

***PEDICULARIS BHUTANICA* (OROBANCHACEAE), A NEW SPECIES FROM BHUTAN**

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A new species, *Pedicularis bhutanica*, is described from the Dagala region in Thimphu district, Bhutan. Discovered along well-used trekking routes, this species is morphologically distinct from its closest congeners, *Pedicularis heydei* Prain, known from India, Nepal and Bhutan, and *P. pheulpinii* Bonati, from China, by the absence of basal leaves, specific stem indumentum patterns, and distinctive features of its leaves, bracts, calyx, lower corolla lip and capsules. Phylogenetic analysis of ITS sequence data supports the recognition of this new species. It is assessed as Critically Endangered (CR) under IUCN Criterion B.

Keywords. Critically Endangered, Dagala, integrative taxonomy, internal transcribed spacer (ITS), *Pedicularis bhutanica* sp. nov.

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Introduction

Pedicularis L. (Orobanchaceae) is a large genus of flowering plants, comprising an estimated 722 species, 391 synonyms and 62 unresolved names (WFO, 2025). These plants are hemiparasites, capable of photosynthesis but also obtaining water and nutrients by attaching to the roots of nearby host plants (Heide-Jørgensen, 2008). The genus is widely distributed across the Northern Hemisphere, inhabiting arctic, alpine and temperate regions. Its greatest species diversity is in the Himalaya–Hengduan Mountains (Prain, 1890; Li, 1948, 1949; Ree, 2001), a globally recognised biodiversity hotspot (Myers, 1988), where more than 350 species occur, with about 75% endemism (Yu et al., 2015).

Pedicularis in Bhutan remain comparatively underexplored and understudied. The treatment of *Pedicularis* in the *Flora of Pan-Himalaya* (Yang, 2024) includes species found in Bhutan, with descriptions largely drawn from earlier treatments, particularly Mill's accounts in the *Flora of Bhutan* (Mill, 2001). However, this treatment is incomplete; to date, it covers

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only the species with alternate leaves, representing 48 of 76 species of *Pedicularis* recorded in the *Flora of Bhutan*.

Accurate species delimitation is essential for conservation planning, particularly in Bhutan's fragile alpine and subalpine habitats, where many *Pedicularis* taxa are narrow endemics. In Bhutan, 70 taxa of *Pedicularis* are currently recorded, including four subspecies and four varieties and 26 putative endemic species (Mill, 2001; Yamazaki, 2003; Mill, 2011; Yangzom & Long, 2015). Many of these taxa remain poorly understood or taxonomically unresolved. Several are known only from their type specimens and a single type locality.

Here, using an integrative taxonomic approach, we describe a species of *Pedicularis* that is new to science from Bhutan's Dagala region (Thimphu district) (Dayrat, 2005; Pante et al., 2015; Bocanegra-González et al., 2025). Our findings are based on new field collections and existing herbarium specimens from three known distinct populations. We present detailed morphological comparisons of allied taxa and phylogenetic analyses of nuclear ribosomal internal transcribed spacer (ITS) sequence data. All known populations of the new species occur along the heavily used Dagala trekking route, where habitat disturbance from tourism poses a growing threat. Clarifying its taxonomy is therefore not only a scientific priority but also a conservation imperative. Accordingly, this study provides an IUCN Red List assessment to evaluate the species' conservation status and guide future monitoring and management efforts.

Materials and methods

Field collections

A botanical expedition was undertaken in Bhutan's Dagala region, known as the Trek of a Thousand Lakes. Thirty-four individuals of the putative new species were collected in August 2024 at three sites along the trail: below Pagala Pass, at 4192 m; on Pagala pass, at 4204 m; and at Labachung (4287 m) on west-facing alpine slopes (Figure 1). Voucher specimens were prepared and are deposited at E, K, NE and THIM (herbarium codes follow Index Herbariorum, updated continuously). Field collections were conducted under Permit No. 838956, issued on 15 April 2024 by the Department of Forests and Park Services, Ministry of Energy and Natural Resources, Royal Government of Bhutan.

Morphological analysis

Morphological characteristics were measured manually using ImageJ Win64 version 1.54p (Rueden et al., 2017). Floral and fruit dissections were carried out and photographed under a Nikon SMZ25 stereomicroscope (Nikon, Tokyo, Japan) to document diagnostic features. For comparative analysis, *Pedicularis heydei* Prain was examined from specimens collected in Bhutan by Georg and Sabine Miehe between July and September 2000 (collection numbers 00-188-18 and 00-374-11) at Bontela and Gophula, supplemented with specimen images

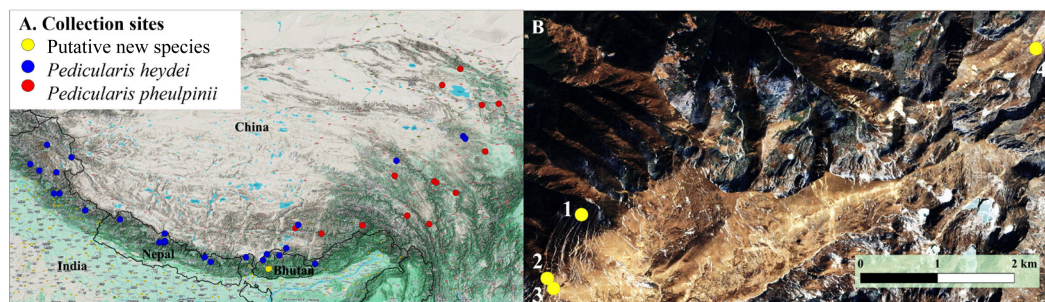


Figure 1. A, Known distribution of the putative new species of *Pedicularis* (yellow) and its close relatives *P. heydei* (blue) and *P. pheulpinii* (red), across the Hengduan region of the Himalayas. B, Localised distribution of the putative new species of *Pedicularis* within Bhutan, showing three populations: 1, below Pagala Pass; 2 and 3 (combined), Pagala Pass proper; and 4, Labachung in the Dagala region, Thimphu.

obtained from CAL, E and K. *Pedicularis pheulpinii* Bonati was studied exclusively through digital images available from the Chinese Virtual Herbarium (<https://www.cvh.ac.cn/>), the Chinese Field Herbarium (<https://www.cfh.ac.cn/>), the website of the Biodiversity of Hengduan Mountains (<https://www.hengduan-biodiversity.net/fieldnotes>) and the Museum National d'Histoire Naturelle, Paris (<https://www.mnhn.fr/en/vascular-plants-collection>). The morphological comparisons using high-resolution images were sufficient, as they allowed assessment of all diagnostic characters, such as the shape and serration of bracts, structure of lower corolla lip, shapes of leaves, and presence or absence of indumentum.

Collection locations of *Pedicularis heydei* and *P. pheulpinii* specimens were mapped with sampling locations of the putative new species in QGIS version 3.44.3. [Supplementary file 1](#) provides a list of all specimens and images examined in the morphological analysis. *Pedicularis heydei* is primarily known from the Indian and Nepalese Himalayas, although five specimens (comprising more than 24 individuals) from China, housed at E and K herbaria, have been identified as *P. heydei*; the species has also been recently recorded from Bhutan. *Pedicularis pheulpinii* appears to be restricted to China, whereas the *Pedicularis* species newly described below is endemic to Bhutan. Populations were defined as distinct using a 1000 m straight-line distance threshold; 2 and 3 were treated as a single population because they occur below this threshold.

DNA extraction, amplification and sequencing

Six samples of the putative new species were used for DNA extraction, representing all known sites of occurrence. It included three putative populations separated by at least 1000 m ([Figure 1](#)). Total DNA was isolated from silica gel-dried leaf tissues of freshly collected specimens using the CTAB extraction method (Doyle & Doyle, 1987). The ITS region, including the ITS1 and ITS2 spacer regions and the 5.8S rRNA gene, was reported as

the most effective single-region barcode for *Pedicularis* (Yu et al., 2011; Wu et al., 2025) and thus examined in this study.

The ITS region was amplified using PCR with primers ITS4 and ITS5 (White et al., 1990). PCR was performed in a volume of 25 µL containing about 10 ng of genomic DNA, 1 unit of GoTaq Green Master Mix (Promega) and 0.4 µM of each primer. The PCR cycle was as follows: 1 cycle at 94°C for 3 min, followed by 35 cycles of 94°C for 45 s, 53°C for 1 min, and 72°C for 1 min, with a final extension at 72°C for 5 min. The PCR products were purified with shrimp alkaline phosphatase and exonuclease I (Promega, Madison, Wisconsin, USA) and used as templates for cycle sequencing reactions with the same primers. Direct sequencing was performed according to the manufacturer's protocol on an ABI Prism 3130 DNA analyser (Applied Biosystems, Foster City, California, USA).

Phylogenetic analysis

Raw sequences of the new species were assembled and edited in Unipro UGENE version 52.0 (Okonechnikov et al., 2012). Additional taxon sampling was based on the phylogenetic framework of Ree (2001), Tkach et al. (2014) and Yu et al. (2015), and included all members of their Subclade 1A (11 taxa), Subclade 1B (20 taxa) and Subclade 1C (27 taxa). Because previous studies indicated that series *Brevifoliae* is paraphyletic and closely associated with these subclades, we also sampled available sequences for three of its taxa (*Pedicularis alopecuroides* Franch. ex Maxim., *P. smithiana* Bonati and *P. verbenifolia* Franch. ex Maxim.). To complement this and clarify the morphological boundaries of the group, *Pedicularis brevifolia* Don was included in a detailed morphological comparison, despite currently lacking available molecular data.

The dataset also included sequences of three outgroup taxa: *Aureolaria pedicularia* (L.) Raf. ex Farw., *Brachystigma wrightii* (A.Gray) Pennell and *Phtheirospermum japonicum* (Thunb.) Kanitz. A list of ITS sequence accessions with GenBank numbers used in phylogenetic analysis is provided in [Supplementary file 2](#). Sequence alignments were subset with R version 4.4.0. (R Core Team, 2025), aligned using MUSCLE (Edgar, 2004) and manually refined in Unipro UGENE. Phylogenies were inferred from the aligned sequence matrix using IQ-TREE version 3.0.1. (Wong et al., 2025). Model Finder Plus (MFP; Kalyaanamoorthy et al., 2017) was used to select the best-fit substitution model, which was identified as GTR+I+G4. Branch support was assessed with 1000 standard, non-parametric standard Felsenstein bootstrap support (SBS; Felsenstein, 1985) replicates and 1000 SH-aLRT replicates (Guindon et al., 2010). To ensure clarity, only branches with support values $\geq 50\%$ in both SH-aLRT and SBS were retained in the final phylogeny. The resulting phylogenetic trees were visualised and inspected using FigTree version 1.4.4. (Rambaut, 2018).

Conservation assessment

The conservation status of the new species was assessed according to the *IUCN Red List Categories and Criteria* version 3.1 (IUCN, 2012). Extent of Occurrence and Area of Occupancy were calculated using the Geospatial Conservation Assessment Tool, GeoCAT (Bachman et al., 2011). Distribution maps were created using QGIS version 3.44.3 (Figure 1A).

Results

Morphological examination revealed that the putative new species shares certain traits with *Pedicularis heydei* and *P. pheulpinii*; however, it is readily distinguishable by its unique combinations of root structures, stem indumentum, flower, and leaf and calyx features. Measurements and dissections highlighted clear differences in stem indumentum, leaf and calyx shapes.

The maximum-likelihood phylogeny (Figure 2) produced from analysis of all members of Subclade 1B, as well as representatives from Subclades 1A and 1C within Clade 1 (Ree, 2001, 2005; Tkach et al., 2014; Yu et al., 2015), resolved the putative new species as a strongly supported monophyletic lineage (100% SH-aLRT/100% SBS), sister to a robustly supported clade comprising *Pedicularis pheulpinii* and *P. heydei* (91.6/95), confirming their close evolutionary relationship and its status as a species new to science. These sister groups form a clade clearly separated from other species of *Pedicularis* (99.9/100).

Taxonomic treatment

***Pedicularis bhutanica* R.Yangzom & P.Kuss, sp. nov.**

Pedicularis bhutanica is morphologically similar to *P. heydei* (India, Nepal and Bhutan) and *P. pheulpinii* (China) in its leaf and flower arrangements but can be readily distinguished from these two species by its stem indumentum of white villous hairs arranged in two rows (vs uniformly greyish white, subdensely crisped, spreading hairs), fibrous root system (vs fleshy, fascicled, fusiform roots), lack of basal leaves (vs presence), cauline leaves that are sessile to slightly auriculate at base (vs consistently sessile), bracts leaf-like and lanceolate-trullate (vs palmatilobate or broadly ovate and deeply lobed), corolla pale purple with a white throat and a deep purple beak (vs uniformly purple or reddish), lower lip ovate to cordate (vs orbicular) in outline, with a narrow, spatulate mid-lobe that projects outwards, a broadly ovate capsule with an acute apex and either as long as or slightly longer than the calyx (vs ovate capsule with a slightly acuminate apex that is typically shorter, less than half the length of the calyx). – Type: Bhutan, Thimphu, Dagala region, near Pagala Pass, sandy rocky slope in *Rhododendron* scrub, 4192 m a.s.l., 27°15'30"N, 89°38'56"E, 4 viii 2024 (fl.), Rinchen Yangzom & Choki Wangmo, R. Yangzom 2033 (holotype THIM; isotypes E, NE, THIM). Figures 3, 4, 5.

Annual herb with roots divided into two or three rootlets, fibrous. *Stem* 6–20 cm, slender, ascending, erect or decumbent, with lines of white villous hairs. *Leaves* all cauline, opposite, sessile, adaxially sparingly villous, abaxially glabrous, lanceolate in outline on lower stem to trullate on mid-stem, 7–23 × 2–4 mm, base cuneate to slightly auriculate, pinnatisect with 5–15 pairs of segments, 0.3–2 mm, subopposite, margins dentate and recurved. *Inflorescence* a terminal spike or short-pedicellate raceme, up to 11 flowers, opening acropetally. *Bracts* leaf-like, ovate, sessile, (5–)9–14 mm, base cuneate to auriculate, apex acuminate, as long as calyx or slightly longer; adaxially ciliate, abaxially glabrous; margin dentate, recurved. *Pedicels* 1.5–2.5 mm, glabrous. *Calyx* green with prominent dark purple, parallel ribs, tubular, 8.5–9.5 × 0.7–2.5 mm, villous on the upper internal surface and along external ribs, lacking anterior split; teeth 5, nearly equal, triangular 1.5–3.0 mm; margin recurved, dentate, acute. *Corolla* tube pale purple, straight, 10–14 mm, equal or longer than the calyx, puberulent; lower lip 3-fid, pale purple with white throat, c.8–9 mm, outspread, ovate or cordate outline, margin entire, glabrous; middle lobe narrow, spatulate, flat or folded, protruding, 2.5–3.0 × 2.0–2.5 mm, apex emarginate; lateral lobes equal in size, rounded, c.3–3.5 mm, ovate, emarginate or entire, glabrous; galea dark wine-red underside with pale upper part tapered distally into deep purple beak, bent at right angle, subinflated, glabrous; beak 5–7 mm, truncate and dilated at apex with stigma exerted. *Stamens* inserted at the middle or above the middle of tube; filaments all glabrous; anther ellipsoid, c.7–9 mm. *Stigma* exerted at maturity. *Capsule* broadly ovate, apex acute, as long as or slightly longer than the calyx. *Seeds* numerous, cream, ovate, distinctly reticulate c.1.0 × 2.0 mm.

Distribution. Bhutan, Thimphu district, Dagala region, below Pagala Pass, Pagala Pass, Labachung.

Habitat and ecology. Growing in sandy, rocky soils on open alpine slopes at elevations ranging between 4115 and 4400 m, within alpine scrub with *Rhododendron*. Associated species include *Anaphalis nepalensis* (Spreng.) Hand.-Mazz., *Bistorta vacciniifolia* (Wall. ex Meisn.) Greene, *Cassiope* sp., *Dasiphora arbuscula* (D.Don) Soják, *Geranium* sp., *Rhodiola* sp., *Rhododendron anthopogon* D.Don, *R. setosum* D.Don and *Rubus* sp., and various alpine grasses (Figure 3E). Flowering was observed during August across three separate field visits. While no fruiting individuals were observed during recent expeditions, a historical specimen collected on 8 August 1989 bore mature fruit (Figure 5B).

Etymology. The specific epithet *bhutanica* honours Bhutan, the country of origin of the species.

Proposed IUCN conservation category. All three known populations of the new species were found immediately adjacent to trekking trails (as shown in Figure 3E). The popularity of these routes places the species at high risk of habitat disturbance from human activity. Potential threats include trail widening, trampling by trekkers, and the use of ponies for



Figure 2. Phylogram inferred from the maximum-likelihood analysis using IQ-TREE under the GTR+I+G4 substitution model (selected by Model Finder Plus, MFP). The analysis is based on all members of Subclades 1B, 1A and 1C within Clade 1. The putative new species of *Pedicularis* is in red. Branch labels indicate SH-aLRT and standard bootstrap support (with only branches supported by SBS $\geq$ 50% threshold shown).

transporting supplies. These activities contribute to soil compaction, reduced vegetation cover, and disturbance to associated host plants, collectively threatening the survival and reproductive success of the species. Based on the IUCN *Red List Categories and Criteria* version 3.1 (IUCN, 2012), *Pedicularis bhutanica* is assessed as Critically Endangered (CR) under Criterion B. Given its critical conservation status, monitoring and the implementation of effective habitat management strategies are urgently recommended to mitigate human impacts and ensure the long-term persistence of the species in its natural environment.



Figure 3. Morphology and habitat of *Pedicularis bhutanica* R.Yangzom & P.Kuss, sp. nov. A, Habit; B, uprooted individual, showing fibrous roots; C, two distinct rows of white villous hairs on the stem and slightly auriculate leaf base and recurved margins; D, close-up photograph of a flower, showing galea with a deep-purple beak and prominent ovate-cordate lower corolla lip with a narrow, protruding middle lobe; E, alpine habitat with a population (indicated by the arrow) along a trail on a west-facing slope (4192 m). Photographs: R. Yangzom.

The calculated Extent of Occurrence of 2.798 km² is well below the 100 km² threshold required for the category of Critically Endangered. The species also meets subcriteria B1a, namely very restricted number of locations, with only three known populations, and B1b(iii), continuing decline in habitat quality due to the ongoing human activity along the trails. Thus, the assignment of Critically Endangered (CR) status under Criterion B is strongly supported.

Notes. The absence of basal leaves is unlikely to be an effect of age, stage or condition, as no specimens showed persistent basal leaves, regardless of season, size or condition. A morphological comparison with closely related species is provided in the [Table](#) below.

Additional specimens examined. BHUTAN. Thimphu, between Pagala & Lawgu (Daga-Thimphu), 4400 m, quite frequent on open well-drained moorland slopes, 8 viii 1989, J.R.Wood 7072 (E00645588, THIM07718); Thimphu, Dagala, 4115 m, open slope, 1 viii 2019, R. Yangzom & C. Wangmo 1277 (THIM19301); Thimphu, Dagala, 4224 m, open slope, 1 viii 2019, R. Yangzom & C. Wangmo 1282 (THIM19302); Thimphu, Dagala region, near Pagala Pass, on an open grassy slope, 4205 m a.s.l., 27°15'25"N, 89°38'59"E, 4 viii 2024 (fl.), Rinchen Yangzom & Choki Wangmo, R. Yangzom 2037 (THIM);

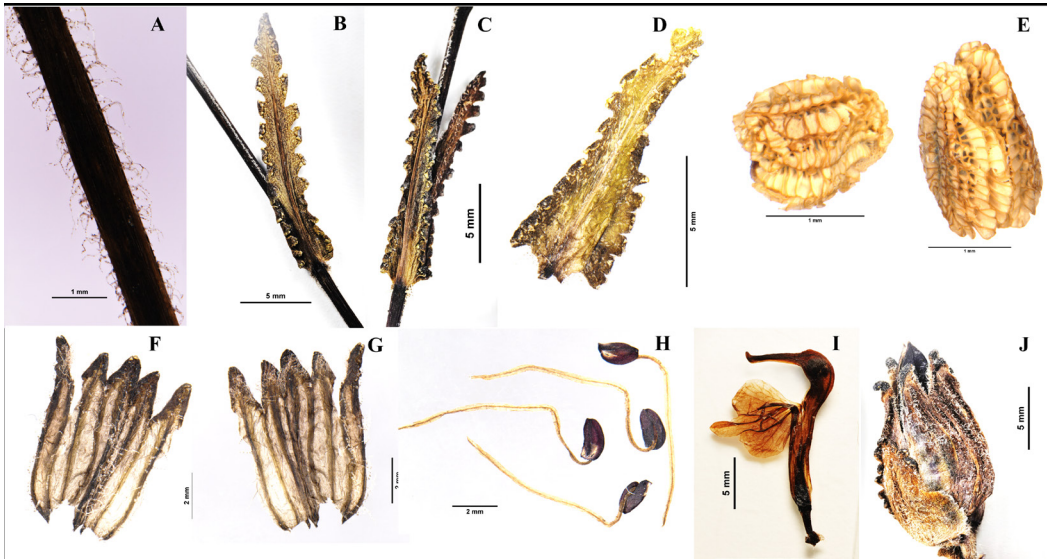


Figure 4. Key morphological features of *Pedicularis bhutanica* R.Yangzom & P.Kuss, sp. nov. A, Stem hairs arranged in two rows; B, leaf with recurved lobes and dentate margins, and a clear line of white villous hairs on the stem; C, leaf base, sessile and trullate; D, bract – leaf-like, ovate shape with a sessile, cuneate to auriculate base, ciliate, with an acuminate apex and recurved lobes; E, seeds – ovate, cream-coloured, and with a distinctly reticulate surface; F, calyx with villous hairs on outer surface and along veins, calyx teeth dentate, nearly equally triangular (revolute in fresh material); G, calyx with villous hairs on inner upper surface; H, filaments, glabrous and ovate anthers; I, galea with a straight or slightly bent beak and a truncate apex, lower lip ovate in outline with a protruding, narrow, spatulate mid lobe; J, capsule – ovate, with a length almost equal to the calyx. Photographs: R. Yangzom.

Thimphu, Dagala region Labachung, open *Rhododendron* scrub, 4287 m a.s.l., 27°17'18"N, 89°42'47"E, 5 viii 2024 (fl.), Rinchin Yangzom & Choki Wangmo, R. Yangzom 2049 (K, NE, THIM).

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Figure 5. A, Holotype of *Pedicularis bhutanica*: R. Yangzom 2033 (THIM). B, The only known specimen with matured capsules (Wood 7074, THIM07718). Photographs: R. Yangzom.

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Supplemental material

Supplementary material is available from the *Edinburgh Journal of Botany* online portal.

Supplementary file 1. List of specimens and images examined for morphological comparison of *Pedicularis bhutanica* sp. nov., *P. brevifolia* Don., *P. heydei* Prain and *P. pheulpinii* Bonati. Data were used to generate a distribution map for the three species *Pedicularis bhutanica* sp. nov., *P. heydei* Prain and *P. pheulpinii* Bonati.

Supplementary file 2. List of ITS sequence accessions (with GenBank numbers) used in phylogenetic analysis.

Table. Key diagnostic characteristics distinguishing *Pedicularis bhutanica* sp. nov., from its closest relatives, *P. brevifolia* Don, *P. heydei* Prain and *P. pheulpinii* Bonati.^a

Character	<i>P. bhutanica</i> sp. nov.	<i>P. brevifolia</i> Don	<i>P. heydei</i> Prain	<i>P. pheulpinii</i> Bonati
Stem indumentum	White villous hairs, in two rows	Villous	Villous	Very hairy
Petiole size	Absent	5–10 mm ^b	30 mm	10 mm
Basal leaf	Absent	Tufted, eventually withering ^b	Tufted, long petiolate	Whorled, petiolate, numerous (10–20), 20 mm long, pinnately lobed
Cauline leaf shape	Lower cauline leaves lanceolate, mid-upper petiolate, pinnatifid	Lanceolate or ovate ^b , deeply pinnatifid	Lanceolate, acute, pinnatifid	Lanceolate-acute, pinnatisect
Cauline leaf arrangement	Opposite	Whorls of 2–4	Opposite	Opposite
Leaf indumentum	Springily villous adaxially, glabrous abaxially	Villous on both sides	All shortly pubescent	Ciliate
Leaf base (mid leaf)	Cuneate to slightly auriculate	Not noted	Attenuate	Slightly cordate
Inflorescence	Terminal spike or short-pedicellate raceme, up to 11 flowers	Flowers in clusters of four, sessile, whorled spikes	Flower subspicate, whorled, verticillate clusters, upper most compact	Spicate with few flowers, spike interrupted at the base, slightly curved at apex
Bract shape	Leaf-like, ovate, apex acuminate, base cuneate to auriculate	Foliar, shortly petiolate, becoming crowded above, the uppermost sessile ^b	Oblong	Palmatilobate, tapering at base, upper ones trifid
Bract size relative	As long as calyx or slightly longer	Shorter than calyx ^c	Shorter than calyx	Not noted
Bract base	Cuneate to auriculate, sessile	Short-stalked or sessile ^b	Attenuate	Attenuate
Calyx indumentum	Villous on upper part within and along veins on outer surface	Densely long-pilose ^b	Densely villous	Woolly
Calyx lobe	Nearly equal triangular teeth, ovate	Two upper ones larger, with the smallest ones interspersed	All teeth nearly equal, base broad, lanceolate	Ovate, acute of four larger, slightly lobed, with obtuse lobules, fifth lobe lanceolate
Calyx margins	Recurved, dentate, acute	Crested or dentate	Crenulate	Entire, woolly
Corolla colour	Pale purple with white throat and deep-purple beak	Purple	Red	Purple
Corolla tube size (relative)	Equal or longer than calyx	One and a half times as long as the calyx ^b	More than one and a half times the length of calyx	Almost twice the length of calyx
Beak apex	Truncate, dilated at apex	Truncated, emarginate	Acute	Not noted
Lower lip size (relative)	As long as galea or slightly longer	As long as or longer than galea ^c	Small or shorter than galea ^d	Shorter than galea ^e
Lower lip lobe	Ovate to cordate outline	Rounded	Semirotund, equal ^f	Rounded outline
Lower lip middle lobe shape	Narrow, spatulate, projecting out	Orbicular, slightly broader ^b	Equal	Broadly triangular-ovate, much projecting ^f
Capsules	Broadly ovate	Ovate ^b	Ovate	Lanceolate
Capsule apex	Acute	Obliquely acuminate ^b	Slightly acuminate, barely oblique	Acute
Capsule size (relative)	Slightly longer or as long as the calyx	Half as long as the calyx ^b	More than half the length of calyx	Barely twice the length of the calyx
Seed size	c. 1.0 × 2.0 mm	1.25 × 0.75 mm ^b	Not noted	Not noted

^a Terminology follows Beentje (2016). The bract base of *Pedicularis heydei* is described as *attenuate* based on observations, and the middle lobe of the lower lip of *P. heydei* is noted as *equal*, consistent with both examined specimens and Prain's (1889) illustration of floral parts on the holotype.

^b Prain's description of *Pedicularis brevifolia* (1889), based on 22 specimens from three locations in India.

^c Yamazaki's description of *Pedicularis brevifolia* (Yamazaki, 1988), based on the specimens from Nepal.

^d Small or shorter than galea: Prain (1889) described the lower corolla lip as small in the protologue of *Pedicularis heydei* and sometimes indicated in the main text (Prain, 1890) that it is "shorter than the galea". However, this appears to be an artefact of drying visible on some, but not all, flowers of the holotype material (i.e. mounted individuals and flowers inside capsule; CAL0000018966).

^e Prain (1889) clearly described the lower lip lobe of *Pedicularis heydei* as "semicircular, equal", whereas Bonati (1908) referred to the lower lip of the species as "polygonal" in outline.

^f Yang et al. (1998; *Flora of China*).

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