

Taxonomic notes on *Parnassia* section *Saxifragastrum* (Parnassiaceae) from China

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Morphological variation within and among populations of closely related taxa of *Parnassia* sect. *Saxifragastrum* from China was studied based on literature, specimen examinations and field survey. *Parnassia angustipetala* T.C. Ku, *P. yulongshanensis* T.C. Ku, *P. longipetaloides* J.T. Pan, and *P. yanyuanensis* T.C. Ku were reduced to synonymy of *P. yunnanensis* Franchet. *Parnassia humilis* T.C. Ku is different from *P. yunnanensis*, and is proposed as a new synonym of *P. trinervis* Drude. The geographic distribution and illustrations of *P. yunnanensis* and *P. trinervis* are also presented.

Key words: distribution, morphology, *Parnassia* sect. *Saxifragastrum*, taxonomy

Introduction

The genus *Parnassia*, consisting of about 50 species, occurs mainly in arctic and temperate zones of the northern hemisphere. Most of the species have a limited range, with more than 30 confined to China and the Himalayan region (Hultgård 1987). The eastern Himalayas and Hengduan Mountain regions is one centre of diversification and high endemism of *Parnassia* (Phillips 1982, Ku 1987, Wu *et al.* 2003, Simmons 2004). Based primarily on characteristics of the staminal node, Drude (1875) established a taxonomic system of *Parnassia* and assigned the 18 species then known to four sections. Many new species were described in subsequent studies, particularly by Fedchenko (1917: 16–42) and Nekras-

ova (1927), Evans (1921) and Handel-Mazzetti (1941). Engler (1930) followed Drude's (1875) classification, but added a fifth section. This taxonomic framework was also recognized by Handel-Mazzetti (1941) and Phillips (1982). The members of sect. *Saxifragastrum* are distributed in northern India and neighbouring mountains of SW China. Quite different taxonomic classifications were proposed for this section and some related taxa (Engler 1930, Handel-Mazzetti 1941, Ku 1987, 1995, Gu & Hultgård 2001).

Parnassia yunnanensis was first described by Franchet in 1896, based on the specimen collected by Delavay in Yunnan, China in 1884. Handel-Mazzetti (1941) placed *P. yunnanensis* in sect. *Saxifragastrum*, which then included *P. tenella* Hook. f. & Thoms., *P. longipetala* Hand-

Mazz., *P. esquirolii* Lévl., and *P. petitmenginii* Lévl. When Ku (1987) revised Chinese *Parnassia*, he treated *P. angustipetala*, *P. yulongshanensis*, *P. longipetaloides*, *P. yanyuanensis*, *P. humilis* and *P. yunnanensis* as distinct species in sect. *Saxifragastrum*. This treatment was accepted by Gu and Hultgård (2001), Wu et al. (2003), and Simmons (2004). After carefully comparing the characters of type specimens of these six taxa, and from the original descriptions, we found that the above-mentioned taxa are very similar to each other, except *P. humilis*. The objective of this study is to revise sect. *Saxifragastrum* and to synonymize those names that refer to the taxa that are too similar to warrant species status.

Material and methods

Over 1000 herbarium specimens from six herbaria (E, K, MB, PE, HNWP, and KUN) were examined. The diagnostic characters used by previous authors were meticulously studied and compared among the six taxa currently included in sect. *Saxifragastrum*. The type specimens were particularly carefully studied. During the field survey of *Parnassia* in the mountainous regions of SW China, patterns of character variation were observed within and/or among populations.

We studied almost all the type specimens (holotypes and/or isotypes) to the species described by Ku (1987, 1995). In few cases, when holotypes and/or isotypes were not available, the syntypes or paratypes were used to represent the primary source of information. We have also listed selected illustrations from the earlier literature, to show important features of the taxa. The shape and size of the staminode and leaf was measured on all available specimens. All characters of taxonomic importance in this group were studied and character states described using standardized and clearly defined terms (see Table 1).

Results and discussion

Variation of diagnostic characters

The morphological characters chosen for this

investigation were those mainly referred to by previous authors (Drude 1875, Franchet 1897, Nekrasova 1917, Engler 1930, Handel-Mazzetti 1941, Hultgård 1987, Ku 1987, Gu & Hultgård 2001). After studying herbarium specimens and observations in the field, we found that the morphology of basal leaf shape, occurrence and position of cauline leaf, size and shape of petals, and staminode are good diagnostic characters for separating species of *Parnassia* sect. *Saxifragastrum*.

All species examined, except *P. humilis*, closely resembled each other in their leaf and corolla morphology. However, the staminodes (Fig. 1) were very variable, and no distinguishing differences could be found among *P. yunnanensis*, *P. angustipetala*, *P. yulongshanensis*, *P. longipetaloides*, and *P. yanyuanensis*. The petal colour and patterning (with purple-brown dots in *P. yunnanensis*) was also used as a key character for distinguishing *P. yunnanensis* from the other above-mentioned taxa by Ku (1987). However, based on our field and specimen observations, these characters varied considerably within and between populations of *P. yunnanensis* and its related taxa, the variation being likely environmentally induced. No distinct characters separate *P. yunnanensis* and its supposed related taxa. Consequently, we reduced *P. angustipetala*, *P. yulongshanensis*, *P. longipetaloides*, and *P. yanyuanensis* into taxonomic synonymy of *P. yunnanensis*.

In the previous treatments, *P. humilis* was recognized to be close to *P. yunnanensis* and thus placed in sect. *Saxifragastrum* (Ku 1987, Gu & Hultgård 2001). Characters of the basal leaf and staminodes, however, can easily distinguish the two species (Table 1). Ku (1987) described the staminodes of *P. humilis* as rounded at the apex, but the illustration showed staminodes with three lobes, which indicates that *P. humilis* may be more allied to *P. trinervis* than to *P. yunnanensis* (see Fig. 2). After carefully examining the characters of type specimens of *P. humilis*, we found that the bract-like leaf near the base, and ovate-triangular base leaf of this species is very similar to that of *P. trinervis* (Ku 1987). Based on the staminodial shape and basal leaf characters, we treat *P. humilis* as a synonym of *P. trinervis*, of sect. *Nectarotrilobos*.

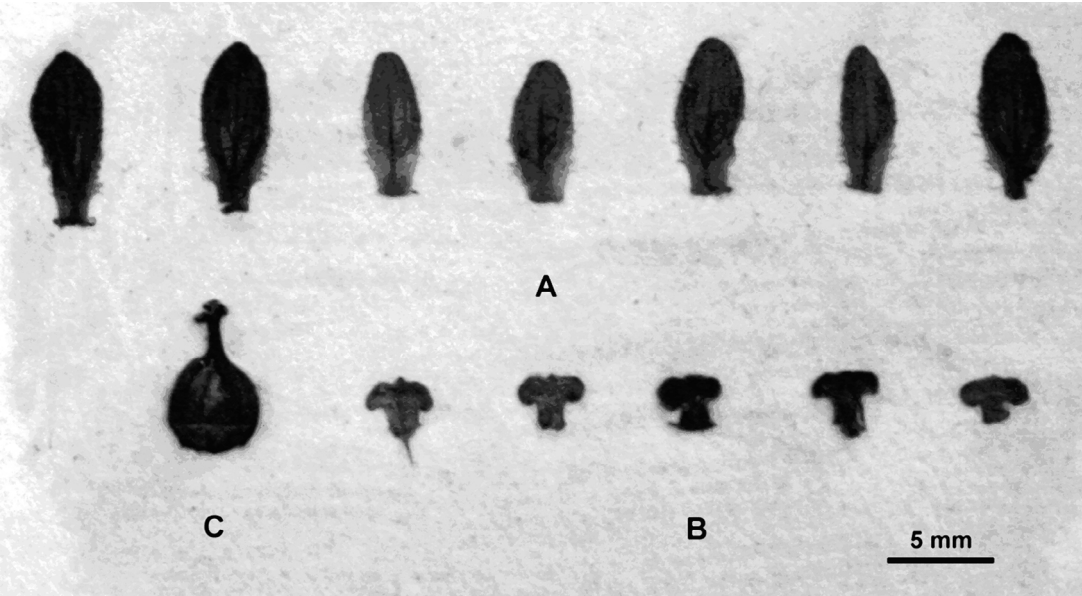


Fig. 1. *Parnassia yunnanensis* (from the topotype G. Forrest 6154, E). — A: Petals. — B: Stamines. — C: Ovary.

Table 1. Comparison of taxonomically diagnostic morphological characters between *Parnassia yunnanensis* and its supposed related taxa in *Parnassia* sect. *Saxifragastrum* based on specimens examined and literature.

	Habit	Flowers	Leaves
<i>P. yunnanensis</i>	stems 1–3, 4–8 cm long, with a bract-like leaf distally or near apex	petals white or whitish green, obovate-oblong, ca. 7 mm, 3-veined, short fimbriate below; staminodes terete, 1–1.5 mm, tips discoid, and rim undulate, or indistinctly 3-dentate	blade 6–9 mm long, ovate-cordate or reniform, apex obtuse, base
<i>P. longipetaloides</i>	stems 1–2, 2.7–4 cm long, with a bract-like leaf distally	petals yellow-green, oblong or lanceolate, 3–4 mm, 3-veined, erose below; staminodes terete, ca. 1.5 mm, tips discoid, and rim indistinctly 4–6-dentate	deeply cordate blade 4–7 mm long, ovate-reniform, apex obtuse, base cordate
<i>P. angustipetala</i>	stems 1–3, 2.5–4 cm long, with a bract-like leaf distally or near apex	petals green, spatulate or ovate-oblong, 5–7 mm, entire or indistinctly erose; staminodes terete, ca. 1.5 mm, apex rounded	blade 5–7 mm long, ovate-cordate, apex obtuse, base cordate
<i>P. yulongshanensis</i>	stems 1–3, 1.5–2 cm long, with a bract-like leaf near apex	petals green, oblong, ca. 3 mm, 3-veined, erose below; staminodes terete, ca. 1.5 mm, tips discoid, and rim 1- or 2-dentate centrally	blade 4–5 mm long, ovate-reniform, apex obtuse, base cordate
<i>P. yanyuanensis</i>	stems 1 or 2, 3–4 cm long, with a bract-like leaf distally or near apex	petals yellowish, obovate-oblong, 4–5 mm, 3-veined, erose below; staminodes terete, ca. 1 mm, tips discoid, and rim rounded	blade 6–11 mm long, ovate-cordate, apex obtuse, base cordate
<i>P. humilis</i>	stems 1–3, 3–5 cm long, with a bract-like leaf near base	petals white, elliptic or oblong, 6–7 mm, 3-veined, indistinctly erose or subentire; staminodes terete, ca. 2 mm, 3-lobed, lobes very short	blade 8–14 mm long, ovate-triangular, apex acuminate, base attenuate

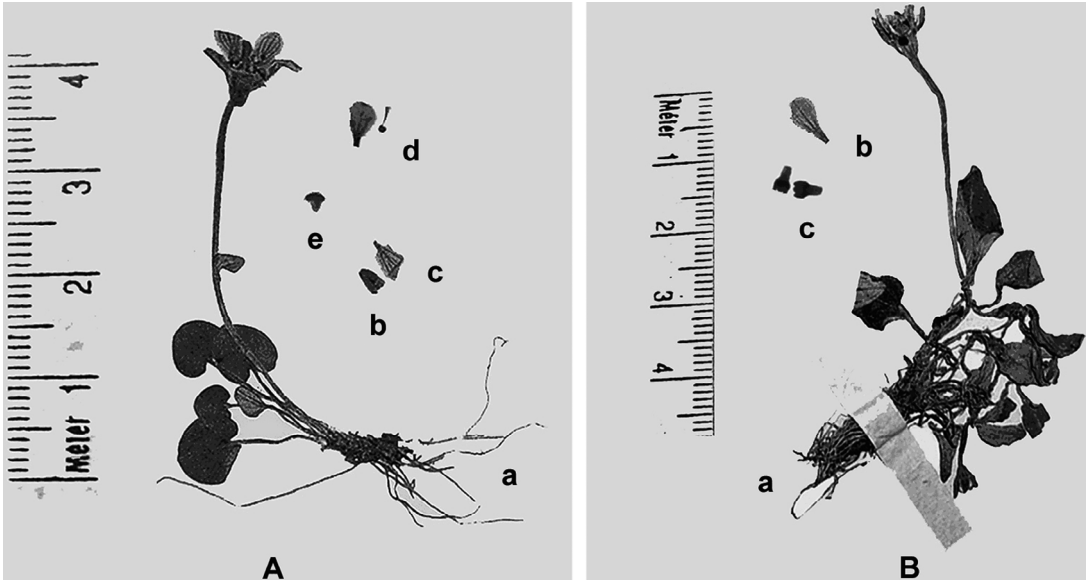


Fig. 2. — A: *Parnassia yunnanensis* (from K. M. Feng 1802, PE). — a: Plant. — b: Sepal. — c: Petals. — d: Stamen. — e: Staminode. — B: *Parnassia humilis* (from the holotype). — a: Plant. — b: Petal. — c: Staminodes.

Taxonomic treatment

Parnassia yunnanensis Franchet

J. Bot. (Morot) 10: 266. 1896. — TYPE: China. Yunnan, Hokin, *Delavay 710* (holotype K!); Sichuan, near Tatchienlu, *Pratt 542* (syntype, BM!).

Parnassia longipetaloides J.T. Pan, Acta Phytotax. Sin. 23: 222. 1985, *syn. nov.* — TYPE: China. Yunnan, Eryuan, *Jinshajiang Exped. 6105* (holotype KUN!).

Parnassia angustipetala T.C. Ku, Bull. Bot. Res. (Harbin) 7(1): 23. 1987, *syn. nov.* — TYPE: China. Sichuan, Muli, *T.T. Yü 7429B* (holotype PE; isotype KUN!).

Parnassia yulongshanensis T.C. Ku, Bull. Bot. Res. (Harbin) 7(1): 25. 1987, *syn. nov.* — TYPE: China. Yunnan, Lijiang, *Hengduan Shan Exped. 2207* (holotype PE!).

Parnassia yanyuanensis T.C. Ku, Bull. Bot. Res. (Harbin) 7(1): 26. 1987, *syn. nov.* — TYPE: China. Sichuan, Yanyuan, *Qing-Zang Exped. 12269* (holotype PE!).

Perennial herbs, rhizomes short, erect. Flowering stems 1–3, 1.5–8 cm tall, with a bract-like leaf distally or near apex. Basal leaves 2–9, long petiolated, glabrous; petiole 5–20 mm long; blade broadly ovate, ovate-cordate or ovate-reniform, 4–11 mm long and 4–11 mm wide, apex obtuse, base cordate or deeply cordate. Cauline leaf sessile, ovate-lanceolate, ovate or semiorbicular, 2–7 mm long and 1.5–5 mm wide, sometimes with a few rusty brown appendages at

base. Flowers solitary, 3.5–14 mm in diameter; hypanthium campanulate or hemispheric. Sepals oblong, ovate-oblong or semiorbicular, 2.5–4 × 1.5–3 mm, 3-veined, margin entire, sometimes shallowly erose, apex obtuse or rounded; petals white, whitish green, green, yellow-green or yellowish, parallel veins distinct, oblong, obovate-oblong, spatulate or ovate-oblong, 3–7 mm long, margin entire to densely erose or shortly fimbriate, apex emarginate; anthers ellipsoid or oblong, 0.5–1 mm, filaments 2.5–4 mm; staminodes terete, 1–1.5 mm, stalk 0.2–1 mm, lamina apically discoid, disc 0.6–1.2 mm in diameter. Ovary superior, globose or ovoid; style ca. 0.5–1.5 mm; stigma 3-lobed. Capsules depressed globose or ovoid. Seeds ellipsoid, slightly winged.

DISTRIBUTION. Endemic to NW Yunnan and SW Sichuan, southwest China (Fig. 3).

ECOLOGY. Along streams, marshy meadows, or wet grassy slopes.

PHENOLOGY. Flowering from July to August, fruiting September.

Parnassia trinervis Drude (Fig. 4)

Linnaea 39: 322. 1875. — TYPE: China. W. Xizang, without detailed locality (holotype, not seen).

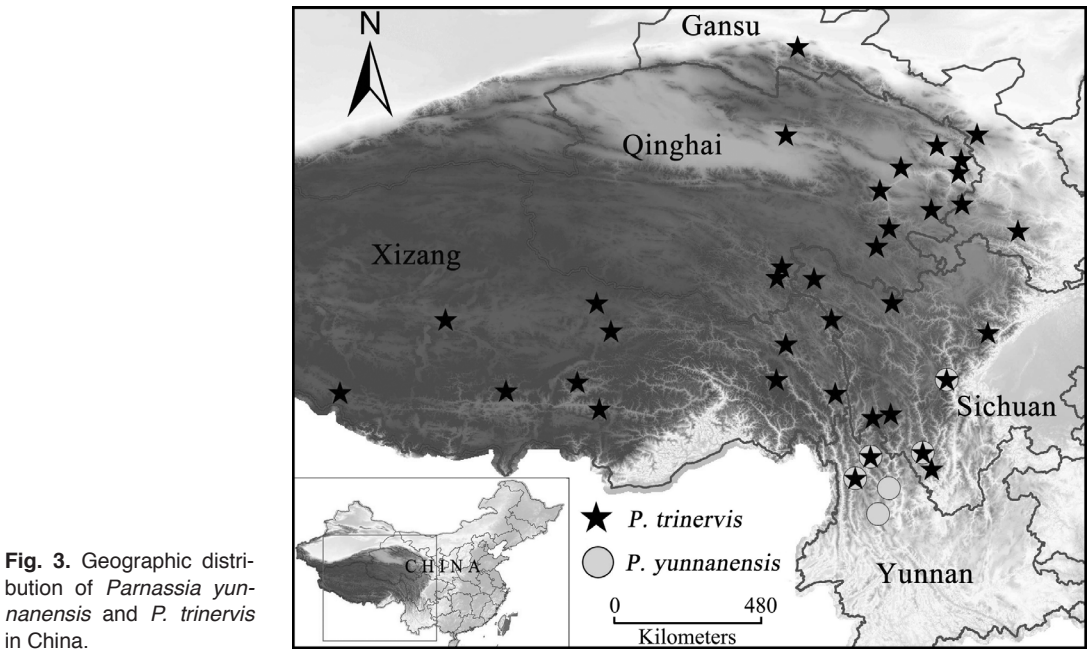


Fig. 3. Geographic distribution of *Parnassia yunnanensis* and *P. trinervis* in China.

Parnassia viridiflora Batalin, Acta Hort. Petrop. 12: 168. 1892.

Parnassia humilis T.C. Ku, Bull. Bot. Res. (Harbin) 7(1): 27. 1987, *syn. nov.* — TYPE: China. Xizang, Anduo, X. J. Yang 1985 (holotype PE; isotype KUN/HNWP!).

Perennial herbs, rhizomes short, erect. Flowering stems 1–4, 3–14(20) cm tall, with 1 leaf near base. Basal leaves 4–9, long petiolated, glabrous; petiole 5–15 mm long; blade oblong, ovate-oblong, or ovate-triangular, 8–15 cm × 5–12 mm, base truncate, or attenuate, apex acute. Cauline leaf sessile, ovate or semiorbicular, similar to basal ones but smaller, sometimes with a few rusty brown, hair-like appendages at base. Flowers solitary, 6–10 mm in diameter; calyx tube short, lobes lanceolate, ca. 4 × 1.5 mm, 3-veined abaxially, margin entire, apex obtuse; petals white or whitish green, green parallel veins distinct, oblanceolate, ca. 7.8 × 2 mm, 3-veined, base cuneate into a claw ca. 1.5 mm, margin entire; anthers ellipsoid; filaments 1.5–2 mm; staminodes broadened toward the top, 3-lobed, lobes shortly clavate. Ovary semi-inferior or superior, oblong, style ca. 0.5 mm, stigma 3-lobed. Capsule 3-valved. Seeds brown, glossy, oblong.

DISTRIBUTION. It mainly distributes in Qinghai-Tibet Plateau and Hengduan mountain

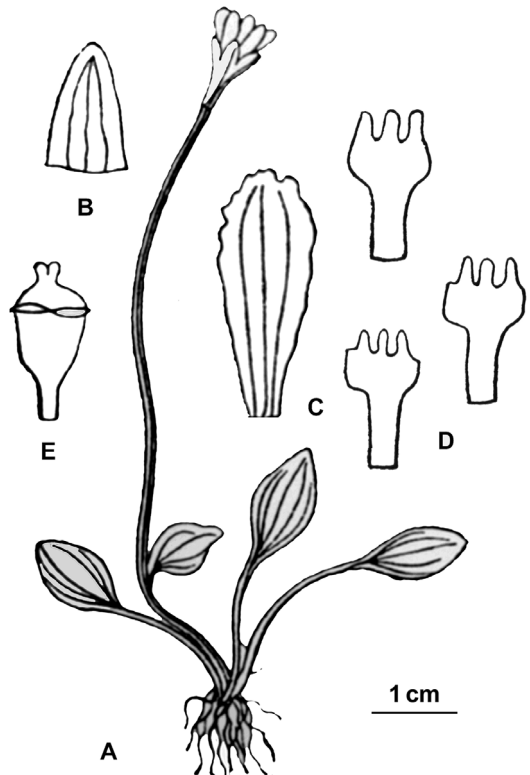


Fig. 4. *Parnassia trinervis* (from *Flora Xizangica*, drawn by Pan Jin-tan & Wang Ying). — **A:** Plant. — **B:** Sepal. — **C:** Petal. — **D:** Staminode. — **E:** Ovary.

regions of China (e.g. Yunnan, Qinghai, Sichuan, and Gansu) (Fig. 3), and neighbouring mountains of northern India.

ECOLOGY. In valleys, marshy meadows, and/or on river banks.

PHENOLOGY. Flowering from July to August, fruiting September.

Identification key of species of *Parnassia* sect. *Saxifragastrum*

NOTE: According to Engler (1930), the staminode anatomy of *P. faberi* and *P. petitmenginii* is significantly different, supporting their re-evaluation as two distinct species. For this reason we here treat the latter as a distinct species, despite its apparent macro-morphological affinity with *P. faberi* (i.e. basal leaves numerous).

1. Basal leaves numerous, forming a rosette 2.
1. Basal leaves few, 3–5(–8), not forming a rosette 3.
2. Petals broadly elliptic; staminodes knoblike at apex; sepals oblong; cauline leaf borne near middle of stem 1. *P. petitmenginii*
2. Petals narrowly obovate-spatulate; staminodes sublingulate at apex; sepals lanceolate; cauline leaf borne near apex of stem 2. *P. esquirolii*
3. Basal leaf ovate-cordate, ovate-reniform, petals white, whitish green or green; staminodes often indistinctly 3-crenate at apex or entire 3. *P. yunnanensis*
3. Basal leaf blade reniform, deeply cordate at base, petals green; staminodes rounded at apex 4.
4. Plants 15–30 cm tall; petals lanceolate to oblong-lanceolate 4. *P. longipetala*
4. Plants 5–11 cm tall; petals broadly obovate 5. *P. tenella*

SPECIMENS EXAMINED. *Parnassia yunnanensis*. C. S. Liu 1028 (PE), 883 (PE); C. W. Wang 64660 (PE), 68611 (PE, KUN); D. Wu 02016 (KUN); D. Wu & J. M. Lu 03005 (KUN); D. Wu et al. 05005 (KUN); G. Forrest 6154 (K, E); H. Wang 030 (KUN), 040 (KUN); Handel-Mazzetti 7023 (K); J. F. Rock 5255 (E); Jinshajiang Exped. 636118 (PE, KUN); K. M. Feng 1802 (PE, KUN), 1648 (KUN), 6209 (PE, KUN); Qinghai-Xizang Exped. 14963 (KUN); T. T. Yu 12085 (PE, KUN), 12254 (KUN), 9080 (KUN), 8758 (KUN), 8758 (KUN), 9080 (KUN). — *Parnassia trinervis*. Anonymous 1974 (PE), 7506 (PE), 6598 (PE); C. Ho & Z. L. Chou 13742 (PE); C. W. Wang 70193 (PE), 68447 (PE); C. Y. Wu 780 (HNWP); D. D. Tao 10855 (HNWP); F. Ludlow & G. Sherriff 8496 (E), 8882 (E), 11129 (E); G. H. Cave 148 (E); G. L. Chu 4122 (PE); H. Wang 03065 (KUN); J. M. Liu 5976 (PE), 6227 (PE); J. Y. Lang 9853 (KUN); K. C. Kuan & W. T. Wang 704 (PE), 1030 (PE); K. C. Kuan 77212 (PE); K. J. Fu 8476 (KUN); K. M. Feng 2277 (KUN), 23323 (KUN); L. H. Zhou & L. N. Sun 1599 (HNWP); Maqin Exped. 366 (HNWP); Nanshuibeidiao 02535 (PE), 06426 (KUN); P. C. Ku & T. N. Ho 9464 (HNWP); P. C. Ku 702 (HNWP), 399

(HNWP), 927 (HNWP), 6299 (KUN), 1382 (HNWP); P. C. Kuo & W. Y. Wang 12094 (HNWP), 22874 (HNWP); Q. Du 0271 (HNWP); Q. Q. Wang 7549 (PE); Qinghai-Xizang Exped. 5573 (KUN), 6050 (KUN), 6430 (HNWP), 12704 (KUN), 14235 (KUN), 004963 (PE, KUN); R. J. D. McBeath 1529 (E); S. Jiang 6426 (PE), 02535 (PE); S. W. Liu & D. S. Luo 1554 (HNWP); S. X. Wang 146 (HNWP); S. Z. Zhang 631036 (HNWP); Sichuan Veg. Exped. 7506 (PE), 6598 (PE), 7549 (PE); T. N. Ho 00197 (HNWP), 2249 (HNWP); T. N. Ho, B. Bartholomew & M. Gilbert 702 (E, BM, HNWP), 399 (E, BM, HNWP), 927 (BM, HNWP), 1382 (E, BM, HNWP), 1539 (BM, HNWP), 1768 (E, BM, HNWP), 2114 (BM, HNWP), 2365 (BM, HNWP); T. P. Wang 1791 (PE), 20215 (HNWP), 7552 (PE), 5782 (PE), 5708 (PE); T. T. Yu 7751 (KUN), 9264 (PE), 12743 (PE, KUN), 9211 (PE, KUN); P. C. Tsong 8689 (PE); W. K. Chou & C. Ho 10755 (PE); W. P. Fang 36582 (PE); X. J. Yang 1985 (PE, KUN, HNWP); X. L. Jiang 36582 (PE); Xizang Exped. 2104 (HNWP); Y. C. Yang 01326 (HNWP, KUN); Y. F. Huang 3378 (HNWP); Y. H. Wu 3262 (HNWP), 4191 (HNWP); Z. D. Wei 22120 (HNWP); Z. H. Zhang 4777 (HNWP); Zangyao Exped. 907 (HNWP), 1303 (KUN); Zhongdian Exped. 1653 (PE), 2148 (KUN).

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References

- Drude, O. 1875: Über die Blüthengestaltung und die Verwandtschaftsverhältnisse des Genus *Parnassia*, nebst einer systematischen Revision seiner Arten. — *Linnaea* 39: 239–324.
- Engler, A. 1930: Saxifragaceae. — In: Engler, A. & Prantl, K. (eds.), *Die natürlichen Pflanzenfamilien* 18(a): 178–182. W. Engelmann, Leipzig
- Evans, W. E. 1921: *Parnassia* sp. nov. — *Not. Bot. Garden Edinb.* 13: 172–175.
- Franchet, A. 1897: Les *Parnassia* de l'Asie Orientale. — *Bull. Soc. Bot.* 44: 244–263.
- Gu, C. & Hultgård, U. M. 2001: *Parnassia*. — In: Wu, C. Y. & Raven, P. H. (eds.), *Flora of China* 8: 95–118. Sci. Press, Beijing & Missouri Bot. Garden Press, St. Louis.
- Handel-Mazzetti, H. 1941: Die Chinesischen *Parnassia*-Arten. — *Oesterr. Bot. Zeitschr.* 90: 127–136.
- Hultgård, U. M. 1987: *Parnassia apulstris* L. in Scandinavia. — *Acta Univ. Upsal./Symb. Bot. Upsal.* 28: 1–128.

- Ku, T. C. 1987: [A revision of the genus *Parnassia* (Saxifragaceae) in China]. — *Bull. Bot. Res.* (Harbin) 7: 1–59. [In Chinese].
- Ku, T. C. 1995: Parnassioideae Engl. — In: Lu, L. & Hwang, S. (eds.), *Flora Reipublica Popularis Sinicae* 35(1): 1–66. Sci. Press, Beijing. [In Chinese].
- Fedchenko, B. A. [Федченко, Б. А.] 1917: [*Flora of Asian Russia, II: Saxifragaceae*]. Petrograd. [In Russian].
- Nekrasova, V. 1927: Les *Parnassia* de la section Nectarotri-lobos. — *Bull. Soc. Bot.* 74: 635–655.
- Phillips, R. B. 1982: *Systematics of Parnassia (Parnassiaceae): Generic overview and revision of North American taxa*. — Ph.D. thesis, Univ. California, Berkeley.
- Simmons, M. P. 2004: Parnassiaceae. — In: Kubitzki, K. (ed.), *The families and genera of vascular plants*, 6: 291–296. Springer, Berlin.
- Wu, Z. Y., Lu, A. M., Tang, Y. C., Chen, Z. D. & Li, D. Z. 2003: *The families and genera of angiosperms in China, a comprehensive analysis*. — Science Press, Beijing. [In Chinese].