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 staminode, 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 Nekrasova (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. longipetaloides* Drue...
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.
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.

<table>
<thead>
<tr>
<th>Species</th>
<th>Habit</th>
<th>Flowers</th>
<th>Leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. yunnanensis</em></td>
<td>stems 1–3, 4–8 cm long, with a bract-like leaf distally or near apex</td>
<td>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</td>
<td>blade 6–9 mm long, ovate-cordate or reniform, apex obtuse, base</td>
</tr>
<tr>
<td><em>P. longipetaloides</em></td>
<td>stems 1–2, 2.7–4 cm long, with a bract-like leaf distally</td>
<td>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</td>
<td>deeply cordate blade 4–7 mm long, ovate-reniform, apex obtuse, base cordate</td>
</tr>
<tr>
<td><em>P. angustipetala</em></td>
<td>stems 1–3, 2.5–4 cm long, with a bract-like leaf distally or near apex</td>
<td>petals green, spatulate or ovate-oblanceolate, 5–7 mm, entire or indistinctly erose; staminodes terete, ca. 1.5 mm, apex rounded</td>
<td>blade 5–7 mm long, ovate-cordate, apex obtuse, base cordate</td>
</tr>
<tr>
<td><em>P. yulongshanensis</em></td>
<td>stems 1–3, 1.5–2 cm long, with a bract-like leaf near apex</td>
<td>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</td>
<td>blade 4–5 mm long, ovate-reniform, apex obtuse, base cordate</td>
</tr>
<tr>
<td><em>P. yanyuanensis</em></td>
<td>stems 1 or 2, 3–4 cm long, with a bract-like leaf distally or near apex</td>
<td>petals yellowish, obovate-oblong, 4–5 mm, 3-veined, erose below; staminodes terete, ca. 1 mm, tips discoid, and rim rounded</td>
<td>blade 6–11 mm long, ovate-cordate, apex obtuse, base cordate</td>
</tr>
<tr>
<td><em>P. humilis</em></td>
<td>stems 1–3, 3–5 cm long, with a bract-like leaf near base</td>
<td>petals white, elliptic or oblong, 6–7 mm, 3-veined, indistinctly erose or subentire; staminodes terete, ca. 2 mm, 3-lobed, lobes very short</td>
<td>blade 8–14 mm long, ovate-trianglar, apex acuminatae, base attenuate</td>
</tr>
</tbody>
</table>

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


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 semiobicular, 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 semiobicular, 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-oblanceolate, 3–7 mm long, margin entire to densely erose or shortly fimbriate, apex emarginated; 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).


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 semi-orbicular, 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, ob lanceolate, 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 regions.
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. 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. Petals narrowly obovate-spatulate; staminodes sublinear at apex; sepals lanceolate; cauline leaf borne near apex of stem ........................................ 2. Petals narrowly obovate-spatulate; staminodes sublinear at apex; sepals lanceolate; cauline leaf borne near apex of stem ........................................ 3. Basal leaf blade reniform, deeply cordate at base, 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
   5. Plants 5–11 cm tall; petals broadly obovate .......................... 5. P. tenella

Specimens examined. Parnassia yunnanensis. C. S. Liu 1529 (KUN), 6029 (HNWP); C. 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 (PE, KUN); K. M. Feng 1802 (KUN), 7506 (KUN). — Parnassia trinervis. Anonymous 1974 (PE), 7506 (PE), 6598 (PE); C. Ho & Z. L. Chou 13742 (PE); C. Wang 70193 (KUN), 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. Yang 9853 (KUN); K. C. Kuan & W. T. Wang 704 (PE), 1030 (PE); K. C. Kuan 7712 (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); Zanyao Exped. 907 (HNWP), 1303 (KUN); Zhongdian Exped.1653 (PE), 2148 (KUN).

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