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Petrocosmea purpureomaculata sp. nov. and *P. wui* sp. nov. (Gesneriaceae) from Yunnan, China with additions to *P. coerulea* and *P. parryorum*

Meng-Qi Han, Ji-Dong Ya, Chao-Qun Li and Jie Cai

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Two new species of *Petrocosmea* (Gesneriaceae), *P. purpureomaculata* M.Q. Han, J. Cai & J. D. Ya from Jinping County and *P. wui* M.Q. Han, J. Cai & J. D. Ya from Eshan County, Yunnan Province, China, are described and illustrated. *Petrocosmea wui* was previously misidentified as *P. coerulea* due to its shield-shaped leaf base, but can be distinguished by several salient characters. *Petrocosmea purpureomaculata* is most similar to but distinguishable from *P. parryorum*. Additions and revisions of previously published descriptions of *P. coerulea* and *P. parryorum*, are also provided.

Keywords: Flora of Yunnan, Karst habitats, marlstone, *Petrocosmea coerulea*, *P. parryorum*

Introduction

Petrocosmea Oliv. (1887, p. 1716) is a genus currently with a total of about 60 species belonging to Gesneriaceae subfam. Didymocarpoideae (Weber et al. 2013, Jiang et al. 2020). They are mainly distributed in the South China Karst Region, with the richest diversity on the Yunnan-Guizhou Plateau and its extension areas, but traces of them have also been found in northeastern India and northern Myanmar, Thailand, Laos and Vietnam (Burtt 2001, Middleton and Triboun 2010, Qiu et al. 2015, Tran et al. 2020). Since the second revision in 1985, nearly 30 new species of this genus have been published (Wang 1985, Han 2018, Jiang et al. 2020). However, the boundaries of the genus have not changed after research based on molecular and morphological data (Qiu et al. 2015). Still, although some issues have been clarified, there are some obvious inconsistencies between names and reality in this genus (Han et al. 2017, 2018, 2019). For example, *P. parryorum* C.E.C. Fisch. (1926, p. 438) is a species that was originally discovered in India and is distributed also in Myanmar, but has been thought to be distributed in China as well (Li 1983, Wang 1985, Han 2018).

Relying on the information exchanged with many local nature observers and the field investigations of other scientific researchers, we got field distribution information

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of several suspicious taxa related to *P. parryorum*. We went to the sites in the spring and summer of 2020 to examine and observe these populations. Through literature research and studies in the lab and herbaria, we determined that *P. parryorum* is indeed distributed in China, but so is an undescribed species similar to *P. parryorum* which we here describe as *P. purpureomaculata*. Furthermore, the material identified by Qiu (Qiu and Liu 2015) as *P. coerulea* C.Y. Wu ex W.T. Wang (1985, p. 60) represents an undescribed species which we here describe as *P. wui*. Additions and revisions of previously published descriptions of *P. coerulea* and *P. parryorum* are also provided.

Material and methods

Measurements and morphological character assessments of the taxa were performed using the specimens deposited in the following herbaria in China, France, the United States and the United Kingdom: CSFI, E, GXMI, HITBC, HT, HUH, IBK, IBSC, K, KUN, MICH, MO, NL, NY, P, PE, WUK.

Taxonomic treatment

Petrocosmea purpureomaculata M.Q. Han, J. Cai & J. D. Ya, sp. nov. (Fig. 1, 2)

A species much similar to *P. parryorum*, but with petioles, pedicels and the outside of calyx lobes densely covered with capitate-glandular hairs as well as sparsely villous (versus densely transparent-villous), throat that is white and with numerous irregularly arranged purple-red spots that vary in size, sometimes with two yellow and narrowly elliptic spots (versus throat purple to pale purple), filaments that are geniculate near the middle with an angle of about 140°, and their upper abaxial portion with densely set pilate-glandular hairs (versus U-shaped bending near the middle, abaxial portion of base with densely set pale brown pilate-glandular hairs, with a pronounced projection at the knee), anthers that are constricted at apex (versus not constricted), thecae that are poricidal at apex (versus poricidal close to the apex) and with four pores in pairs fusing into a tubular beak toward the stigma (versus four pores fusing into one toward the style).

Type: China, Yunnan Province: Jinping County, 1800 m a.s.l., 22°46′N, 103°2′E, 7 May 2020, J.-D. Ya & J. Cai 20CS19002 (holotype: KUN! isotype: PE!).

Etymology

The epithet refers to the spots in the throat which are purple-red, of different sizes and irregularly arranged.

Description

Perennial herb with short rhizomatous stem and crowded fibrous roots; rhizomes sparsely covered with umber villi. Leaves 5–12 per plant, all basal; petioles 1.5–5.0 cm long, ca 1.5 mm in diameter, green, densely covered with capitate-glandular hairs and sparsely covered with villi; blades borne on a stalk attached to the lower surface, ovate, lance-ovate to elliptic, 1.5–2.5 × 0.6–1.2 cm, papery, rounded at base, with entire margins, acute to rounded at apex, their adaxial surface densely covered with capitate-glandular hairs and abaxial surface densely covered with capitate-glandular hairs and sparsely covered with villi; lateral veins 3–5 on either side of midrib, adaxially impressed, abaxially conspicuous. Flowers solitary or 1–6; pedicels 2.5–3.5 cm long, densely covered with capitate-glandular hairs. Calyx green, of 2 free ventral lobes and 3 slightly fused dorsal lobes, the dorsal 3-lobed to the middle, all lobes lanceolate, almost equal, ca 4 mm long, outside densely covered with capitate-glandular hairs and sparsely covered with villi, glabrous inside. Corolla purple, bilabiate, its outside covered with pilate-glandular hairs, glabrous inside; tube ca 7 mm long, ca 8 mm in diameter, oblique, campanulate, with ovate orifice, ca 5 × 8 mm, with two yellowish-brown ovate spots inside the tube under the stamens; throat white, with many irregularly arranged purple-red spots that vary in size, sometimes with two yellow narrowly elliptic spots; adaxial lip ca 4 mm long, 2-lobed nearly to base, its lobes purple, widely ovate; abaxial lip ca 10 mm long, ca 17 mm wide, 3-lobed to the middle, its lobes almost equal, widely ovate, ca 6 × 8 mm. Stamens 2, ca 8 mm long, adnate to the corolla tube at the base; filaments ca 4.5 mm long, geniculate near the middle with an angle of about 140°, with upper portion of the abaxial side densely set with pilate-glandular hairs; anthers ca 4.5 mm long, ovate, light yellow, dithecal, subbasifixed, constricted at apex; anthers 2, connivent at ventral side of abaxial theca, but parted at the apex; thecae narrowly oblong, poricidal at apex, with four pores in pairs fusing into a tubular beak and toward the stigma. Staminodes 3, adnate to the corolla tube at the base, glabrous. Pistil ca 8 mm long; ovary ca 2.5 mm long, narrow-ellipsoid, densely covered with capitate-glandular hairs and sparsely covered with pilate-glandular hairs, 1-loculed; placentas 2, parietal, projecting inward, 2-cleft; style ca 5.5 mm long, glabrous, at base sparsely covered with capitate-glandular hairs, close to the abaxial corolla tube; stigma globose, white. Capsules not seen.

Phenology

Flowering during April; fruiting period unknown.

Distribution, habitat and ecology

Petrocosmea purpureomaculata has been observed to grow on moist shady cliffs on a limestone hill, at 1800 m a.s.l. in Jinping County, Yunnan Province, China.

Vernacular name

Chinese name: jiàng zhū shí hú dié (绛珠石蝴蝶), which can be translated as 'Petrocosmea with purple-red round spots', Jiangzhu comes from a fictional plant in the novel 'Dream of the Red Chamber'.

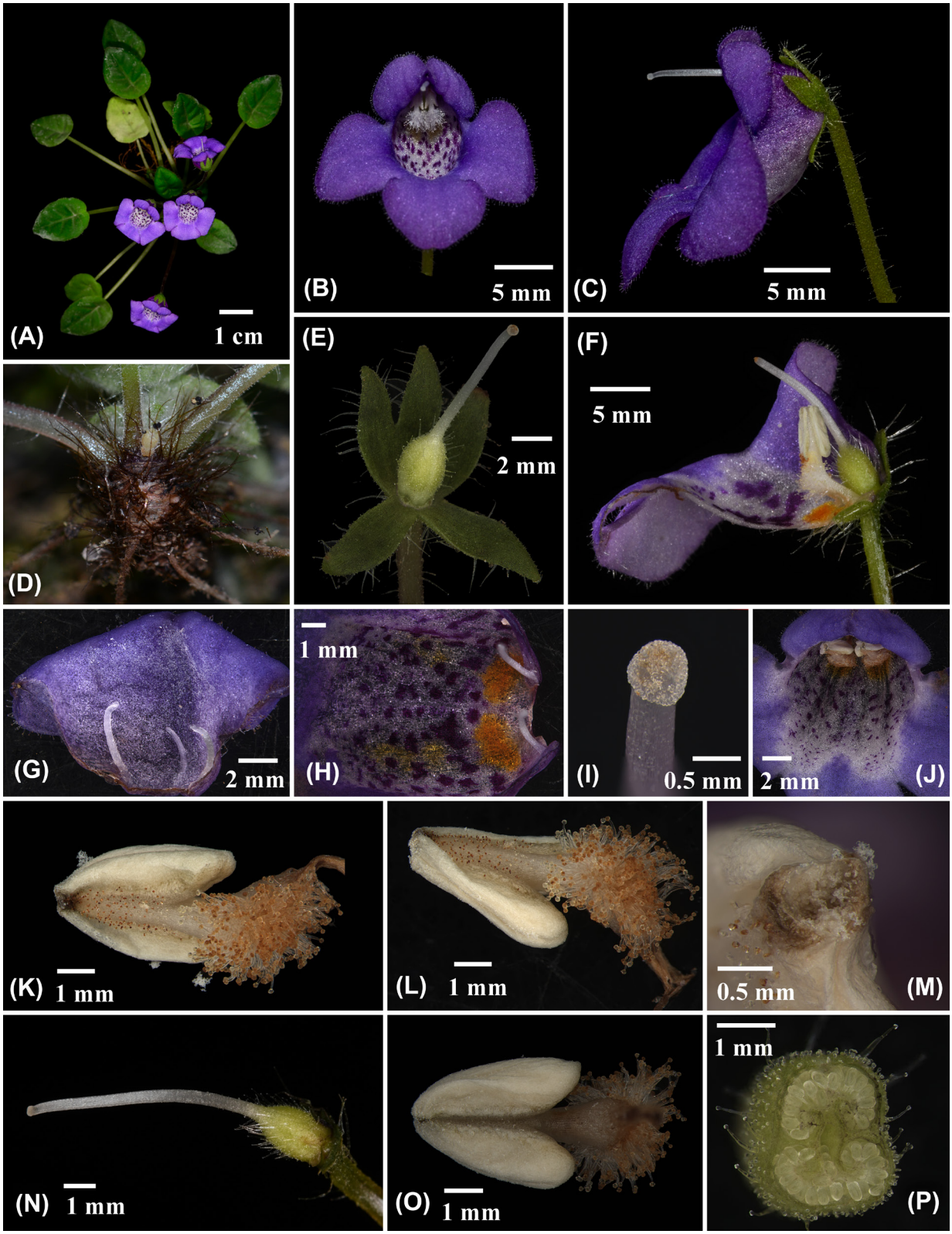

Figure 1. *Petrocosmea purpureomaculata* sp. nov. (A) habit, (B) flower in front view, (C) flower in side view, (D) rhizomatous stem, (E) calyx and pistil, (F) longitudinally cut corolla, (G) adaxial lips in inside view and staminodes, (H) throat, (I) stigma, (J) throat in front view, (K) individual stamen in down view, (L) individual stamen in side view, (M) apex of anthers, (N) pistil, (O) individual stamen in above view and (P) transversely cut ovary.

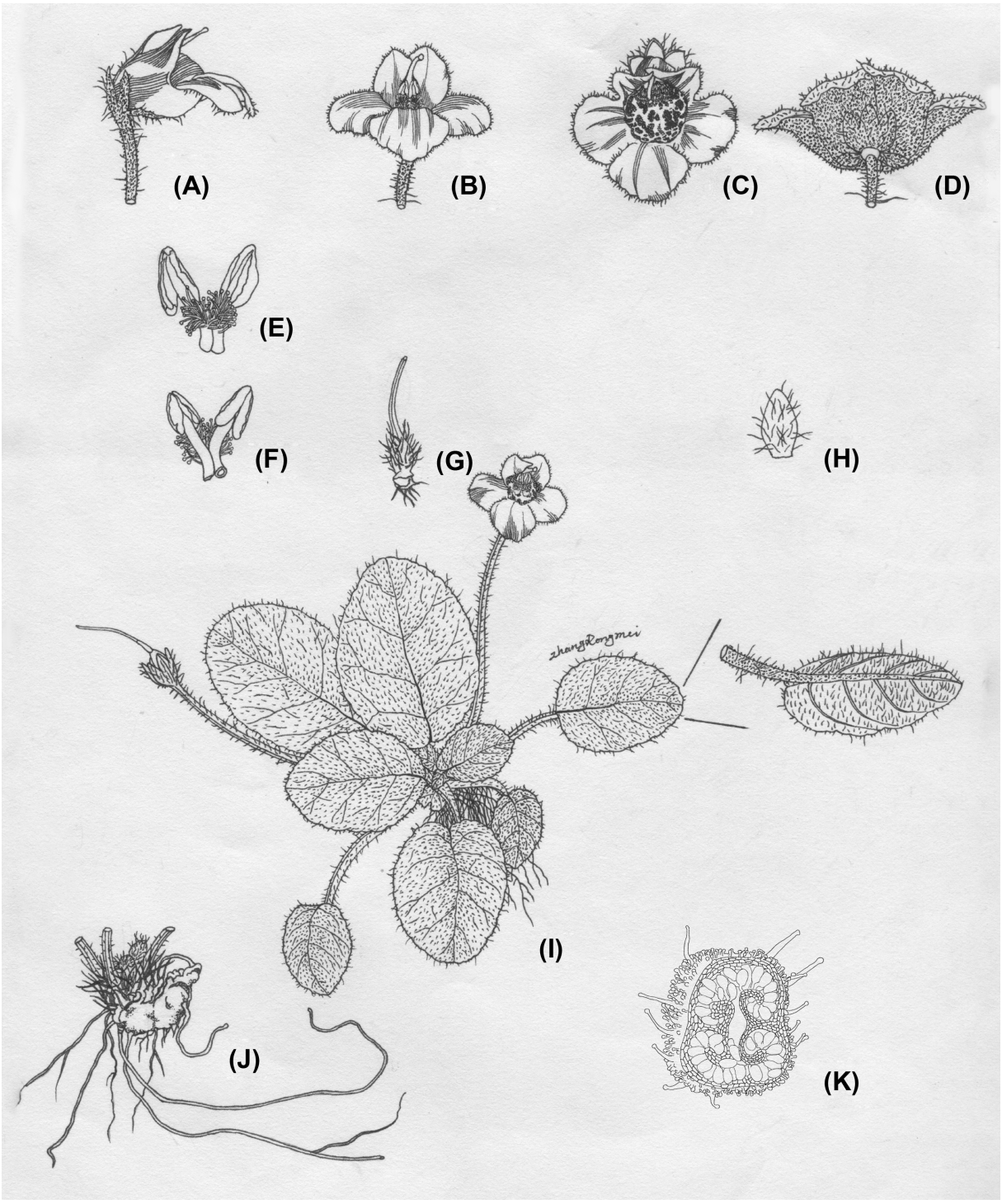

Figure 2. *Petrocosmea purpureomaculata* sp. nov. (A) flower in side view, (B–C) flower in front view, (D) flower in back view, (E) pair of stamens with adhering anthers from below view, (F) pair of stamens with adhering anthers from above view, (G) pistil, (H) calyx lobe, (I) habit, (J) rhizomatous stem, (K) transversely cut ovary. Drawn by Rong-Mei Zhang and Yuan Luo (K).

Additional specimens examined (paratypes)

China, Yunnan Province, Jinping County, 1800 m a.s.l., 22°46′N, 103°2′E, 20 Mar 2021, M. Q. Han et al. HMQ1939 (PE!), Kunming, voucher from cultivated plant at Kunming Institute of Botany, 22 Apr 2021 (flowering), J.-D. Ya BC210430, originally collected in China, Yunnan Province, Jinping county, 1800 m a.s.l., 22°46′N, 103°2′E (KUN!).

Notes
The most striking character of *Petrocosmea purpureomaculata* is that the throat of its flowers has numerous irregularly arranged purple-red spots, which is unique among all known species of *Petrocosmea*.

Petrocosmea wui M.Q. Han, J. Cai & J. D. Ya, sp. nov. (Fig. 3, 4)

A species most similar to *P. coerulea*, but with pale green petioles, peduncles, pedicels, bracts and calyx lobes (versus dark purple), both surfaces of the leaf blades densely pilose and sparsely villous (versus densely tomentose), a inflorescence that is a cymes or trichasium with 4–12 flowers (versus cymes, 1–5 flowered), and filaments that are densely covered with transparent pilate-glandular hairs (versus densely set with yellow uniseriate hairs).

Type: China, Yunnan Province: Yuxi City, Eshan County, 1800 m a.s.l., 24°18′N, 102°16′E, 4 Aug 2020, Cai J., J.-D. Ya, H.-Q. Han, 20CS19144 (holotype: KUN!, isotype: PE!).

Etymology
We dedicate this new species of *Petrocosmea* to Wu Zheng-yi (Wu Chengyih) (1916–2013), who devoted over 70 years to the study of the flora of China.

Description
Perennial herb with short rhizomatous stem and crowded fibrous roots. Leaves 6–15 per plant, all basal; petioles 3–10 cm long, 3–5 mm in diameter, green, densely pilose and sparsely villous; blades borne on a stalk attached to the lower surface, ovate, broadly ovate to elliptic, 3–8 × 2–6 cm, papery, rounded and oblique at base, with crenate to dentate margins, acute to obtuse at apex, with both surfaces densely pilose and sparsely villous; lateral veins 5–7 on either side of midrib, adaxially impressed, abaxially conspicuous. Cymes or trichasia 3–11, 4–12 flowered; peduncles ca 12 cm long, densely pilose; bracts 3, lanceolate, ca 5 mm long; secondary peduncle usually very short making the entire inflorescence look like an umbel, pedicels ca 2 cm long. Calyx pale green, of 2 free ventral lobes and 3 slightly fused dorsal lobes; dorsal 3 lobes fused at base for 1.5–2.0 mm; all lobes lanceolate, almost equal, ca 12 mm long, villous outside, glabrous inside. Corolla purple, bilabiate, pubescent outside, glabrous inside; tube ca 7 mm long, ca 7 mm in diameter, oblique, campanulate, its orifice widely ovate, ca 5 × 8 mm, white near base, with two yellowish-brown ovate spots inside the tube under the stamens; throat purple; adaxial lip ca 5 mm long, 2-lobed to the middle, its lobes purple, with lobes fused and rolled laterally to form a spindly carinate-plicate shape of the upper lip that encloses the style, white at fused part; abaxial lip ca 8 mm long, ca 15 mm wide, 3-lobed to the middle, its lobes almost equal, widely ovate, ca 5 × 6 mm. Stamens 2, ca 6 mm long, adnate to the corolla tube at the base; filaments ca 4 mm long, geniculate near the middle with an angle of about 110°, densely set with transparent pilate-glandular hairs; anthers ca 3 mm long, ovate, light yellow, dithecal, subbasifixed, the two anthers connivent at ventral side of abaxial theca; thecae narrowly oblong, poricidal close to the apex, with four pores fusing into one toward the style. Staminodes 3, adnate to the corolla tube at the base, glabrous. Pistil ca 11 mm long; ovary ca 4 mm long, ovate, densely villous, 1-loculed; placentas 2, parietal, projecting inward, 2-cleft; style ca 9 mm long, glabrous, close to the abaxial corolla tube; stigma globose, white. Capsules straight, brown, ensiform, about 25 mm, dehiscing loculicidally to base; valves 4, glabrous. Seeds unknown.

Phenology
Flowering during July–August; fruiting during August–September.

Distribution, habitat and ecology
Petrocosmea wui has been observed to grow on moist shady cliffs near a small waterfall in a sandstone valley, at 1800 m a.s.l. in Eshan County, Yunnan Province, China.

Vernacular name
Chinese name: zhēng yì shí hú dié (征镒石蝴蝶).

Additional specimens examined (paratypes)
China, Yunnan Province, Eshan County, 1823 m a.s.l., 24°18′N, 102°16′E, 28 Aug 2013, J. Cai, X.J. Hu & H.T. Li, 13CS7142 (KUN!).

Notes
The most striking character of *Petrocosmea wui* is that its secondary peduncle of cymes (or truchasium) usually is very short making the entire inflorescence look like an umbel, which is unique among all known species of *Petrocosmea*.

Supplementary and revised descriptions of *P. coerulea* and *P. parryorum*

Petrocosmea parryorum C.E.C. Fisch (Fig. 5), in Bull. Misc. Inform. Kew (1926, p. 438)

Type: India, Assam, Lushai Hill, 1700 m near Sailsuk, Muallung, on the Chin Hill border, Sep-Nov Mr. and Mrs. N. E. Parry (holotype: K! barcode K000196635, isotypes: K! barcode K000196636, K000196637, K00196638, HT).

Description
Perennial herb with short rhizomatous stem and crowded fibrous roots; rhizomes sparsely covered with brown villi. Leavers 5–16 per plant, all basal; petioles 2–13 cm long, ca 5 mm in diameter, green or sometimes slightly purple, densely covered with transparent villi; blades borne on a stalk attached to the lower surface, lance-ovate to widely ovate, elliptic to widely elliptic, 2–13 × 1–7 cm, papery, rounded at base, sometimes oblique, with entire or undulate margins, acute to rounded at apex, its adaxial surface covered with capitate-glandular hairs and villi, abaxial surface densely covered with villi; lateral veins 3–5 on either side of midrib, adaxially impressed, abaxially conspicuous. Cymes 1–6, 1–8-flowered;

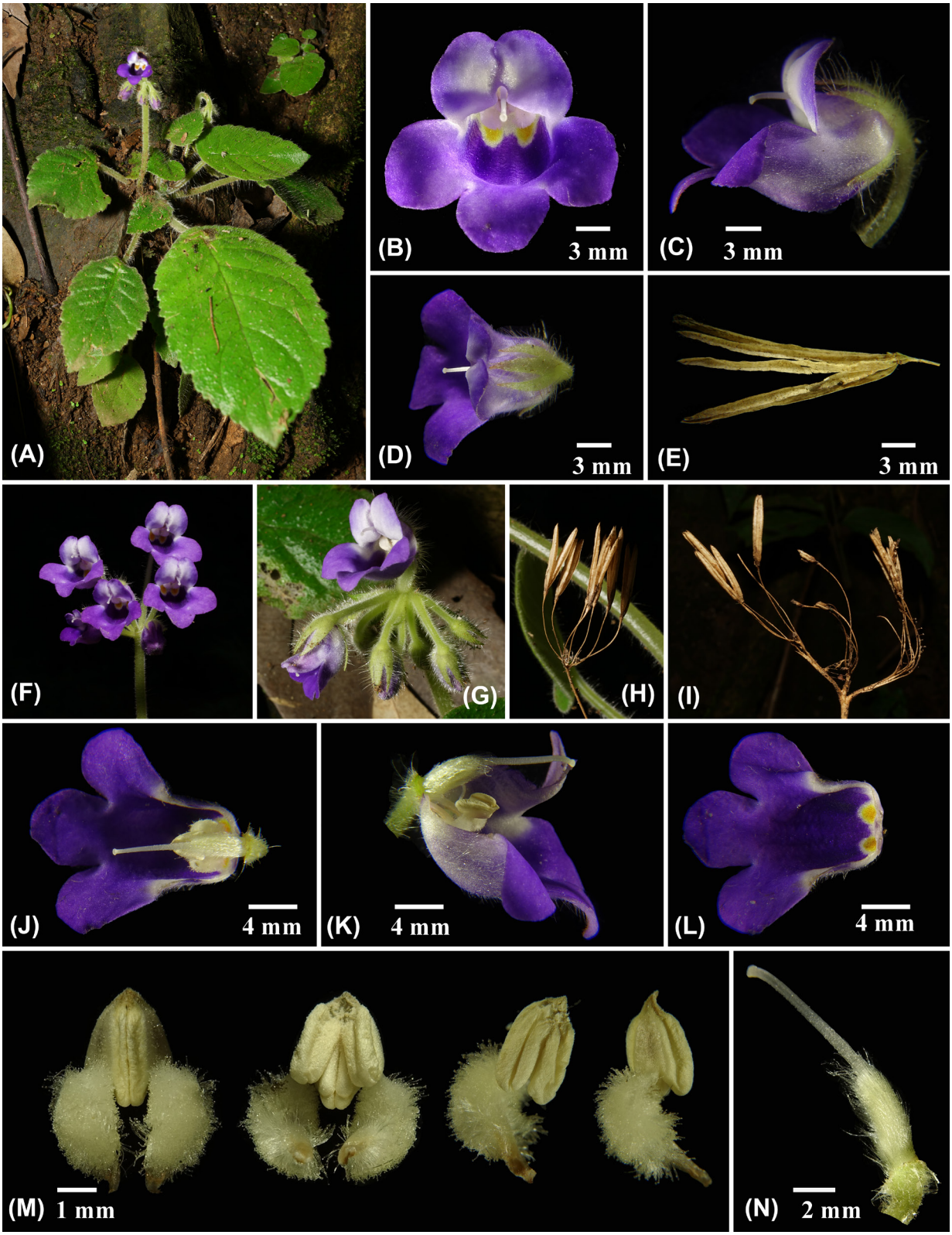

Figure 3. *Petrocosmea wui* sp. nov. (A) habit, (B) flower in front view, (C) flower in side view, (D) flower in top view, (E) capsule, (F–H) approximately umbellate inflorescence, (I) cyme, (J) transversely cut corolla, (K) longitudinally cut corolla, (L) abaxial lip, (M) from left to right, pair of stamens with adhering anthers from below, from above and individual stamen in above and down view and (N) pistil.

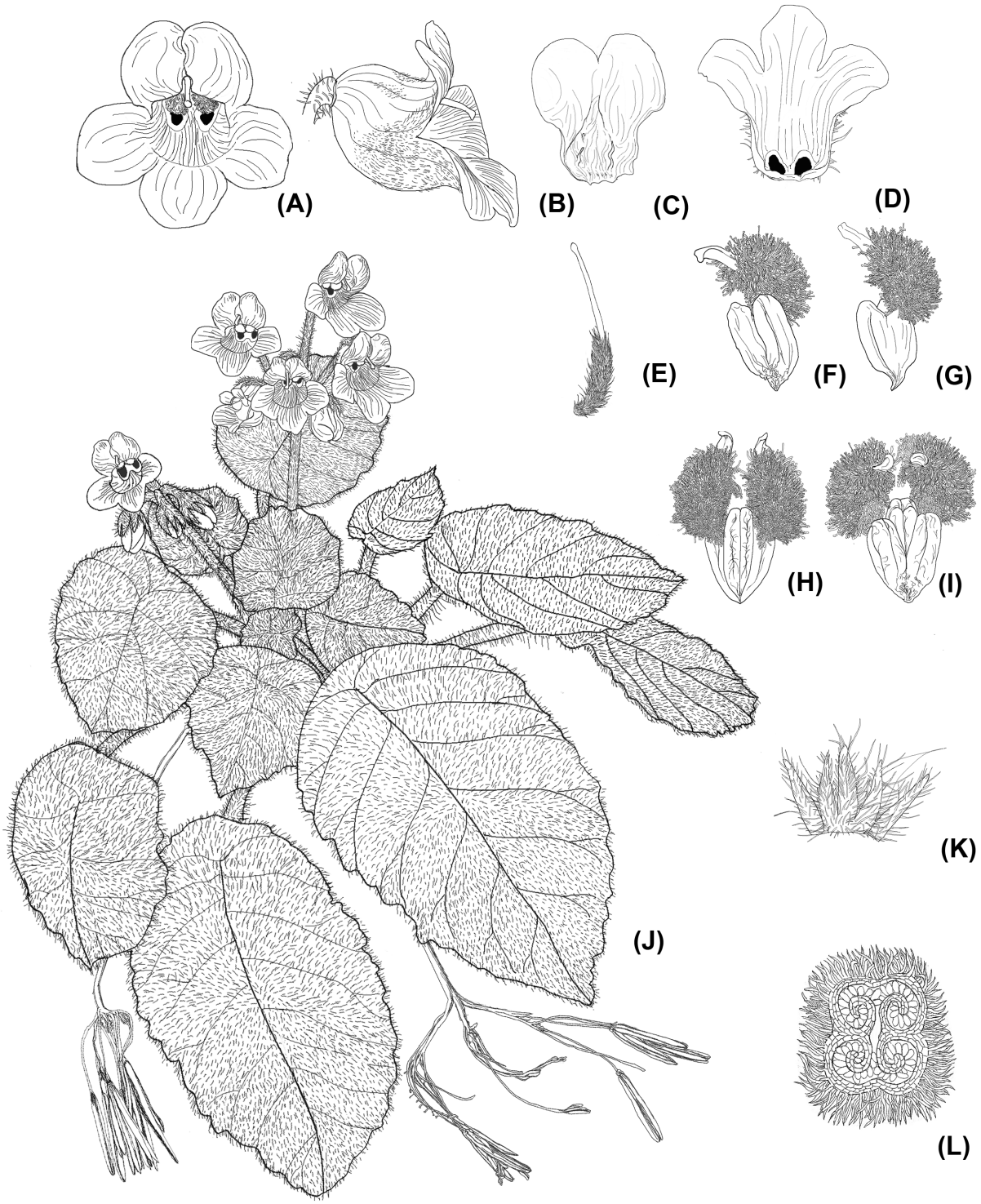

Figure 4. *Petrocosmea wui* sp. nov. (A) flower in front view, (B) flower in side view, (C) adaxial lips in inside view, (D) abaxial lip, (E) pistil, (F) individual stamen in above view, (G) individual stamen in down view, (H) pair of stamens with adhering anthers from below view, (I) pair of stamens with adhering anthers from above view, (J) habit, (K) calyx lobes, (I) transversely cut ovary. Drawn by Yuan Luo.

peduncles 3–13 cm, densely covered with villi; involucre 3, narrowly triangular, lanceolate or oblanceolate, 0.6–1.5 cm long, the ventral two larger; involucel 3, lanceolate, 0.3–0.6 cm long, the ventral two larger; bracts 2, lanceolate, 0.2–0.5 cm long, equal; secondary peduncle 1.0–1.5 cm long, densely covered with villi; pedicels 0.9–1.5 cm long, densely covered with villi. Calyx green to purple, 5-lobed nearly to base; lobes ca 6 mm long, lanceolate, equal, villous outside, glabrous

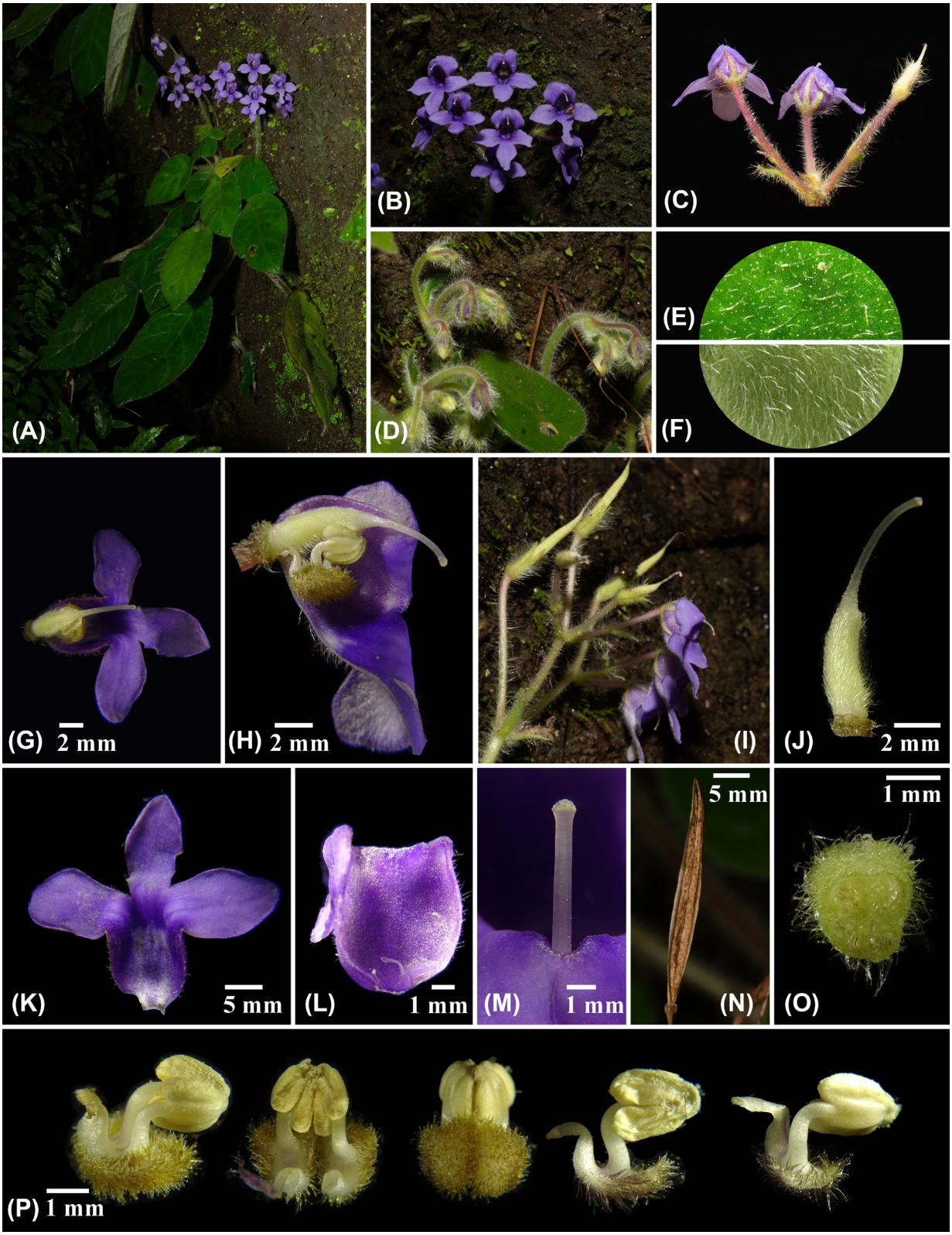

Figure 5. *Petrocosmea parryorum*. (A) habit, (B) flowers in front view, (C) flowers in back view, (D) buds, (E) adaxial leaf blade surface, (F) abaxial leaf blade surface, (G) transversely cut corolla, (H) longitudinally cut corolla, (I) immature fruits and flowers, (J) pistil, (K) abaxial lip, (L) adaxial lips in inside view, (M) stigma, (N) capsule, (O) transversely cut ovary and (P) from left to right, pair of stamens with adhering anthers from side, from above, from below and individual stamen in above and down view.

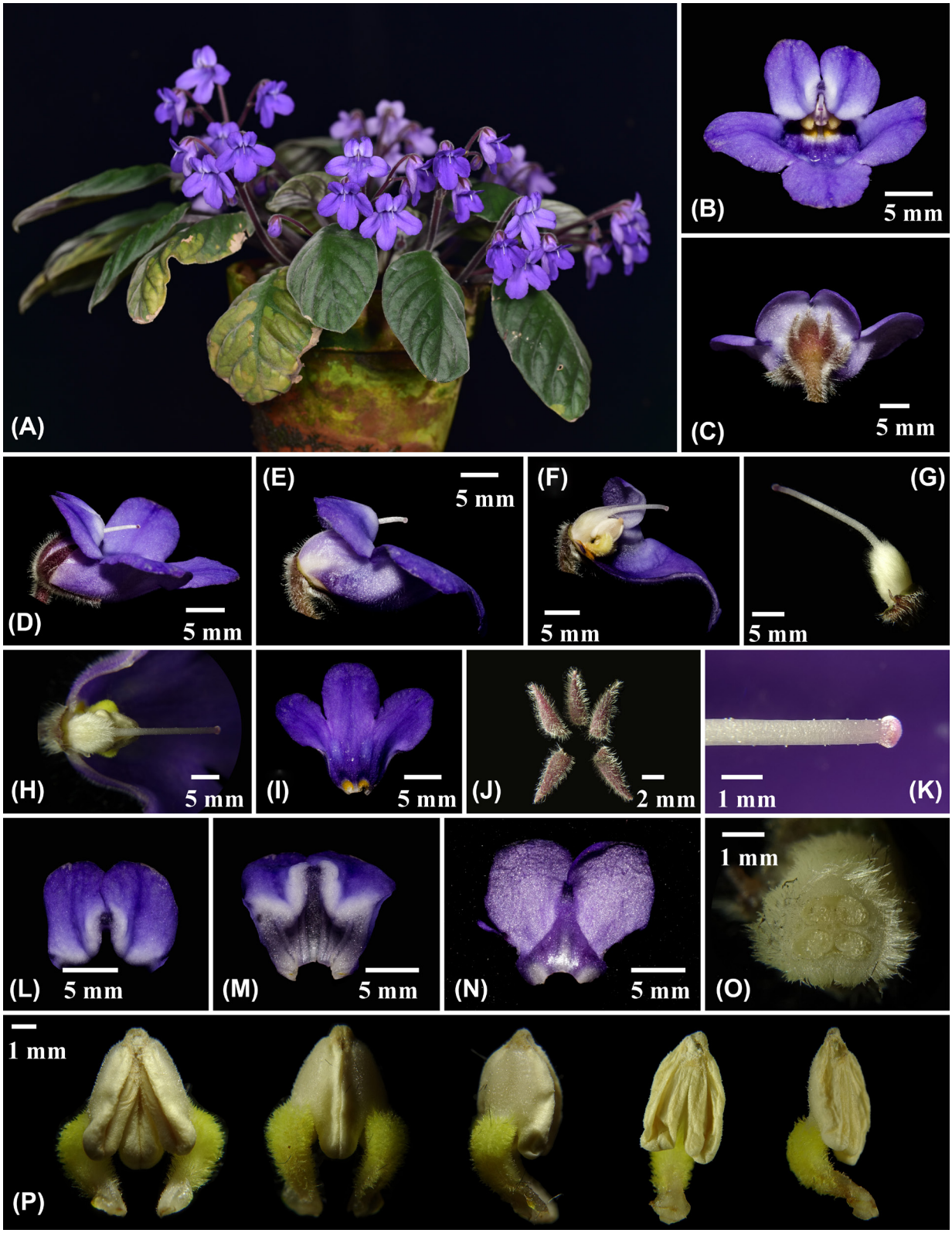

Figure 6. *Petrocosmea coerulea*. (A) habit, (B) flower in front view, (C) flower in back view, (D–E) flower in side view, (F) longitudinally cut corolla, (G) pistil, (H) ovary and stamens, (I) abaxial lip, (J) dissected calyx lobes, (K) stigma, (L) adaxial lips in front view, (M) adaxial lips in inside view, (N) adaxial in outside view, (O) transversely cut ovary and (P) from left to right, pair of stamens with adhering anthers from above, from below and individual stamen in down, above and side view. Photographed by Meng-Qi Han and De-Chang Meng (A).

inside. Corolla purple, bilabiate, pilose outside, glabrous inside; tube ca 7 mm long, oblique, campanulate, its orifice narrowly ovate-pentagonal, ca 5 × 8 mm; throat purple to pale purple; adaxial lip ca 4 mm long, 2-lobed nearly to base, its lobes purple, half oval, ca 4 × 5 mm; abaxial lip ca 10 mm long, ca 17 mm wide, 3-lobed to the middle, its lobes almost equal, obelliptical, ca 6 × 8 mm. Stamens 2, ca 4 mm long, adnate to the corolla tube at the base; filaments ca 4 mm long, with an U-shaped bending near the middle, abaxial portion of the base densely set with pale brown pilate-glandular hairs, with a pronounced projection at the knee, its abaxial portion densely set with yellow brown pilate-glandular hairs; anthers ca 2 mm long, widely ovate, light yellow, dithecal, subbasifixed, the two anthers connivent at ventral sidr of abaxial theca; thecae narrowly oblong, poricidal close to the apex, with four pores fusing into one toward the style. Staminodes 3, adnate to the corolla tube at the base, glabrous. Pistil ca 10 mm long; ovary ca 5 mm long, narrow-ellipsoid, densely pilose, 1-loculed; placentas 2, parietal, projecting inward, 2-cleft; style ca 5.5 mm long, glabrous, at base sparsely covered with capitate-glandular hairs, close to the abaxial corolla tube; stigma globose, white. Capsules straight, brown, ensiform, 13–27 mm, dehiscing loculicidally to base; valves 2, glabrous. Seed fusiform, brown, smooth, 0.3–0.5 mm long.

Additional specimen examined

China, Yunnan Province, Lushui City, Liuku Town, 1800 m, 29 Aug 2020, M. Q. Han HMQ1800 (PE!, IBK!, KUN!), Jingdong County, Mt Wuliang, 2100 m, 12 Sep 2020 M. Q. Han HMQ1837 (PE!).

India, Assam, Thevopesimi Reserve, 1800 m, 7 Aug 1942, Bor, NL 16289 (NL!), Nagaland, Takubama, Naga Hills, ca 2100 m, 4 Sep 1950, Walter N. Koelz 26039 (MICH!).

Myanmar: N. E. Upper Burma, 2134 m, G. Forrest 24873 (K!).

Petrocosmea coerulea C.Y. Wu ex W.T. Wang (Fig. 6) in Acta Bot. Yunnan. (1985, p. 60–61)

Type: China, Yunnan province, Jinping County, 5 Apr 1962, Wu Shu-Kung 3901 (holotype KUN! barcode Kun0208637, isotype KUN! barcode Kun0208637).

Description

Perennial herb with short rhizomatous stem and crowded fibrous roots. Leaves 7–15 per plant, all basal; petioles 1.5–2.7 cm, dark purple, densely tomentose; blades borne on a stalk attached to the lower surface, narrowly oblong, narrowly elliptic to elliptic, lance-ovate to ovate, 1.0–6.0 × 0.7–2.2 cm, papery, rounded and sometimes oblique at base, with entire margins, obtuse at apex, both surfaces densely tomentose; lateral veins 4–6 on either side of midrib, adaxially impressed, abaxially purple, conspicuous. Cymes 1–8, 1–5-flowered; peduncles 1.5–9.0 cm long, dark purple, densely pilose; bracts 2, narrowly triangular ca 4 mm long; pedicels 2–4 cm, dark purple, densely pilose. Calyx dark purple, 5-lobed nearly to base; lobes ca 7 mm long, lanceolate, equal, densely pilose outside, glabrous inside. Corolla blue-purple, bilabiate, pubescent outside, glabrous inside; tube ca 7 mm long, ca 9 mm in diameter, oblique, campanulate, with two yellow ovate spots inside the tube under the stamens; throat blue-purple; adaxial lip ca 5 mm long, 2-lobed to the middle, with lobes blue-purple, fused and rolled laterally to form a spindly carinate-plicate shape of the upper lip that encloses the style, white at fused part; abaxial lip ca 15 mm long, ca 21 mm wide, 3-lobed to the middle, its lobes almost equal, widely ovate, ca 10 × 10 mm. Stamens 2, ca 6 mm long, adnate to the corolla tube at the base; filaments ca 4.5 mm long, geniculate near the middle with an angle of about 120°, densely set with yellow uniseriate hairs; anthers ca 4 mm long, ovate, light yellow, dithecal, subbasifixed, the two anthers connivent at ventral side of abaxial theca; thecae narrowly oblong, poricidal at close to the apex. Staminodes 3, adnate to the corolla tube at base, glabrous. Pistil ca 14 mm long; ovary ca 4 mm long, widely ovate, densely villous, 1-loculed; placentas 2, parietal, projecting inward, 2-cleft; style ca 10 mm long, sparsely covered with capitate-glandular hairs, close to the abaxial corolla tube; stigma globose, purple. Capsules unknown.

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Author contributions

Mengqi Han: Conceptualization (equal); Formal analysis (equal); Investigation (equal); Writing – original draft (lead). **Ji-Dong Ya**: Investigation (lead); Resources (lead). **Chao-Qun Li**: Resources (equal); Writing – review and editing (equal). **Jie Cai**: Conceptualization (equal); Funding acquisition (lead); Project administration (lead); Resources (equal); Writing – review and editing (equal).

Data availability statement

There are no additional data to this paper.

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