such approach runs into serious problems since the GenBank does not pro-

vide sufficiently reliably verified data on most Arctic species. Sequencing of a number of specimens, which are not represented in the GenBank or identification of which caused us some doubt, allowed us to shed light on the taxonomy of some species.

Particularly the identification of eight specimens from the genera *Lophoziopsis* and *Cephaloziella* was verified by obtaining of ITS1-2 nrDNA and *trn*L-F cpDNA sequence according to protocols described in Konstantinova *et al.* (2020b) with subsequent analyses in appropriate datasets.

Results

The annotated list of species

The annotated list of liverworts is given in alphabetical order. It includes 23 species. The nomenclature generally follows Hodgetts *et al*. (2020). Brief descriptions of each species include some synonyms that were used in earlier Russian publications (in brackets). After the species name the presence of reproductive structures is given in parentheses (and. – androecia; gyn. – gynoecia; per. – perianths or pseudoperianths; spor. – sporophytes; gemm. – gemmae). The collecting sites are listed according to the enumeration given above and shown in Fig. 1. The most common associated species and at least one reference to herbarium number in KPABG are given.

All specimens are deposited in the Herbarium of Polar-Alpine Botanical Garden-Institute of the Kola Scientific Center, Russian Academy of Sciences (KPABG). Specimen voucher information is incorporated in the L, former CRIS – Cryptogamic Russian Information System (https://isling.org)

Two asterisks before a species name mean a new record for the Franz Josef Land Archipelago, one asterisk marks new species for Alexandra Land.

Anthelia juratzkana (Limpr.) Trevis. (per., and) – I (1, 3), V (1, 2, 4): On gravelly-clay soil and peat in crevices and on ledges on rubble-block ruins, on spots of bare soil and gravel among the rubble-block ruins and rubble screes, in the hollow on a moraine with mats of lichens and bryophytes. In pure mats or mixed with other liverworts, more often with *Trilophozia quinquedentata* f. *gracilis, Cephaloziella varians, Blepharostoma brevirete, Gymnomitrion concinnatum.*

Blepharostoma brevirete (Bryhn et Kaal.) Vilnet et Bakalin [*Blepharostoma trichophyllum* (L.)Dumort. var. *brevirete* Bryhn et Kaal.] – III (6), V (1, 2): On spots among the rubble-block ruins, on gravelly-clay soil among stones [125389]. Usually mixed with other liverworts, more often with *Odontoschisma macounii, Gymnomitrion concinnatum, Cephaloziella varians.*

Cephaloziella varians (Gottsche) Steph. [*Cephaloziella arctica* Bryhn et Douin] (per., and.) – I, II, III, IV, V: The species is found almost everywhere and with almost all other species of liverworts [125345]. It dominates in some places. Several specimens were initially referred to other species of the genus, but after re-examination, including sequencing of some specimens, it turned out that they all apparently belong to the same species (see discussion as well).

***Diplophyllum albicans* (L.) Dumort. – III (6): On peat soil and cushions of mosses and lichens on clefts and in crevices [123014]. In several specimens as single plants mixed with other liverworts including liverworts common in archipelago (*Gymnomitrion* spp., *Trilophozia quinquedentata*) and two new to Franz Josef Land (*Marsupella boeckii* and *M. apiculata*).

Gymnomitrion concinnatum (Lightf.) Corda – I(3), III(3), V(1,2,3): On spots of bare soil and gravel among the rubble-block ruins, on soils and peat among mosses and lichens in crevices and on ledges of basalt blocks [125390]. Mostly in mats with other liverworts, both widespread (*Anthelia juratzkana, Odontoschisma macounii, Trilophozia quinquedentata* etc.) and rare and newly recorded for archipelago.

G. corallioides Nees (gyn.) – I (1, 3), III (3), V (1, 3): On spots of bare soil and gravel among the rubble-block ruins, on peat soil and cushions of mosses and lichens on clefts and in crevices of rubble-block ruins [125330]. Often with *Gymnomitrion concinnatum*, *Trilophozia quinquedentata, Scapania obcordata,* as well as with *Marsupella* spp., etc.

Jungermannia polaris Lindb. – III (1, 5): On crushed rock with dead plants and among the rubble-stone ruins and products of frost weathering [125386], single shoots in mats of other liverworts.

Lophoziopsis polaris (R.M. Schust.) Konstant. et Vilnet (gemm.) – III (1, 5, 7), IV (2), V (1, 2): On soils and peat, on gravelly-clay soil among stones, in cushions among mosses and lichens on spots among rubble-block ruins, in dry tundra on coast of the bay [125349]. One of the most common species in collections. In pure mats or scattered among mosses or mixed with other liverworts.

L. rubrigemma (R.M. Schust.) Konstant. et Vilnet (gemm.) – I (1), II, III (2, 4, 5, 7, 8), IV (1, 4, 6), V (4): Among rocks and in cracks, on mosses on rubble scree, among coarse-grained remnants of the basalt plateau, on rocks in dry tundra on coast of the bay, in rubble-block ruins on plain, on spot partly covered by mosses, in hollow along coast with moss cover [125357]. Quite common. Often occurs in mats of mosses or with admixture of liverworts, mostly *Cephaloziella varians*, *Trilophozia quinquedentata*, rarely with *Anthelia juratzkana* and *Scapania obcordata*. The species was collected several times with the somewhat similar *Lophoziopsis polaris*. It was previously recorded for Alexandra Land by Bakalin (2005) as *Lophozia pellucida* R.M. Schust. var. *rubrigemma* (R.M. Schust.) Bakalin.

***Marsupella apiculata* Schiffn. – III (3): In crevices and on ledges on soils and peat in cushions among mosses and lichens. Several specimens [123016], mixed with other liverworts, both widespread (*Gymnomitrion* spp., *Scapania obcordata*, *Trilophozia quinquedentata, Cephaloziella varians*) and newly recorded for Franz Josef land (*Marsupella sprucei, Diplophyllum albicans*).

***M. boeckii* (Austin) Lindb. ex Kaal. – III (3): In crevices and on ledges on soils and peat in cushions among mosses and lichens [123005], mixed with *Gymnomitrion* spp., *Diplophyllum albicans, Trilophozia quinquedentata*.

***M. sprucei* (Limpr.) Bernet (per., and.) – III (3): On peat soil and cushions of mosses and lichens, on clefts and in crevices, mixed with *Gymnomitrion concinnatum, G. corallioides, Marsupella varians* [125379].

Mesoptychia heterocolpos (Thed. ex Hartm.) L.Söderstr. et Váňa var. *harpanthoides* (Bryhn et Kaal.) L.Söderstr. et Váňa

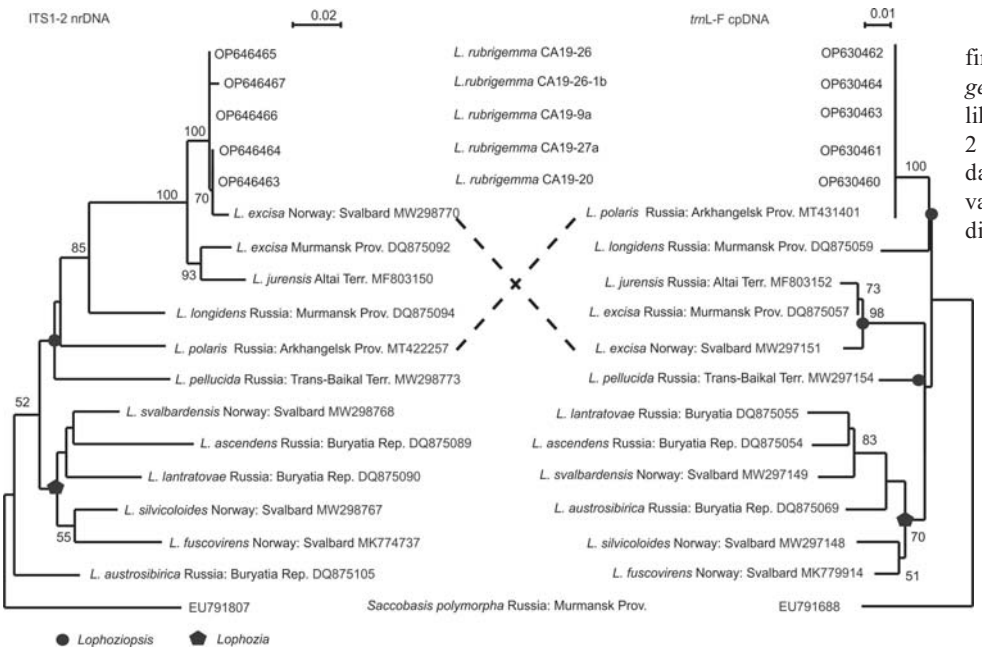

Fig. 3. The phylogenetic affinity of *Lophoziopsis rubrigemma* achieved by maximum likelihood method from ITS1-2 nrDNA and *trn*L-F cpDNA datasets. Bootstrap support values more than 50% are indicated.

– V (1): In depression among rubble-block ruins, with *Blepharostoma brevirete* [125394].

**Odontoschisma macounii* (Austin) Underw. – I (3), V (1, 2, 4): On gravelly-clay soil among rocks, on spots among the rubble-block ruins [125392]. Small mats among liverworts, more often with *Blepharostoma brevirete*, *Gymnomitrion concinnatum, Trilophozia quinquedentata, Cephaloziella varians*.

***Prasanthus suecicus* (Gottsche) Lindb. – III (3): In cushions among mosses and lichens, on soil in crevices [123017], single shoots with *Cephaloziella varians, Trilophozia quinquedentata, Scapania obcordata*.

Scapania spitsbergensis (Lindb.) Müll. Frib. – III (3): Among mosses and lichens, on soil and peat, in crevices and on ledges in basalt prismatic columns, mixed with *Trilophozia quinquedentata*, *Gymnomitrion* spp. [123011].

S .gymnostomophila Kaal. (gemm.) – V (7, 8): On spots among rubble-stone ruins and products of frost weathering [125325 125289], single shoots in mats dominated by *Lophoziopsis polaris*.

S. ligulifolia R.M. Schust. – I (1, 2), III (5): On mosses on rubble scree, on crushed rock with dead plants, in dry tundra, among rubble [125386]. Mostly as single shoots among liverworts: *Lophoziopsis rubrigemma, Cephaloziella varians, Scapania obcordata*.

S. obcordata (Berggr.) S.W. Arnell (gemm.) – I (1, 2), II, III (1,3,5.8), IV (1), V (3,6): On soil covered by mosses and lichens, on spots of bare soil among the rubble-block ruins, on rubble scree, on soil and peat in crevices and on ledges, in dry tundra. In most collected specimens mixed with other liverworts, more often with *Cephaloziella varians, Lophoziopsis rubrigemma, Scapania* spp., *Gymnomitrion* spp.

Schljakovianthus quadrilobus (Lindb.) Konstant. et Vilnet (gemm.) – III (5), V (2): On gravelly-clay soil among stones, on spots with mosses [125304], mixed with *Odontoschisma macounii, Blepharostoma trichophyllum, Trilophozia quinquedentata, Cephaloziella varians*.

Solenostoma sp. – III (1): In dry tundra, on the spot among the rubble-stone ruins and products of frost weathering, mixed with *Scapania gymnostomophila, Cephaloziella varians.* Plants without gametangia that do not allow its satisfactory identification.

Sphenolobus minutus (Schreb.) Berggr. – I (3), III (3), IV (2), V (1): On peat soil and in cushions of mosses and lichens on clefts and in crevices of basalt rocks, on spots of bare soil among the rubble-block ruins [123012]. Mostly as single shoots in mats of other bryophytes, more often with *Gymnomitrion* spp., *Cephaloziella varians, Trilophozia quinquedentata*.

Trilophozia quinquedentata (Huds.) Bakalin – I (1, 2, 3), III (3, 4, 6), IV (2), V (1, 2, 3, 4, 5). The most common species collected in almost all habitats and with all recorded in the island liverworts. The species is represented in most specimens by f. *gracilis* (R.M. Schust.) Konstant.

As a result of this short-term and fragmentary, but specialized study of the liverworts of the Alexandra Land, the list of species of the Franz Josef Land archipelago has increased by 6 species, that is, around 14% of the previously known number of species, and currently counts 48 species.

Molecular phylogenetic sudies of the difficult taxa

In order to verify identifications and to barcode some Arctic taxa, we obtained ITS1-2 nrDNA and *trn*L-F cpDNA sequence data of five specimens identified as *Lophoziopsis rubrigemma* and *L. elegans,* two specimens of *Lophoziopsis polaris* and single specimen of *Cephaloziella* sp. (Table 1). Fifteen newly obtained nucleotide sequences were assembled in BioEdit 7.0.1 (Hall, 1999). Ten of them assigned to *Lophoziopsis rubrigemma* and *L. elegans* were incorporated with previously published accessions into appropriate datasets for the genera *Lophoziopsis* and *Lophozia*. Phylogenetic estimations were provided by RaxML search (Kozlov *et al*., 2019) with GTR+I+G model and automatic bootstrapping for ITS1-2 and *trn*L-F datasets separately. In each calculation all

five tested specimens composed a clade in different affinity within the genus *Lophoziopsis*: the ITS1-2 phylogeny suggested their relation with specimens of *Lophoziopsis excisa* (this species presented by two subclades and its taxonomy still not clear, cf. Konstantinova *et al*., 2020b); the *trn*L-F phylogeny attended them to *Lophoziopsis polaris*. Due to ambiguous phylogenetic signals from different DNA loci the datasets could not be combined for subsequent estimation. The *p*-distance calculation in Mega 11 (Tamura *et al*., 2021) reveals variability in ITS1-2 within the tested *Lophoziopsis* specimens (0-0.5%), whereas *trn*L-F loci stayed identical. The differences between the tested *Lophoziopsis* specimens and representatives of the appropriate subclade of *Lophoziopsis excisa* counts 0.7% in ITS1-2, between tested specimens and samples of *Lophoziopsis polaris* – 0.1% in *trn*L-F (estimates were done including an unpublished dataset of the discussed species). Evidently, the five *Lophoziopsis* specimens belong to a single species that is characterized by hybrid origin from *Lophoziopsis excisa* and *Lophoziopsis polaris.* The heterogeneity in sequenced loci was not registered, thus concerted evolution within this taxon was completed.

The sequenced specimens are quite consistent with the description of *L. rubrigemma* in the shape of the leaves with a width exceeding the length, more or less pellucid and green in the middle and yellow brown to chestnut and red brown in lobes and along margins in combination with more deep colored, relatively numerous dark bright red to violet-red gemmae concentrated on tips on upper leaves and with very large cells that are (30–)35–40(–45) μm wide and 35–45(–50) μm long. It seems that this species is not rare in Franz Josef Land.

The nucleotide sequences of two specimens of *Lophoziopsis polaris* were compared with previously published dataset (Konstantinova *et al*., 2020b) and supported species identification. The *trn*L-F sequence of *Cephaloziella* sp. specimen was included in working alignment of the genus *Cephaloziella* (unpublished data) and revealed similarity with multiply sampled *Cephaloziella varians.*

DISCUSSION

The compiled list includes 23 species, of which 5 were not previously listed for Franz Josef Land. Of these, *Prasanthus suecicus* is a widespread species at least in some Arctic regions (e.g. Svalbard) and the lack of records of this species for Franz Josef Land can only be explained by the obviously insufficient knowledge of the flora of the archipelago. One species, *Diplophyllum albicans,* occurs in the Arctic sporadically with previously most northern known locality in Nordaustlandet (the Svalbard Archipelago) which is located 60 km to the south (Konstantinova & Savchenko, 2008). Three species of the genus *Marsupella* were so far known from isolated localities in the Arctic. *Marsupella boeckii* and *M. sprucei* have been recorded for Svalbard in Prins Oscars Land (Konstantinova & Savchenko, 2008), and *Marsupella apiculata* occurs sporadically in Svalbard (Söderström *et al*., 2021) and recorded as well for Bolshevik Island (Potemkin & Matveyeva, 2015). The high proportion of species new to the archipelago on one of the most visited and most well-studied islands indicates that we are still far from fully recording the flora of the archipelago's liverworts.

Several species were known from other islands of the archipelago but not recorded previously for Alexandra Land. One of these, *Odontoschisma macounii,* is quite common in the Arctic and an easily identifiable liverwort. It was collected several times on Alexandra Land. Another species not previously recorded for Alexandra Land is *Scapania spitsbergensis.* However, Zhukova (1973) cites *Scapania nemorea* (L.) Grolle for the island, which, given the distribution of the species, is extremely unlikely and that is most likely *Scapania spitsbergensis.* And finally, the absence in Zhukova's list (l.c.) *Trilophozia quinquedentata*, which is one of the most widespread liverworts on the island, can be explained by the incorrect interpretation of its forma *gracilis* as *Tritomaria scitula* (Taylor) Jørg. *or Pseudotritomaria heterophylla* (R.M. Schust.) Konstant. et Vilnet.

Eighteen species recorded for the Alexandra Land by Zhukova (1973) were not found in this study. Three of

Table 1. The list of specimens tested from integrative floristic approach with collection and GenBank accession numbers.

Taxon	Collection number	GenBank accession numbers	
		ITS1-2	trnL-F
Cephaloziella varians	CA19-23-7 (KPABG-125348)	No data	OQ029677
Lophozia polaris	CA19-9b (KPABG-125292)	OQ001104	OQ029675
L. polaris	CA19-15-3a (KPABG-125319)	OQ001105	OQ029676
Lophoziopsis rubrigemma	CA19-20 (KPABG-125329)	OP646463	OP630460
L. rubrigemma	CA19-27a (KPABG-125359)	OP646464	OP630461
L. rubrigemma	CA19-26a (KPABG-125353)	OP646465	OP630462
L. rubrigemma	CA19-9a (KPABG-125295)	OP646466	OP630463
L. rubrigemma	CA19-26-1b (KPABG-125356)	OP646467	OP630464

them are mentioned above as misidentified records of *Scapania nemorea, Tritomaria scitula* and *Pseudotritomaria heterophylla.* The inaccuracy of the indication of *Protolophozia elongata* (Steph.) Schljakov [as *Orthocaulis elongatus* (Lindb.) A. Evans], for Franz Josef Land was pointed out by Schuster & Damsholt (1974) and later by Schljakov (1980). Four species: *Sphenolobopsis pearsonii* (Spruce) R.M. Schust. [as *Cephaloziella pearsonii* (Spruce) Douin], *Obtusifolium obtusum* (Lindb.) S.W. Arnell (as *Lophozia obtusa* (Lindb.) A. Evans), *Gymnomitrion obtusum* Lindb. and *Scapania lingulata* H. Buch were excluded by Konstantinova & Potemkin (1996). The reports of six more species indicated by Zhukova (1973) for the island need confirmation: *Barbilophozia sudetica* (Nees ex Huebener) L. Söderstr., De Roo & Hedd. [as *Lophozia alpestris* (Schleich.) A. Evans and *Lophozia alpestris* var. *gelida* (Taylor) Macvicar], *Mesoptychia collaris* [as *Lophozia collaris* (Nees) Dumort.], *Lophoziopsis excisa* (Dicks.) Konstant. et Vilnet [as *Lophozia excisa* (Dicks.) Dumort. and *L. excisa* var. *grandiretis* S.W. Arnell], *Mesoptychia gillmanii* [as *Lophozia gillmanii* (Austin) R.M. Schust. var. *ciliolata* R.M. Schust.], *Schistochilopsis grandiretis* [as *Lophozia grandiretis* (Lindb. ex Kaal.) Schiffn.], *Schljakovia kunzeana* (Hübener) Konstant. et Vilnet [as *Orthocaulis kunzeanus* (Hübener) H. Buch]. Of them the greatest doubts are caused by such species as *Barbilophozia sudetica.* According to Zhukova (1973), *Barbilophozia sudetica* is not uncommon on Alexandra's Land; however, we did not find any specimen in our collection that we could attribute to this species without doubt. At first, we assigned several specimens to this species based on small leaf cells, but with a significant degree of doubt because of color of gemmae (rather red but not rusty brown). However, sequencing of one of these dubious specimen showed its identity with the specimens we referred to *Lophoziopsis polaris,* that is not rare on this island and on earlier studied Zigler Island (Konstantinova *et al*., 2020).

No less doubtful is the record of *Lophoziopsis excisa* (Dicks.) Konstant. et Vilnet. This species is characterized by a paroicous inflorescence and always occurs with perianths, whereas Ladyzhenskaya & Zhukova (1972) write that all studied specimens of this as well as other species in the collection from Alexandra Land were without gametangia. We believe that the large-celled variety of *L. excisa* which is recorded by Ladyzhenskaya & Zhukova (1972) represents *Lophoziopsis rubrigemma* described by Schuster (1969) from northeastern Greenland. Numerous findings of this little-known and poorly understood liverwort is one of the most interesting results of this study. *Lophoziopsis rubrigemma* was treated by Bakalin (2005) as *Lophoziopsis pellucida* R.M. Schust. var. *rubrigemma* (R.M. Schust.) Bakalin whereas Damsholt (2013) synonymized it with *Lophoziopsis longidens* (Lindb.) Konstant. et Vilnet ssp. *arctica* (R.M. Schust.) Váňa & L. Söderstr. The species was first recorded for Alexandra Land by Bakalin as *Lophoziopsis pellucida* R.M. Schust. var *rubrigemma*, based on study of specimens collected by V.D. Alexandrova (Bakalin, 2005). Discussing this species, Bakalin suggested that it is likely that *L. rubrigemma* "is a spontaneous polyploid from *L. propagulifera* or even *L. excisa* "(translation from Russian, Bakalin, 2005: 111).

In general red-gemmae *Lophoziopsis* and *Lophozia* in the Arctic is a complicated problem. The solution of this problem is possible only on the basis of study of large set of specimens from different regions of the Arctic, including Greenland, as well as central and western Europe, from where many taxa have been described.

Another big problem faced by all researchers in the Arctic is the identification of species of the genus *Cephaloziella*. Some species of the genus can dominate many plant communities in the high Arctic but often occur here without gametangia. At the same time, gametangia are necessary for more or less accurate identification of species. There were also no gametangia in the vast majority of the studied specimens. Attempts to identify specimens based on shape of the lobes and the thickness of the stem were unsuccessful. Molecular study of some such specimens identified as *C. polystratosa* based on a very wide stem (more than 100 μm wide), leaf lobes two-layered at the base and 8–10 cells wide turned out to be identical in terms of *trn*L-F loci to *C. varians* specimens with narrower lobes and a narrow stem. With that in mind we referred all studied specimens of *Cephaloziella* to *C. varians*.

It is important to note that attempts to identify plants from specimens without gametangia and gemmae lead to numerous erroneous identifications, which further complicates the assessment of the diversity of liverworts in the Arctic. To this we can add numerous taxa described from the Arctic relatively recently, often known from isolated localities and interpreted very differently. At the same time, the use of an integrative approach is extremely difficult due to the lack of verified data on Arctic species in the GenBank, as well as the inaccessibility of most Arctic regions to get fresh material. The data obtained by us illuminate several dark corners in the study of the flora of Arctic liverworts and highlight a number of problems, the solution of which is a matter of the future.

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