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## *Saussurea arctecapitulata* Lipsch. – new species for the flora of Russia

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**Summary.** *Saussurea arctecapitulata*, a herbaceous perennial species, belonging to the type section of the genus *Saussurea*, previously known only from a few localities in the northern Mongolia, has been found in the Naryn River Valley during field trips to the territory of Republic of Tuva. This article presents an updated description accompanied by photos of the species in nature, updated data on the distribution of the species, as well as phylogenetic relationships with morphologically similar species of the section based on the variability of the site ITS1–5.8S–ITS2.

## *Saussurea arctecapitulata* Lipsch. – новый вид для флоры России

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**Ключевые слова:** биоразнообразие, Республика Тыва, Сибирь, сосудистые растения, флористические находки.

**Аннотация.** *Saussurea arctecapitulata* – травянистый многолетник, относящийся к типовой секции рода *Saussurea*, ранее известный лишь из нескольких местонахождений на территории Северной Монголии. В ходе полевых экспедиций по территории Республики Тыва нами были обнаружены популяции данного вида в долине реки Нарын. В статье представлены дополненное описание, сопровождаемое фотографиями вида в природе, обновленные данные о распространении вида, а также результаты филогенетического анализа с включением в анализ морфологически близких видов секции на основе изменчивости участка ITS1–5.8S–ITS2.

### Introduction

The genus *Saussurea* DC. comprises about 450–500 species of perennial, biennial herbs and subshrubs widely distributed in temperate and subarctic regions of Asia (Lipschitz, 1979; Smirnov et al., 2018). It is one of the largest genera in the tribe *Cardueae* Cass. with the center of species richness and greatest morphological diversity in the Sino-Hi-

malaya and adjacent regions (Xu et al., 2019), however, the number of species may be still significantly underestimated due to lack of floristic investigations in different parts of the genus distribution range, especially in remote mountain areas. In June 2019, during a floristic investigation carried out in the Sayan Mountains, a population of *Saussurea arctecapitulata* Lipsch. was found in the Sangilen Plateau, near the mouth of the Bayan-Gol River. This species was

described by S. J. Lipschitz in 1972 based on the herbarium materials collected by V. L. Komarov from northern Mongolia in 1902 (Lipschitz, 1972), and it was not previously reported for the flora of Russia. In August 2023, expeditionary research was carried out in this area, and several more populations of this species, apparently common in the valley of the Naryn River in the Sangilen Plateau, were found.

### Material and Methods

Samples for phylogenetic analyses and herbarium specimens were collected by the authors during field trips to Republic of Tuva, Republic of Altai (Russia), Khovd Aimag (Mongolia), Friuli-Venezia Giulia (Italy) in 2016–2023. In total, 8 taxa (*S. arctecapitulata*, 6 morphologically related species from the type section of the genus, *Jurinea multiflora* (L.) B. Fedtsch. as an outgroups) were included in the study. All newly generated sequences were deposited in GenBank, for *S. pseudoalpina* N. D. Simpson, *S. parviflora* (Poir.) DC., *S. neoserrata* Nakai and *J. multiflora* we refer to GenBank data (Table 1). The studied specimens collected by the authors were deposited in the Herbarium of P. N. Krylov of Tomsk State University (TK, Tomsk, Russia). *DNA extraction and sequencing.* – Genomic DNA isolation from plant tissues was performed following a modified 2xCTAB protocol (Doyle J. J., Doyle J. L., 1990). To quantify DNA extracted from silica-gel dried samples, NanoDrop2000 spectrophotometer (Thermo Fisher Scientific, USA) was used. ITS1-5.8S-ITS2

fragments were amplified by polymerase chain reaction using the following primer combinations: ITS-p5(ccttatcaytttagaggaaggag) / ITS-u4 (rgtttctttctcgcctta) (Cheng et al., 2016), according to program, starting with 94 °C for 4 minutes, followed by 35 cycles of 30 seconds at 94 °C, 30 seconds at 53 °C and a final extension of 45 seconds at 72 °C with a final step of 10 minutes at 72 °C. Automated DNA sequencing was carried out directly from the purified with the PCR Purification Kit (Roche, Germany) PCR products using BigDye Terminator v.2 reagents in the ABI310 sequencer (PE-Applied Biosystems, USA). *Sequence alignment and phylogenetic analyses.* – DNA sequences were aligned in the MAFFT vs. 7 (Katoh, Standley, 2013), after which the alignment results were checked manually and edited using BioEdit vs. 7.0.1 (Hall, 1999). The best-fitting models of nucleotide substitution selected in MrModeltest v.2.4 using the Akaike Information Criterion (AIC) was GTR+I. Phylogenetic analyses was performed with MrBayes 3.1.2 (Ronquist, Huelsenbeck, 2003) using the Bayesian method. The analysis was performed using four incrementally heated Markov chains, simultaneously started from random trees and run for one million cycles, recording one tree every 1000 generations until the average standard deviation of split frequencies < 0.01 was achieved. The first 25 % of the trees were discarded as burn-in, after which the remaining trees were used to calculate a majority-rule phylogenetic tree edited using the FigTree 1.4.4 program (Rambaut, 2018).

Table 1

GenBank accession numbers and information about voucher specimens for the samples used in the phylogenetic analysis. Newly generated sequences highlighted in bold

№	Species	Voucher specimens	ITS1-5.8S-ITS2
1	<b><i>Saussurea arctecapitulata</i></b>	<b>TK-005031</b>	<b>OR565243</b>
2	<i>S. subacaulis</i>	<b>AP2016002</b>	<b>OR565245</b>
3	<i>S. klementzii</i>	<b>AP2019013</b>	<b>OR565244</b>
4	<i>S. alpina</i>	<b>EP2019003</b>	<b>OR565246</b>
5	<i>S. pseudoalpina</i>	WYJ201607020	OR119937
6	<i>S. pseudoalpina</i>	WYJ201308135	OQ539813
7	<i>S. pseudoalpina</i>	WYJ201308201	OQ539809
8	<i>S. parviflora</i>	LJQ-2008-GN-092	OQ539754
9	<i>S. parviflora</i>	Ikeda200714073	OQ539755
10	<i>S. neoserrata</i>	unpublished, no data	AB254668
11	<i>Jurinea multiflora</i>	WYJ201308102	MH003704

### Results and discussion

*Saussurea arctecapitulata* Lipsch.: “Russia. Republic of Tuva, Erzinsky district, Sangilen Plateau,

Naryn River Valley, mouth of the Bayan-Gol River, 1577 m. 50°09'17.40"N, 95°58'28.1"E. 06 IX 2019. A. I. Pyak, E. A Pyak, S. Karachurina / Россия. Республика Тыва, Эрзинский район. Нагорье Сан-

гилен, долина реки Нарын, устье реки Баян-Гол, 1577 м. 50°09'17.40"N, 95°58'28.15"E. 06 IX 2019. А. И. Пяк, Е. А. Пяк, С. Карачурина" (ТК [ТК-004155]); "Russia. Republic of Tuva, Erzinsky district. Sangilen Plateau, Naryn River Valley, 1840 м. 50°12'15.7"N, 96°12'59.7"E. 03 VIII 2023. Е. А. Рудьев, А. В. Рудьев, А. И. Пяк" (ТК [ТК-005031]).

*Phylogenetic analyses.* – Phylogenetic tree constructed based on the results of the ITS1-5.8S-ITS2 site variability is shown in the Fig. 1. The ingroup belonging to the species of the section *Saussurea* was retrieved as the monophyletic group (1.00 PP) and including two main clades. *S. parviflora* and *S. neoserrata* which constitute the first clade are sisters to the rest of the ingroup which includes *S. pseudoalpina* related by sister relationship to *S. alpina* (L.) DC. with *S. subacaulis* (Ledeb.) Serg. (grouped together with 0.97 PP), *S. klementzii* Lipsch. and *S. arctecapitula*. The relationships between these taxa are unresolved due to polytomies.

*Morphological description.* – Herbs perennial, (5–)10–40 cm tall (Fig. 2). Root collar covered with remains of petioles of previous years leaves. Stems solitary, erect, simple, wingless. Leaves firm, leathery,

abaxially pale green, adaxially green, both surfaces glabrous or sparsely pubescent only along midvein and margins, apex acuminate, margin sinuate-dentate. Basal leaves withered at anthesis, petiolate; petioles short, usually up to 5 cm. Lower and middle stem leaves shortly petiolate to sessile; leaf blade elliptic, 4–10 × 1.5–3 cm. Upper stem leaves sessile, narrowly elliptic to linear-lanceolate, 3–9 × 1–2 cm. Capitula (1–)4–20, shortly pedunculate, in a dense corymbiform synflorescence. Involucre narrowly campanulate, 12–15 × 5–7. Phyllaries in 4–6 rows, abaxially from light green to dark colored, pubescent; inner phyllaries narrowly elliptic, apex subobtusate, outer phyllaries equal or slightly shorter, apex acuminate with a straight or slightly recurved cusp. Receptacle densely covered with persistent whitish subulate-filiform bristles. Corolla purple. Anthers dark-colored, 4–4.5 mm long, basal appendages obtuse, with lacerate tails, up to 1 mm long. Pappus of two series, inner row of whitish yellow (darker at the base) plumose bristles connated at base, 10.5–11.5 mm long, outer series of scabrid unequal bristles. Achenes glabrous, cylindric, 4–5 mm, usually more or less purple due to purple dots. The main characteristics that make it possible to distinguish *S. arctecapitulata* from morphologically related species, which include *S. klementzii*, *S. subacaulis*, *S. tilesii* (Ledeb.) Ledeb., *S. parviflora*, *S. pseudoalpina*, are presented in Table 2.

Table 2

Comparative features of morphologically similar species to *Saussurea arctecapitulata*

Species	Stem	Leaves	Phyllaries
<i>Saussurea arctecapitulata</i>	(5–)10–40 cm, wingless, simple	both surfaces green (abaxially pale green, adaxially green), glabrous or sparsely pubescent only along midvein and margins	pubescent; inner subobtusate; outer equal or slightly shorter, apex acuminate with a straight or slightly recurved cusp
<i>Saussurea klementzii</i>	(5–)10–50 cm, wingless, simple or apically branched	both surfaces green (abaxially pale green, adaxially green), gland-dotted; stem leaves are half-stem-embracing with auricles	glabrous or sparsely pubescent; inner subobtusate; outer clearly shorter, apex acuminate with a straight or slightly recurved cusp
<i>Saussurea subacaulis</i>	5–15(–20) cm, wingless, simple	abaxially grayish green and tomentose, adaxially green and glossy	pubescent, apex acuminate; outer equal or slightly shorter than inner
<i>Saussurea pseudoalpina</i>	5–25(–40) cm; wingless or rarely with short and narrow wings; simple	abaxially grayish green, gland-dotted and arachnoid, adaxially green, sparsely pubescent	pubescent, gland-dotted; inner subobtusate; outer clearly shorter, apex acuminate
<i>Saussurea parviflora</i>	20–100(–150) cm, narrowly winged; simple or apically branched	both surfaces green (abaxially pale green, adaxially green), gland-dotted; glabrous or abaxially sparsely pubescent with uniseriate trichomes	glabrous or sparsely pubescent along margins, apex subacute to obtuse; outer clearly shorter
<i>Saussurea tilesii</i>	5–10(–15) cm, wingless, simple	both surfaces usually gland-dotted, abaxially grayish green and tomentose, adaxially green and glossy	pubescent; inner subobtusate; outer slightly shorter, apex acuminate with a straight or slightly recurved cusp



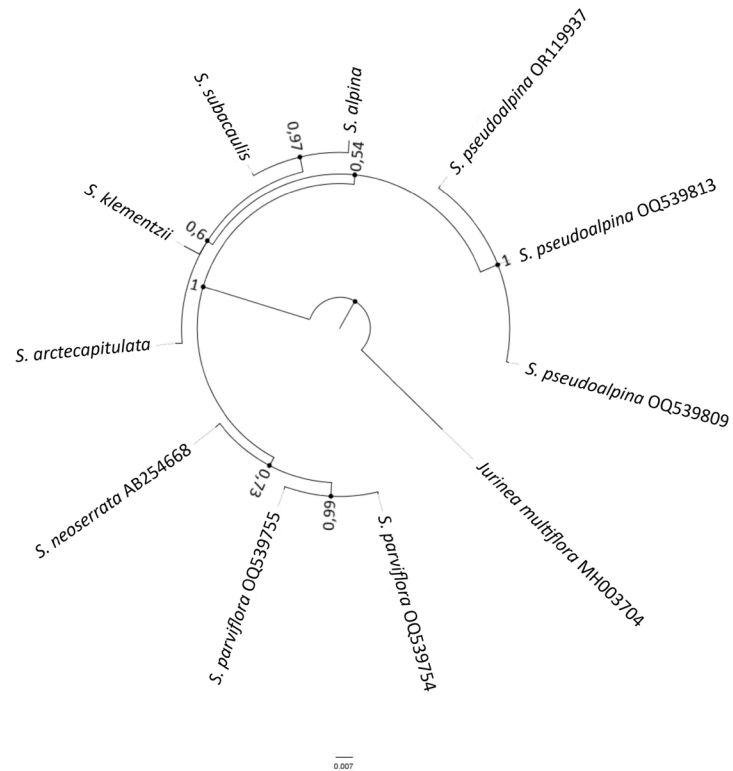


Fig. 1. Bayesian 50 % majority-rule consensus phylogenetic tree from nrDNA ITS1-5.8S-ITS2 site for *Saussurea arctecapitulata* and the related taxa with indication of Bayesian Posterior Probability (PP) values for the internal tree nodes.



Fig. 2. *Saussurea arctecapitulata*: A – synflorescence; B – achene; C – involucre; D – receptacle bristles; E – habit (photos by E. A. Pyak).

**Distribution.** – *Saussurea arctecapitulata* has been considered as an endemic of Mongolia, known from the Khangai Mountains and Western Prihubsugul region (Lipschitz, 1972). However, the specimens from the Khangai Mountains, preserved in LE and MW belong to *S. parviflora* (Poir.) DC., a common species widely distributed in the Altai and Sayan Mountains and adjacent regions. Two species can be distinguished by involucre (with phyllaries of equal length in *S. arctecapitulata* vs. imbricate in *S. parviflora*) and stems ((5–)10–40 cm, wingless vs. 20–100(–150) cm, narrowly winged). To our knowledge, there is no other specimen collected in the Khangai Mountains that can be assigned to *S. arctecapitulata*. In Wehrden et al. (2009) *S. arctecapitulata* was mentioned from Gobi Altai as a diagnostic species of Kobresietum myosuroidis communities restricted to the moistest north-facing slopes of the Gobi Gurvan Saykhan, but the specimen preserved in HAL belongs to *S. pseudoalpina* N. D. Simpson, widely distributed in Altai Mountains. Thus, to date, the species is known only from the crossbordered territory, from Khövsgöl Aimag of Mongolia (Lake Khubsugul) and Republic of Tuva of Russia (Naryn River Valley).

**Specimens examined:** “Mongolia. Lake Kosogol. 18 VII 1902. V. Комаров / Монголия. Озеро Косогол. 18 VII 1902. В. Комаров” (LE [LE 01025564; LE 01025565]); “[Mongolia]. Dzuun Saikhan, Yoliin Am catchment, mountain meadow (grazed) replacing *Betula* – *Salix* scrub on valley ground, 2300–2350 m. 43°29'N, 104°06'E. 02 VII 1996. G. Meihe, S. Meihe. 96-010-10” (HAL [HAL 50155]); “Mongolia. Khangai, 30 km from Tévchrüleg Village, subalpine lawns on top of Mount Khairkhan, 2500 m. 24 VII 1980. I. A. Gubanov. 990 / Монголия. Хангай, 30 км на ЮЮЗ от пос. Тэвшрүлег Архангайского аймака, субальпийские лужайки на вершине г. Хайрхан, 2500 м. 24 VII 1980. И. А. Губанов. 990” (LE; MW); “Mongolia. Khangai, upper reaches of the Urd-Tamir River, near the Holsain-Daba Pass, 2600–2700 m. 4 VIII 1980. I. A. Gubanov. 1124 / Монголия. Хр. Хангай, верховья р. Урьд-Тамира у перевала Холсайн-Даба, 2600–2700 м. 4 VIII 1980. I. A. Gubanov. 1124” (LE; MW).

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