A MORPHOLOGOCAL AND MOLECULAR PHYLOGENGETIC STUDY OF THE GENUS CALLIERGON (CALLIERGONACEAE, BRYOPHYTA) IN RUSSIA

МОРФОЛОГИЧЕСКОЕ И МОЛЕКУЛЯРНО-ФИЛОГЕНЕТИЧЕСКОЕ ИЗУЧЕНИЕ РОДА CALLIERGON (CALLIERGONACEAE, BRYOPHYTA) В РОССИИ

ELENA A. IGNATOVA¹, IRINA V. CZERNYADJEVA², ALINA V. FEDOROVA³ & MICHAEL S. IGNATOV^{1,3} ЕЛЕНА А. ИГНАТОВА¹, ИРИНА В. ЧЕРНЯДЬЕВА², АЛИНА В. ФЕДОРОВА³, МИХАИЛ С. ИГНАТОВ^{1,3}

Abstract

The genus Calliergon is usually accepted in the Northern Hemisphere with only four widespread species and 1-2 less well-known ones, but nevertheless practical identification work often ends with specimens that are difficult to identify. This is especially so in Asian Russia, where combinations of character states in many plants do not always fit the classical treatments for Europe and North America. Especially problematic are dioicous plants with large alar groups and a thin costa. Such morphotypes prevail in some northern regions of Siberia. A molecular phylogenetic tree based on ITS and *rpl*16 placed such plants in a grade with clades of C. giganteum s.str. and C. megalophyllum nested within. The differences from C. giganteum and C. megalophyllum are moderately sharp and stable, thus we suggest segregation the northern Siberian plants as a subspecies, C. giganteum subsp. sibiricum Ignatova & Czernyadjeva. Calliergon cordifolium populations from high Arctic are differentiated by nrITS, and some of these plants have very broad leaves and fit the concept of C. orbicularicordatum, but other plants of the same haplotype are morphologically identical to Calliergon cordifolium s.str., precluding acceptance of C. orbicularicordatum at the species level. Far Eastern populations of Calliergon cordifolium s.l. appeared to be most sharply differentiated in both ITS, rpl16 and morphology by exceptionally well differentiated leaf borders. However, taxonomic segregation seems unwise due to enormous variation in these populations.

Резюме

Обычно считается, что в Северном полушарии род *Calliergon* представлен четырьмя широко распространенными видами, и иногда выделяются еще 1-2 вида. Тем не менее, при определении образцов нередко встречаются такие, которые невозможно уверенно отнести ни к одному из этих видов. Это особенно часто бывает с образцами из азиатской России, которые имеют комбинацию морфологических признаков, не соответствующую классическим обработкам рода для Европы и Северной Америки. Наиболее проблематичными являются двудомные растения, имеющие листья с крупными группами ушковых клеток и узкой жилкой. Этот морфотип часто встречается в некоторых регионах Сибири. В молекулярно-филогенетических деревьях, полученных при анализе ядерного ITS и хлоропластного rpl16, эти образцы образуют граду, внутри которой располагаются клады С. giganteum s.str. и С. megalophyllum. Такие растения умеренно резко, но стабильно отличаются от *C. giganteum* и *C. megalophyllum*, и мы предлагаем выделять их в ранге подвида, *C.* giganteum subsp. sibiricum Ignatova & Czernyadjeva. Популяции Calliergon cordifolium из высокой Арктики имеют определенные отличия в ядерном ITS, некоторые из них характеризуются очень широкими листьями и хорошо соответствуют C. orbicularicordatum, но к этому гаплотипу относятся и растения, морфологически идентичные Calliergon cordifolium s.str., что не позволяет выделять C. orbicularicordatum как особый вид. На Дальнем Востоке России также встречаются растения Calliergon cordifolium s.l., наиболее сильно отличающиеся по обоим изученным молекулярным маркерам, ITS и rp/16, а также имеющие очень резко дифференцированную кайму по краю листа. Однако их выделение в отдельный таксон также представляется невозможным из-за сильной морфологической вариабельности растений в этих популяциях.

KEYWORDS: mosses, taxonomy, ITS, rpl16, new subspecies

INTRODUCTION

Pleurocarpous mosses form a terminal clade in moss evolution, and their relatively recent diversification is usually considered as a reason for the poor morphological differentiation of many species. For taxonomy, this caused instability of generic circumscriptions. In the middle of 20th century, the genus Calliergon (Sull.) Kindb. (Podpera, 1954) included some species that are

¹ - Lomonosov Moscow State University, Faculty of Biology, Geobotany Dept., Leninskie Gory Str. 1-12, Moscow 119234 Russia; e-mail: arctoa@list.ru; ORCID (EI): 0000-0001-6287-5660; (MI): 0000-0001-6096-6315 ² – Komarov Botanical Institute, RAS, Prof. Popov Str., 2, St. Petersburg, 197376 Russia; ORCID (IC): 0000-0002-7137-8604

³ - Tsitsin Main Botanical Garden, RAS, Botanicheskaya Str., 4, Moscow 127276 Russia; ORCID (AF): 0000-0001-7362-2124

now classified in other genera: *Calliergon trifarium* (F. Weber & D. Mohr) Kindb. is now in *Drepanocladus* (Müll. Hal.) G. Roth (Amblystegiaceae), *C. sarmentosum* (Wahlenb.) Kindb. in *Sarmentypnum* Tuom. & T.J. Kop. (Calliergonaceae), and *C. stramineum* (Dicks. ex Brid.) Kindb. in *Straminergon* Hedenäs (Calliergonaceae), according to recent nomenclature (Hodgetts *et al.*, 2020).

The modern circumscription, however, was developed before the molecular phylogenetic studies started. The main revisions that rectified the concept of the genus were conducted by Karczmarz (1971), Tuomikoski & Koponen (1979) and Hedenäs (1993), and the taxonomy of widespread species of this genus did not change later on.

However, despite these treatments, practical identification of *Calliergon* specimens from the Russian territory is not always easy, as critical character states occasionally occur in combinations that are missed in identification keys. Especially difficult to interprete are dioicous plants with a narrow leaf costa (i.e. excluding *C. giganteum*) and alar group almost reaching the costa (i.e. excluding *C. megalophyllum*). The primary aim of the present study was to address to such phenotypes. In addition, other unusual morphotypes from different parts of Russia were included, for example, to shed light on the status and distribution of *C. orbicularicordatum* (Renauld & Cardot) Broth., a species reported from the North American Arctic, although remaining poorly known (Hedenäs, 1993, 2014).

MATERIAL AND METHODS

At first, collections from LE, MW, and MHA were studied, and the difficult phenotypes were selected for sequencing, along with a few 'typical' representatives of all species. The dataset was then supplemented to test the hypothesis that arose from the preliminary analysis.

Molecular phylogenetic study

We sequenced nuclear ITS region, as the most informative one for phylogenetic reconstructions of pleurocarps (Huttunen *et al.*, 2012), and the plastid *rpl*16, as these were found to be useful in other studies of the Calliergonaceae (Hedenäs, 2006, 2011), and are also available in GenBank for dataset extension. Species of all other genera of the family Calliergonaceae were used as the outgrop.

The laboratory protocol for ITS was essentially the same as in previous moss studies, described in detail by, e.g., Gardiner *et al.* (2005). For ITS amplification the primers 'ITS1' and 'ITS-B' (White, 1990; Sahin *et al.*, 2007) and for *rpl*16 region the primers 'F71' and 'RI661' (Jordan *et al.*, 1996) were used.

Sequences were aligned using MAFFT v. 7.402 (Katoh & Standley, 2013) with standard settings.

Vouchers of newly sequenced specimens and Gen-Bank accession numbers of all used sequences are compiled in Appendix 1.

At first the ITS (1135 bp) and rpl16 (1098 bp) datasets were analysed separately to check their congruence. No supported conflicts were detected in preliminary Bayesian analyses and therefore a concatenated dataset was built and analysed.

Bayesian analyses were performed in MrBayes 3.2.6 (Ronquist *et al.*, 2012), in each case with four runs, six chains, 10,000,000 generations, 25% burnin, chain temperature 0.02, and GTR+G model. Convergence of each analysis was evaluated using Tracer1.4.1 (Rambaut & Drummond, 2007). Analyses were performed on the Cipres Science Gateway (http://www.phylo.org/portal2) on XSEDE (Miller *et al.*, 2010).

Maximum parsimony analysis was performed in Nona (Goloboff, 1994) in the Winclada shell (Nixon, 1999), with bootstrap calculation for 2000 replications (N searches 100, starting trees per rep 100, max trees 100, do max).

Morphological study

The morphological study of the dioicous *Calliergon* species was conducted after molecular phylogenetic analysis sorted these into three groups (two clades and one grade), somewhat expected from preliminary morphological studies, i.e. 'typical' *C. giganteum* with stout costa, 'typical' *C. megalophyllum* with thin costa and small alar groups, and problematic specimens with a thin costa and large alar groups.

Measurements were done for two sets of samples. The first set included only sequenced specimens: 30 samples, 5 well-developed leaves taken from one stem from each sample, thus 150 leaves were measured.

The second set had about an equal number of measurements, but we took more samples, measuring 3 leaves in each of them, thus 53 samples and 159 leaves were studied. The second set was taken from LE herbarium specimens, identified previously as *C. giganteum* and *C. megalophyllum* and putatively a third undescribed species, characterised by thin costa and alar cells reaching or almost reaching the costa.

The following characters were used for measurements: (1) leaf length, mm; (2) leaf width, mm; (3) costa width at leaf base, μ m; (4) costa width at 1/3 the leaf length, μ m; (5) costa length, % of leaf length; (6) alar group extending % of distance to costa; (7) mid-leaf cell length, μ m; (8) mid-leaf cell width, μ m. Ten cells were measured in each leaf and their mean length and width were used for the analysed dataset.

Four additional values were calculated for comparison of species and putative species:

(1):(2) leaf length to width ratio;

(3):(4) costa width at base to its width at 1/3 leaf length;

(7):(8) cell length to width ratio;

(7):(1) ratio cell length in μ m to leaf length in mm, as this character was found to be useful in *Drepanocla- dus* (Hedenäs, 1998, 2014).

Specimen data and measurements are available as a Supplementary Materials.

The morphological data were processed with PAST (Hammer *et al.*, 2001).

RESULTS

Molecular phylogenetic study

Separate Bayesian analyses of ITS and rpl16 datasets revealed no supported conflicts. The plastid marker is less variable and, expectedly, the rpl16 based tree has lower resolution: the Calliergon clade was almost unresolved with only two clades nested in the polytomy: (1) two-specimen clade of Far Eastern C. cordifolium (marked in the tree in Fig. 1 as C. cordifolium A), and (2) the rest of C. cordifolium accessions. Specimens of dioicous species of Calliergon and C. richardsohnii form a polytomy.

The ITS tree is resolved almost identically to that of concatenated tree, thus only the latter is shown here in Fig. 1. The basal grade of the tree rooted on Loeskypnum includes, sequentionally, species of Straminergon, Warnstorfia, Sarmentypnum, and the terminal clade of Calliergon. The latter has a maximal Bayesian posterior probability, while in MP analysis its bootstrap support is nonsignificant (PP=1, BS=50). The Calliergon clade includes two subclades: one is formed by C. richardsonii (PP=1, BS=96), and another (PP=1, BS=100) with all other species

This maximally supported clade of Calliergon with 0.85/79 long costa is subdivided into two subclades: one with autoicous plants (PP=1, BS=99) and another with dioicous (PP=0.85, BS=79). Autoicous plants, usually classified as one species, C. cordifolium, include a small clade of specimens from the Russian Far East (PP=1,

1/50

1/96

Straminergon stramineum JF710082 JF710133 Loeskypnum badium AY625990 DQ304449

Warnstorfia pseudostraminea OK2782 Taimvr

Warnstorfia pseudostraminea JF710036 JF710088

0,99/59

0.99/55

0.99/-



shown at branches.



Costa width at base Costa width at one third the leaf length Costa width at base to one third Fig. 2. Comparison of six morphological characters of three groups of *Calliergon* (Sib: *C. giganeum 'sibiricum'*; Gig: *C. gig*

BS=88) sister to other specimens of *C. cordifolium* (PP=1, BS=70), which is further subdivided into two clades: one with high Arctic species from Northern Siberia, some of which with the phenotype of *C. orbicularicordatus* (PP=1, BS=64), and another clade from scattered localities from Russia, including both eastern, western, southern, and Arctic populations, and also West European plants (PP=0.92, BS=56).

The diocous species clade is poorly supported (PP=0.85, BS=79). It comprises a polytomy composed by plants with narrow costa, from Siberia, mostly from areas with permafrost, and this polytomy has four nested clades. Two of them include species from the same region as in the polytomy and combine species without any geographical or morphological peculiarity. The third nested clade includes *C. megalophyllum* (PP=1, BS=85),



Fig. 3. Comparison of six morphological characters of three groups of *Calliergon* (Sib: *C. giganeum 'sibiricum'*; Gig: *C. giganeum s.str.*; Meg: *C. megalophyllum*), in two sets of morphometrical studies: sequenced and non-sequenced ones.

represented by seven accessions that form a polytomy. The last nested clade (PP=0.92, BS=58) includes *C. gi-ganteum* s. str. (mostly with a broad costa) from different parts of Eurasia, mostly outside the permafrost region in Siberia.

Morphological study

A partial genetic and geographic differentiation of plants from the permafrost region of Siberia raised a necessity to check if they can be identified by morphology. Results of the measurements are displayed in Figs. 2 and



3, showing twelve studied characters for pairs of sequenced and non-sequenced plants. These characters show rather similar patterns, that differ mostly for *C*. *megalophyllum* which was measured in sequenced dataset only in four specimens.

The box plots in Figs. 2 and 3 point to five characters that differentiate taxa of three groups better that others: leaf length, leaf width, cell length, width of costa at one third leaf length, and alar group (extension towards costa).

Using these five characters, the two morphological

datasets were compared by the Principal coordinate analysis in PAST (Hammer *et al.*, 2001), Fig. 4. The overlap between 'typical *C. giganteum*' and 'typical *C. megalophyllum*' is absent in the dataset of sequenced plants (Fig. 4A) or is very small in second set of non-sequenced plants (Fig. 4B). The putative third species (denoted in Fig. 1 as *C. giganteum* '*sibiricum*') overlaps strongly with the two mentioned taxa, and in the scatterplot of sequenced plants (Fig. 4A) this overlap is greater than in non-sequenced ones (Fig. 4B).

DISCUSSION

Dioicous species

The molecular phylogenetic tree found dioicous plants of *Calliergon* rather poorly resolved, with only two clades of high support: one (PP=1, BS=95) combines four specimens that are separated from other plants of the group neither in morphology, nor in geography. Another well supported clade (PP=1, BS=95) joins seven specimens of *C. megalophyllum*.

The clade sister to C. megalophyllum is poorly supported (PP=0.92, BS=58), but at the same time it is more or less consistent in morphology with 'typical C. giganteum': most plants of this clade have a broad, stout costa, whereas dioicous Calliergon outside this clade almost never have such costa. Therefore, the North Siberian plants with thin costa and large alar groups, which identity was in the main focus of the present study, receive genetic support (albeit poor) for their segregation. Interestingly, such plants were found so far mostly in the area of permafrost in Siberia, with a few finds in the high mountains of Altai and Transbaikalia. A number of specimens from the Urals and West Siberian lowland with a comparatively thin costa and large alar groups similar to North Siberian plants of C. giganteum 'sibiricum' were found in the C. giganteum clade.

The interpretation of these results is not straightforward. The first possibility would be to combine all dioicous *Calliergon* in one species as there are specimens that are impossible to identify by morphology, i.e. sort between two known species: *C. giganteum* and *C. megalophyllum*. However, an inconsistence between molecular and morphological groupings of specimens occur in some other genera of the family Calliergonaceae. In expanded analysis of the genus *Sarmentypnum* Hedenäs (2011, 2015) found few such inconsistencies, which nevetheless require special study and being infrequent, 1-3%, do not preclude recognition of species which are well recognizable in most cases. Similarly, *C. giganteum* and *C. megalophyllum* in Europe rarely provide identification problems.

The Asian plants called *C. giganteum 'sibiricum'* in Fig. 1 overlap strongly with other species. However, the overlap with *C. giganteum* is obviously greater than with *C. megalophyllum* (Fig. 4A,B), so further discussion of the possible inclusion of *C. giganteum 'sibiricum'* in *C. megalophyllum* is not necessary. The status of *C. giganteum 'sibiricum'* therefore needs to be decided only relative to *C. giganteum*.

One could argue for the segregation of *C. giganteum* '*sibiricum*' as a separate species as follows: (1) an almost allopatric distribution; (2) genetic differentiation in ITS; 3) differentiation in most cases by the combination of thin costa and large alar groups; (4) a costa that occasionally ends far below the leaf apex. At the same time, the main difference for practical identification will be in the width of the costa, which overlaps rather strongly and suboptimally developed plants of *C. giganteum* (cf. Fig. 5) will likely cause many cases of misidentifications.

One more problem with recognising *C. giganteum 'sibiricum'* as a species based on the mentioned two features, the thin costa and large alar groups, can be seen in Fig. 4A, B. The molecular circumscription of *C. giganteum 'sibiricum'* in Fig. 4A is obviously wider than the morphologically defined group in Fig. 4B. The much broader variation in Fig. 4A raises suspicion that it is easy to misidentify outlying morphotypes, that genetically belong to the *C. giganteum 'sibiricum'*, as *C. giganteum* or *C. megalophyllum*. Figure 5 includes both typical and outlying morphotypes of *C. giganteum* s. str., *C. giganteum 'sibiricum'*, and *C. megalophyllum*, illustrating the difficulties of making a certain identification in some cases.

On the other hand, a simple inclusion of *C. giganteum* '*sibiricum*' into *C. giganteum* provides a considerable difficulty to circumscribe *C. giganteum* s.l., and its differentiation from *C. megalophyllum* only by the alar group size.

We suggest the formal recognition and description of *C. giganteum 'sibiricum'* as a subspecies, that will make possible to sort out this morphotype in many cases (and continue searching for additional characters differentiating these plants), while it makes possible to accept *C. giganteum* sensu lato for equivocally looking plants, and to retain the name, that is abundantly represented in studies of the vegetation science.

Calliergon giganteum subsp. *sibiricum* Ignatova & Czernyadjeva, subsp. nov. Figs. 6, 5: E–L, 7.

Holotype: Right bank of Tirekhtyakh River in middle course, west of Mramornaya Mt., 64°52'43"N, 146°31'13"E, 1240 m alt., flat depression with lakes, flooded site with *Carex stans* between lakes, 14 July 2018, Ignatov & Ignatova 18-1525 (Holotype: MHA9028275!, isotype MW9091937!). Figs. 6, 7.

Diagnosis: Dioicous Calliergon, differs from C. gigantum in weak costa and from C. megalophyllum in large alar groups.

Description: Plants medium-sized, green or olivaceous-green. Stems 3-7(-15) cm long, simple, irregularly branched or, rarer, pinnately branched. Stem leaves appressed to erect, (1.2-)1.7-2.7(-3.3)×(0.9-)1.2-1.4 (-2.2) mm; ovate or ovate-triangular, rounded at apex, cordate at base, concave; costa thin, reaches 0.9-1.0 leaf length, rarely in largest leaves only 0.7 the leaf length, often indistinct in upper portion, (50-)60-80(-180) µm wide at base, (20-)25-40(-60) µm wide at one third the leaf length; median laminal cells (40)50-65(-120)×(4.5-) 6-7.5(-10) µm, with moderately thickened walls; alar cells large, thin-walled, forming large, sharply delimited group reaching (0.5-)0.7-0.9(-1.0) the distance from leaf margin to costa. Dioicous, sporophytes rare. Male plants not seen. Inner perichaetial leaves 2.25–2.5×0.9– 1.2 mm, straight, not plicate, oblong-triangular, strongly concave, subobtuse at apex, with entire margins, costa single, thin, reaching 0.65-0.95 of leaf length. Setae 3-4 cm long, reddish-brown. Capsules inclined to horizontal, oblong, curved, occasionally with mouth turned down-



Fig. 5. Leaves of three dioicous taxa of the genus *Calliergon*, showing their variation. A–D – *Calliergon giganteum* subsp. *giganteum* (A: OK2699, Commander Islands; B: OK2703, Tyumen Province; C: OK2704, Novosibirsk Province; D: OK2705, Murmansk Province); E–L – *C. giganteum* subsp. *sibiricum* (E: OK2654, central Yakutia; F: OK2701, Taimyr; G: OK2655, eastern Yakutia; H: OK2651, eastern Yakutia; I: OK2708, Taimyr; J: OK2707, Taimyr; K: OK2702, Taimyr; L: OK2656, Taimyr); M–P – *C. megalophyllum* (M: OK2760, Zabaikalsky Territory; N: OK2762, Zabaikalsky Territory; O: OK2758, Yamal; P: OK2777, Ivanovo Province). Scale bars: 1 mm for all.



Fig. 6. *Calliergon giganteum* subsp. *sibiricum* (from holotype): A, C: habit, dry; B, D: capsules; E: upper leaf cells; F–G: branch leaves; H–I: median laminal cells; J: inner perichaetial leaf; K–M: stem leaves; N: basal laminal cells. Scale bars: 1 cm for A; 5 mm for C; 2 mm for B, D; 1 mm for F–G, J–M; 200 µm for N; 100 µm for E, H–I.





wards, ca. 2 mm long, brownish. *Operculum* conic, with short obtuse beak. *Peristome* perfect; *exostome teeth* 600–700 μ m long, light brownish, on dorsal surface finely striolate-reticulate below, finely papillose above; endostome with high basal membrane, segments about the same length as exostome teeth, perforated, finely papillose, cilia 2–3, long, nodose to shortly appendiculate. *Spores* 13–18 μ m, finely papillose. *Calyptrae* not seen.

Distribution and ecology. The subspecies occurs in the tundra zone and in mires in permafrost regions of the boreal zone, occasionally in the upper belts of high mountains in continental areas. Fig. 4C–D shows approximate limits of the species distribution; preliminary attempts to find it in Europe failed. Because the easternmost localities of dioicous *Calliergon* belong to *C. gi*- Puc. 7. *Calliergon giganteum* subsp. *sibiricum* (from holotype): A: leaf; B: alar and basal laminal cells; C: upper laminal cells and end of costa, note its indistinct outlines in uppermost part.

ganteum s.str., we presume that *C. giganteum* subsp. *sibiricum* is absent in oceanic regions of the Russian Far East. Collections were done in a variety of wet grasslands, boggy forests, and mires.

Differentiation and variation. Besides the combination of a thin costa and large alar groups, *Calliergon* giganteum subsp. sibiricum can be preliminary identified by a small plant size (Fig. 6). Leaf length and width are, however, often correlated with plants that are robust or slender and show only small difference from *C. gi*ganteum subsp. giganteum. However, in northern Siberia where the latter subspecies was so far not found, the problem of differentiation of plants in the field is separation from *C. megalophyllum*, and for that this character works well.

Another trait that often is conspicuous in *C. giganteum* subsp. *sibiricum* is a costa that is gradually vanished in its uppermost part and it is somewhat difficult to decide exactly where it ends (Fig. 7C). In some especially large leaves the costa ends far below the leaf apex: one such leaf is shown in Fig. 5L. Such plants could be identified as *C. richardsonii*, so DNA was re-extracted and re-sequenced to confirm the identity of this specimen with most other specimens of *C. giganteum* subsp. *sibiricum*.

Specimens examined: (other than those in Appendix 1, with sequenced samples).

Selected specimens examined: RUSSIA: Altai Territory: Biisky Okrug, Malyi Ad mire, 27 Jul 1928, Sheludyakova s.n. (LE). Amur Province, Bysa River, 25 Aug 1927, Kuzeneva 88 (LE); Zeya River basin, Bomnak River, 28 Aug 1910, Abramov 121 (LE). Arkhangelsk Province: Franz Josef Land, Meibl Island, 28 Jul 1979, Safronova s.n. (LE); Franz Josef Land, Hooker Island, 80°20'18.7"N, 52°47'27.6"E, 29 Jul 2019, Konoreva 913 (LE). Buryatia Republic, West Sayan, Oka River, 52°34'N, 100°07'E, 9 Jul 2008, Afonina 02808 (LE); Mukhorshibirsky District, Bolshoy Sibilduy River, 50°48'57"N, 107°20'18"'E, 25 Aug 2018, Afonina s.n. (LE, #1218). Chukotsky Autonomous District: Ioni Lake, 3 Jul 1977. Afonina s.n. (LE); Yanrakynnot Settlement, 20 Jul 1976, Afonina s.n. (LE); Amguema River, 17 Aug 1970, Afonina s.n. (LE); Aion Island, 19 Jul 1983, Afonina CH-00064 (LE); Il'myneiveem River, 30 Jul 1978, Afonina s.n. (LE); Vrangel Island, Somnitelnaya Bay, 23 Jul 1985, Afonina s.n. (LE). Krasnoyarsk Territory: Kureika station, 17 Sept 1933, Sokolov s.n. (LE, #26); Archipelago Severnaya Zemlya, Island of the October Revolution, 24 Aug 1975, Safronova s.n. (LE); Evenkia, Turukhansk Region, Lower Tunguska River, 9 Jul 1932, Rubin & Maskil s.n. (LE): Chunva River, 9 Jul 1931, Rubin s.n. (LE); Taimyr Autonomous District: mouth of Malaya Logata River, 98°24'N, 73°25'E, 5 Aug 1988, Pospelova s.n. (MW9026350); Lake Syrutaturku, 73°35'N, 97°30'E, Pospelova 94/55 & 94/66 (MW9026351, MW9026352); West Taimyr, Willem Barentz Biostation, Meduza Bay, 20 Jul 2001, Varlygina s.n. (MW9026276); Afanas'evskie Lakes, 71.5896°N, 106.117°E, Fedosov 06-64 (MW9026280); between Afanas'evskie Lakes and Fomich River, 71.6208°N, 106.315°E, Fedosov 06-442 (MW9026274); mouth of Kogotok Creek, 70.8195°N, 100.983°E, Fedosov 09-227 (MW9026273); Nyurai-tar Creek - left tributary of Bikada River, 17 Aug 1978, Sokolova s.n. (MW9026284); northern edge of Anabar Plateau, watershed of Popigai and Anabarka Rivers, 72.1283°N, 110.702°E, Fedosov 08-305 (MW9010425); Taimyr, Dixon Island, 7 Aug 1954, Dorogostaiskaya (LE); Uboinaya River, 19 Aug. 1988, Kannukene s.n. (LE, #14975); Mamontova River, 12 Aug. 1949, Tikhomirov & Uvarov s.n. (LE); Kresty Settlement, Aug. 1976, Matveeva s.n. (LE); Tareya Settlement, 22 Jul 1970, Blagodatskikh s.n. (LE); Novaya River, Ary-Mas, 1 Aug. 1972, Afonina s.n. (LE); Plateau Putorana, Ayan Lake, 23 Jul 1983, Czernvadjeva 88 (LE); Plateau Putorana, Lama Lake, Jul 1984, Czernyadjeva 65 (LE). Kamchatsky Territory: Paratunka River, 25 June 1957, anonym (LE). Khabarovsk Territory, Nikolaevsky District, Kulchi Settlement, 13 Aug 1964, Ganeka s.n. (LE). Magadan Province: Chaunsky District, 18 Jul 1977, Blagodatskikh s.n. (LE); Olsky District, Atargan Settlement, 29 Jul 1978, Blagodatskikh s.n. (LE). Zabaikalsky Territory: vicinity of Nerchinsk Town, 4 Jul 1908, Novopokrovskij 1564 (LE); Sokhondinski Reserve, 49°27'N, 110°51'E, 11 Jul 2010, Czernvadjeva 8-10 (LE); Gazimuro-Zavodskiy District, 52°14'48"N, 119°23'22"E, 22 Jul 2012, Afonina 2912 (LE); Kalarsky District, Naminga Settlement, 56°36'N, 118°32'E, 2 Aug 1985, Filin s.n. (LE, MW); Alkhanay National Park, 50°48'N, 113°03'E, 16 Jul 2005, Afonina 1005 (LE). Tuva Republic: East Tannu-Ola Range, 50.90890°N, 94.32896°E, 30 Jun 2018, Pisarenko tv18-5d (LE). Yamalo-Nenetzky Autonomous District: Yamal, Junto Lake, 67°40'N, 68°00'E, 10 Aug 1993, Czernyadjeva 56 (LE); Yamal, vicinity Syunyaj-Sale Settlement, 66°55'N, 71°20'E, 26 Jul 1996, Czernyadjeva 42 (LE). Republic of Sakha/Yakutia: Momsky District: Ulakhan-Chistai Mt. Range, west of Mramornaya Mt., 64°52'43"N, 146°31'13"E, Ignatov & Ignatova 18-1523 (MHA9028171); middle course of Tirekhtyakh River, Ulakhan-Chistai Mt. Range, 64°54'28"N, 146°25'52"E, Ignatov & Ignatova 18-1897 (MHA9092425); lower course of Tirekhtyakh River, Tymny-Ulakh Creek, 64°10'33"N, 146°45'09"E; Ignatov & Ignatova 18-2498 (MHA9029134); Khangalassky District: Ulakhan Keteme Creek near road to Tit-Ary, 61°15'50"N, 128°05'09"E, Ignatov & Ignatova 16-165 (MHA9022144); Tomponsky District: between Khandyga and Teplyi Klyuch Settlements, 62°45'28"N, 136°28'19"E, Ignatov & Ignatova 18-1214 (MHA9027704): New Siberian Islands, Stolbovoi Island, 74°10'31.2"N, 135°27'36.6"E, 3 Aug 2019, Czernyadjeva 8-19 (LE); New Siberian Islands, Kotelny Island, 25 May 1947, Gorodkov s.n. (LE); New Siberian Islands, Bolshoi Lyakhovsky Island, 73°20'N, 140°00'E, 25 Aug 1956, Pigulevskaya s.n. (LE); Tiksi, 71°40'42.6"N, 128°51'7.1"E, 30 Jul 2019, Czernyadjeva 3-19 (LE); delta of Lena River, Samoilovsky Island, 72°22'N, 126°29'E, Aug 1998, Zhurbenko s.n. (LE); lower course of Indigirka River, 17 Aug 1974, Afonina s.n. (LE); Medvezhji Islands Archipelago, Chetyrekhstolbovoi Island, 70°37'N, 162°27'E, 7 Aug 1980, Zaslavskaja s.n. (LE): Nizhnekolymsk District, Pokhodsk Village, 6 Aug. 1973, Stepanova 2/6 (LE); Suntarsky District, Vilui River basin, 5 Aug. 1958, Kildyushevsky 77/5 (LE); Indigirka River basin, Moma River, 66.5°N, 30 May 1936, Sheludyakova s.n. (LE); Lensk District, Dzerba River basin, 60°29'N, 116°50'E, 20 Jul 2000, Ivanova s.n. (LE); Tomponsky District, Delinnya River, 28 Jun 1955, V. Ivanova s.n. (LE); Olekminsk District, Tokko River, 20 Jul 1995, Krivoshapkin 02.04.01.09 (LE).

Comment on the subspecies' distribution. The distribution of dioicous taxa of *Calliergon giganteum* group (Figs. 4C–D; 8) shows that subsp. *sibiricum* appears to be restricted mostly to areas with permafrost, and it is absent in the extensive boggy lowland of West Siberia and oceanic regions along Pacific coast of Asia where *Calliergon giganteum* subsp. *giganteum* occurs (Figs. 4C–D; 8). Interestingly, in the severe climate of the Transbaikalia, with local (though not rare) permafrost spots, *Calliergon giganteum* subsp. *sibiricum* appears to be much more common than subsp. *giganteum*.

Comment on phytogeography. In general, the known distribution of *Calliergon giganteum* subsp. *sibiricum* is similar to some common Yakutian species, e.g. *Tomentypnum involutum* (Limpr.) Hedenäs & Ignatov (Hedenäs *et al.*, 2020). However, in contrast to *T. involutum*, which populations in Yakutia are sympatric with *T. nitens*, a wide-spread Holarctic species, the distributions of *C. giganteum* subsp. *sibiricum* and subsp. *giganteum* hardly overlap.

A more similar situation has been found by Hedenäs (2009) for *Scorpidium cossonii–S. scorpioides* complex. *Scorpidium scorpioides* has obviously evolved inside basal *S. cossonii*; similarly, *Calliergon megalophyllum* originated from *C. giganteum* s.l., that gave also a lineage of *C. giganteum* s.str. In both cases 'ancestral' grades (of *S. cossonii* and *C. giganteum* subsp. *sibiricum*) have Arctic to northern distributions. In both cases the derivatives, *S. scorpioides* and *C. megalophyllum* received a rather strong morphological difference and bigger size, and also both latter species often grow submerged, at least for larger parts of their bodies.

Hedenäs (2009) estimated that *S. cossonii* must have evolved before the general cooling of the climate started in Pliocene, earlier than the Arctic region expanded. As the complex of the dioicous *Calliergon* taxa received a stronger genetic differentiation, we may suggest that it is likely no less ancient; moreover, *C. giganteum* was re-



Fig. 8. Distribution of *Calliergon giganeum* subsp. *giganteum* (A), *C. giganeum* subsp. *sibiricum* (B), and *C. megalophyllum* (C), based on specimens in LE, MHA, and MW.



Fig. 9. *Calliergon cordifolium*, high Arctic morphotype corresponding to *C. orbicularicordatum* (from: Russia, Franz-Josef Land, 23 Aug 2012, *Kholod* #71, LE). A: upper leaf cells; B, D: median laminal cells; C: branch leaf; E: basal laminal cells; F–G: stem leaves. Scale bars: 1 mm for C, F–G; 200 µm for E; 100 µm for A–B, D.



Fig. 10. *Calliergon cordifolium*, Far Eastern morphotype with sharply delimited leaf border, showing variation (from: Russia, Yakutia, Yugorenok, *Ignatov 00-901*, MHA9010447). A–B, F–G: stem leaves; C–D, I–J: median laminal cells; E, H: basal laminal cells; K–L: branch leaves. Scale bars: 1 mm for A–B, F–G, K–L; 200 µm for E, H; 100 µm for C–D, I–J.

ported from Late Miocene or Pliocene deposits of Beaufort Formation (Kuc & Hills, 1971; Kuc, 1973). Although the overlap in distribution of *C. giganteum* subsp. *giganteum* and subsp. *sibiricum* is considerably smaller compared to that for haplopypes of *Scorpidium cossonii* (Hedenäs, 2009), the genetic isolation between these *C. giganteum* subspecies seems to be not strict.

Autoicous species

The autoicous species of *Calliergon* in Eurasia are usually treated as two species, *C. richardsonii* and *C. cordifolium* (Hodgetts *et al.*, 2020; Ignatov *et al.*, 2006).

The former is a northern species, and usually providing no problems with identification because its leaf costa ends far below the leaf apex. A short costa rarely occurs in *C. giganteum* subsp. *sibiricum* (cf. Fig. 5L) but in this species the short costa is not constant: study of many leaves from several shoots would find some (and usually a majority) leaves with a costa reaching leaf apex or almost so (>0.95 distance to apex).

The present analysis found a certain incongruence regarding *C. richardsonii*: in the ITS tree *C. richardsonii* is sister to the rest of the genus, and low support for the whole *Calliegon*-clade (BS=50) contrasts with the maximal support of a clade that includes *Calliergon* specimens other than *C. richardsonii*. Thus, even a position of *C. richardsonii* in the genus *Calliergon* is not unequivocal based on the MP analysis. However, a separate analysis of plastid *rpl*16 does not resolve *C. richardsonii* at all, leaving its specimens in polytomy intermingled with dioicous species of *Calliergon*.

The second autoicous species, *Calliergon cordifolium*, appeared to be quite heterogeneous molecularly (Fig. 1). The present study revealed that plants from Arctic (Fig. 9) form a separate lineage with high to moderate support (PP=1, BS=64, see Fig. 1), and some plants of this genotype have characters considered diagnostic for *C. orbicularicordatum*: short and broad laminal cells and differentiated border of narrow cells in the lower part of the leaf (Fig. 10).

Calliergon orbicularicordatum was described from Hudson Bay in Canada, an area with a severe climate equivalent to that of continental areas in northern Russia. There were no records of this species in Eurasia yet, although northern plants fit it rather well (cf. Fig. 9) in having very broad leaves with a distinct leaf border of narrow cells. The alar cells in such plants form a large group, but the transition to laminal cells is less distinct than in most plants of C. cordifolium. Thus, how far they extend towards the costa is described differently by different authors. However, not all plants of this high Arctic ribotype possess this combination of traits, and some specimens with the identical sequences are indistinguishable from the most common morphotype of C. cordifolium from the forest zone. Thus, our present observations do not support a taxonomic segregation of high Arctic plants of C. cordifolium affinity and their relationship to the North American plants of *C. orbicularicordatum* remains to be studied.

An even stronger morphological and genetic variation was found in Far Eastern plants of *C. cordifolium* (PP=1, BS=88, see Fig. 1), with ovate (not orbicular) leaves having an especially conspicuous border of narrow cells along the leaf margin, often extending almost to the leaf apex and fairly contrasting with the laminal cells further inwards, which are rhomboidal, with a length to width ratio of ca. 4:1 (Fig. 10). However, again, this morphology is not stable and in some shoots of the same collection (that looks otherwise homogeneous), we saw in some leaves a very distinct border, while a border was almost absent in other leaves. Such variation seems to depend on an extreme plasticity in a species adapted to growth in habitats with highly variable moisture conditions.

Kanda (1975) discussed C. cordifolium var. japonicum Card. and confirmed the conclusion of Karczmarz (1971) that this variety cannot be distinguished from var. cordifolium. The distinctions of this variety include smaller size of plants and sparse branching, which coincides with the Russian Far Eastern plants of the genotype mentioned above. Kanda did not mention a border of narrow cells, but it is illustrated in his publication and is contrasting with short mid-leaf cells (Kanda, 1975, figs. 49-6 and 49-7). Thus, it is likely that the eastern genotype found in the present study and shown in Fig. 10 occurs in Japan. However, Karczmarz (1971), in his key to the genus Calliergon, used the border of narrow cells and short mid-leaf cells as diagnostic only for C. orbicularicordatum, thus we are pending the applicability of the name C. cordifolium var. japonicum to the plants of the mentioned eastern genotype).

The morphological variation does not support taxonomic segregation in *Calliergon cordifolium* s.l., although it might be considered for future investigations based on data on haplotype distributions and modelling of the species distribution (e.g., Hedenäs, 2019).

KEY TO CALLIERGON SPECIES IN RUSSIA

1.	Costa in most leaves to (0.4–)0.5–0.8 the leaf length
	Costa in most leaves to 0.9-1.0 the leaf length 2
2.	Alar cells gradually grading into other laminal cells; autoicous; leaf marginal cells often form more or less distingt horder
	Alar cells rather abruptly delimited from other lam- inal cells; dioicous; leaf marginal cells never form border
3.	Stem leaves $(2.5-)3.0-4.0(-5.0)\times1.5-2.0(-3.0)$ mm; alar group reaching 0.4-0.7 of distance to costa 3. <i>C. megalophyllum</i>
	Stem leaves $(1.2-)1.5-2.7(-3.3)\times 0.9-1.5(-2.2)$ mm; alar group reaching $(0.5-)0.7-1.0$ of distance to costa

- Plants medium-sized; costa weak, (45–)60–80(–130) μm wide at base; stem leaves (1.5–)1.7–2.5(–3.3) ×(0.9–)1.2–1.4(–2.2) mm; alar cells extend to (0.5–) 0.7–0.9(–1.0) of distance to costa
- 4a. *C. giganteum* subsp. *sibiricum* Plants medium-sized to large; costa strong, being (80–)110–160(–210) μm wide at base; stem leaves (1.5–)1.7–2.7(–3.0)×(0.9–)1.2–1.5(–1.8) mm; alar cells extend to 0.8–1.0 of distance to costa

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M.A. BRUGGEMAN-NANNENGA, M. BRUGUÉS, J. ENROTH, K.I. FLATBERG, R. GARILLETI, L. HEDENÄS, D.T. HOLYOAK, V. HUGONNOT, I. KARIYAWASAM, H. KÖCKINGER, J. KUČERA, F. LARA & R.D. PORLEY. 2020. An annotated checklist of bryophytes of Europe, Macaronesia and Cyprus. – *Journal of Bryology* **42**: *1*– *116*. https://doi.org/10.1080/03736687.2019.1694329

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Appendix 1. Newly sequenced specimens, with voucher information and GenBank accession numbers.

Calilogon OK Fussia, Komi Republic Kueherov & Kuenekov 28 June 2007 #654 Cordificium OK14901 (OK14001 (OK140001 (OK1400001 (OK	Species	Isolate	Region	Voucher	ITS	rpl16
C. contipliatium OK220 Russia, New Siberian Islands. Cerrulyaliyuv M231479 M231479 M233479 C. contipliatium OK2374 Russia, Chukorovak Iganatov & Iganatova 13-257 (MW902045) M233484 M239585 C. contipliatium OK2347 Russia, Yakuria Iganatov & Okit (M450010447) M233484 M239585 C. contipliatium OK2378 Russia, Yakuria, Lu-Mayap Disr. Iganatov & Okit (M450010448) M233484 M239585 C. contipliatium OK2767 Russia, Farna-Josef Land Koseve 25 Aug. 2016 (MH43010368) M233488 M239585 C. contipliatium OK2767 Russia, Korayiak Kuzimina 18 Jul 2016 (MH49010370) M233488 M239555 C. contipliatium OK2767 Russia, Karachia Kuzimina 18 Jul 2014 (MW9026038) M233488 M239555 C. contipliatium OK2771 Russia, Karachia Kuzhan Kasuko 42 Jul 14 Aug. 2013 (MH49010374) M233488 M233555 C. contipliatium OK287 Russia, Karachia Kuzhan Kasuko 42 Jul 14 Aug. 2016 (MH4190104754) M233490 M233490 M233494 M233494 M2334941 <	Calliergon cordifolium	OK2900	Russia, Komi Republic	Kucherov & Kutenkov 28 June 2007 #65d (MHA9010504)	MZ333478	MZ395587
C. condificitum OK2921 Russia, Chukorka Affirma, 15 Aug 1969 (LE) M2334480 M229555 C. condificitum OK2914 Russia, Khabarovsk [gmatov & Jarourous 13-295 (NW02004)5) M2334481 M229555 C. condificitum OK2435 Russia, Pranz-Josef Land Kholod 23-as-2012 471 (LE) M2334481 M229555 C. condificitum OK2767 Russia, IN & Siberiani Islanda Caremagideva J-19 (MHLA)103070) M2334481 M239555 C. condificitum OK2767 Russia, Rosenberg Janamos Distric Lavinnenko #1-13 (MW030540) M233448 M239555 C. condificitum OK2767 Russia, Romelatka Russia, Romelatka Russia, Russia	C. cordifolium	OK2920	Russia, New Siberian Islands	Czernyadieva 34-19a (LE)	MZ333479	MZ395588
C. cordifolium OK2714 Russin, Kabuarovsk Ignatov 0.10 (MIA4001047) MZ33441 MZ29555 C. cordifolium OK2435 Russin, Takuin, Usi-Maya Dist. Ignatov 0.10 (MIA401047) MZ33448 MZ29555 C. cordifolium OK2758 Russin, Takuin, Usi-Maya Dist. Ignatov 0.10 (MIA4010370) MZ33148 MZ39555 C. cordifolium OK2766 Russin, Krachina Cabaro Caranya Division (MIA40103056) MZ33148 MZ39555 C. cordifolium OK2767 Russin, Karchina Zakharchenko hm-16-3 (MW0111418) MZ33148 MZ39555 C. cordifolium OK2767 Russin, Karchina Kazmina 18 Jal 2014 MZ331480 MZ39555 C. cordifolium OK2780 Russin, Karchina Kazmina 18 Jal 2014 MZ39340 MZ39556 C. cordifolium OK2780 Russin, Karncharka Kaznina Rahdnova Kan-34459 (MW9021541) MZ33140 MZ39566 C. giganteum OK2880 Russin, Karncharka Kaznina Rahdnova Kan-34459 (MW9021649 MZ33444 MZ39566 C. giganteum OK2891 Russin, Norosin Kerina Lanova Kan-4414 (MW0075440) MZ33444	C. cordifolium	OK2921	Russia, Chukotka	Afonina, 15 Aug 1969 (LE)	MZ333480	MZ395589
C. conf.jolium OK2414 Russia, Prazz-Asoff Land Landor 00-501 (MIA9010447) M233442 M239555 C. conf.jolium OK2453 Russia, Prazz-Asoff Land Lynavo 00-908 (MIA9010448) M2333484 M239555 C. conf.jolium OK2764 Russia, Karelia Coremucificavi a1-10 (MIA9130370) M2333486 M239555 C. conf.jolium OK2767 Russia, Karelia Coremucificavi a1-16 (MIA9130370) M2333486 M239555 C. conf.jolium OK2767 Russia, Korgakia Hayrophyt Rossia (At14 (MW9073540) M2333480 M239555 C. conf.jolium OK2767 Russia, Korgakia Hayrophyt Rossia (At14 (MW9073540) M2333480 M239555 C. conf.jolium OK2777 Russia, Korgakia Hayrophyt Rossia (At14 (MW9073540) M2333480 M239556 C. conf.jolium OK2787 Russia, Korgakia Hayrophyt Rossia (At14 (MW9073540) M233448 M239566 C. giganteum OK2892 Russia, Korgakia Hayrophyt Rossia (At14 (MW9073540) M233449 M239566 C. giganteum OK2894 Russia, Korgakia Hayrophyt Rossia (M44041044)	C. cordifolium	OK2774	Russia, Khabarovsk	Ignatov & Ignatova 13-295 (MW9026045)	MZ333481	MZ395590
C. conf.jofutum OK2453 Russia, Pranz-Josef Land Kholod 23-8-2012 #71 (LE) MZ334483 MZ39555 C. conf.jofutum OK2763 Russia, Row Siborian Islands Cerryrudjeva 34-19 (MHA9110370) MZ333446 MZ39555 C. conf.jofutum OK2764 Russia, Karelia Zakharchenko bm 1-6-3 (MY9111418) MZ333446 MZ39555 C. conf.jofutum OK2767 Russia, Karelia Zakharchenko bm 1-6-3 (MY9111418) MZ333448 MZ39555 C. conf.jofutum OK2776 Russia, Karelia Kuzmini 18 Jul 2014 MZ333448 MZ39555 C. conf.jofutum OK2770 Russia, Ramchatka Robin 10 2014 MZ3334490 MZ335490 C. conf.jofutum OK2780 Russia, Ramchatka Robin 4 2014 (MY907360) MZ3334490 MZ3555 C. conf.jofutum OK2891 Russia, Perm Province Bezgadovi 1 Aug 2014 2166 MHA9010479 MZ33449 MZ35440 MZ3566 C. giganteum OK2898 Russia, Norosobinsk Province Zolotin k Lvanov 4 June 2013 MHA9010478 MZ33449 MZ3566 C. giganteum OK2899 Russia, Norosobinsk Province	C. cordifolium	OK2914	Russia, Yakutia	Ignatov 00-901 (MHA9010447)	MZ333482	MZ395591
C. contification OK2759 Russia, Nakutia, Ust-Maya Distr. [grantov 00-908 (MHA9010448) M233444 M239555 C. contification OK2767 Russia, Nerothy Autonomous Distric C. contification OK2767 Russia, Karona C. Russia, Karona Province Bezgadovi 7 Aug 2004 r166 MHA9010487 M2333494 M239566 C. grganteum OK2898 Russia, Ivento Province Lapshina ap00906 MHA9010482 M233494 M239566 C. grganteum OK2898 Russia, Ivento Province Lapshina ap00906 MHA9010482 M233497 M23566 C. grganteum OK2898 Russia, Neets Autonomous Distric Vanov & Donskov 09-284 MHA9010478 M233349 M239566 C. grganteum OK2898 Russia, Kostona Province Sorotixia & Funov 4 June 2013 MHA9010472 M233350 M239566 C. grganteum OK299 Russia, Commander Is, Bering Island Fedosov 10-3-66 (MW9007240) M233350 M233561 M239566 C. grganteum OK2707 Russia, Katatian Brancho 2005352 (MHA9010538) M233510 M239567 C. grganteum OK2707 Russia, Katatian Brancho 2005352 (MHA9010538) M233510 M239567 C. grganteum OK2778 Russia, Katatian Brancho 2005352 (MHA9010538) M233510 M239567 C. grganbas, shirticam OK2767 Russia, Katatian Brancho 2004433 (MW9007240) M233350 M233567 C. grgabas, shirtic	C. cordifolium	OK2453	Russia, Franz-Josef Land	Kholod 23-8-2012 #71 (LE)	MZ333483	MZ395592
C. cordifolium OK2763 Russia, Russies Care, Josef Land Mosece 22 Aug 2016 (MHAPA)130368) M233486 M233487 M233488 M23355 C. cordifolium OK2767 Russia, Karciia Lavrinenko #12, 11 Aug 2013 (MHA9130374) M233488 M23355 C. cordifolium OK2770 Russia, Kamchatka Kozinia & Hudinova Kam-M-859 (MW9026038) M233498 M23955 C. cordifolium OK2780 Russia, Roem Province Bezgadov 1 Aug 2012 #166 MHA9010497 M233494 M23956 C. giganteum OK2898 Russia, Perm Province Bezgadov 1 Aug 2012 #166 MHA9010487 M233494 M23956 C. giganteum OK2898 Russia, Ivanovo Province Borokin & Vanos & So MHA9010482 M233494 M23956 C. giganteum OK2898 Russia, Kostroma Prov. Sorokin & Vanos & Vanos & M149010476 M233498 M23956 C. giganteum OK2997 Russia, Kostroma Prov. Sorokin & Vanos & Vanos & Vanos & Vanos & Vanos & Vanos &	C. cordifolium	OK2759	Russia, Yakutia, Ust-Maya Distr.	Ignatov 00-908 (MHA9010448)	MZ333484	MZ395593
C. cordifolium OK2764 Russia, Franz-Josef Land Moseve 24 Aug 2016 (MHAPJ13038) MZ33486 MZ33487 C. cordifolium OK2767 Russia, Koryakia Kuzznina I8 Jal 2014 MZ33487 MZ33490 MZ33494 MZ33494 MZ33494 MZ33492 MZ33492 MZ33492 MZ33492 MZ33492 MZ33492 MZ33494 MZ33	C. cordifolium	OK2763	Russia, New Siberian Islands	Czernyadjeva 34-19 (MHA9130370)	MZ333485	MZ395594
C. cortifolum OK2766 Russia, Karclia Zakharchenko Im-16-3 (MW9111418) M233347 M233347 C. cordifolum OK2767 Russia, NectXay Aunonowos Distric Lavrienko H21, 11 Aug 2013 (MHA9130374) M233348 M239555 C. cordifolum OK2767 Russia, Karchak Aunonowos Distric Bryophyta Rossia, #414 (MW9073540) M233449 M239555 C. cordifolum OK2780 Russia, Kauchaka Kozhin & Budanova Kam-M-859 (MW900131) M233494 M239556 C. gigganteum OK2828 Russia, Perm Province Bezgodov 1 Aug 2012 #166 MHA9010487 M233494 M239566 C. gigganteum OK2898 Russia, Perm Province Delotov Iz82 MHA9010484 M233494 M239566 C. gigganteum OK2898 Russia, Vanovo Province Sorokin & Ivanov 4 June 2013 MHA9010482 M233494 M239566 C. gigganteum OK2898 Russia, Kostrona Prov. Sorokin & Ivanov 4 June 2013 MHA9010476 M233494 M239566 C. gigganteum OK2907 Russia, Kostrona Prov. Sorokin & Ivanov 4 June 2013 MHA9010476 M233409 M233569 M233569 M233569 M233560 M23	C. cordifolium	OK2764	Russia, Franz-Josef Land	Moseev 25 Aug 2016 (MHA9130368)	MZ333486	MZ395595
C. cordifolium OK2767 Russia, Nonetzky Autonomous District Lavrimenko #12, 11 Aug_2013 (MHA9130374) MZ333488 MZ33548 C. cordifolium OK2767 Russia, Koryakia Kuzmina I Jul 2014 MZ33449 MZ33489 MZ33548 MZ33549 MZ33565 C gigantem OK289 Russia, Perm Province Bezgadov 17 Aug 2012 #16.60 MHA9010497 MZ3349 MZ33549 MZ33566 C gigantem OK2898 Russia, Novosibirsk Province Laphina op00900 MHA901054 MZ33490 MZ33560 C gigantem OK2898 Russia, Vuenne Province Bezgadov 19.81 July 20.4 MHA9010484 MZ33490 MZ33560 MZ	C. cordifolium	OK2766	Russia, Karelia	Zakharchenko bm-16-3 (MW9111418)	MZ333487	MZ395596
C. cordifolium OK2769 Russia, Koryakia Kuzmina 18 Jul 2014 C. cordifolium OK2771 Russia, Rainchatka Bryophyta Rossia ef414 (MW0073540) MZ333490 MZ39555 C. cordifolium OK2701 Russia, Romchatka Kozhin & Budanova Kam-M-859 (MW901931) MZ333490 MZ39565 C. giganteum OK2892 Russia, Rome Province Bezgodov 1 Aug 2012 /166 MH30010497 MZ333491 MZ39565 C. giganteum OK2891 Russia, Perm Province Bezgodov 1 Aug 2014 /166 MHA9010454 MZ33449 MZ39565 C. giganteum OK2895 Russia, Nenets Autonomous District Vianov & Donskov 09-284 MHA9010454 MZ33496 MZ39566 C. giganteum OK2897 Russia, Commander Is, Bering Islam Fedosov 10-3-66 (MW9007240) MZ333490 MZ39566 C. giganteum OK2697 Russia, Sachtoma Prov. Sorokin at Ja Jane 2009 MHA 9010478 MZ33494 MZ39566 C. giganteum OK2697 Russia, Novosbirsk Pisarenko 090552 (MHV9007240) MZ333504 MZ39566 C. giganteum OK2707 Russia, Sakhalin Pisarenko 0905352 (MHA9010577 MZ33506 </td <td>C. cordifolium</td> <td>OK2767</td> <td>Russia, Nenetzky Autonomous District</td> <td>Lavrinenko #12, 11 Aug 2013 (MHA9130374)</td> <td>MZ333488</td> <td>MZ395597</td>	C. cordifolium	OK2767	Russia, Nenetzky Autonomous District	Lavrinenko #12, 11 Aug 2013 (MHA9130374)	MZ333488	MZ395597
Bryophyta Rossia: #414 (MW907540) MZ233489 MZ23555 C. cordifolium OK2780 Russia, Kamchatka Kozhin & Budanova Kam-M-859 (MW9091931) MZ333490 MZ335491 MZ335401 MZ335501 MZ335501 MZ335501 <td>C. cordifolium</td> <td>OK2769</td> <td>Russia, Korvakia</td> <td>Kuzmina 18 Jul 2014</td> <td></td> <td></td>	C. cordifolium	OK2769	Russia, Korvakia	Kuzmina 18 Jul 2014		
C. cordificitum OK2771 Russia, Taimyr Pospelava 42.9 Jul 1992 (MV9002083) MZ333490 MZ39561 C. cordificitum OK2892 Russia, Kacnehatka Kozbin & Budanova Kan-M-&S90 (MV9091931) MZ33491 MZ39561 C. giganteum OK2892 Russia, Perm Province Bezgodov 1 Aug 2012 #166 MH30010497 MZ33494 MZ39566 C. giganteum OK2891 Russia, Perm Province Doltov 1282 MHA9010484 MZ33494 MZ39566 C. giganteum OK2894 Russia, Norobinsk Province Lolotov 1282 MHA9010484 MZ333494 MZ39566 C. giganteum OK2895 Russia, Norobinsk Province Lopshin ap00906 MHA9010564 MZ333494 MZ39566 C. giganteum OK2895 Russia, Cormander Is, Bering Islan Fedosov 10.3-66 (MW9026322) MZ33504 MZ39566 C. giganteum OK2709 Russia, Novosibirsk Pisarenko 0p043331(MW9007247) MZ333504 MZ39566 C. giganteum OK2705 Russia, Nitrumansk Kozhin M-40014 (MW90260921) MZ333504 MZ39566 C. giganteum OK2757 Russia, Sakhatin Fisarenko 0p03552 (MHA9010378) </td <td></td> <td></td> <td></td> <td>Bryophyta Rossica #414 (MW9073540)</td> <td>MZ333489</td> <td>MZ395598</td>				Bryophyta Rossica #414 (MW9073540)	MZ333489	MZ395598
C cordifilium OK2780 Russia, Kam-Ínaka Kozhin & Budamova Kam-McS90(WW909191) MZ333491 MZ335491 C giganteum OK2892 Russia, Moscow Province Bezgodov 1 Aug 2012 #166 MHA9010497 MZ333494 MZ39560 C giganteum OK2890 Russia, Perm Province Bezgodov 1 Aug 2014 #166 MHA9010497 MZ333494 MZ39560 C giganteum OK2894 Russia, Perw Province Zolotov 182 MHA9010484 MZ333495 MZ39560 C giganteum OK2894 Russia, Novosibirsk Province Lapshina op00906 MHA9010564 MZ333497 MZ39560 C giganteum OK2899 Russia, Commandrov. Sorokin et al. 30 June 2009 MHA 9010476 MZ33349 MZ39560 C giganteum OK2698 Russia, Commandrov. Sorokin et al. 30 June 2009 MHA 9010476 MZ333408 MZ39560 C giganteum OK2707 Russia, Nation Pisarenko 0p04353 (MW9007246) MZ333501 MZ39561 C giganteum OK2707 Russia, Atalia Ignatova & Lapstonico MU40000577 MZ33350 MZ39561 C giganteum OK2571 Russia, Atakutia Ignatova & Ignatova 18-334 (MHA90	C. cordifolium	OK2771	Russia, Taimyr	Pospelova 42 9 Jul 1992 (MW9026038)	MZ333490	MZ395599
C. giganteum OK2892 Russia, Moscow Province Ignatov & Notov 08-55 MH A0010450 MZ333492 MZ39560 C. giganteum OK2890 Russia, Perm Province Bezgodov 1 Aug 2012 #166 MH A9010497 MZ334343 MZ39560 C. giganteum OK2891 Russia, Perm Province Bezgodov 1 Aug 2004 #166 MH A9010484 MZ33496 MZ39560 C. giganteum OK2894 Russia, Nonovo Province Lophina op0006 MH A9010564 MZ333497 MZ39560 C. giganteum OK2898 Russia, Nonovo Province Sorokin & Ivanov 4 June 2013 MHA9010478 MZ333498 MZ39560 C. giganteum OK2699 Russia, Kostroma Prov. Sorokin et al. 30 June 2009 MHA 9010476 MZ33349 MZ39560 C. giganteum OK2709 Russia, Novosibrisk Pisarenko 0p04433 (MW9007247) MZ333501 MZ39561 C. giganteum OK2707 Russia, Altai Ignatova & Ignatova & Ignatova & Ignatova 16-334 (MHA9010538) MZ333501 MZ39366 C. g. gubps, bibricum OK2757 Russia, Altai Ignatova & Ignatova 16-334 (MHA9010538) MZ333506 MZ39561 C. g. gubps, bibricum OK2757 <	C. cordifolium	OK2780	Russia, Kamchatka	Kozhin & Budanova Kam-M-859 (MW9091931)	MZ333491	MZ395600
C. g'ganteum OK2889 Russia, Perm Province Bezgodov 1 Aug 2012 #166 MHA9010497 MZ333493 MZ33560 C. giganteum OK2890 Russia, Pevo Province Zoltovicz NA9010484 MZ33564 MZ33564 C. giganteum OK2894 Russia, Nevo Province Zoltovicz MA9010484 MZ33564 C. giganteum OK2898 Russia, Norosibirsk Province Strokin & Ivanov 4 June 2013 MHA9010478 MZ33349 MZ39566 C. giganteum OK2899 Russia, Noroma Prov. Sorokin et al. 30 June 2009 MHA 9010476 MZ33349 MZ39566 C. giganteum OK2708 Russia, Tumen Bezgodov #198 19 July 2014 (MW9007247) MZ33300 MZ39566 C. giganteum OK2707 Russia, Sakhalin Ipantov & Sorositor 41.04(MW9002692) MZ33303 MZ39566 C. giganteum OK2707 Russia, Natuia Ipantov & Sorositor 41.8-2498 (MHA901257) MZ33304 MZ39566 C. giganteum OK2707 Russia, Yakutia Ipantov & Igantova B-2344 (MHA901210) MZ333504 MZ39561 C. g. gubsp. sibiricum OK2655 Russia, Yakutia Ipantov & Ig	C. giganteum	OK2892	Russia, Moscow Province	Ignatov & Notov 08-55 MHA9010459	MZ333492	MZ395601
C. giganteum OK2890 Russia, Perm Province Bezgodov 17 Aug 2004 #166 MHA9010496 MZ333494 MZ39560 C. giganteum OK2891 Russia, Nskov Province Zoltotov L82 MHA9010484 MZ333496 MZ39560 C. giganteum OK2895 Russia, Navosibirsk Province Sorokin & Ivanov 4 June 2013 MHA9010478 MZ333496 MZ39560 C. giganteum OK2899 Russia, Consintest Autonomous District Tranov & Donskov 09-284 MHA9010478 MZ333501 MZ39560 C. giganteum OK2699 Russia, Commander Is, Bering Island Fedosov 10-3-66 (MW90026322) MZ33501 MZ39560 C. giganteum OK2703 Russia, Novosibirsk Pisarenko op04433 (MW9007246) MZ333501 MZ39560 C. giganteum OK2707 Russia, Alumiansk Fosarenko op03552 (MHA901038) MZ33506 MZ39560 C. gi subsp. sibiricum OK2651 Russia, Yakutia Ignatov & Ignatova 18-129 (MHA902120) MZ33506 MZ39560 C. g. subsp. sibiricum OK2656 Russia, Yakutia Ignatov & Ignatova 18-132 (MHA902120) MZ33506 MZ39561 C. g. subsp. sibiricum OK2656 R	C. giganteum	OK2889	Russia, Perm Province	Bezgodov 1 Aug 2012 #166 MHA9010497	MZ333493	MZ395602
C. giganteum OK2891 Russia, Pskov Province Zolotov 1z82 MHA9010484 MZ333495 MZ39560 C. giganteum OK2894 Russia, Narovsibirsk Province Lapshina op0096 MHA9010544 MZ333497 MZ39560 C. giganteum OK2898 Russia, Narovo Province Sorokin & Lanovo 4 June 2013 MHA9010478 MZ33540 MZ39560 C. giganteum OK2899 Russia, Kostoma Prov. Sorokin et al. 30 June 2009 MHA 9010476 MZ333500 MZ39560 C. giganteum OK2699 Russia, Novosibirsk Pisarenko 0p04433 (MW9007247) MZ33500 MZ39560 C. giganteum OK2707 Russia, Avosibirsk Pisarenko 0p04343 (MW9007247) MZ33501 MZ39561 C. giganteum OK2707 Russia, Akhalin Pisarenko op0352 (MHA9010578) MZ33501 MZ39561 C. giganteum OK2697 Russia, Akhalia Ignatov & Ignatova 16-334 (MHA901232) MZ33505 MZ39561 C. g. subsp. sibiricum OK2657 Russia, Yakutia Ignatov & Ignatova 16-334 (MHA901232) MZ33506 MZ39561 C. g. subsp. sibiricum OK2707 Russia, Taimyr Fedosov 0 5-102 (M	C. giganteum	OK2890	Russia, Perm Province	Bezgodov 17 Aug 2004 #166 MHA9010496	MZ333494	MZ395603
C. giganteum OK2894 Russia, Novosibirsk Province Lapshina op00906 MHA9010564 MZ333496 MZ39560 C. giganteum OK2899 Russia, Kostroma Prov. Sorokin et al. 30 June 2009 MHA 9010476 MZ33500 MZ39560 C. giganteum OK2699 Russia, Commander Is, Bering Island Fedosov 10-3-66 (MW90026322) MZ33500 MZ39560 C. giganteum OK2707 Russia, Tyumen Bezgodov #198 19 July 2014 (MW9007246) MZ33500 MZ39560 C. giganteum OK2777 Russia, Akutia Ignatov 36/239 MHA9010577 MZ33506 MZ39560 C. g. gubspibiricum OK2651 Russia, Yakutia Ignatov 4 (Janz dova 18-3498 (MHA902120) MZ33506 MZ39560 C. g. subspibiricum OK2656 Russia, Taimyr Fedosov 08-602 (MHA901059) MZ33510 MZ39561 C. g. subspibiricum OK2768 Russia, Taimyr Fedosov 08-612 (MW90026029) MZ33511 MZ39561 C. g. subspibiricum OK2768 Russia, New Siberian	C. giganteum	OK2891	Russia, Pskov Province	Zolotov 1z82 MHA9010484	MZ333495	MZ395604
C. gigunteum OK2895 Russia, Ivanovo Province Sorokin & Ivanov 4 June 2013 MHA901042 MZ333497 MZ39560 C. gigunteum OK2898 Russia, Nenets Autonomous District Ivanov & Donskov 09-284 MHA9010478 MZ333498 MZ39560 C. gigunteum OK2699 Russia, Costroma Prov. Sorokin et al. 30 June 2009 MHA 9010476 MZ333500 MZ39560 C. gigunteum OK2703 Russia, Tyumen Bezgodov 10-3-66 (MW0026022) MZ33500 MZ39560 C. gigunteum OK2704 Russia, Novosibirsk Pisarenko 0p04433 (MW9007246) MZ33503 MZ39560 C. gigunteum OK2757 Russia, Sakhalin Pisarenko 0p04532 MLA9010577 MZ33505 MZ39560 C. gigunteum OK2651 Russia, Yakutia Ignatov & Ignatov a Is-2498 (MHA902132) MZ33506 MZ39561 C. g subps. sibiricum OK2654 Russia, Yakutia Ignatov & Ignatova 18-2498 (MHA902132) MZ33508 MZ39561 C. g subps. sibiricum OK2654 Russia, Taimyr Fedosov 05-213 (MW9026029) MZ33510 MZ33510 MZ33510 MZ33510 MZ33511 MZ39562	C giganteum	OK2894	Russia Novosibirsk Province	Lapshina op00906 MHA9010564	MZ333496	MZ395605
C. granther OK2898 Russia, Nenets Autonomous District Ivanov & Donskov 09-284 MHA9010478 MZ333498 MZ39560 C. granteum OK2899 Russia, Kostroma Prov. Sorokin et al. 30 June 2009 MHA 9010476 MZ333409 MZ39560 C. granteum OK2703 Russia, Commander Is, Bering Island Fedosov 10-3-66 (MW9026322) MZ33501 MZ39560 C. granteum OK2703 Russia, Novosibirsk Pisarenko 0p04433 (MW9007246) MZ33501 MZ39561 C. granteum OK2705 Russia, Murmansk Kozhim M-Mo14 (MW902602) MZ33504 MZ39561 C. graubsp. sibiricum OK2757 Russia, Altai Ignatov & Ignatova 18-2498 (MHA9010577 MZ33506 MZ39561 C. g. subsp. sibiricum OK2651 Russia, Yakutia Ignatova & Ignatova 18-1525 (MHA9022120) MZ33506 MZ39561 C. g. subsp. sibiricum OK2656 Russia, Taimyr Fedosov 08-602 (MHA9010599) MZ33507 MZ39561 C. g. subsp. sibiricum OK2707 Russia, Taimyr Fedosov 05-213 (MW9026283) MZ33511 MZ39561 C. g. subsp. sibiricum OK2707 Russia, New Siberian Islan	C giganteum	OK2895	Russia Ivanovo Province	Sorokin & Ivanov 4 June 2013 MHA9010482	MZ333497	MZ395606
C. grigenteum OK2899 Russia, Kostroma Prov. Sorokin et al. 30 June 2009 MHA 9010476 MZ333499 MZ39560 C. grigenteum OK2699 Russia, Commander Is., Bering Island Fedosov 10-3-66 (MW0907247) MZ333500 MZ39560 C. grigenteum OK2704 Russia, Tyumen Bezgodov #108 I9 July 2014 (MW9007246) MZ33500 MZ39561 C. grigenteum OK2705 Russia, Murmansk Kozhin M-M-0014 (MW9020692) MZ333500 MZ39561 C. grigenteum OK2757 Russia, Sakhalin Pisarenko 0p0552 (MHA9010577) MZ333506 MZ39561 C. g. subsp. sibiricum OK2651 Russia, Atatia Ignatova I8-2498 (MHA9021332) MZ33506 MZ39561 C. g. subsp. sibiricum OK2654 Russia, Yakutia Ignatova I Ignatova I8-132 (MHA9012132) MZ33508 MZ39561 C. g. subsp. sibiricum OK2656 Russia, Taimyr Varlygina s.n., 15 July 2001 (MW9026283) MZ33511 MZ39561 C. g. subsp. sibiricum OK2707 Russia, Taimyr Fedosov 05-213 (MW9026029) MZ33511 MZ33511 MZ33511 MZ33551 MZ33551 MZ33551 MZ33551	C giganteum	OK2898	Russia Nenets Autonomous District	Ivanov & Donskov 09-284 MHA9010478	MZ333498	MZ395607
C. giganteum OK2699 Russia, Commander Is., Bering Island Fedosov 10-3-66 (MW9026322) MZ333500 MZ333501 MZ333501 MZ333501 MZ333501 MZ333501 MZ33501 MZ33506 MZ33507 MZ333508 MZ33506 MZ33506 MZ33507 MZ33506 MZ33506 MZ33506 MZ33506 MZ33506 MZ33506 MZ39561 MZ39561 MZ39561 MZ39561 MZ39561 MZ39561 MZ39561 MZ39561 MZ39561 MZ39561 </td <td>C giganteum</td> <td>OK2899</td> <td>Russia Kostroma Prov</td> <td>Sorokin et al. 30 June 2009 MHA 9010476</td> <td>MZ333499</td> <td>MZ395608</td>	C giganteum	OK2899	Russia Kostroma Prov	Sorokin et al. 30 June 2009 MHA 9010476	MZ333499	MZ395608
C. giganteum OK2703 Russia, Tyumen Bezgodov #198 19 July 2014 (MW9007247) MZ333501 MZ39561 C. giganteum OK2704 Russia, Novosibirsk Pisarenko 0p04433 (MW9007246) MZ333501 MZ39561 C. giganteum OK2705 Russia, Murmansk Kozhin M-40014 (MW9006202) MZ393501 MZ39561 C. giganteum OK2757 Russia, Athai Ignatova 6/239 (MHA9010577 MZ333501 MZ39561 C. g. subps. <i>ibiricum</i> OK2651 Russia, Yakutia Ignatova 18-2498 (MHA902130) MZ333506 MZ39561 C. g. subps. <i>ibiricum</i> OK2654 Russia, Taimyr Fedosov 06-602 (MHA9010579) MZ333510 MZ39561 C. g. subps. <i>ibiricum</i> OK2701 Russia, Taimyr Fedosov 06-602 (MHA9010599) MZ333510 MZ39561 C. g. subps. <i>ibiricum</i> OK2701 Russia, Taimyr Fedosov 06-602 (MHA9103075) MZ333511 MZ39561 C. g. subps. <i>ibiricum</i> OK2708 Russia, New Siberian Islands Czernyadjeva 14-19 (MHA9130376) MZ333514 MZ39562 C. g. subps. <i>ibiricum</i> OK2776 Russia, Zabaikalsky Territory Afonina 14	C giganteum	OK2699	Russia Commander Is Bering Island	Fedosov 10-3-66 (MW9026322)	MZ333500	MZ395609
C. giganteum OK2704 Russia, Novosibirsk Pisarenko 0p04433 (MW9007246) MIZ33502 MIZ33502 C. giganteum OK2705 Russia, Novosibirsk Pisarenko 0p04552 (MHA9010538) MIZ33504 MIZ39561 C. giganteum OK2777 Russia, Sakhalin Pisarenko 0p03552 (MHA9010538) MIZ33504 MIZ39561 C. giubsp. sibiricum OK2651 Russia, Yakutia Ignatov & Ignatov a Is-2498 (MHA902132) MIZ33506 MIZ39561 C. g. subsp. sibiricum OK2655 Russia, Yakutia Ignatov & Ignatov a Is-2498 (MHA902132) MIZ33506 MIZ39561 C. g. subsp. sibiricum OK2656 Russia, Taimyr Fedosov 08-602 (MHA9010599) MIZ333510 MIZ39561 C. g. subsp. sibiricum OK2707 Russia, Taimyr Fedosov 08-602 (MHA9010599) MIZ333511 MIZ39562 C. g. subsp. sibiricum OK2707 Russia, New Siberian Islands Czernyadjeva 14-19 (MHA9130375) MIZ333514 MIZ39562 C. g. subsp. sibiricum OK2776 Russia, Yakutia Czernyadjeva 2-19 (MHA9130375) MIZ333514 MIZ39562 C. g. subsp. sibiricum OK2776 Russia, Yak	C giganteum	OK2703	Russia Tyumen	Bezgodov #198 19 July 2014 (MW9007247)	MZ333501	MZ395610
C giganteum OK2705 Russia, Murmansk Kozhim M-M-0014 (MW9026092) MZ333503 MZ39561 C giganteum OK2757 Russia, Sakhalin Pisarenko op03552 (MHA9010577 MZ333504 MZ39561 C g subps, sibiricum OK2651 Russia, Yakutia Ignatov & Ignatova 18-2498 (MHA902132) MZ33506 MZ39561 C g subps, sibiricum OK2657 Russia, Yakutia Ignatov & Ignatova 18-32498 (MHA902132) MZ33506 MZ39561 C g subps, sibiricum OK2656 Russia, Yakutia Ignatov & Ignatova 18-3255 (MHA9028275) MZ333509 MZ39561 C g subps, sibiricum OK2656 Russia, Taimyr Fedosov 08-602 (MHA9010599) MZ33510 MZ39561 C g subps, sibiricum OK2707 Russia, Taimyr Fedosov 05-213 (MW9026029) MZ333511 MZ39562 C g subps, sibiricum OK2768 Russia, New Siberian Islands Czernyadjeva 14-19 (MHA9130375) MZ33514 MZ39562 C g subps, sibiricum OK2770 Russia, Yakutia Czernyadjeva 22-19 (MHA9130372) MZ33514 MZ39562 C g subps, sibiricum OK2777 Russia, Yakutia Czer	C giganteum	OK2704	Russia Novosibirsk	Pisarenko 0n04433 (MW9007246)	MZ333502	MZ395611
C. g. gustralim OK2757 Russia, Sakhalin Pisarenko op03552 (MHA901057) MZ333504 MZ333504 MZ333504 MZ333505 MZ333505 MZ333505 MZ333505 MZ333505 MZ333506 MZ333507 MZ333508 MZ333508 MZ33508 MZ33508 MZ333508 MZ33508 MZ33508 MZ33508 MZ33508 MZ33508 MZ33508 MZ335508 MZ335508 MZ335508 MZ335508 MZ33551 MZ33551 MZ33551 MZ33551 MZ33551 MZ33551 MZ33551 MZ33551 MZ335511 MZ33551 MZ33	C giganteum	OK2705	Russia Murmansk	Kozhin M-M-0014 (MW9026092)	MZ333503	MZ395612
C g subp. sibiricum OK2897 Russia, Altai Ignatov 36/239 MIA9010577 MZ333506 MZ39561 C g subp. sibiricum OK2651 Russia, Yakutia Ignatov 36/239 MIA9010577 MZ333506 MZ39561 C g subp. sibiricum OK2657 Russia, Yakutia Ignatov a 16-334 (MIA902132) MZ333506 MZ39561 C g subp. sibiricum OK2657 Russia, Yakutia Ignatov a 16-334 (MIA9028275) MZ333508 MZ39561 C g subp. sibiricum OK2656 Russia, Taimyr Varlygina s, 15 July 2001 (MW9026283) MZ333510 MZ39561 C g subp. sibiricum OK2707 Russia, Taimyr Varlygina s, 15 July 2001 (MW9026339) MZ333511 MZ39562 C g subp. sibiricum OK2768 Russia, New Siberian Islands Czernyadjeva 14-19 (MIA9130375) MZ333516 MZ39562 C g subp. sibiricum OK2777 Russia, New Siberian Islands Czernyadjeva 22-19 (MIA9130371) MZ333516 MZ39562 C g subp. sibiricum OK2777 Russia, Taimyr Afonina 1406 (MIA91130371) MZ333511 MZ39562 C g subp. sibiricum OK2777 Russia, Taimyr Czernyadjeva 2-19 (MIA9130371) MZ333516 MZ333516 MZ39562<	C giganteum	OK2757	Russia Sakhalin	Pisarenko op03552 (MHA9010538)	MZ333504	MZ395613
C.g. subsp. sibiricum OK2651 Russia, Yakutia Ignator & Ignator	$C \sigma$ subsp sibiricum	OK2897	Russia Altai	Ignatov 36/239 MHA9010577	MZ333505	MZ395614
C.g. subsp. sibiricum OK2654 Russia, Yakutia Ignatov & Ignatova I 6-334 (MIHA9021332) MZ33507 MZ33507 C.g. subsp. sibiricum OK2654 Russia, Yakutia Ignatov & Ignatova I 6-334 (MIHA9021332) MZ33507 MZ33507 C.g. subsp. sibiricum OK2655 Russia, Taimyr Fedosov 08-602 (MIHA9010599) MZ33510 MZ39561 C.g. subsp. sibiricum OK2707 Russia, Taimyr Fedosov 05-213 (MW9026029) MZ33511 MZ39562 C.g. subsp. sibiricum OK2708 Russia, Taimyr Fedosov 05-213 (MW9026029) MZ33511 MZ39562 C.g. subsp. sibiricum OK2708 Russia, New Siberian Islands Czernyadjeva 16-34 (MIHA910375) MZ33514 MZ39562 C.g. subsp. sibiricum OK2770 Russia, New Siberian Islands Czernyadjeva 26-19 (MIHA9130372) MZ33514 MZ39562 C.g. subsp. sibiricum OK2770 Russia, Yakutia Czernyadjeva 29-19 (MIHA9130369) MZ33517 MZ39562 C.g. subsp. sibiricum OK2777 Russia, Yakutia Czernyadjeva 42-19 (MIHA9130371) MZ33517 MZ39562 C.g. subsp. sibiricum OK2777 Russia, Yakutia Czernyadjeva 5-19 (MIHA9130371) MZ33517 MZ3956	C q subsp sibiricum	OK2651	Russia Vakutia	Ignatov & Ignatova 18-2498 (MHA9092120)	MZ333506	MZ395615
C. g. subsp. sibiricum OK2655 Russia, Yakutia Ignatov & Ignatova 18-1525 (MIHA9028275) MZ2333508 MZ239561 C. g. subsp. sibiricum OK2656 Russia, Taimyr Fedosov 08-602 (MIHA9010599) MZ233510 MZ239561 C. g. subsp. sibiricum OK2707 Russia, Taimyr Fedosov 05-213 (MW9026029) MZ333511 MZ39562 C. g. subsp. sibiricum OK2707 Russia, Taimyr Fedosov 05-213 (MW9026029) MZ333511 MZ39562 C. g. subsp. sibiricum OK2761 Russia, New Siberian Islands Czernyadjeva 14-19 (MIA9130375) MZ333513 MZ39562 C. g. subsp. sibiricum OK2778 Russia, New Siberian Islands Czernyadjeva 26-19 (MIA9130375) MZ333516 MZ39562 C. g. subsp. sibiricum OK2777 Russia, Xew Siberian Islands Czernyadjeva 26-19 (MIA9130369) MZ333517 MZ39562 C. g. subsp. sibiricum OK2777 Russia, Yakutia Czernyadjeva 5-19 (MIA9130371) MZ33518 MZ39562 C. g. subsp. sibiricum OK2779 Russia, Zabaikalsky Territory Afonina 1406 (MIA9130369) MZ333518 MZ39562 C. megalophyllum OK2760 Russia, Zabaikalsky Territory Fedosov 08-602 (MIA9010655)	C g subsp <i>sibiricum</i>	OK2654	Russia Yakutia	Ignatov & Ignatova 16-334 (MHA9021332)	MZ333507	MZ395616
C.g. subsp. sibiricum OK2656 Russia, Taimyr Fedosov 08-602 (MHA9010599) MZ333509 MZ333510 MZ333509 MZ333510 MZ333509 MZ333510 MZ333509 MZ333510 MZ333510 MZ333510 MZ333510 MZ333510 MZ335511 MZ39561 C.g. subsp. sibiricum OK2707 Russia, Taimyr Fedosov 05-213 (MH9026629) MZ333511 MZ39562 C.g. subsp. sibiricum OK2761 Russia, New Siberian Islands Czernyadjeva 14-19 (MHA9130375) MZ333511 MZ39562 C.g. subsp. sibiricum OK2770 Russia, New Siberian Islands Czernyadjeva 26-19 (MHA9130372) MZ333514 MZ39562 C.g. subsp. sibiricum OK2777 Russia, New Siberian Islands Czernyadjeva 26-19 (MHA9130371) MZ333511 MZ39562 C.g. subsp. sibiricum OK2777 Russia, Yakutia Czernyadjeva 25-19 (MHA9130371) MZ333518 MZ39562 C.g. subsp. sibiricum OK2778 Russia, Yamal Czernyadjeva 8-10 (MHA9130373) MZ333518 MZ39562 C.g. subsp. sibiricum OK2758 Russia, Yamal Czernyadjeva 4-10 (MHA9130373) MZ333519 MZ333510	C q subsp sibiricum	OK2655	Russia Vakutia	Ignatov & Ignatova 18-1525 (MHA9028275)	MZ333508	MZ395617
C. g. subsp. sibiricum OK2701 Russia, Taimyr Varlygina s.n., 15 July 2001 (MW9026283) MZ333510 MZ333511 MZ333511 MZ333511 MZ333512 MZ333512 MZ335512 MZ335513 MZ39562 C; g: subsp. sibiricum OK2768 Russia, New Siberian Islands Czernyadjeva 26-19 (MHA9130372) MZ333516 MZ335516 MZ33552 MZ335516 M	C g subsp <i>sibiricum</i>	OK2656	Russia Taimyr	Fedosov 08-602 (MHA9010599)	MZ333509	MZ395618
C. g. subop. sibiricumOK2707Russia, TaimyrFedosvo (5-213 (MW9026029))MZ33511MZ39562C. g. subsp. sibiricumOK2708Russia, TaimyrFedosvo (5-213 (MW9026029))MZ333512MZ39562C. g. subsp. sibiricumOK2768Russia, New Siberian IslandsCzernyadjeva 26-19 (MHA9130375)MZ333514MZ39562C. g. subsp. sibiricumOK2770Russia, New Siberian IslandsCzernyadjeva 26-19 (MHA9130369)MZ333515MZ39562C. g. subsp. sibiricumOK2777Russia, YakutiaCzernyadjeva 22-19 (MHA9130366)MZ333516MZ39562C. g. subsp. sibiricumOK2777Russia, YakutiaCzernyadjeva 2-19 (MHA9130366)MZ333517MZ39562C. g. subsp. sibiricumOK2777Russia, TaimyrFedosov 08-602 (MHA9103071)MZ333518MZ39562C. megalophyllumOK2760Russia, Zabaikalsky TerritoryAfonina 1307 (MHA9130365)MZ333519MZ33520C. megalophyllumOK2762Russia, Zabaikalsky TerritoryCzernyadjeva 8-111 (MW9026335)MZ333520MZ33522C. megalophyllumOK2767Russia, YamalCzernyadjeva 18-1895 (MHA9010585)MZ333522MZ39562C. richardsoniiOK2653Russia, YakutiaIgnatova 18-1895 (MHA901061)MZ333524MZ39562C. richardsoniiOK2667Russia, KamchatkaCzernyadjeva 18-1895 (MHA901061)MZ333524MZ39563C. richardsoniiOK2668Russia, TuimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ33352MZ39563C. richardsoniiOK2698Russia, Tuimyr <td>C q subsp sibiricum</td> <td>OK2701</td> <td>Russia Taimyr</td> <td>Varlygina s n 15 July 2001 (MW9026283)</td> <td>MZ333510</td> <td>MZ395619</td>	C q subsp sibiricum	OK2701	Russia Taimyr	Varlygina s n 15 July 2001 (MW9026283)	MZ333510	MZ395619
C. g. subsp. sibiricumOK2708Russia, TaimyrFedosov 15 June 2004 (MW9026339)MZ333512MZ335512MZ335512C. g. subsp. sibiricumOK2768Russia, New Siberian IslandsCzernyadjeva 26-19 (MHA9130375)MZ333515MZ33556C. g. subsp. sibiricumOK2770Russia, New Siberian IslandsCzernyadjeva 22-19 (MHA9130369)MZ333516MZ33551C. g. subsp. sibiricumOK2777Russia, Zabaikalsky TerritoryAfonina 1406 (MHA9130371)MZ333516MZ33551C. g. subsp. sibiricumOK2775Russia, TaimyrFedosov 08-602 (MHA9130371)MZ333518MZ39562C. g. subsp. sibiricumOK2779Russia, TaimyrFedosov 08-602 (MHA910599)MZ333519MZ33551C. megalophyllumOK2760Russia, Zabaikalsky TerritoryFedosov 08-602 (MHA9103036)MZ333519MZ333520C. megalophyllumOK2760Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130373)MZ333521MZ39562C. megalophyllumOK2767Russia, IvanovoSorokin & Nosov 779 (MHA9010585)MZ333523MZ39563C. richardsoniiOK2657Russia, KamchatkaIgnatova I8-1895 (MHA9010601)MZ333524MZ39563C. richardsoniiOK2667Russia, KamchatkaIgnatova I8-1895 (MHA9010601)MZ333526MZ39563C. richardsoniiOK2676Russia, TumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2767Russia, TumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK	C q subsp sibiricum	OK2707	Russia Taimyr	Fedosov 05-213 (MW9026029)	MZ333511	MZ395620
C.g. subsp. sibiricumOK2761Russia, New Siberian IslandsCzernyadjeva 14-19 (MHA9130375)MZ233513MZ233513MZ239562C.g. subsp. sibiricumOK2770Russia, New Siberian IslandsCzernyadjeva 22-19 (MHA9130372)MZ333515MZ33556C.g. subsp. sibiricumOK2771Russia, New Siberian IslandsCzernyadjeva 22-19 (MHA9130372)MZ333516MZ39562C.g. subsp. sibiricumOK2777Russia, Zabaikalsky TerritoryAfonina 1406 (MHA9130366)MZ333517MZ39562C. g. subsp. sibiricumOK2775Russia, TaimyrFedosov 08-602 (MHA9010599)MZ333519MZ39562C. megalophyllumOK2760Russia, Zabaikalsky TerritoryFedosov 08-602 (MHA9130373)MZ33520MZ33520C. megalophyllumOK2762Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130373)MZ33521MZ39563C. richardsoniiOK2677Russia, IvanovoSorokin & Nosov 779 (MHA9010585)MZ333522MZ39563C. richardsoniiOK2677Russia, Novaya ZemlyaIgnatov & Ignatova 18-1895 (MHA9010601)MZ333524MZ39563C. richardsoniiOK2697Russia, Novaya ZemlyaBeldiman NZ-2016-52 (MW9111380)MZ33523MZ39563C. richardsoniiOK2676Russia, TimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ33526MZ39563C. richardsoniiOK2766Russia, TimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ33526MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ33526MZ39563C. r	C g subsp <i>sibiricum</i>	OK2708	Russia Taimyr	Fedosov 15 June 2004 (MW9026339)	MZ333512	MZ395621
C. g. subsp. sibiricumOK2768Russia, New Siberian IslandsCzernyadjeva 26-19 (MHA9130372)MZ333514MZ39562C. g. subsp. sibiricumOK2770Russia, New Siberian IslandsCzernyadjeva 22-19 (MHA9130369)MZ333515MZ39562C. g. subsp. sibiricumOK2777Russia, Zabaikalsky TerritoryAfonina 1406 (MHA9130366)MZ333516MZ39562C. g. subsp. sibiricumOK2777Russia, YakutiaCzernyadjeva 25-19 (MHA9130371)MZ333518MZ39562C. g. subsp. sibiricumOK2778Russia, YamalCzernyadjeva 4 Kuzmina 29 July 1996C. megalophyllumOK2760Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130365)MZ333519MZ39562C. megalophyllumOK2762Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130373)MZ333521MZ39563C. richardsoniiOK2657Russia, YakutiaIgnatova 18-1895 (MHA901055)MZ333522MZ39563C. richardsoniiOK2697Russia, Novaya ZemlyaBeldiman NZ-2016-52 (MW9111380)MZ33352MZ39563C. richardsoniiOK2766Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ33352MZ39563C. richardsoniiOK2768Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333526MZ39563C. richardsoniiOK2768Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333527MZ39563C. richardsoniiOK2768Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333526MZ39563C. richardsoniiOK2698Russia, SakhalinPisaren	C g subsp <i>sibiricum</i>	OK2761	Russia New Siberian Islands	Czernyadieva 14-19 (MHA9130375)	MZ333513	MZ395622
C. g. subsp. sibiricumOK2770Russia, New Siberian IslandsCzernyadjeva 22-19 (MHA9130369)MZ333515MZ39562C. g. subsp. sibiricumOK2772Russia, Zabaikalsky TerritoryAfonina 1406 (MHA9130366)MZ333516MZ39562C. g. subsp. sibiricumOK2779Russia, TaimyrFedosov 08-602 (MHA910599)MZ333518MZ39562C. megalophyllumOK2768Russia, TaimyrFedosov 08-602 (MHA910599)MZ333519MZ39562C. megalophyllumOK2760Russia, Zabaikalsky TerritoryFedosov 08-602 (MHA910365)MZ333519MZ39562C. megalophyllumOK2760Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130365)MZ333519MZ39562C. megalophyllumOK2762Russia, Zabaikalsky TerritoryCzernyadjeva 13-10 (MHA9130373)MZ33521MZ39563C. richardsoniiOK2653Russia, YakutiaIgnatov & Ignatova 18-1895 (MHA9010585)MZ333523MZ39563C. richardsoniiOK2677Russia, KamchatkaCzernyadjeva 15 Aug 2004(Bryophyta Rossica #208 (MHA9010601)MZ333524MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333527MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333526MZ39563C. richardsoniiOK2768Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ33526MZ39563C. richardsoniiOK2768Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardso	<i>C. g.</i> subsp. <i>sibiricum</i>	OK2768	Russia, New Siberian Islands	Czernyadjeva 26-19 (MHA9130372)	MZ333514	MZ395623
C. g. subsp. sibiricumOK2772Russia, Zabaikalsky TerritoryA fonina 1406 (MHA9130366)MZ333516MZ39562C. g. subsp. sibiricumOK2775Russia, YakutiaCzernyadjeva 5-19 (MHA9130371)MZ333516MZ39562C. g. subsp. sibiricumOK2779Russia, TaimyrFedosov 08-602 (MHA910599)MZ333518MZ39562C. megalophyllumOK2760Russia, Zabaikalsky TerritoryA fonina 03107 (MHA9130365)MZ333519MZ33520C. megalophyllumOK2762Russia, Zabaikalsky TerritoryA fonina 03107 (MHA9130373)MZ333521MZ39563C. megalophyllumOK2777Russia, YawaiCzernyadjeva 13-10 (MHA9130373)MZ333522MZ39563C. megalophyllumOK2777Russia, YakutiaIgnatova 8 Ignatova 18-1895 (MHA9010585)MZ333522MZ39563C. richardsoniiOK2657Russia, KamchatkaCzernyadjeva 15 Aug 2004MZ333525MZ39563C. richardsoniiOK2697Russia, TuimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333526MZ39563C. richardsoniiOK2765Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333526MZ39563C. richardsoniiOK2765Russia, TuimenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2766Russia, TuimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333526MZ39563C. richardsoniiOK2765Russia, TuimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333526MZ39563C. richardsoniiOK2766Russia, Tuimyr <td>C g subsp <i>sibiricum</i></td> <td>OK2770</td> <td>Russia New Siberian Islands</td> <td>Czernyadieva 22-19 (MHA9130369)</td> <td>MZ333515</td> <td>MZ395624</td>	C g subsp <i>sibiricum</i>	OK2770	Russia New Siberian Islands	Czernyadieva 22-19 (MHA9130369)	MZ333515	MZ395624
C. g. subsp. sibiricumOK2775Russia, YakutaCzernyadjeva 5-19 (MHA9130371)MZ33517MZ33562C. g. subsp. sibiricumOK2779Russia, YakutaCzernyadjeva 5-19 (MHA9130371)MZ333517MZ39562C. megalophyllumOK2758Russia, YamalCzernyadjeva 5-19 (MHA9130371)MZ333519MZ39562C. megalophyllumOK2760Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130365)MZ333520MZ39562C. megalophyllumOK2762Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130373)MZ33521MZ39562C. megalophyllumOK2762Russia, Zabaikalsky TerritoryCzernyadjeva 13-10 (MHA9130373)MZ33522MZ39563C. richardsoniiOK2657Russia, YakutiaIgnatov & Ignatova 18-1895 (MHA9010585)MZ333523MZ39563C. richardsoniiOK2657Russia, Novaya ZemlyaBeldiman NZ-2016-52 (MW49010601)MZ333526MZ33525MZ39563C. richardsoniiOK2766Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333526MZ39563C. richardsoniiOK2768Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333526MZ39563C. richardsoniiOK2768Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333526MZ39563C. richardsoniiOK2766Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333526MZ39563C. richardsoniiOK2766Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333527MZ39563C. richardsoniiOK2765Russia, Sak	C g subsp <i>sibiricum</i>	OK2772	Russia Zabaikalsky Territory	Afonina 1406 (MHA9130366)	MZ333516	MZ395625
C. g. subsp. sibiriumOK2779Russia, TaimyrFedosov 08-602 (MHA9010599)MZ333518MZ39562C. megalophyllumOK2758Russia, YamalCzernyadjeva & Kuzmina 29 July 1996MZ333519MZ39562C. megalophyllumOK2760Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130365)MZ333520MZ39562C. megalophyllumOK2762Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130365)MZ333521MZ39563C. megalophyllumOK2777Russia, JvanovoSorokin & Nosov 779 (MHA9010585)MZ333522MZ39563C. richardsoniiOK2657Russia, YakutiaIgnatov & Ignatova 18-1895 (MHA9010651)MZ333523MZ39563C. richardsoniiOK2657Russia, Novaya ZemlyaBeldiman NZ-2016-52 (MW9111380)MZ333526MZ39563C. richardsoniiOK2766Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333527MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333526MZ39563C. richardsoniiOK2698Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333526MZ39563C. richardsoniiOK2668Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ33526MZ39563C. richardsoniiOK2668Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ33526MZ39563C. richardsoniiOK2668Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333526MZ39563C. richardsoniiOK2766Russia, SakhalinPis	<i>C. g.</i> subsp. <i>sibiricum</i>	OK2775	Russia. Yakutia	Czernyadieva 5-19 (MHA9130371)	MZ333517	MZ395626
C. megalophyllumOK2758Russia, YamalCzernyadjeva & Kuzmina 29 July 1996C. megalophyllumOK2760Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130365)MZ333520C. megalophyllumOK2762Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130365)MZ333521C. megalophyllumOK2777Russia, Zabaikalsky TerritoryCzernyadjeva XastaMZ333521C. megalophyllumOK2777Russia, IvanovoSorokin & Nosov 779 (MHA9010585)MZ333522C. richardsoniiOK2653Russia, YakutiaIgnatov & Ignatova 18-1895 (MHA9028117)MZ333523C. richardsoniiOK2677Russia, Novaya ZemlyaBeldiman NZ-2016-52 (MW9111380)MZ333526MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333527MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333526MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333526MZ39563C. richardsoniiOK2765Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333528MZ39563C. richardsoniiOK2766Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333526MZ39563C. richardsoniiOK2	<i>C. g.</i> subsp. <i>sibiricum</i>	OK2779	Russia, Taimyr	Fedosov 08-602 (MHA9010599)	MZ333518	MZ395627
C. megalophyllumOK2760Russia, Zabaikalsky TerritoryBryophyta Rossica #111 (MW9026335)MZ33519MZ39562C. megalophyllumOK2762Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130365)MZ333520MZ39563C. megalophyllumOK2777Russia, IvanovoSorokin & Nosov 779 (MHA9010585)MZ333522MZ39563C. richardsoniiOK2653Russia, YakutiaIgnatov & Ignatov & Ign	C. megalophyllum	OK2758	Russia, Yamal	Czernyadieva & Kuzmina 29 July 1996		
C. megalophyllumOK2760Russia, Zabaikalsky Territory Russia, Zabaikalsky TerritoryAfonina 03107 (MHA9130365)MZ333520MZ39562C. megalophyllumOK2762Russia, Zabaikalsky Territory Russia, IvanovoAfonina 03107 (MHA9130365)MZ333521MZ39563C. megalophyllumOK2777Russia, IvanovoSorokin & Nosov 779 (MHA9010585)MZ333522MZ39563C. richardsoniiOK2653Russia, YakutiaIgnatov & Ignatova 18-1895 (MHA9028117)MZ333524MZ39563C. richardsoniiOK2697Russia, KamchatkaCzernyadjeva 15 Aug 2004MZ333525MZ39563C. richardsoniiOK2698Russia, TyumenBeldiman NZ-2016-52 (MW9111380)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333528MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333526MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333526MZ39563C. richardsonii<				Bryophyta Rossica #111 (MW9026335)	MZ333519	MZ395628
C. megalophyllumOK2762Russia, Zabaikalsky TerritoryCzernyadjeva 13-10 (MHA9130373)MZ333521MZ39563C. megalophyllumOK2777Russia, IvanovoSorokin & Nosov 779 (MHA9010585)MZ333522MZ39563C. richardsoniiOK2653Russia, YakutiaIgnatov & Ignatova 18-1895 (MHA9028117)MZ333523MZ39563C. richardsoniiOK2657Russia, KamchatkaCzernyadjeva 15 Aug 2004MZ333525MZ39563C. richardsoniiOK2697Russia, Novaya ZemlyaBeldiman NZ-2016-52 (MW9111380)MZ333526MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333527MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333526MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333527MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333526MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko	C. megalophvllum	OK2760	Russia, Zabaikalsky Territory	Afonina 03107 (MHA9130365)	MZ333520	MZ395629
C. megalophyllumOK2777Russia, IvanovoSorokin & Nosov 779 (MHA9010585)MZ333522MZ39563C. richardsoniiOK2653Russia, YakutiaIgnatov & Ignatov & Ignatov a 18-1895 (MHA9028117)MZ333523MZ39563C. richardsoniiOK2657Russia, KamchatkaCzernyadjeva 15 Aug 2004MZ333524MZ39563C. richardsoniiOK2697Russia, Novaya ZemlyaBeldiman NZ-2016-52 (MW9111380)MZ333525MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333527MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9007250)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333527MZ39563C. richardsoniiOK2706Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333526MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA901062	C. megalophyllum	OK2762	Russia, Zabaikalsky Territory	Czernvadieva 13-10 (MHA9130373)	MZ333521	MZ395630
C. richardsoniiOK2653Russia, YakutiaIgnatov & Ignatova 18-1895 (MHA9028117)MZ333523MZ39563C. richardsoniiOK2657Russia, KamchatkaIgnatov & Ignatova 18-1895 (MHA901601)MZ333524MZ39563C. richardsoniiOK2697Russia, Novaya ZemlyaBeldiman NZ-2016-52 (MW9111380)MZ333525MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2766Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333528MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333527MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333527MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563	C. megalophvllum	OK2777	Russia, Ivanovo	Sorokin & Nosov 779 (MHA9010585)	MZ333522	MZ395631
C. richardsoniiOK2657Russia, KamchatkaCzernyadjeva 15 Aug 2004 (Bryophyta Rossica #208 (MHA9010601)MZ333524MZ39563C. richardsoniiOK2697Russia, Novaya ZemlyaBeldiman NZ-2016-52 (MW9111380)MZ333525MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333528MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333527MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563	C. richardsonii	OK2653	Russia, Yakutia	Ignatov & Ignatova 18-1895 (MHA9028117)	MZ333523	MZ395632
C. richardsoniiOK2697Russia, Novaya Zemlya(Bryophyta Rossica #208 (MHA9010601)MZ333524MZ39563C. richardsoniiOK2697Russia, TyumenBeldiman NZ-2016-52 (MW9111380)MZ333525MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333527MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333528MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333527MZ39563C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333527MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563	C. richardsonii	OK2657	Russia, Kamchatka	Czernvadieva 15 Aug 2004		
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C. richardsonii OK2698 Russia, Tyumen Bezgodov #205, 19 July 2014 (MW9007250) MZ333526 MZ39563 C. richardsonii OK2706 Russia, Taimyr Fedosov Calln3, 21 June 2004 (MW9026415) MZ333528 MZ39563 C. richardsonii OK2765 Russia, Tyumen Bezgodov #205, 19 July 2014 (MW9007250) MZ333528 MZ39563 C. richardsonii OK2698 Russia, Tyumen Bezgodov #205, 19 July 2014 (MW9007250) MZ333526 MZ39563 C. richardsonii OK2698 Russia, Tyumen Bezgodov #205, 19 July 2014 (MW9007250) MZ333526 MZ39563 C. richardsonii OK2706 Russia, Taimyr Fedosov Calln3, 21 June 2004 (MW9026415) MZ333527 MZ39563 C. richardsonii OK2706 Russia, Sakhalin Pisarenko op03553 (MHA9010623) MZ333528 MZ39563 C. richardsonii OK2765 Russia, Sakhalin Pisarenko op03553 (MHA9010623) MZ333528 MZ39563	C. richardsonii	OK2697	Russia, Novava Zemlya	Beldiman NZ-2016-52 (MW9111380)	MZ333525	MZ395634
C. richardsonii OK2706 Russia, Tyinthi Fedosov Calla3, 21 June 2004 (MW9026415) MZ333527 MZ39563 C. richardsonii OK2765 Russia, Tyinthi Fedosov Calla3, 21 June 2004 (MW9026415) MZ333528 MZ39563 C. richardsonii OK2698 Russia, Tyinten Fedosov Calla3, 21 June 2004 (MW9007250) MZ333526 MZ39563 C. richardsonii OK2698 Russia, Tyinten Bezgodov #205, 19 July 2014 (MW9007250) MZ333526 MZ39563 C. richardsonii OK2706 Russia, Taimyr Fedosov Calla3, 21 June 2004 (MW9026415) MZ333527 MZ39563 C. richardsonii OK2706 Russia, Sakhalin Pisarenko op03553 (MHA9010623) MZ333528 MZ39563 C. richardsonii OK2765 Russia, Sakhalin Pisarenko op03553 (MHA9010623) MZ333528 MZ39563	C richardsonii	OK2698	Russia Tyumen	Bezgodov #205_19 July 2014 (MW9007250)	MZ333526	MZ395635
C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ333528C. richardsoniiOK2698Russia, TyumenBezgodov #205, 19 July 2014 (MW9007250)MZ333526MZ333526C. richardsoniiOK2706Russia, TaimyrFedosov Calln3, 21 June 2004 (MW9026415)MZ333527MZ333526C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563C. richardsoniiOK2765Russia, SakhalinPisarenko op03553 (MHA9010623)MZ333528MZ39563	C richardsonii	OK2706	Russia Taimyr	Fedosov Calln3 21 June 2004 (MW9026415)	MZ333527	MZ395636
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C. richardsonii OK2706 Russia, Taimyr Fedosov Calln3, 21 June 2004 (MW9026415) MZ333527 MZ39563 C. richardsonii OK2765 Russia, Sakhalin Pisarenko op03553 (MHA9010623) MZ333528 MZ39563	C richardsonii	OK 2698	Russia Tyumen	Bezgodov $\#205$ 19 July 2014 (MW9007250)	MZ333526	MZ395635
C. richardsonii OK2765 Russia, Sakhalin Pisarenko op03553 (MHA9010623) MZ333528 MZ39563	C. richardsonii	OK2706	Russia, Taimyr	Fedosov Calln3, 21 June 2004 (MW9026415)	MZ333527	MZ395636
	C. richardsonii	OK2765	Russia, Sakhalin	Pisarenko op03553 (MHA9010623)	MZ333528	MZ395637
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nseudosarmentisum OK2783 Russia, Yakutia Ivanova 36-37 (MHA9111773) M7333529 M739563	pseudosarmentisum	OK2783	Russia, Yakutia	Ivanova 36-37 (MHA9111773)	MZ333529	MZ395638
S sarmentosum OK2652 Russia Yakutia Ionatov & Ionatova 17-70 (MHA9025792) MZ33330 MZ39563	S sarmentosum	OK2652	Russia Yakutia	Ignatov & Ignatova 17-70 (MHA9025792)	MZ333530	MZ395639
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