MARIA LOMONOSOVA & HELMUT FREITAG

A new species of *Suaeda (Chenopodiaceae)* from the Altai, Central Asia

Abstract

Lomonosova, M. & Freitag, H.: A new species of *Suaeda (Chenopodiaceae)* from the Altai, Central Asia. – Willdenowia 33: 139-147. 2003. – ISSN 0511-9618; © 2003 BGBM Berlin-Dahlem

Suaeda tschujensis is described as a species new to science and compared with related species of *S*. sect. *Brezia* (= *Heterosperma*). It is endemic to high-mountain semideserts in the Russian Altai and to the Gobi Altai in Mongolia. The species is of particular interest for the phylogeny of the genus because of its rare diploid chromosome number of 2n = 18.

Introduction

During the study of Siberian chenopods in the Herbarium of the Central Siberian Botanical Garden (NS), the first author came across some specimens of *Suaeda* collected in the Altai Mts that did not belong to any species known from the region (Lomonosova 1992) nor from the area of the former USSR (Iljin 1936). She sent duplicates to the second author who stated that the taxon did not fit any of the species known from neighbouring areas of Kazakhstan, Kirgistan and Tadzhikistan, nor from Central Asia (Grubov 1966), Mongolia (Grubov 1982), the western and northern provinces of China (Mao 1994, Li & Ma 1983, Fu & al. 1990) and N Pakistan (Freitag 2001). After joint studies carried out in Kassel, the authors became convinced that the specimens belonged to a new species. For additional information on its distribution, the first author screened the herbaria of Tomsk (TK), Barnaul (ALTB), Moscow (MW) and St Petersburg (LE). She also identified its chromosome number and made phytosociological relevés. The species was also cultivated during 2001 in the greenhouse of the Faculty of Biology in Kassel from seeds taken from *Korolyuk 82,* together with the related species *S. prostrata* Pall. and *S. corniculata* Bunge, both likewise grown from seeds of specimens collected from nearby habitats. After germination in April, isolated seedlings were transferred to pots with loamy soil. Once a week a liquid full fertilizer was added (0.5 % "Wuxal" containing 8 % N, 8 % P, 6 % K plus some trace elements), and twice a week a 0.5 mol NaCl solution. The plants developed as in optimal conditions in nature. They flowered at the beginning of August (about 2 weeks later than in natural habitats) and died in October after rich fruit-setting. The cultivated individuals were used for measurements by the second author. Relevant vouchers are kept in KAS.

The nomenclature of other plant species mentioned follows Czerepanov (1995).

Fig. 1. *Suaeda tschujensis* Lomon. & Freitag; one of several individuals of the collection *Korolyuk 82* (NS). – Drawing by N. Prijdak.

Suaeda tschujensis Lomon. & Freitag, **sp. nova** – Fig. 1-3
Holotypus: Russia, Altai Republic, Kosh-Agach District, at the foot of the Kurai mountain 4 km east of Chegan-Uzun village, 1950 m, around a spring, 31.8.2002, *M. Lomonosova 254* (NS; isotypi: B, K, KAS, LE, TK)

Species nova habitu et magnitudine *Suaedae prostratae* et formis gracilibus *S. corniculatae* similis. A prima differt imprimis tepalis post anthesin inaequaliter accrescentibus et foliis obtusis assurgentibus necnon apiculatis horizontaliter patentibus, ab altera inflorescentiis dense confertis et foliatis, perianthio fructifero 1-3 tuberculis tantum praedite, colore et chromosomatum numero diploideo discedit.

The new species is named after the valley system of the river Chuya (Čuya, Tschuja) in the central part of the Altai Mts.

Annual, (1)3-7(10) × (0.5)5-20(30) cm, prostrate, forming usually semi-circular to circular mats, primary stem usually equalled by some basal laterals; living plants pale green, finally turning pinkish, dried specimens pale, only the younger parts darkish green; glabrous. *Stem* 1-2 times branched from any leaf axil, only in dwarf specimens unbranched, at base up to 1.5(2.5) mm thick, when young with alternating green and pale lines, later turning straw-coloured, delicately

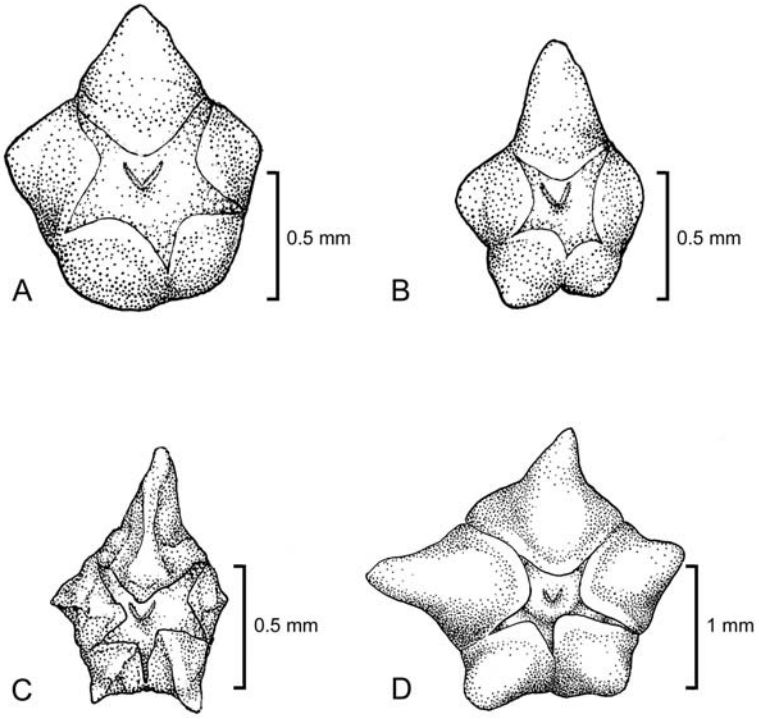

Fig. 2. *Suaeda tschujensis* Lomon. & Freitag, fruits – A-C: immature black-seeded fruits with unequally enlarged tepals; A: from a central flower (fresh); B, C: from lateral flowers (fresh, desiccated); D: immature brown-seeded fruit (fresh); dry fruit from *Korolyuk 82* (NS), fresh fruits from offsprings of *Korolyuk 82* (KAS). – Drawings by N. Prijdak.

striate; internodes in lower half 5-10(15) mm long, higher up decreasing to 3 mm; any branch terminating into an ascending to erect inflorescence. *Leaves* alternate, moderately succulent, linear- to narrow-ovate, in lower half 9-14(18) × 1.75-1.9(2.0) × 0.8-1 mm, towards the inflorescence decreasing to 8 × 1.6 × 0.7 mm, obtuse or acutish, slightly canaliculate, with C_3 anatomy. *Inflorescences* in apical part very dense due to 1-2 mm long internodes, laxer in lower part, very variable in length, at the main branch and unbranched laterals up to 12 cm, at branches of higher order only (0.5)0.7-1.5(3) cm, very dense; bracts similar to upper leaves but gradually shorter, usually 3.5-1 × 1.1 × 0.5 mm, narrow ovate to oblong, sheathing at base. *Bracteoles* hyaline, at the central flower 0.4-1 × 0.1-0.2 mm, entire or almost so, at the lateral flowers c. 0.3 × 0.15 mm, ovate, erose-dentate. *Flowers* (1)3-5(7) in axillary clusters, mostly perfect, protandrous, almost globular, in male stage c. 0.5 mm in diameter, in female stage c. 0.7 mm in diameter, producing dimorphic fruits. *Tepals* fused for about ½, green with hyaline margins, obtuse, slightly hollowed. *Stamens* 2-4, inserted at c. ½ of tepal length, anthers slightly exserted, 0.2-0.3 mm wide, 0.1-0.2 mm long, divided for c. 3/4, thecae spreading. *Ovary* superior, depressed-ovoid; stigmas 2, arising at top of ovary, separated by a cleft, divergent to slightly recurved, 0.2 mm long, with short papillae. *Fruits* and, correspondingly, seeds dimorphic. *Fruiting perianth with black seeds* rather variable in shape and size, before drying out 1.2-1.6 mm in longest diameter, c. 0.7-0.9 mm high, tepal lobes firmly appressed to the fruit leaving a star-like section in its upper part unhidden, the outermost tepal usually with a large obtuse horn or rounded bulge on its back, the two adjoining tepals with smaller outgrowths and the remainder only slightly and con-

tinuously enlarged. *Fruiting perianth with brown seeds* similar but flattened and with greater variation, up to 2-2.5(3) mm in longest diameter, in the larger fruits more regular, somewhat star-like. *Seeds* horizontal; black seeds lenticular, 0.8-1.1 × 0.7-0.9 × 0.45-0.55 mm, testa crustaceous, somewhat shining and distinctly reticulate; brown seeds disc-shaped, the coiled embryo visible through the thin, papery to brownish testa, either similar in size to the black seeds and c. 1 mm in largest diameter, or, more rarely, 1.6-2 mm wide and 0.5-0.7 mm thick. – Flowering July to August, fruiting September to October.

Chromosome number (by M. Lomonosova & A. Krasnikov). – Chromosome counts in plants of the type collection *(Lomonosova 254)* and of *Korolyuk 82* revealed a diploid chromosome complement of 2n = 18.

Conservation status. – Proposed conservation status (IUCN 2001) for Russia: Vulnerable (C2a - less than 10 locations; C2c - extreme fluctuations in number of mature individuals).

Additional specimens examined. – RUSSIA: ALTAI REPUBLIC: KOSH-AGACH DISTR.: 10 km NE of Kokorya, 2000 m, 30.8.2002, *Lomonosova 221, 224* (NS); at foot of Kurai mountain 4 km E of Chegan-Uzun, 31.8.2002, *Lomonosova 255, 256* (NS); at foot of Kurai mountain E of Chegan-Uzun, 24.8.2000, *Korolyuk 82* (NS, KAS); Ukok plateau, middle part of Musdu Bulak river valley, 49°19'N, 87°42'E, 20.7.1995, *Kamelin & al.* (ALTB, NS); ibid., the Kokorya river valley, 1850 m, 17.8.2001, *Pyak* (TK); Kalgutta river valley, 3.9.1936, *Kalinina* (LE); Chuya steppe, 20-35 km SE of Kosh-Agach, *Achnatherum* thicket along river Kurlei, 17.8.1932, *Butorina* (TK). — MONGOLIA: Kobdo distr., Mongolian Altai, 6.8.1991, *Ogureyeva 42* (MW); Mongolia borealis, near lake Baga-Nor, 25.8.1894 *Klementz 188b* (LE); Gobi Altai aimak, 45°20'35"N, 96º41'34"E, Tugrik river valley, 12.8.2000, *Rudaya* (TK).

Relationships

Suaeda tschujensis belongs to *S.* sect. *Brezia* (Moq.) Volkens, this name according to Schenk & Ferren (2001) having priority over *S.* sect. *Heterosperma* Iljin. The sectional placement is evident from the gynoecium structure with two distinct apical stigmas at the top of the gradually attenuated ovary, the horizontal seed position, the chlorenchymatous stem cortex and the typical C_3 anatomy of the leaves. *S. tschujensis* is similar and probably related to *S. prostrata* and occurs sympatric with delicate forms of a taxon hitherto classified under *S. corniculata*. With *S. prostrata, S. tschujensis* shares the otherwise very rare chromosome number of 2n = 18. It places *S. tschujensis* in a basal evolutionary line both in the section and genus. This position is supported by recent molecular data (ITS, cp *atp*B-*rbc*L spacer) provided by Peter Schütze from Kassel (see also Schütze & al. 2003). This puts *S. tschujensis* at the base of a clade comprising *S. corniculata,* the above mentioned undescribed Siberian relative of *S. corniculata* and, surprisingly, the South American *S. patagonica* Speg.

Differential characters, remarks on variability

The new species has the same growth form and about the same size as *Suaeda prostrata* and the delicate relative of *S. corniculata* (Fig. 3). Because all three taxa occur in the same region, their differences are summarized in Table 1.

As in other annual species of *Suaeda,* variability related to salinity, water and nutrient supply is considerable. This affects, in particular, the size of individual plants, length of internodes, and the shape and size of leaves. This variation makes especially difficult the identification of dwarf individuals. Unfortunately, one of the most significant characters of *S. tschujensis,* the distinct shape of the fruiting perianth, varies considerably depending on the central or lateral position of the flower in the glomerule (Fig. 2a-b) and the developmental stage of the fruit. In young fruits, the perianth has not yet reached its adult shape and size. On the other hand, in fully mature fruits and on herbarium specimens, the perianth has shrunk and the enlarged succulent parts of the tepal

Table 1. Diagnostic characters of well-developed individuals of *Suaeda tschujensis, S. corniculata* and *S. prostrata.*

	S. tschujensis	*S. corniculata*[1]	*S. prostrata*
Tepals in fruit	moderately unequal with 1 horn	strongly unequal with 3-5 horns	± equal without horns
Colour of living plants	pale green	green	greyish green
Leaf apex	obtuse to acutish	apiculate	apiculate
Leaf position in living plants	ascending or appressed	ascending	horizontally to recurved
Inflorescence, upper part	very dense	loose	dense
Internodes in lower half of stem [mm]	5-10(15)	10-12(15)	3-7
Chromosome numbers	2n = 18	2n = 54[2]	2n = 18[3]
Altitudinal distribution	upper montane zone	lowland to upper montane zone	lowland to lower montane zone

[1] Here only the delicate and prostrate form is considered.
[2] Unpublished data from M. Lomonosova & A. Krasnikov, plants from Siberia and Kazakhstan.
[3] Unpublished data from H. Freitag, plants from Saratov *(Freitag 28 312)* and Samara provinces *(Freitag 28 322),* and from M. Lomonosova & A. Krasnikov, Novosibirsk region, Tuva and Kazakhstan.

backs might change from their regular bulge or horn shape to cones, pyramids or wrinkled keels (Fig. 2c). Special attention is needed to distinguish the regular black-seeded fruits from the rather different brown-seeded fruits (Fig. 2d). For unknown reasons, the proportion of both seed types varies very much, and individuals have been seen that bear seeds and fruits of one type only.

Ecology

Nothing is known about the ecological conditions of the three localities in the Mongolian and Gobi Altai. Probably they do not differ much from the localities in the Russian Altai, where the

Table 2. Plant communities with *Suaeda tschujensis* from the Kosh-Agach district in the Altai Mts.

Relevé no	1	2	3	4	5
Area [m^2]	15	10	30	7	5
Total coverage [%]	30	10	20	15	15
Height of vegetation [cm]	40	60	25	15	50
Number of species	12	6	5	5	6
Suaeda tschujensis	2	+	2	1	+
Suaeda corniculata	5	2	15	8	10
Leymus paboanus	10	3	–	–	–
Artemisia compacta	–	5	2	3	1
Halogeton glomeratus	–	–	–	2	3
Kochia prostrata	+	–	+	1	+
Silene repens	+	+	–	–	–

Other taxa represented only once: 1 – *Agropyron cristatum* +, *Artemisia dolosa* +, *Artemisia glauca* +, *Artemisia santolinifolia* +, *Festuca lenensis* 5, *Koeleria cristata* 5, *Puccinellia altaica* 3; 2 – *Leymus ordensis* +; 3 – *Krascheninnikovia ceratoides* +; 5 – *Psathyrostachys juncea* +.
Localities: 1, 2 – Altai, Kosh-Agach district, 10 km north east of Kokorya village, 2000 m; 3-5 – ibid, at the foot of the Kurai mountain, 4 km east of Chegan-Uzun village, 1950 m.

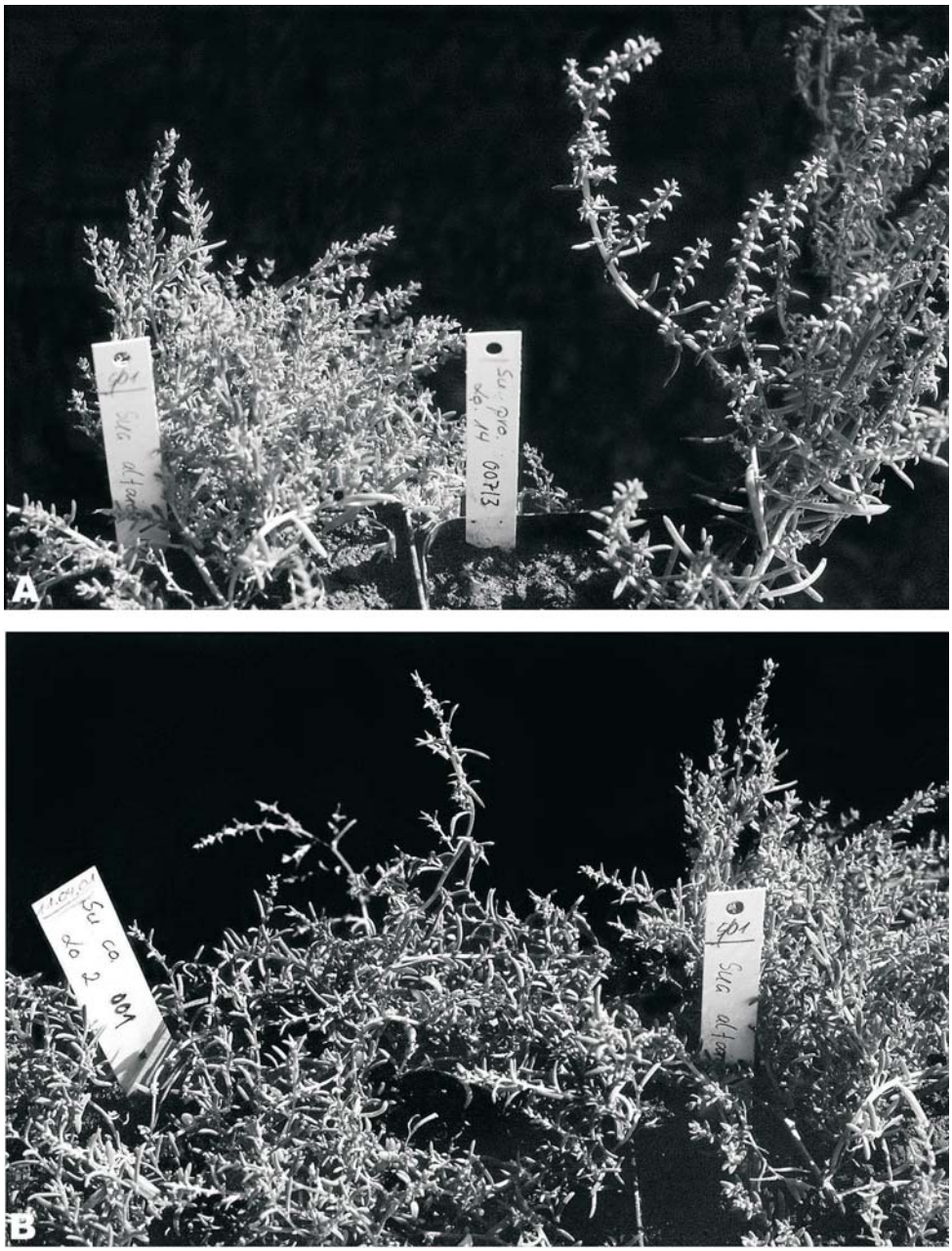

Fig. 3. *Suaeda tschujensis* Lomon. & Freitag cultivated side by side with related species – A: with *S. prostrata* (on the right); B: with a delicate prostrate form of *S. corniculata* (on the left). – Photos by H. Freitag.

Fig. 4. Chuya steppe in the Altai Mts, near Kosh-Agach, c. 1750 m; view in SW direction towards the S Chuya Mts. – Photo by Y. Ovczinnikov.

new species is restricted to a few larger intramountain depressions at altitudes of 1750-2000 m (Fig. 4), characterized by an extremely continental and dry climate resembling the high plains of the Pamir. The annual mean temperature (data from Kosh-Agach) is at -6 °C and might drop to -9 °C nearby. The mean of the warmest month (July) is 14.2 °C and of the coldest month (January) -31.5 °C. The vegetation period is very short and free from frost only for about 25-35 days. Annual precipitation varies from 70 to 170 mm, with a distinct maximum in summer. The thickness of the snow cover is 10-12 cm but frequently the snow is blown away by strong winds. Permafrost was observed in some parts of the Chuya depression.

The habitats themselves are shallow depressions and ravines above river terraces or at the edge of small lakes. They are temporarily flooded and due to continuous salinisation, the soils, built of alluvial deposits, have developed into solonchaks. This is the northernmost place in Asia with solonchaks in high mountains areas (Kovalev 1973).

Usually *Suaeda tschujensis* is a subordinate component of a plant community dominated by *Leymus paboanus* (Claus) Pilger, *S. corniculata* or *Artemisia compacta* DC. (see Table 2). Descriptions of the communities with *Suaeda* in this region were also given by Kalinina (1948) and Kuminova (1960) as "solonchak desert steppes", but only *S. corniculata* was noted.

Phytogeographical considerations

Phytogeographically, the area of *Suaeda tschujensis* belongs to the Mongolian Altai District in the Mongolian Province of the Central Asiatic floristic subregion (Lavrenko 1962, Grubov 1963). In other classifications, it comes within either the Mongolian and Gobi Altai Province of the Central Asiatic subregion (Račkovskaja 1993) or the Mongolian Province of the Dahuro-Mongolian steppe area (Ogureeva 1980).

In any case, the discovery of *Suaeda tschujensis* in the Russian and Mongolian Altai is an interesting addition to a rather small but significant phytogeographical element distributed through

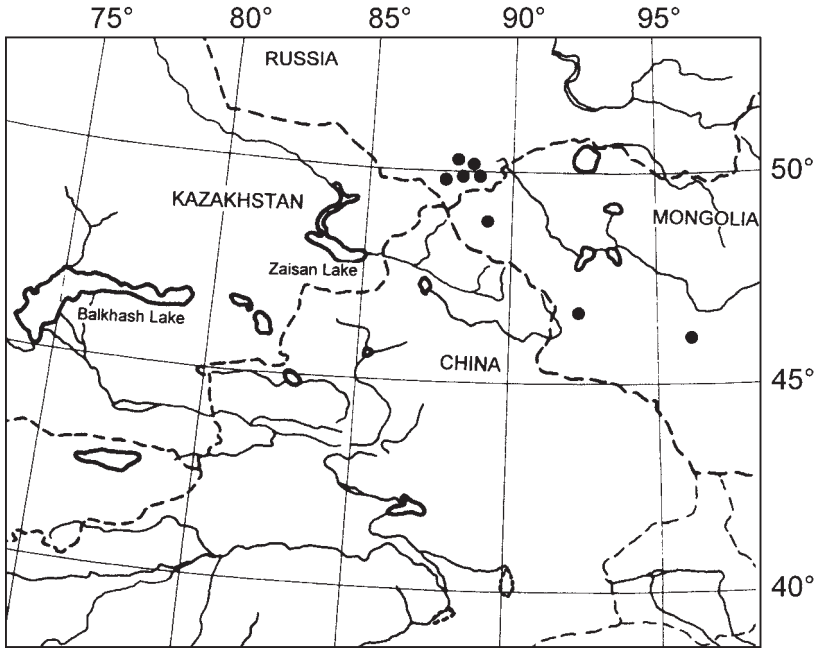

Fig. 5. Distribution of *Suaeda tschujensis* Lomon. & Freitag (●).

the mountain deserts in the western parts of Central Asia (Fig. 5). It meets the typical Central Asiatic semidesert flora of lower and middle altitudes, with species such as *Anabasis brevifolia* C. A. Mey., *Reaumuria songorica* Maxim, *Zygophyllum pterocarpum* Bunge, *Kochia melanoptera* Bunge, *K. krylowii* Litw., *Salsola monoptera* Bunge, etc., but enters higher up and has a more restricted distribution. A similar distribution pattern is represented by *Chenopodium frutescens* C. A. Mey., the only shrubby Eurasian species of the genus, which also appears to be a derivative of a very old stock (for a map and plant communities see Buyan-Orish 1999). Another typical species of that group is *Suaeda olufsenii* Paulsen, albeit it extends further SW and SE to the Alai, the Pamir, and the high mountain plains of N Pakistan, SW Sinkiang and Tibet. Finally, the occurrence of *S. tschujensis* further to the east and southeast cannot be ruled out due to insufficient knowledge of the genus in China. "Flora intramongolica" (Fu & al. 1990: t. 113, fig. 2) gives a strange illustration of a fruit ascribed to *S. prostrata* but somewhat resembling our new species.

Acknowledgements

We are thankful to the curators of the herbaria ALTB, LE, MW and TK for the opportunity to study their material and to have some specimens on loan. Furthermore, we thank Peter Schütze for his generosity allowing us to use unpublished molecular data. We are indebted to Ms N. Prijdak for the drawings, to Ms Hage and Ms Müller for processing the photographs and the map. Finally, we acknowledge with gratitude linguistic and other suggestions by P. Uotila and I. Hedge.

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Addresses of the authors:
Dr M. Lomonosova, Central Siberian Botanical Garden, Novosibirsk, Russia; Fax: (007) 3832 301986; e-mail: root@botgard.nsk.su

Prof. Dr H. Freitag, Dept. of Plant Taxonomy, Kassel University, D-34132 Kassel, Germany; Fax: 030 (0)561 804 4200; e-mail: hfreitag@uni-kassel.de