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Astragalus poroshiriensis (Fabaceae), a new species from limestone outcrops in the Hidaka Mountains, Hokkaido, Japan

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Abstract

We describe a new species, *Astragalus poroshiriensis*, from limestone outcrops on the Hidaka Mountains in Hokkaido, northern Japan. This new species belongs to sect. *Oroboidei* and is morphologically similar to five congeners distributed in East Asia or the Russian Far East. However, it is readily distinguishable by the following combination of morphological characters: stems with black and white hairs, legumes and upper surface of leaflets glabrous, 8–19 mm long leaflets, 9–15 cm long peduncles, 4.5–6 mm long calyx and 1–1.5 mm long calyx teeth, and pale lilac petals. The new species and four of the five morphologically similar species collectively exhibit fragmented endemism in Japan and Sakhalin Island, consistent with many species in the genus with specialized habitat preferences and restricted distributions. Possibly, the common ancestor may have a wider distribution during cooler glacial periods. *Astragalus poroshiriensis* is confined to an isolated, subalpine limestone area. Its allopatric speciation may have been promoted by climate change, whereby the limestone outcrops functioned as refugia during the post-glacial warming period. On the basis of its extremely small population size at a single known locality, we recommend classifying *A. poroshiriensis* as Critically Endangered (CR) according to the IUCN Red List criteria and categories.

Key words: endemic, herbarium, morphology, sect. *Oroboidei*, taxonomy

Introduction

Astragalus Linnaeus (1753: 755) is the largest genus of flowering plants, comprising more than 3,000 species distributed primarily in the temperate regions of the Northern Hemisphere (Sanderson & Wojciechowski 1996, Frodin 2004, Podlech & Zarre 2013, Maassoumi 2020). The high species diversity in this genus reflects highly localized endemism (Rundel *et al.* 2015, Jones *et al.* 2021, Maassoumi & Ashouri 2022). Geographic or ecological fragmentation may have greatly accelerated diversification within the “Astragalean clade” in the Fabaceae, which includes *Astragalus* and its relatives (Sanderson & Wojciechowski 1996). Especially in North America, many species are geographically restricted and occupy ecologically distinct habitats, making them inherently rare (Barneby 1964, Rundel *et al.* 2015, Jones *et al.* 2021). Furthermore, genetic isolation has been demonstrated even between two geographically adjacent species with narrow distribution ranges (Jones *et al.* 2021). Especially high species diversity is observed from the Mediterranean region to Central Asia (Podlech & Zarre 2013, Maassoumi 2020, Bidarlord & Ghahremaninejad 2021, Ghahremaninejad *et al.* 2022a, 2022b, Munkhtulga *et al.* 2025). As new species still continue to be discovered even today (Bagheri *et al.* 2014, 2016, Maassoumi *et al.* 2022, Avazzadeh *et al.* 2025), taxonomic, phylogenetic, and evolutionary studies focused on the genus is one of the most important topics. In contrast, the diversity of *Astragalus* in Japan is relatively limited with 11 species recorded (Ohashi 2001, 2016).

In June 2024, during a floristic survey in the Hidaka Mountains, central Hokkaido, Japan, we found an *Astragalus* population that could not be assigned to any taxa recorded in Japan (Fig. 1). When the population was discovered initially, we received the impression that this population was most similar to *A. shiroumaensis* Makino (1906: 23) (“*A. shiroumensis*” has been sometimes used by some authors; Matsumura 1912, Ohashi 2001, 2016) among only Japanese congeners, based on its ascending stems, free stipules, glabrous upper surface of the leaflets, loosely capitate raceme with 7–15 flowers, calyx with dense, subappressed black hairs, and sessile, pendulous legumes with an abaxial groove (Ohashi 2001, 2016). However, the population was readily distinguishable from *A. shiroumaensis* in having

pale lilac flowers (Fig. 1B; vs. pale yellowish white) and glabrous legumes (Fig. 1C; vs. with sparse black hairs). The population was located in Niikappu-cho, Niikappu-gun, Hidaka Subprefecture. The habitat was limestone cliffs in the subalpine zone (ca. 1100 m elev.) near Mt. Poroshiri.

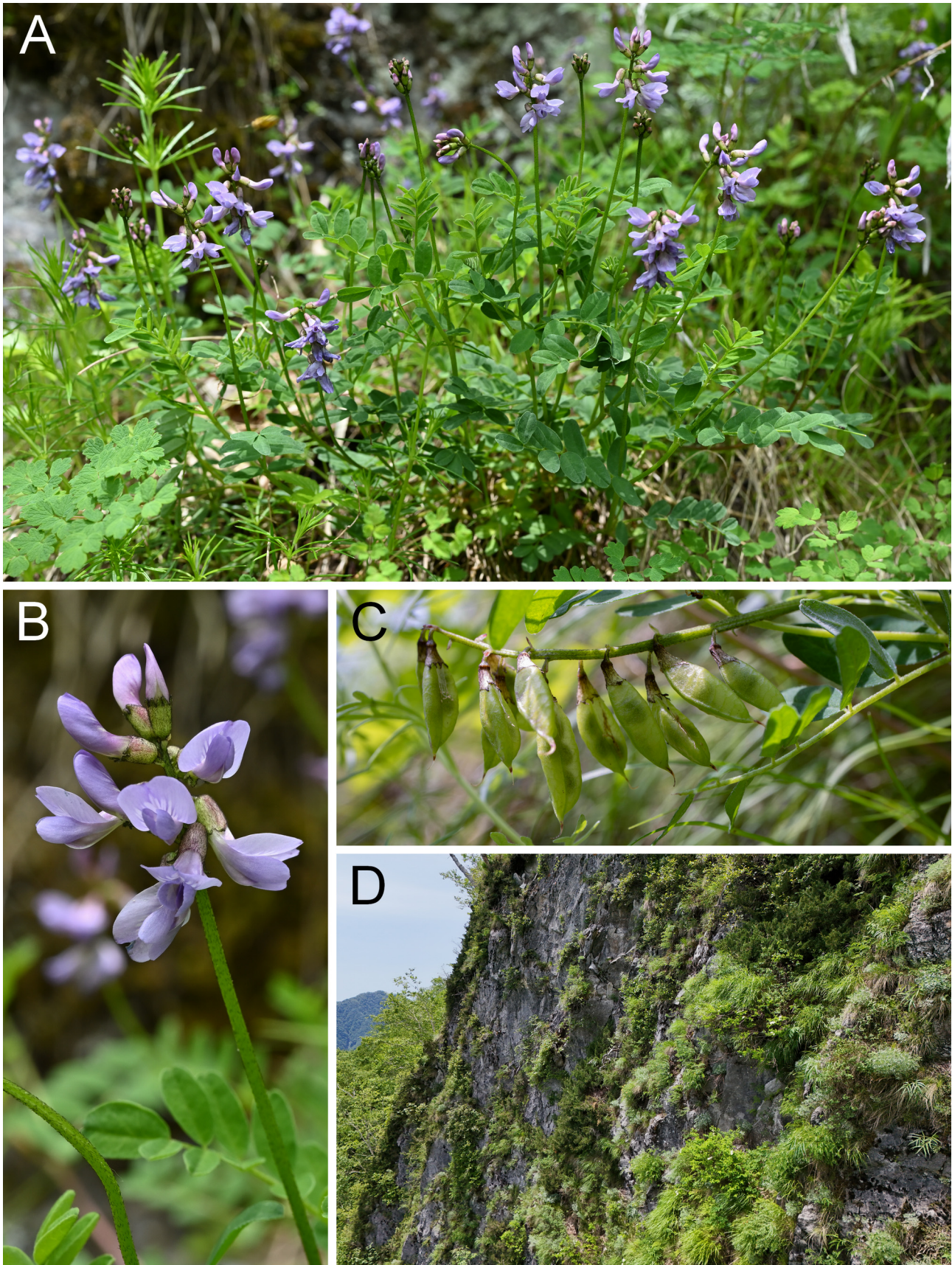


FIGURE 1. Habit and habitat of *Astragalus poroshiriensis* Kimura-Yokoyama & Shutoh, *sp. nov.* **A**, Habit at flowering. **B**, Raceme of a wild individual. **C**, Fruiting inflorescence in the wild. **D**, Habitat at the type locality.

We hypothesized that the population may represent an undescribed taxon. The Hidaka Mountains are geologically complex and were formed by the collision of island arcs, resulting in a mosaic of rock types, including extensive ultramafic bodies and sporadic limestone outcrops (Kiminami & Kontani 1983, Komatsu *et al.* 1989). Such a patchy network of distinct substrates, often called “edaphic islands”, have promoted plant speciation by acting as refugia for relict lineages isolated from the surrounding zonal soils (Kruckeberg 2002, Rajakaruna *et al.* 2024). Currently, 12 species and nine varieties, such as *Callianthemum miyabeianum* Tatewaki (1928: 79) (Ranunculaceae) and *Silene hidakalpina* (Miyabe & Tatewaki 1937: 41) Ohwi & H. Ohashi (1974: 345) (Caryophyllaceae), are recorded as endemic taxa on these mountains (Ohashi *et al.* 2015, 2016a, 2016b, 2017a, 2017b). Furthermore, *Astragalus* exhibits localized species endemism in geographically restricted, rocky areas in Japan and Sakhalin Island with six species recognized: *A. sachalinensis* Bunge (1868: 23), *A. sugawarae* Kimura-Yokoyama & Shutoh (2025: 113), *A. austrosachalinensis* N.S.Pavlova (1989b: 906), *A. tokachiensis* T.Yamazaki & Kadota (1986: 199), *A. yamamotoi* Miyabe & Tatewaki (1934: 381), and *A. shiroumaensis* (Pavlova 1989a, Ohashi 2001, 2016, Kimura-Yokoyama & Shutoh 2025; Fig. 2).

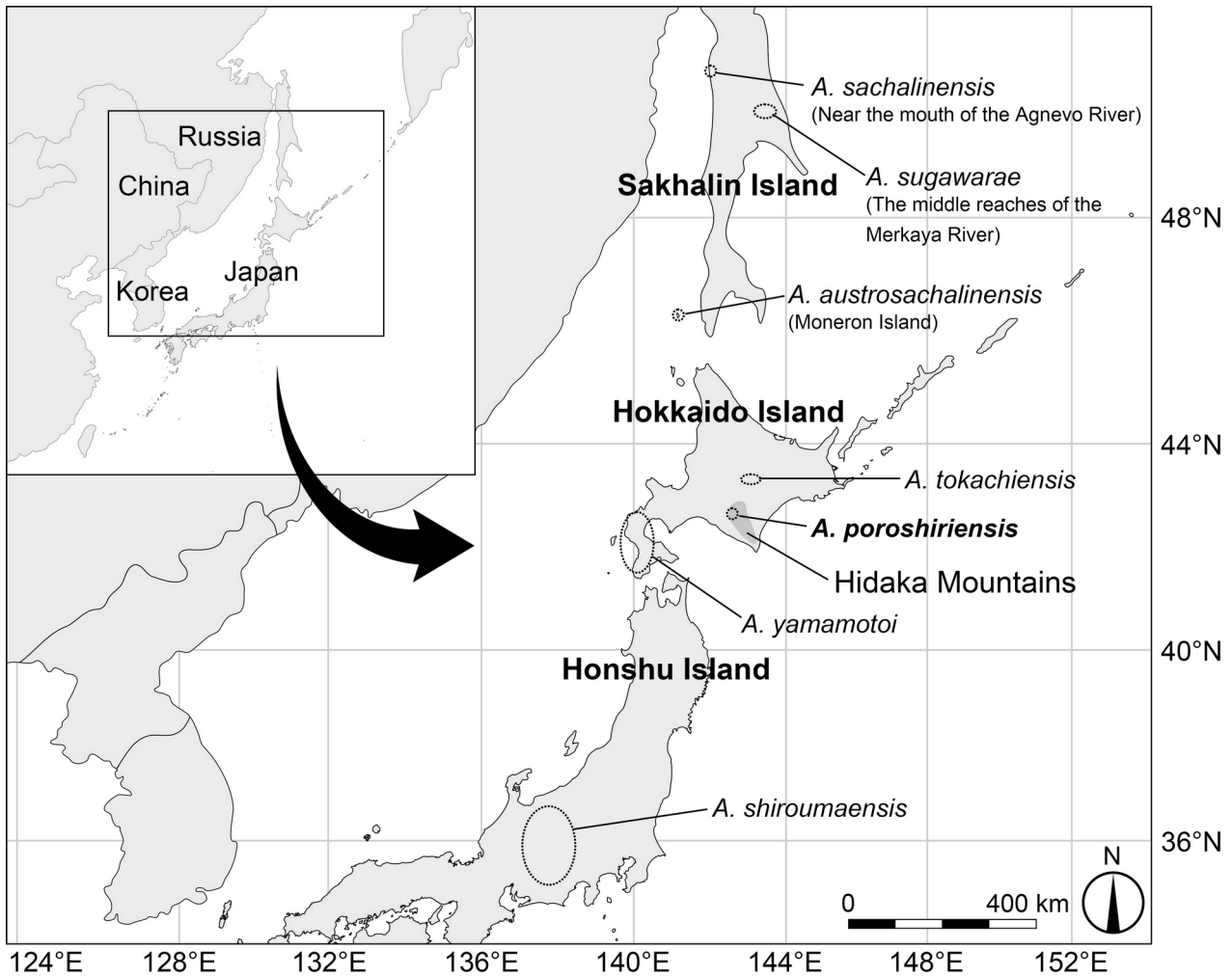


FIGURE 2. Distribution of seven endemic species of the genus *Astragalus* in Japan and on Sakhalin Island with geographically restricted distributions.

The aim of this study was to clarify the identity of the *Astragalus* population in the Hidaka Mountains based on morphological observations and morphometric data. Molecular phylogenetic techniques are often used to assist with the identification of undescribed lineages, including *Astragalus* taxa (Liu *et al.* 2025, Maylandt *et al.* 2025, Munkhtulga *et al.* 2025). However, such techniques were not feasible in the present study because of the difficulty of collecting fresh samples for extraction of usable DNA among the morphologically similar species, especially *A. sachalinensis*, *A. sugawarae*, and *A. austrosachalinensis*, which are endemic to strongly inaccessible localities (Kimura-Yokoyama & Shutoh 2025). Furthermore, previous phylogenetic studies that were focused on *Astragalus* did not include sequence data for these species (Su *et al.* 2021, Bagheri *et al.* 2023, Folk *et al.* 2024, Buono *et al.* 2025).

Material and methods

We collected 10 individuals in the *Astragalus* population on the Hidaka Mountains in 2024 and 2025. The specimens were preserved as herbarium vouchers and their morphology was subsequently examined. Measurements of floral parts and vegetative organs were recorded using a stereomicroscope (SMZ645, Nikon, Tokyo, Japan) and a digital caliper. Qualitative characters, such as floral color and plant habit, were recorded from living plants in the field prior to pressing the collected specimens. The voucher specimens were deposited in the Herbarium of the Hokkaido University Museum (SAPS).

We compared the Hidaka population to morphologically similar species via detailed morphological examinations. A search was performed based on an identification key and descriptions for all species classified in *Astragalus* sect. *Oroboidei* A.Gray (1864: 203) recognized in recent comprehensive revisions of the genus in the Old World (Podlech & Zarre 2013) and the New World (Welsh 2023) as well as floristic literature for Japan (Ohashi 2001, 2016) and the Russian Far East (Pavlova 1989a). The Hidaka population was assigned to sect. *Oroboidei* based on the following combination of characters: perennial, non-spiny herb with simple white or black hairs distributed over the entire plant; long, slender stems up to 50 cm tall; loosely flowered racemes elongating during fruiting (Fig. 1B, C); papilionaceous flowers with a campanulate calyx persistent at fruiting (Fig. 1B, C), glabrous petals, and keels shorter than the wings without minute teeth (Fig. 3B); sessile legumes at least two-times longer than wide with neither wrinkled nor warty valves (Fig. 3E); and imparipinnate leaves with stipules free from the petiole and from each other.

The recorded morphological characters of the Hidaka population were compared with the morphologically similar species screened in the foregoing search. Specifically, we consulted the descriptions in protologues and relevant literature for *A. sachalinensis* (Bunge 1868, 1869, Pavlova 1989a, Podlech & Zarre 2013), *A. sugawarae* (Kimura-Yokoyama & Shutoh 2025), *A. austrosachalinensis* (Pavlova 1979, 1989b, Podlech & Zarre 2013), *A. shiroumaensis* (Makino 1906, Ohashi 2001, Podlech & Zarre 2013), and *A. taipaishanensis* C.Y.Ho & S.B.Ho (1980: 63) (Ho 1980; Xu & Podlech 2010; Podlech & Zarre 2013). In addition, we examined herbarium specimens of these species housed in SAPS. Because no specimens of *A. sachalinensis* and *A. taipaishanensis* were available in Japanese herbaria, we scrutinized high-resolution digital images of herbarium specimens, including the lectotype of *A. sachalinensis* (*F. Schmidt s.n.*, P00623255) designated by Podlech & Sytin (1996).

Leaflet length, leaflet width, calyx length, and calyx tooth length of the Hidaka population and the most morphologically similar species, *A. sachalinensis*, were statistically compared. We selected these characteristics because those of the Hidaka population differed from those specified in the protologue or published descriptions of *A. sachalinensis*. The maximum dimensions of fully developed organs in each specimen were measured and the significance of differences among the specimens was tested using the Mann-Whitney *U* test ($n = 10$ for the Hidaka population and $n = 7$ for *A. sachalinensis*). All statistical analyses were performed using EZR version 1.70 (Jichi Medical University, Tochigi, Japan), which is a graphical user interface for *R* (R Foundation for Statistical Computing, Vienna, Austria) and represents a modified version of the *R* Commander package incorporating additional statistical functions that are frequently used in biostatistics (Kanda 2013).

Results

Using the *Astragalus* identification key provided by Podlech & Zarre (2013), the Hidaka population was indicated to be most similar to *A. sachalinensis*. The two taxa shared glabrous legumes and upper surface of the leaflets (Fig. 3C, E), free stipules, 5–7 pairs of leaflets, calyx covered only with subappressed black hairs (Fig. 3A), pedicels 1–2 mm long (Fig. 3A), standard 11–13 mm long (Fig. 3B), hairy rhachis and peduncles (Fig. 3A), racemes 1.5–4 cm long, and stems with subappressed hairs (Fig. 3A, D). However, the Hidaka population was distinct from *A. sachalinensis* in having pale lilac flowers (Fig. 3A; vs. white with violet veins in standards), mixed black and white hairs on stems (Fig. 3D; vs. only white hairs), calyx 4.5–6 mm long and calyx teeth 1–1.5 mm long (vs. 3–4 mm and ca. 0.5 mm, respectively), and leaflets 8–19 mm long \times 4–8 mm wide (vs. 6–10(–15) \times 3–6(–10) mm).

The Hidaka population and *A. sachalinensis* were distinguishable in morphological measurements and statistical analyses of the morphometric data. The largest leaflet dimensions in members of the Hidaka population were 16.3 ± 2.0 (13.8–19.0) mm long and 7.2 ± 0.6 (5.9–8.0) mm wide, whereas those of *A. sachalinensis* were 13.0 ± 1.8 (10.3–15.9) mm long and 6.6 ± 0.8 (5.7–8.4) mm wide. The largest leaflet of the Hidaka population was significantly longer than those of *A. sachalinensis* ($P < 0.01$), although the difference in width of the largest leaflet was not significant (P

= 0.08). The largest calyx and calyx teeth in members of the Hidaka population were 5.5 ± 0.2 (5.4–5.8) mm and 1.3 ± 0.1 (1.2–1.6) mm long, which were significantly longer than those of *A. sachalinensis*: 3.7 ± 0.4 (3.3–4.2) mm and 0.7 ± 0.1 (0.5–0.8) mm long, respectively (both $P < 0.01$; Fig. 4). Notably, the lengths of the calyx and calyx teeth did not overlap between the Hidaka population and *A. sachalinensis* across any of the recorded measurements (see **Taxonomic Treatment**).

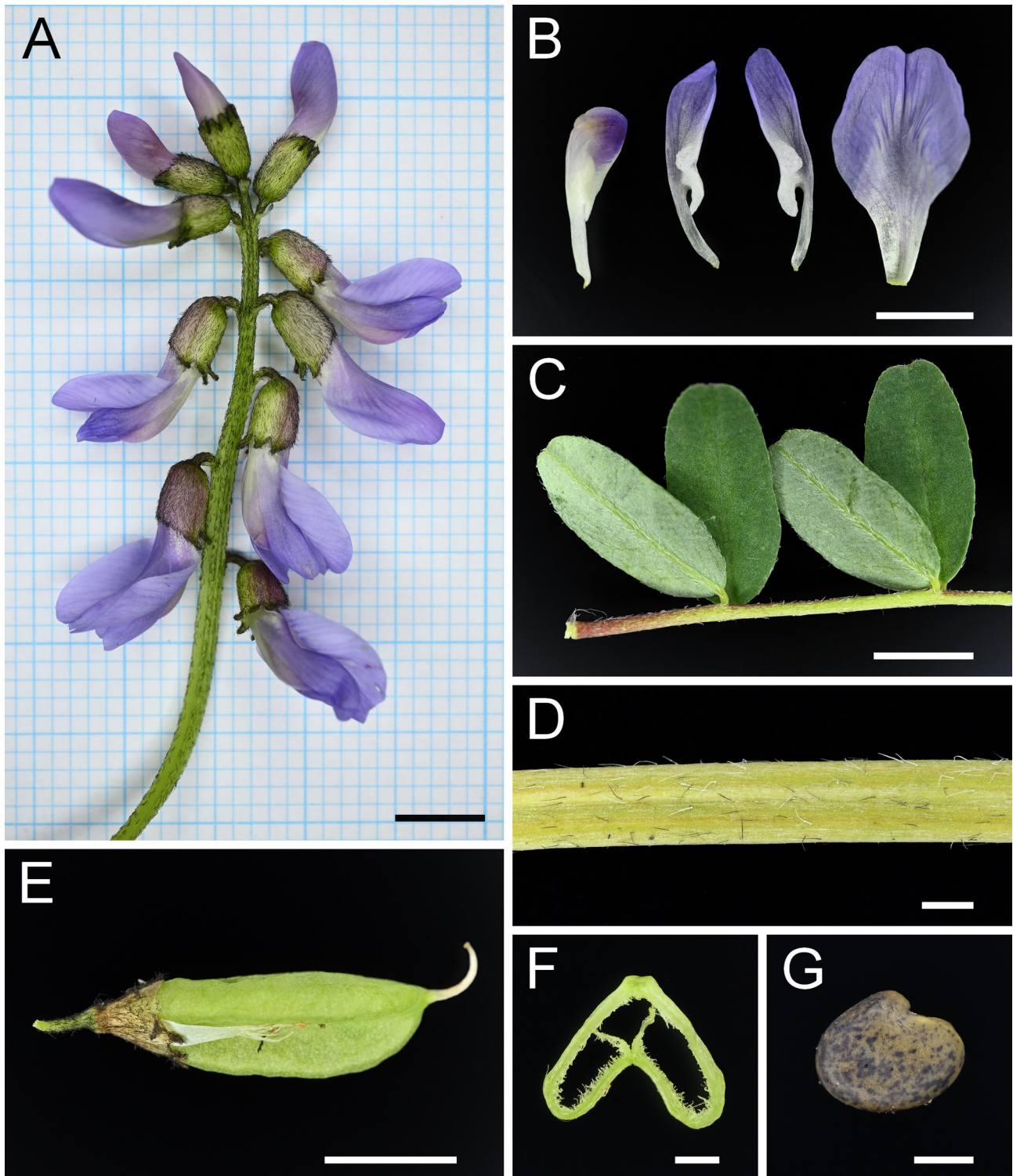


FIGURE 3. Morphology of *Astragalus poroshiriensis* Kimura-Yokoyama & Shutoh, *sp. nov.* **A**, Raceme. **B**, Petals. **C**, Leaflets. **D**, Stem. **E**, Legume. **F**, Cross-section of legume. **G**, Seed. Scale bars are 5 mm (A–C, E) or 1 mm (D, F, G).

TABLE 1. Morphological comparison of *Astragalus poroshiriensis*, *A. sachalinensis*, *A. shiroumaensis*, *A. austrosachalinensis*, *A. sugawarae*, and *A. taipaisihanensis*.

Character	<i>A. poroshiriensis</i>	<i>A. sachalinensis</i>	<i>A. sugawarae</i>	<i>A. austrosachalinensis</i>	<i>A. shiroumaensis</i>	<i>A. taipaisihanensis</i>
Distribution	Hokkaido (Japan)	Sakhalin Island	Sakhalin Island	Moneron Island (Sakhalin)	Honshu (Japan)	China
Stem	white and black	white	white	white and black	white and black	white
Leaflet	8–19	6–10 (–15)	7–15	8–15	10–20	5–20
upper surface	glabrous	Glabrous	sparsely to densely hairy	sparsely hairy	glabrous	glabrous
Peduncle	white and black	white and black	white and black	white and black	white and black	white
length (cm)	9–15 (1.5–2 times longer than leaves)	10–12 (2–3 times longer than leaves)	9–17 (1.5–2 times longer than leaves)	4–10 (1.5–2 times longer than leaves)	5–12	5–7 (often shorter than leaves)
Pedicel	1–2	ca. 1	1–2	2–3	ca. 1.5	2–5
Bract	1–2	ca. 1.5	ca. 1.5	ca. 1	ca. 2	2–5
pubescence	black	black	black	white and black	black	white and black
Calyx	4.5–6	3–4	4–5	4.5–5	ca. 5	5–6
teeth (mm)	1–1.5	ca. 0.5	0.7–0.8	1–1.2	ca. 1	0.5–1
Corolla color	pale lilac	white (with violet veins in standards)	pale yellow	pale lilac	pale yellowish white	violet or rose purple
Legume	glabrous	glabrous	glabrous	sparsely black hairy	sparsely black hairy	glabrous

Note: Only diagnostic traits that distinguish *A. poroshiriensis* from the other listed species are included. Morphological data for the five species other than *A. poroshiriensis* were obtained from taxonomic descriptions in Bunge (1868, 1869), Makino (1906), Ho (1980), Pavlova (1989a, b), Podlech & Zarre (2013), and Kimura-Yokoyama & Shutoh (2025).

The identification key also revealed that *A. taipaihanensis* was generally similar to the Hidaka population. The similar characteristics were as follows: glabrous upper surface of the leaflets and legumes, free stipules, more than 4 pairs of leaflets, and more than 4 mm of the calyx covered with only black hairs. However, the Hidaka population was distinguishable from *A. taipaihanensis* in having stems and petioles with mixed black and white hairs (vs. only white hairs), peduncles 9–15 cm long, 1.5–2 times longer than adjacent leaves and covered with white and black hairs (vs. 5–7 cm long, often shorter than the leaves and with only white hairs), bracts and pedicels 1–2 mm long (vs. 2–5 mm), and pale lilac flowers (vs. violet or rose purple). Furthermore, all *A. taipaihanensis* specimens examined had peduncles shorter than their adjacent leaves, and the racemes were lower than the plant height. This characteristic contrasted with the Hidaka population in which the peduncles were distinctly longer than the adjacent leaves and the racemes were taller than the surrounding leaves.

The Hidaka population showed clear differences from the remaining three morphologically similar species distributed in Japan and Sakhalin Island, namely, *A. sugawarae*, *A. austrosachalinensis*, and *A. shiromaensis*. These morphological differences are summarized in Table 1. The Hidaka population was similar to these three species in having slender and ascending stems, free stipules, leaves with 5–7 pairs of leaflets, loosely capitate racemes with 7–15 flowers, calyx with densely subappressed black hairs, and pendulous legumes with an abaxial groove, but readily distinguishable in flower color, and the presence or absence of hairs on the legumes and leaflets (Table 1). Furthermore, no previously named taxon corresponding to the Hidaka population was detected in a comprehensive comparison with other members of *Astragalus* sect. *Oroboidei* based on the descriptions of Podlech & Zarre (2013) and Welsh (2023).

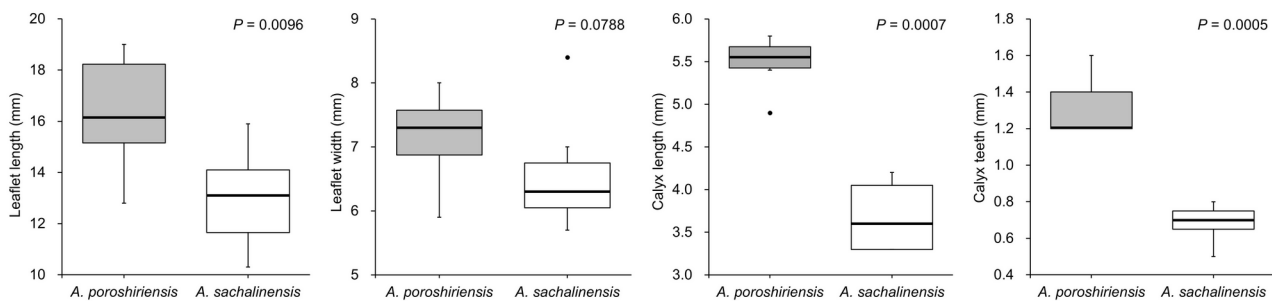


FIGURE 4. Box plots for four quantitative traits in *Astragalus poroshiriensis* and *A. sachalinensis*.

Discussion

In this study, we concluded that the Hidaka population represents an undescribed taxon and describe it as a new species, *Astragalus poroshiriensis*. The most distinctive characteristics of the species are slender and ascending stems, free stipules, 5–7 pairs of leaflets with a glabrous upper surface, loosely capitate racemes with 7–15 flowers, calyx with densely black hairs, pale lilac flowers, and legumes sessile, pendulous, glabrous, narrowly grooved abaxially, and almost 2-locular. The species is clearly distinguishable from five morphologically similar species (*A. sachalinensis*, *A. sugawarae*, *A. austrosachalinensis*, *A. shiromaensis*, and *A. taipaihanensis*) by the following character combination: stems covered with white and black hairs, leaflets 8–19 mm long with the upper surface glabrous, peduncles covered with white and black hairs and 1.5–2 times longer than the adjacent leaves, bracts and pedicels 1–2 mm long and densely covered with black hairs, calyx 4.5–6 mm long and calyx teeth 1–1.5 mm long, pale lilac flowers, and glabrous legumes. It should be noted that we may not cover morphological variations of some similar species, such as *A. austrosachalinensis*, *A. sachalinensis*, *A. sugawarae* completely, because existing herbarium specimens are scarce (Pavlova 1989a, 1989b, Podlech & Zarre 2013, Kimura-Yokoyama & Shutoh 2025). The new species is endemic to limestone cliffs in the Hidaka Mountains, Hokkaido, Japan. The species is currently known from a single locality in the deep interior of the Hidaka Mountains.

The phylogenetic position of *A. poroshiriensis* is unclear, but we speculated that *A. sachalinensis*, *A. sugawarae*, *A. austrosachalinensis*, and *A. shiromaensis* are closely related. Among the five morphologically similar species, these four species collectively exhibit fragmented endemism with restricted distributions and are localized to high elevations or specialized edaphic environments (Ohashi 2001, Pavlova 1989a, Kimura-Yokoyama & Shutoh 2025). The exception is *A. taipaihanensis*, which is endemic to an elevational range of 2400–2900 m in Gansu and Shaanxi, China (Xu & Podlech 2010). We hypothesize that the common ancestor of the aforementioned four species and *A. poroshiriensis* was more widely distributed during cooler glacial periods. Considering the high degree of diversification

and the frequently narrow geographic and ecological endemism of *Astragalus* species (Rundel *et al.* 2015), allopatric speciation promoted by subsequent climatic warming may have occurred with the present-day distributional ranges functioning as isolated refugia, as has been suggested for North American taxa (Jones *et al.* 2021).

Interestingly, *A. sugawarae* is endemic to limestone areas, as is the case for *A. poroshiriensis* (Kimura-Yokoyama & Shutoh 2025). Such habitat-based similarity may suggest their speciation in an isolated, small, allopatric population on limestone outcrops, such as occurred in *Primulina* on limestone karsts of southern China (Gao *et al.* 2015, Wang *et al.* 2017). The other two morphologically similar species, *A. austrosachalinensis* and *A. sachalinensis*, are not limestone tolerant and one, *A. shiroumaensis*, sometimes grows in limestone areas (Ohashi 2001, 2016, Kimura-Yokoyama & Shutoh 2025). It will be interesting to evaluate whether *A. sugawarae* and *A. poroshiriensis* are monophyletic or represent independent, convergent evolution in limestone areas. Further molecular phylogenetic analysis focused on *Astragalus* sect. *Oroboidei* in Far East Asia would reveal such evolutionary traits, but currently such studies cannot progress due to the difficulty of accessing populations and to obtain fresh samples of *A. sugawarae* and several congeners (Kimura-Yokoyama & Shutoh 2025). Our recent discoveries of *A. sugawarae* and *A. poroshiriensis* contribute to the taxonomic coverage of this focal group and will facilitate future phylogenetic, speciation, and biogeographic studies in association with limestone outcrops. *Astragalus* sect. *Oroboidei* in Far East Asia would become an ideal model group to investigate speciation on limestone outcrops in cool-temperate zones.

Taxonomic treatment

Astragalus poroshiriensis Kimura-Yokoyama & Shutoh, *sp. nov.* (Figs. 1, 3)

Type:—JAPAN. Hokkaido Pref.: Hidaka Subpref., Niikappu-gun, Niikappu-cho, Iwashimizu, Lime rock cliff near Mt. Poroshiri, 15 June 2024, O. Kimura-Yokoyama 24392 (holotype: SAPS! [SAPS082182] isotypes: TNS! [TNS VS-1365611], SAPS! [SAPS082183, SAPS082184, SAPS082185, SAPS082186]).

Diagnosis:—*Astragalus poroshiriensis* is distinguishable from *A. austrosachalinensis* (endemic to Moneron Island, Sakhalin) in having leaflets with a glabrous upper surface (vs. densely white hairy), only black hairs on the calyx and bracts (vs. mixed white and black hairs), and glabrous legumes (vs. sparsely black hairy); from *A. sachalinensis* (endemic to Sakhalin Island) it differs in having pale lilac flowers (vs. white with violet veins in standards), mixed black and white hairs on stems (vs. only white hairs), calyx 4.5–6 mm long and calyx teeth 1–1.5 mm long (vs. 3–4 mm and ca. 0.5 mm) and leaflet length 8–19 mm (vs. 6–10(–15) mm); from *A. shiroumaensis* (endemic to Honshu, Japan) in having pale lilac flowers (vs. pale yellowish white) and glabrous legumes (vs. sparsely black hairy); from *A. sugawarae* (endemic to Sakhalin Island) in having pale lilac flowers (vs. pale yellow) and leaflets with a glabrous upper surface (vs. sparsely to densely white hairy); and from *A. taipashanensis* in having stems and petioles with mixed black and white hairs (vs. only white hairs); peduncles covered with white and black hairs and 9–15 cm long, 1.5–2 times longer than adjacent leaves (vs. 5–7 cm long, often shorter than adjacent leaves and only white hairs), pedicels and bracts 1–2 mm long (vs. 2–5 mm) and pale lilac flowers (vs. violet or rose purple).

Description:—Herb, perennial, 35–50 cm tall, loosely hairy. Stems several, slender, ascending to erect, loosely covered with 0.2–0.5 mm subappressed white and black hairs. Leaves 5–9 cm long × 2–4 cm wide, odd-pinnate, sparsely black and white hairy along the axis and petiole; stipules 4–6 mm long, free from petiole and from each other, glabrous or sparsely hairy; leaflets 5–7(–8) pairs, narrowly elliptic to elliptic, 8–19 mm long × 4–8 mm wide, apex slightly emarginate, glabrous on upper surface, loosely covered with 0.2–0.5 mm subappressed white hairs on lower surface and especially conspicuous at the midrib and margins. Peduncles 9–15 cm, 1.5–2 times longer than adjacent leaves, covered with subappressed white and black hairs, loosely on base and densely toward the raceme. Racemes 1.5–4 cm long, loosely capitate, with 7–15 flowers, slightly elongating after flowering; pedicel 1–2 mm long, densely covered with black hairs; bracts triangular, 1–2 mm long, densely covered with black hairs. Calyx campanulate, 4.5–6 mm long, with densely subappressed black hairs; teeth 1.0–1.5 mm long. Petals pale lilac; standard widely elliptic, 11–13 mm long, 6–7 mm wide, broadly and shallowly emarginate; wings 9–10 mm long, blades narrowly oblong, 5–6 × 2–3 mm, auricle ca. 1.5 mm long, claw ca. 4 mm long; keel 7–8 mm long. Legumes sessile, pendulous, narrowly elliptic to elliptic, 8–13 mm long, 4–5 mm wide, triangular in cross-section, membranous, glabrous, slightly carinate adaxially, narrowly grooved abaxially, almost 2-locular. Seeds ca. 2.5 mm long.

Phenology:—Flowering June. Fruiting July to August.

Distribution and habitat:—Known only from the type locality in the Hidaka Mountains, Hokkaido, Japan. The species grows on limestone outcrops under a subarctic climate (ca. 1100 m elev.).

Etymology:—The specific epithet “poroshiriensis” is derived from the name of the type locality, Mt. Poroshiri.

Japanese name:—*Poroshiri-ougi* (nov.).

Conservation status:—The single known population of *A. poroshiriensis* is extremely small, limited to an area within a 40 m radius, with only approximately 20–30 flowering individuals. Accordingly, *A. poroshiriensis* should be classified as Critically Endangered (CR) under Criterion D (Population size estimated to number fewer than 50 mature individuals) of the IUCN Red List Categories and Criteria (IUCN 2024). Furthermore, given that *A. poroshiriensis* is an edaphic specialist strictly dependent on an extremely localized limestone habitat, any habitat alteration would be catastrophic. Although the habitat of *A. poroshiriensis* is located in the Class III Special Zone of the Hidaka Sanmyaku-Erimo Tokachi National Park, the limestone outcrops along the Niikappu River, including the type locality, have been considered for mining operations in past (Suzuki & Matsui 1961). Therefore, *A. poroshiriensis* must be conserved immediately through protection of the limestone outcrops.

The habitat and its surrounding areas appear to maintain natural vegetation without any alien plant species, and the threat from human disturbance is relatively low because of the absence of roads and trails. Furthermore, erosion of the limestone outcrops has not been noted, suggesting that natural disturbance is unlikely to pose a threat.

Additional specimens examined (paratypes):—JAPAN. Hokkaido Pref.: Hidaka Subpref., Niikappu-gun, Niikappu-cho, Iwashimizu, Lime rock cliff near Mt. Poroshiri, 03 July 2024, *O. Kimura-Yokoyama 24393* (SAPS! [SAPS082188]); *ibid.*, 13 June 2025, *K. Shutoh et al. 7500* (SAPS! [SAPS082320, SAPS082321, SAPS082322]).

Key to the species of *Astragalus* sect. *Oroboidei* focused on *A. poroshiriensis*, *sp. nov.*

The following key from Podlech and Zarre (2013) and Kimura-Yokoyama & Shutoh (2025), has been modified to account for *A. poroshiriensis*.

1. Leaflets on upper side hairy (in *A. dutreuilii* and *A. kurgankolensis* only toward the margins) or glabrous with densely white hairy margins2.
- Leaflets on upper side glabrous9.
2. Plants in vegetative parts with flattened, long acuminate white hairs widest near the base; leaflets on upper side glabrous but with densely white hairy margins [S. China]..... *A. nigrodentatus*
- Plants only with thin, thread-like hairs; leaflets on upper side hairy, at least toward the margins.....3.
3. Calyx 6–9 mm long; standard deeply bilobed to forked, often nearly to the middle [W. Iran].....*A. longirostratus*
- Calyx up to 6 mm long; standard rounded to emarginate, never deeply bilobed.....4.
4. Stipules behind the stem distinctly vaginate-connate, often up to the middle or higher up.....
-*A. chateri*, *A. olchonensis*, *A. regestus*, *A. neoassadabadensis*, or *A. facetus*
- Stipules free from each other or rarely the lowest ones very shortly connate.....5.
5. Leaflets in 2–4 pairs6.
- Leaflets in at least 5 pairs7.
6. Leaflets narrowly elliptic, 6–11 × 1–3 mm, on both sides densely hispid; petals pale yellow with purple-tipped keel; standard 10–11 mm [Tadzhikistan].....*A. strizhovae*
- Leaflets elliptic, 7–13 × 3–8 mm, on upper side sparsely hairy; petals pale purple; standard ca. 8 mm [Mongolia, N. China]
..... *A. pavlovii*
7. Stipules up to 3 mm, free; leaflets in 5–7 pairs, 5–9 × 2–3 mm, on upper side hairy only toward the margins; calyx 2–4 mm; petals pale yellow with violet-tipped keel; legumes 7–9 mm long and 3 mm high, glabrous [E. Tadzhikistan] *A. kurgankolensis*
- Stipules 3–7 mm, the lowest ones very shortly connate behind the stem; leaflets in 6–8 pairs, 7–15 × 3–6 mm, on upper side equally sparsely to loosely hairy; calyx 4.5–5 mm; legumes 8–14 × 3.5–7 mm [Sakhalin].....8.
8. Petals pale lilac; calyx and bracts with both black and white hairs; legumes loosely black hairy.....*A. austrosachalinensis*
- Petals pale yellow; calyx and bracts only black hairy; legumes glabrous.....*A. sugawarae*
9. At least the lower stipules behind the stem distinctly vaginate-connate, often high up.....
.....*A. kokandensis*, *A. aflatunensis*, *A. laceratus*, *A. alaschanus*, *A. versicolor*, *A. vallicola*, *A. daqingshanicus*, or *A. sherriffii*
- All stipules free from each other (in *A. clarkeanus* those of lowest leaves sometimes connate).....10.
10. Ovary and legumes hairy.....11.
- Ovary and legumes glabrous17.
11. Standard and wing blades deeply bilobed to forked, often up to the middle; legumes covered with subappressed hairs sitting on little tubercles [W. Iran].....*A. longirostratus*
- Standard and wing blades rounded to emarginate but never deeply lobed; hairs of legumes never with tubercles12.
12. Plants in vegetative parts completely glabrous, rarely (in *A. crassifolius*) sparsely hairy in midrib at leaflet’s underside and margins *A. crassifolius*, *A. luxurians*, or *A. politovii*
- Plants hairy at least at the rachis and leaflet’s underside.....13.
13. Calyx 3–4 mm long; standard 6.5–7 mm long; stems hairy.....*A. caeruleopetalinus* or *A. nangxianensis*
- Calyx at least 5 mm, if only 3–4 mm (in *A. schmakovii*), then stems glabrous14.
14. Stipules 2–3 mm, hairy; leaflets in 9–11 pairs, 5–10 mm; bract 2 mm; like the calyx partly covered with reddish brown hairs [China: Sichuan].....*A. sedaensis*

- Stipules longer, mostly glabrous or very sparsely hairy mainly at the margins; leaflets in 4–9 pairs, often longer; bracts mostly longer, like the calyx covered with white or black hairs 15.
- 15. Stems glabrous (in *A. peterae* and *A. eucosmus* sometimes in upper part very sparsely hairy).....
..... *A. schmakovii*, *A. ohbaensis*, *A. norvegicus*, *A. brachytropis*, *A. peterae*, or *A. eucosmus* 16.
- Stems distinctly black or white and black hairy 16.
- 16. Leaflets 10–20 × 3–7 mm; bracts 2 mm, black hairy at the tip; calyx teeth ca. 1 mm; standard narrowly obovate, 10–14 × 4 mm [Japan] *A. shiroumaensis* 16.
- Leaflets smaller, at most up to 15 mm long and 4.5 mm wide; bracts 3–5 mm, white and black hairy; calyx teeth 1.5–3 mm; standard widely elliptic to widely obovate, 10–11 × 6–7 mm..... *A. clarkeanus*, or *A. latiunguiculatus* 17.
- 17. Leaflets mostly in 3 pairs, sometimes on upper side in some leaves sparsely hairy [Mongolia, N. China] *A. pavlovii* 17.
- Leaflets in at least 4 but mostly in distinctly more pairs (only in *A. ochotensis* leaves with 3–5 pairs), on upper side always glabrous 18.
- 18. Calyx 5–6 mm, loosely to rather densely covered with at least partly spreading, flexuose-tangled white and black hairs [China: Yunnan]..... *A. gongshanensis* 18.
- Calyx mostly distinctly shorter (in *A. taipaihanensis* and *A. poroshiriensis* up to 6 mm) with appressed hair 19.
- 19. Pedicels 2–5 mm, calyx 5–6 mm, teeth 0.5–1 mm, all crowded at the dorsal side *A. taipaihanensis* 19.
- Pedicels up to 3 mm; calyx shorter, up to 5 mm (in *A. poroshiriensis* 4.5–6 mm); teeth not crowded at dorsal side 20.
- 20. Standard 6.5–7 mm; calyx 2–2.5 mm, only in *A. lhorongensis* 3–3.5 mm
..... *A. kongurensis*, *A. dabanshanicus*, *A. lhorongensis*, or *A. puberulus* 21.
- Standard 9–13 mm (unknown in *A. ochotensis*); calyx 3–6 mm, only in *A. macropterus* 2.5–3 mm 21.
- 21. Rhachis and peduncles glabrous; leaflets 8–30 × 3–9 mm [S. Kazakhstan, Kirgizstan] *A. hemiphaca* 21.
- Rachis and peduncles hairy (peduncle in *A. macropterus* rarely glabrous); leaflets distinctly smaller 22.
- 22. Racemes 3–12 cm, loosely many-flowered, elongating toward fruiting time up to 22 cm; calyx 2.5–3 mm, white and predominantly black hairy [Russia-Siberia, Kazakhstan, Kirgizstan, Tadzhikistan, NE. Afghanistan, N. Pakistan, NW India, Mongolia, China]....
..... *A. macropterus* 22.
- Racemes 1–2.5 cm, loosely 8–15-flowered, not elongating or elongating toward fruiting time up to 7 cm; calyx 3–6 mm, black hairy 23.
- 23. Stems appressed hairy; legumes with a stipe 0.5–1.5 mm, not wrinkled 24.
- Stems glabrous or with scattered hairs only; legumes transversely wrinkled 25.
- 24. Stems white hairy; leaflets 6–10 × 3–6 mm; petals white with violet veins in standards; calyx 3–4 mm; calyx teeth ca. 0.5 mm.....
..... *A. sachalinensis* 24.
- Stems white and black hairy; leaflets 8–19 × 4–8 mm; petals pale lilac; calyx 4.5–6 mm; calyx teeth 1–1.5 mm
..... *A. poroshiriensis* 25.
- 25. Leaflets in 5–8 pairs, 6–8 × 3–4 mm; petals pale violet, keel black-violet; wing blades bilobed; legumes sessile [Russian Far East].....
..... *A. vallicoides* 25.
- Leaflets in 3–5 pairs, in main stem 10–20 × 7–13 mm; petals unknown; legumes with a stipe 2–3 mm [Russian Far East]
..... *A. ochotensis* 25.

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Appendix. Specimens of other morphologically similar *Astragalus* species examined.

Astragalus austrosachalinensis:—**Todomoshiri or Kaiba [Moneron] Island**, 24 May 1925, *Shigezo Sugawara s.n.* (SAPS!); Minami-kotan, 19 July 1931, *Murayama s.n.* (SAPS!).

Astragalus sachalinensis:—**RUSSIA. Sakhalin Island**, Agnevo, *F. Schmidt s.n.* (P image! [P00623255]: Lectotype designated by Podlech & Sytin 1996); Aleksandrovsk-Sakhalinsky, Agnevo settlement, rocks on the banks of the Agnevo River, 14 July 1978, *N. Pavlova s.n.* (H image! [H1481999], K image! [K003688680], L image! [L.1960745], MW image! [MW0101587], NMNH image! [NMNH02038741], P image! [P03203462], PE image! [PE00187231]).

Astragalus shiroumaensis:—**JAPAN. Mt. Shiroumadake**, August 1903, *Yonezaburoh Yazawa s.n.* (SAPS!); *ibid.*, 23 August 1905, *Hisayoshi Takeda s.n.* (SAPS! [SAPS025852]); *ibid.*, 21 August 1905, *Hisayoshi Takeda s.n.* (SAPS! [SAPS025853, SAPS025854]); *ibid.*, 12 August 1904, *Haruzo Komatsu s.n.* (SAPS!).

Astragalus sugawarae:—**Sakhalin Island**, Siska Branch, the middle reaches of Asase River [Merkaya River], 6 August 1935, *S. Sugawara 13622* (SAPT!); *S. Sugawara 28926* (SAPS! [SAPS078999]); *S. Sugawara 28929* (SAPS! [SAPS079000]); *S. Sugawara s.n.* (Hakodate City Museum image! [06074]).

Astragalus taipaishanensis:—**CHINA. Gansu**: Xiahe, 3 July 1937, *T.P. Wang 6991* (PE image! [PE00187856]); **Shaanxi**: Taipaishan, near Pingansze, 2700 m, 3 August 1933, *T.P. Wang 1690* (PE image! [PE00187857]); Taipaishan, on way from Tatien to Pinganszu, 6 September 1937, *T.N. Liou & P.C. Tsoong 658* (WUK image! [WUK0027387]); Taipaishan, on way from Tatien to Toumukung, 18 July 1938, *T.N. Liou & P.C. Tsoong 2291* (KUN image! [KUN0600619], PE image! [PE00187855, PE00278917]); 1955, *S.Z. Gao s.n.* (PE image! [PE00279148]); Taipaishan, Fangyangsi, 7 August 1956, *K.J. Fu 8464* (KUN image! [KUN0600618], WUK image! [WUK0359268]); Taipaishan, Doumugong, 26 July 1956, *Qinling Survey Team 344* (WUK image! [WUK0093195]); Taipaishan, Baiyun gorge, 9 July 1957, *K.J. Fu 9399* (WUK image! [WUK0171504]); Shaanxi, Mt. Taipaishan, Doumugong, 6 June 1959, *K.X. Yang 820* (WUK image! [WUK0131864]); Taipaishan, Mingxingsi, 9 June 1959, *K.X. Yang 880* (PE image! [PE00278421], WUK image! [WUK0131761, WUK0409870]); Taipaishan, Ping'ansi, 12 June 1959, *K.X. Yang 576* (PE image! [PE00278423]: isotype?, WUK image! [WUK0409414]: holotype?); Taipaishan, Ping'ansi, 23 June 1960, *C.S. Yang 3149* (PE image! [PE00279383]); Taipaishan, Ping'ansi, 21 July 1963, *Y.M. Liang 206* (WUK image! [WUK0218343, WUK0357665]); Taipaishan, Doumugong, 21 June 1970, *Shaanxi Medicinal Herb Survey Team 299* (WUK image! [WUK0284208]); Taipaishan, Doumugong, 21 June 1970, *Shaanxi Medicinal Herb Survey Team 281* (WUK image! [WUK0284211, WUK0481374]); Taipaishan, on way from Fangyangsi to Mingxingsi, 11 August 1977, *Y.H. Gao & Z.X. Hu 526* (WUK image! [WUK0345373]); Zhouzhi, Taibeishan, Houzhingzhi, 9 July 1999, *Zhu et al. 1460* (PE image! [PE00460978]); Zhouzhi, Taibeishan, Houzhingzhi, 25 July 1999, *Zhu et al. 1674* (PE image! [PE00460977]).



Supplementary FIGURE S1. Holotype of *Astragalus poroshiriensis* Kimura-Yokoyama & Shutoh, *sp. nov.* To protect the population, the latitudinal and longitudinal coordinates are concealed.