



New names in *Heteropolygonatum* (Asparagaceae)

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Abstract

Heteropolygonatum has been considered endemic to China, but molecular analyses and morphological observation of type and living collections necessitate the transfer of several *Polygonatum* to the former: *Heteropolygonatum alternicirrhosum*, *H. anomalum*, *H. marmoratum*, and *H. parcefolium*, which expands the range of the genus to neighboring Vietnam where *H. marmoratum* has been collected. Discussion of their morphology, perigone images, distribution, and full synonymy are given for the species transferred herein. Discussion of the distinctive generic morphology and karyotypes are provided in relation to their generic placement. Furthermore, the expansions of the provincial distributions of *H. ginfushanicum* and *H. roseolum* are given based on examination of herbarium material. A synoptic key to the genus is provided.

Key words: cytology, endemic, *Polygonatum*, Vietnam

Introduction

During systematic studies on *Heteropolygonatum* Tamura & Ogisu in Tamura *et al.* (1997: 950) (Asparagaceae: Reveal & Chase 2011) and *Polygonatum* Miller (1754: without pagination) several species of *Polygonatum* were noted to have perigone morphology composed of imbricate tepals that ally them with the former genus. Preliminary molecular analyses of whole plastids and a limited number of nuclear loci from these species (A. Floden, in preparation) support the reciprocal monophyly of *Heteropolygonatum* and *Polygonatum* confirming that they are distinct. As a result this necessitates the inclusion of *Polygonatum anomalum* Hua (1892: 420), *P. alternicirrhosum* Handel-Mazzetti (1936: 1209), and *P. marmoratum* Lévillé (1909: 384) as members of *Heteropolygonatum*. These same data support the recent transfer of *H. altelobatum* (Hayata 1915: 229) Chao *et al.* (2013: 91). In addition to these species, *P. parcefolium* Wang & Tang (1949: 216) which is known from its type collection and one additional collection is also transferred to *Heteropolygonatum* based on examination of the type collection and paratypes. All of these except *P. alternicirrhosum* have resided under the morphologically dissimilar Himalayan *P. punctatum* Royle ex Kunth (1850: 142) (Chen & Tamura 2000). Although they have been synonymized in recent floristic treatments (Chen & Tamura 2000, Tang 1978), Jeffrey (1980) considered many of these distinct and considered them closely related to one another based on morphology which is corroborated by my own morphological comparisons and molecular data. *Heteropolygonatum* has also been considered to be endemic to China (Wu *et al.* 2007, Chen & Tamura 2000), but *H. marmoratum* has been collected from one site in Vietnam.

Heteropolygonatum is distinguished from *Polygonatum* by two distinctive features, though other morphological characters were utilized initially. The perigone in *Heteropolygonatum* is imbricate whereas the perigone in *Polygonatum* is valvate (Chen & Tamura 2000, Tamura & Ogisu 1997). Additionally, their base chromosome number is $x = 16$ and is distinctly bimodal vs. the lower, although variable basic chromosome number and asymmetric karyotype in *Polygonatum*, $x = 9–15$ (Deng *et al.* 2009, Tamura & Xu 2001, Yamashita & Tamura 2001, Chen & Tamura 2000, Tamura *et al.* 1997a–b). Pseudoterminal inflorescences were considered diagnostic for the genus but these are also observed in several *Polygonatum* species (Floden 2014). Other morphological characters formerly utilized were the ebracteate pedicels and/or peduncles, but all species of *Heteropolygonatum* thus far observed have distinct bracts that vary from subulate and persistent to caducous, and this shows the same range of variation seen in *Polygonatum* species. Dimorphic filament insertion was also utilized initially, but this feature was not consistent (Bao *et al.* 1998). Other morphological characters are shared among the known *Heteropolygonatum* species: pseudo-petiolate leaves distinctly

arched above the plane of the stem; fasciculate inflorescences or sometimes pedunculate inflorescences; moniliform to torulose rhizomes with thick wiry roots; epiphytic or lithophytic habitat; short tapered staminal filaments; style and ovary subequal in length; orange-red to yellow-orange fruit; and ellipsoid seeds.

The chromosome count reported here for *H. marmoratum* ($2n = 4x = 64$) and counts reported in the literature for *H. alternicirrhosum* ($2n = 32$; Chen 1989, Zhao *et al.* 2014) also support the generic transfer of these species.

Material and methods

Somatic chromosome analyses were performed from root tips of one genet each of *Heteropolygonatum marmoratum* from plants cultivated by the author. These were compared to other *Heteropolygonatum* (Tamura & Xu 2001, Yamashita & Tamura 2001, Tamura *et al.* 1997). Excised root tips were fixed in 1:4 ratio 0.2% aqueous colchicine and 0.0001 M 8-hydroxyquinoline solution at 20 °C for 4 hours, then fixed in 3:1 GAA:ETOH solution for 5–10 min. Hydrolytic maceration was performed with 1 N HCl at 60 °C for 6 minutes. Material was rinsed and then stained in aceto-orcein for 20 minutes at 60 °C. Multiple root tip squashes from each sample and multiple cells in metaphase from each squash were observed and photographed with a Zeiss Axioskop microscope and images were taken at 1000× using AxioVision Rel. 4.8 (Carl Zeiss MicroImaging GmbH, Germany).

Morphological comparisons of specimens and living plants (*Heteropolygonatum alternicirrhosum*, *H. anomalum*, and *H. marmoratum*) were made by the author under a stereomicroscope and pertinent features photographed. Digital images of types and specimens (or images) were observed from the following herbaria: BM, CBDI, E, GB, IBSC, K, KUN, MO, P, PE, TAIF (acronyms following Thiers 2014). The holotype of *H. marmoratum* has not been located though it was stated in Jeffrey (1980) that it was housed at LE. New provincial records are marked with *.

Results

The chromosome count reported here for *Heteropolygonatum marmoratum* is $2n = 4x = 64$ (Fig. 1). The karyotype has 10 long pairs with subterminal constrictions and the remaining 22 short pairs with subterminal or median constrictions. Morphological observations of cultivated material of these species shows that each of them have a perigone with imbricate tepals, short tapered filaments, an ovary and style that are subequal in length (Fig. 2), and fasciculate inflorescences. On the basis of these morphological and cytological comparisons *Polygonatum alternicirrhosum*, *P. anomalum*, *P. marmoratum*, and *P. parcefolium* are transferred to *Heteropolygonatum*. An enumeration of pertinent diagnostic features is presented below (Table 1).

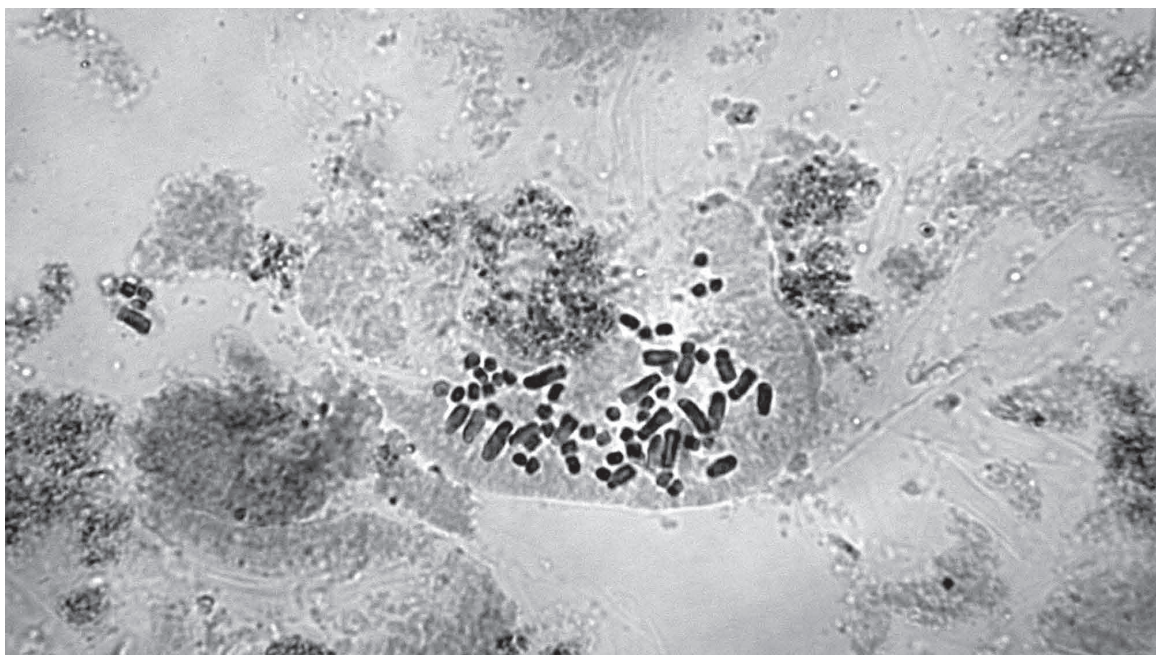


FIGURE 1. Somatic chromosome squash preparation of *Heteropolygonatum marmoratum*, cultivated by the author, $2n = 4x = 64$, Chen Yi *s.n.*

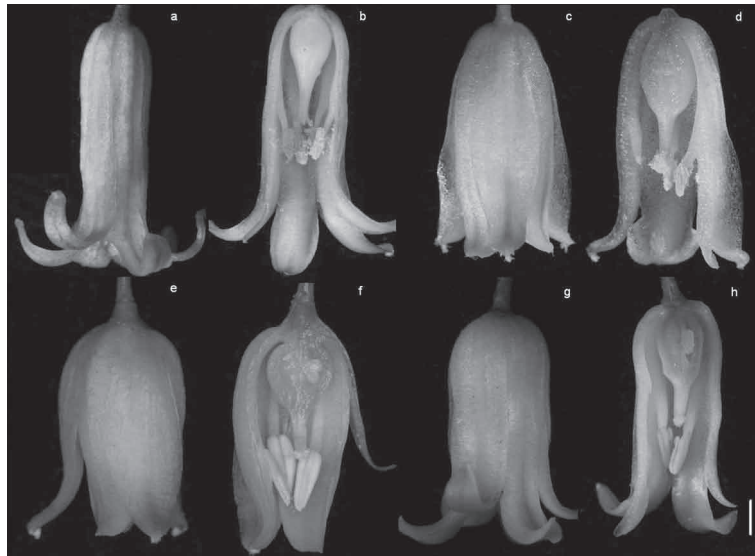


FIGURE 2. Flowers of *Heteropolygonatum* species showing: left; imbricate tepals; and right; dissected perigone showing filament insertion level and ovary-to-style ratio: **a, b**; *Heteropolygonatum anomalum*, *B. Olsen s.n.* (TENN); **c, d**; *H. marmoratum*, *C. Yi s.n.* (TENN) **e, f**; *H. alternicirrosus*, *C. Yi s.n.* (TENN); **g, h**; *H. marmoratum*, *B. Olsen 13-086* (TENN). Scale bars 2 millimeters.

TABLE 1. A table of the pertinent diagnostic morphological characters of the 10 species of *Heteropolygonatum*. The “perigone” column indicates the length of the perigone, the shape, and then the color. The “filament” column first provides the position at which the staminal filament is free from the perigone wall, i.e. the non-connate portion, followed by the length of the free portion, and then its surface texture. All measurements are in millimeters. “-” indicates missing data.

species	stem	leaf	perigone	filament	anther
<i>H. altelobatum</i>	glabrous	ovate	8–10, campanulate, greenish	middle 1/3, 0.7–1, scabrellous	oblong, ca. 1
<i>H. alternicirrhosum</i>	glabrous	elliptic, cirrhose	8–10, campanulate, whitish	middle 1/3, ca. 1, smooth	oblong, ca. 1
<i>H. anomalum</i>	scabrellous	elliptic-ovate	9–12, cylindric, pink	near middle, ca. 1, smooth	oblong, 1.5
<i>H. ginfushanicum</i>	glabrous	ovate	6–8, campanulate, greenish	middle, ca. 1, -	ovate, 0.7–1
<i>H. marmoratum</i>	hirtellous	lance-ovate	8–11, campanulate, greenish-white	middle, 0.8–1.5, scabrous	lanceolate, 1.5–2
<i>H. ogisui</i>	glabrous	ovate-oblong	14–15, campanulate, pink	proximal 1/3, 0.3–0.7, -	lanceolate, 1.8–2.2
<i>H. parcefolium</i>	puberulent	elliptic	6–8, cylindric, pinkish	middle, -, glabrous	lanceolate, 2.5
<i>H. pendulum</i>	glabrous	linear-falcate	9–13, campanulate, white	distal, 1–2, verrucose	lanceolate, 2.5–3
<i>H. roseolum</i>	glabrous	elliptic	14–16, cylindric, pinkish-green	middle, 1–1.5, smooth	lanceolate, 2
<i>H. xui</i>	glabrous	elliptic	9–12, campanulate, whitish-pink	middle, 0.8–1, -	lanceolate, 1.5–2

All *Heteropolygonatum* are mapped from the specimens examined and their distributions plotted from estimated, or given GPS locations (Fig. 3).

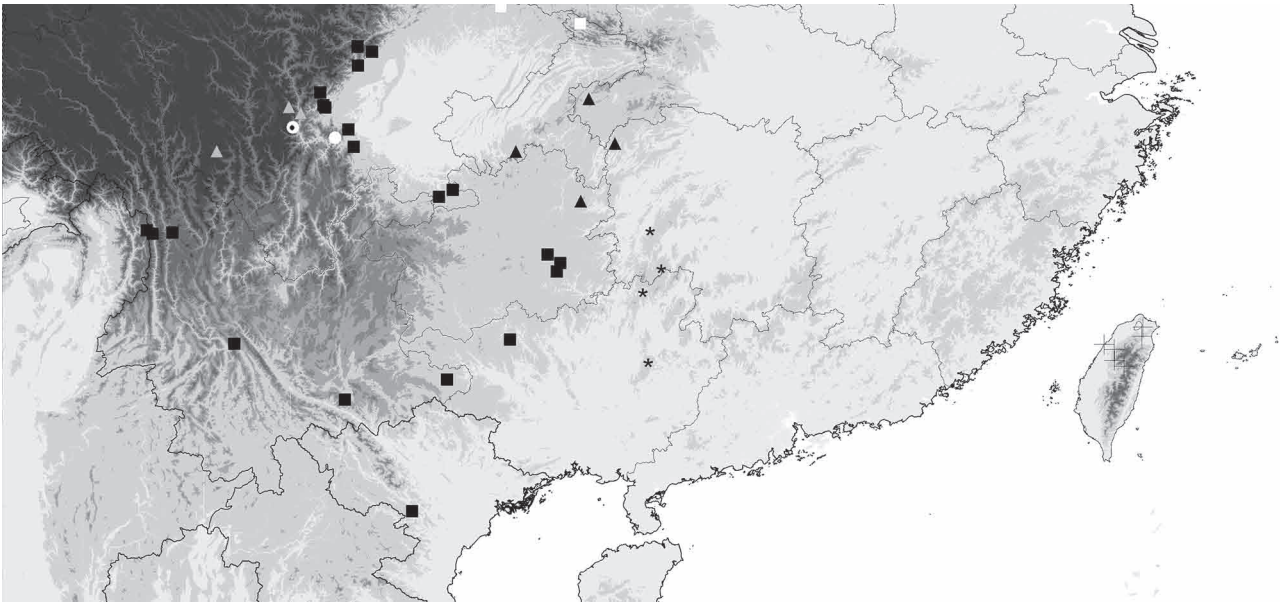


FIGURE 3. Map of China and neighboring countries showing the distribution of *Heteropolygonatum* species in southwest China. *Heteropolygonatum anomalum* and *H. pendulum* = white circle with black center, *H. alternicirrhosum* = grey triangles, *H. ginfushanicum* = black triangles, *H. marmoratum* = black squares, *H. ogisui* and *H. xui* = white circle, *H. parcefolium* = white squares, *H. roseolum* = black star, and *H. altelobatum* = black +. All localities are plotted from label data or estimated coordinates from specimens.

Discussion

The transfer these species to *Heteropolygonatum* increase the genus to ten species. The expansion of the genus increases its distribution southwest outside of China into neighboring Vietnam (Fig. 3). In addition, the distributions of *H. ginfushanicum* (Wang & Tang 1978: 249) Tamura *et al.* (2000: 157) and *H. roseolum* Tamura & Ogisu (1997: 951) are documented to occur each in two further provinces. Furthermore, these additions show consistent morphology of the imbricate nature of the perigone, orange to orange-red fruit color, the distinctive pseudopetiolate leaf, and epiphytic or lithophytic habitat. These transfers, many of which are currently treated as synonyms of *P. punctatum*, further reduce that species distribution to the Sino-Himalaya and westward to Nepal (see also Floden 2014). All of the species of *Heteropolygonatum*, except for *H. marmoratum*, have extremely limited total distributions, i.e. five of the species are known from fewer than a dozen collections, but most of these from a single, or a few locations. Also, *H. marmoratum*, with its broadly scattered disjunct population “islands”, its breadth of morphological variation, and potential polyploidy suggests that further cryptic species may exist. Last, that several pairs of highly dissimilar species grow syntopically without obvious hybridization, and that the remaining species occur in scattered disjunct populations suggests that dispersal limitations (likely ornithochory), self-fertility, or polyploidy might be crucial factors in their evolution.

Fruit Color and Seed shape:—While the fruit color of *Heteropolygonatum* species shows overlaps with some *Polygonatum* the seeds of the former are distinctly elliptic, rather than ovoid with angular edges or spherical like *Polygonatum*. Seeds of *H. anomalum* and three accessions of *H. marmoratum* are elliptic whereas *Polygonatum* seeds are usually spherical. Fruit color of *Heteropolygonatum* seems to be consistently vermilion/scarlet or orange-yellow and has been observed on plants photographed *in situ* and *H. anomalum* and *H. marmoratum* in cultivation. My plants of these two species set fruit without cross pollination which suggests the possibility of partial self-fertility. Fruits of *H. marmoratum* from Sichuan mature orange-yellow which matches the label data of numerous specimens as well as the protologue of *P. marmoratum* (Léveillé 1909) though this character was not mentioned by Jeffrey (1980). Conversely, plants of *H. marmoratum* from western Yunnan have red ripe fruit.

Habitat and epiphytism:—Habitat of all *Heteropolygonatum* has thus far been documented as epiphytes in mid- to upper-elevation temperate forests dominated by *Abies* Mill. or *Picea* A.Dietr., or as lithophytes where they grow in mossy rocks. *Heteropolygonatum anomalum* is epiphytic in the mossy forests in Hailuoguo Valley on Mt. Gongga where it grows as an epiphyte on the branches of *Abies fabri* (Mast.) Craib, *Sorbus multijuga* Koehne, *S. rehderiana* Koehne, and *Rhododendron* species at altitudes of 2500–4000 m (Figure 3). *Heteropolygonatum ogisui* Tamura &

Xu (2001: 92) and *H. xui* W.K.Bao & M.N.Tamura in Bao *et al.* (1998: 143) also grow as epiphytes in *Abies fabri* dominated forests (Tamura & Xu 2001).

Taxonomic treatment

Heteropolygonatum alternicirrhosum (Hand.-Mazz.) Floden, *comb. nov.*

Basionym: *Polygonatum alternicirrhosum* Handel-Mazzetti (1936: 1209). Type:—CHINA. Sichuan: S.: Kalkschutt in der str. t. ober Lumapu im Seitentale des Yalung gegen Yenyüen, 27° 40', 1750 m, 10 May 1914, *Handel-Mazzetti 2108* (holotype W!; isotypes E!, GH!).

= *Polygonatum racemosum* Wang & Tang (1937: 286). Type:—CHINA. Sichuan: Tung Valley, June 1904, *Wilson 4667* (holotype K!; isotypes BM!, PE!).

Distribution:—China, Sichuan.

Taxonomic relationships:—Handel-Mazzetti (1936) and Tang (1937) both considered this species as the intermediate between the alternate leaved clade of *Polygonatum* and the verticillate species, some of which, like this species, have cirrhose leaf apices. This species is similar in appearance and probably closely related to the sympatric *Heteropolygonatum pendulum* (Liu & Hu 1984: 426) Tamura & Ogisu (1997: 951), but that species differs in its long falcate leaves, inflorescences held horizontally, and the plants strictly pendent (Tamura *et al.* 1997). Chen (1989) reported a chromosome number and karyotype of this species from Luding, Sichuan as $2n = 32$. Zhao *et al.* (2014) reported two additional counts from Kanding which match the previous in number and karyotype. Both studies reported karyotypes that are distinctly bimodal with 5 pairs of longer subterminal chromosomes and the remaining eleven distinctly shorter and metacentric. This species is known from only a few collections all from a limited area along the Dadu River.

Other specimens examined:—CHINA. Sichuan: Luding County, Dadu cable bridge, 2 May 1974, *Sichuan Veg. Team 6802* (CDBI!); Daocheng County, Kahn, 2 June 1971, *Liu 0091* (CDBI!); Kanding County, April 1974, *Y. Wu & Q. Zhao 110850* (CDBI!).

Heteropolygonatum anomalum (Hua) Floden, *comb. nov.*

Basionym: *Polygonatum anomalum* Hua (1892: 420). Type:—CHINA. Western Sichuan and Tibetan Frontier: chiefly near Tachienlu, at 9000–15000 feet, s.d., *Pratt 41* (holotype P!; isotypes BM!, K!).

Distribution:—China, Sichuan, only known from Gongga Shan, 2400–4000 m.

Taxonomic relationships:—Hua (1892) doubted his initial placement of this species in *Polygonatum* due to the imbricate perigone and the combination of the ovary to style ratio and the short filaments which are not known in the alternate leaved species (see also Hayata, 1911 who doubted his own generic placement of the recently transferred *H. altelobatum*). *Heteropolygonatum anomalum* is sympatric with *H. pendulum*, but *H. anomalum* is much rarer at the lower elevation where *H. pendulum* grows (Liu & Hu 1984, B. Olsen pers. comm., Yang *et al.* 2012). These two species are clearly distinguishable based on morphology. *Heteropolygonatum anomalum* is also geographically proximal and morphologically similar to *H. ogisui* which grows on Wawu Shan 100 km to the southeast where it is syntopic with the highly dissimilar one or two-leaved and one-flowered *H. xui*. *Heteropolygonatum anomalum* differs from *H. ogisui* by the following characters: a scabrellous stem (vs. smooth); non-glaucous abaxial leaf surfaces (vs. distinctly white-glaucous); perigone length 9–12 mm (vs. 14–15); a cylindrical perigone (vs. campanulate); and different intrafloral measurements (Table 1). It also differs in having a slightly scabrellous stem whereas *H. ogisui* is reportedly smooth.

Other specimens examined:—CHINA. Sichuan: 29 June 1982, *Lang 307* (KUN!, PE!); *ibidem*, 2 June 1983, *Veg. Grp. 30873* (CDBI!); *ibidem*, 8 June 1980, *Wang & Liu 22168* (CDBI!); *ibidem*, 1 June 1980, *Wang and Liu 22434* (CDBI!); *ibidem*, May 1904, *Wilson 4663* (P!, K!); *ibidem*, 9 June 1981, *Xu 25517* (CDBI!); *ibidem*, October 1981, *Xu 26317* (CDBI!).

Heteropolygonatum marmoratum (H.Lév.) Floden, *comb. nov.*

Basionym: *Polygonatum marmoratum* Léveillé (1909: 384). Type:—CHINA. Yunnan: Maire in Herb. *Bonati* 436 (holotype LE).

= *Polygonatum longipedunculatum* Liang (1987: 64). Type:—CHINA. Sichuan: Leibo, Xi Ning Xiang, He Tao Ping, 1820 m, 5 July 1959, *Z.T. Guan* 7904 (holotype PE!).

= *Polygonatum sino-mairei* Wang & Tang (1936: 84) ≡ *Disporopsis mairei* Léveillé (1912: 303). Type:—CHINA. Yunnan: Pied des rochers a Tong-Tchouan (Dongchuan), 2700 m, June 1910, *R.P. Maire* 7459 (holotype E!), non *Polygonatum mairei* Léveillé (1912: 302), non *P. mairei* Léveillé (1909: 384), *nom. illeg.*

Distribution:—China (Guizhou, Sichuan, Yunnan) and Vietnam (Son La). Largely following the uplift and limestone formations of the Yunnan-Guizhou Plateau, 1000–3000 m.

Taxonomic relationships:—Despite not having seen the type collection, the list of synonymic types matches the plants currently cultivated by myself, and Jeffrey (1980) considered all these synonyms, other than *P. longipedunculatum*, as within the range of variation of a species-concept. Nonetheless, future work may reveal that *Heteropolygonatum marmoratum*, as treated here, encompasses several discrete taxa. *Heteropolygonatum marmoratum* is distinct from *H. anomalum* and *H. parcefolium* by its fascicled or long pedunculate inflorescences bearing whitish to greenish campanulate flowers, its overall larger plant size, and by cytology. The leaves are usually lustrous adaxially and abaxially, but sometimes they are whitish pruinose abaxially (at least in Guizhou and Yunnan). A broad species concept is taken here until additional material is available for molecular analyses. This species and its relatively broad distribution present a perplexing issue relative to the narrow distributions of most of the other species. It is also the only species to occur outside China where it has been collected once in Vietnam. It should also be expected in Myanmar along its border with Yunnan. Within the large area of distribution there are morphological variations that require additional examination in combination with molecular analyses and cytological studies. The perigone shape of the two forms pictured here (Fig. 2) are distinctly different as is the overall morphology of the plants, i.e. some plants are distinctly glaucous on the abaxial leaf surface whereas others are lustrous-green. The single count reported here is tetraploid ($2n = 4x = 64$) (Fig. 1). A second report, of what is probably this species, under the name *P. punctatum* from Jinfoshan, Chongqing (Chen 1989) may belong here that is $2n = 2x = 32$ which would support the recognition of more than one species.

Other specimens examined:—CHINA. Guizhou: Leishan, 7 July 1965, *anon.* 51213 (KUN!, PE!); Kaili-Xijiang, 21 May 1959, *Qiannan Team* 2077 (PE!); Sichuan: Emei Shan, s.d., *W.J. Zheng* 10500 (KUN!); Emei Shan, 5 September 1927, *TY Zhou et G. Xu* 511 (PE!); Emei Shan, 24 June 1952, *J.L. Xiu and X. Jinhua* 31281 (IBK!, PE!); Meigu County, 2 July 1976, *anon.* 13564 (CBDI!); Mabian Yi Co., Xiaoliangshan, 1930, *F.T. Wang* 23065 (PE!); [near Meigu], 27 July 1959, *sine coll.* 1473 (KUN!, PE!); E side of Longdanxi, Erlang Mt., 12 August 1961, *Chang and Zhu* 09950 (PE!); Liangshan, 23 May 1959, *anon.* 0977 (PE!); Chungchou City, Kouchia Forestry Centre, 1200 m, 13 August 2003, *P. Wei et L.J. Yang* 604 (TAIF!); Wenchuan Co., Qipangou, 1200 m, 12 August 2004, *K. Xiong and Y.J. Zou* 590 (TAIF!); Dayi Co., Taiping township, 1200m, 16 July 2004, *T.X. Shen and L. Ren* 1600 (TAIF!); Pengzhau City, Yingchanggou, 1200 m, 4 July 2003, *P. Wang and J.S. Wu* 1044 (TAIF!); Dujiangyan City, Dashuigou, 1200 m, 3 September 2004, *D.H. Zhu, T. Shang, and S.K. Liu* 3100 (TAIF!); Yunnan: E side of Gaoligongshan, W of Gonshan, 10 July 2000, *L. Heng* 12249 (MO!); *ibidem*, *Liou* 20264 (PE!); Kunming, 7 July 1946, *Liou* 16215 (PE!); Barrulah, Salween Chikiang divide, October 1935, *C.W. Wang* 67583 (PE!); Weixi, November 1935, *C.W. Wang* 70451 (KUN!); Siao-tske-y, July, *Maire s.n.* (P!); Yunnan-sen, 12 July 1904, *Ducloux* 2896 (P!, PE!); Tchong-chan, 12 June 1905, *Ducloux* 3537 (P!, PE!); Kia Kia, June 1909, *Ducloux* 6124 (P!, PE!); Xishan Forest Park, SW Kunming, 21 May 1993, *Alden, B., Alexander, J.C.M., Long, D.G., McBeath, R.J.D., Noltie, H.J., and M.F. Watson*, *KEG* 10 (GB!); Lunan Xian, Changhu, 2 August 1984, *Bartholomew, B. Boufford, D.E.; Li, H.W., Ma, C.G.; Nicolson, D.H.; Ying, T.S., Yu S.W* 1587 (MO!); Kunming, 8 June 1908, *Tsoong* 2076 (PE!); Longwan, 17 August 1972, *anon.* 51 (KUN!); Jingdong, 13 November 1956, *B. Qiu* 53269 (KUN!); Kunming, Xishan, 9 July 1958, *B. Qiu* 57110 (KUN!); Kunming, March-May 1939, *J. Ying* 16481 (KUN!); Kunming, near San-Ching-Ke, Xishan, 21 June 1945, *S. Liou* 13665 (PE!); Kunming, Sanqing, Xishan, 11 May 1946, *S. Liou* 16106 (PE!); Kunming, Xishan, 1941, *S. Liou* 20264 (PE!). VIETNAM. Son La: Hua Tat village, 7 October 2000, *D.K. Harder, N.T.Hiep, N.Q. Hieu, A.L. Thomas, and P. Manos* 5819 (MO!).

Heteropolygonatum parcefolium (F.T.Wang & Tang) Floden, *comb. nov.*

Basionym: *Polygonatum parcefolium* Wang & Tang (1949: 216). Type:—CHINA. Su-tchuen[Sichuan]: oriental: district de Tchen-kéou-tin [Chengkou], 1800 m, 15 Juin 1893, *Farges* 1184 (holotype image PE00223239!; isotypes K!, KUN!, P!, PE!).

Distribution:—China, Chongqing, Sichuan, 1300–1800 m.

Taxonomic relationships:—Wang & Tang (1949) based this species on Farges collections from eastern Sichuan. Farges seems to have made two collections of this species; one large gathering in flower in June of 1893 and a smaller gathering (only one specimen seen) at P in fruit. Since *Heteropolygonatum* fruit in the fall and are deciduous it is highly unlikely that both collections were gathered on the same date. Another collection has Farges handwritten label on it with collection number 1184 and other details of the plant (P00687126!). The specimen that is in fruit, and some of those that are in flower, are annotated by Wang and Tang with the collection number written in the same hand, not the handwriting of Farges. This fruiting specimen is considered to be a paratype, since it was viewed by Wang and Tang, but is not part of the type gathering. Like *Heteropolygonatum parcefolium*, occasional specimens of *H. anomalum* and *H. ogisui* have the lowermost leaf pair borne oppositely on the stem, but unlike the latter two species this species differs in its puberulent stem and in its long pedunculate inflorescences with 2 or more flowers. Despite the limited knowledge of *H. parcefolium* its morphological dissimilarities and disjunction from *H. anomalum* and *H. ogisui* support its recognition as a distinct species.

Other specimens examined:—CHINA. Sichuan: Nanjiang, Hengdian, anon. 2833 (CBDI01659010!); *ibidem*, anon. s.n. (PE00036899!); Su-tchuen, oriental: district de Tchen-kéou-tin [Chengkou], 1800 m, 15 June 1893, Farges 1184 (P00038366!).

Heteropolygonatum ginfushanicum (F.T.Wang & Tang) Tamura *et al.* (2000: 157).

Basionym: *Smilacina ginfoshanica* Wang & Tang (1978: 249) ≡ *Polygonatum ginfushanicum* (F.T.Wang & Tang) Wang & Tang (1983: 261). Type:—CHINA. Chongqing: Nanchuan County, “Gin-fu-shan” [Jinfo Shan], 1730–1800 m, 17 May 1957, T.H. Hsiung *et T.L. Chou* 90841 (holotype PE!; isotypes KUN!).

Specimens examined:—CHINA. Chongqing: Jinfo, 30 May 1957, T.H. Hsiung *et T.L. Chou* 91094 (PE!); Jinfo, 17 May 1957, T.H. Hsiung *et T.L. Chou* 90841 (PE!, KUN!); Guizhou: Jiangkou, 6 May 1964, Z.S. Zhang *et al.* 400642 (PE!); Hubei: Lichuan, 12 October 1939, H.G. Li 11080 (MO!); Hunan: Sangchi County, Mao River, 13 July 1975, Bing 750259 (PE 00036825!)*.

Heteropolygonatum roseolum M.N.Tamura & Ogisu in Tamura *et al.* (1997: 951). Type:—CHINA. Guangxi: Jinxiu, Mt Dayao, c. 1250 m, in dark mossy evergreen broad-leaved forests. Cult. in Yamasaki, Hyogo, Japan, 30 May 1996, Tamura & Ogisu 5028 (holotype PE; isotype K!).

Specimens examined:—CHINA. Guangxi: Pangxidong, 17 May 1957, D. Chen 202 (IBK!); *ibidem*, 13 May 1936, Tsoong 81601 (PE!, IBK!); *ibidem*, Tsoong 82084 (PE!); Gelao, 15 May 1982, F.T.Fang 65245 (PE!); Dayaoshan, 16 June 1958, Y.K. Liu 400365 (IBK!); Miaoshan, 26 June 1959, Qinghua 2551 (HITBC!); Chanpin, 10 Oct 1935, S.P. Ko 55893 (PE!); Mt. Dayao, 30 May 1996, M.N. Tamura *et M. Ogisu* 5028 (isotype K!); Hunan: Dongkou Co., Daping, 20 May 1959, Tan Peixiang 62939 (IBK00139227!)*; Xinning Co., Mt. Ziyun, 9 September 1984, Ziyunshan Exp. 331 (TAIF!)*; Longsheng County, on rocks in moss, 1955, sine coll. 00191 (PE!); *ibidem*, 1954, sine coll. s.n. (IBM!)*.

Taxonomic relationships:—The Hunan Province specimens are in fruit and are tentatively placed here on the basis of morphological similarities and their geographic proximity to *H. roseolum*. Tsoong 81601 from Shune-yuen, Guangxi was attributed to *Heteropolygonatum altelobatum* by Jeffrey (1980) who considered it an insufficient specimen with an affinity to that species. Later collections of this plant became the type species of *Heteropolygonatum* (see Tamura *et al.* 1997). These additional collections reported here from Hunan Province, China expand the provincial distribution northward. Other specimens, despite their less than adequate locality records, confirm a broader distribution in north-central Guangxi (Fig. 3). Based on these range expansions it is probable that its range occurs throughout the Nanling Shan at elevations where suitable habitats are supported.

Identification key to *Heteropolygonatum* (adapted from Tamura & Xu 2004)

- | | | |
|----|--|----------------------------|
| A | Perigone segments connate for 2/3 or more of their length, tepals valvate..... | <i>Polygonatum</i> |
| B | Perigone segments connate <1/2 of their length, tepals imbricate..... | <i>Heteropolygonatum</i> |
| 1. | Leaves with cirrhose or uncinat apices..... | <i>H. alternicirrhosum</i> |
| - | Leaves apices not cirrhose..... | 2 |
| 2. | Stem pendulous, 50–100 cm long; leaf blade fasciate-falcate; leaves 20–40 cm long..... | <i>H. pendulum</i> |

-	Stem ascending, 5–40 cm long; leaf blade lanceolate, oblong, ovate-oblong, or oblanceolate, 3.5–14 cm	3
3.	Stem and pedicels villosulous, hirtellous, or scabrellous, especially prominent in early growth	4
-	Stems and pedicels glabrous.....	6
4.	Perigone whitish-green.....	<i>H. marmoratum</i>
-	Perigone pink.....	5
5.	Inflorescences of individual flowers, rarely twinned	<i>H. anomalum</i>
-	Inflorescences of multiple flowers borne on peduncles	<i>H. parcefolium</i>
6.	Leaves 3–9; stem 10–40 cm long	7
-	Leaves 1–3(–4); stem 5–14 cm long	9
7.	Perigone pink or pink with green lobes; 11–16 mm long.....	8
-	Perigone greenish-white, 6–8 mm long.....	<i>H. altelobatum</i>
8.	Stem 20–40 cm long; leaves 6–9, shiny pale green abaxially, petiolate; perigone cylindric, 14–16 mm long, lobes green.....	<i>H. roseolum</i>
-	Stem 10–22 cm long; leaves 3–5, whitish abaxially, sessile; perigone campanulate, 11–13 mm long, lobes pink.....	<i>H. ogisui</i>
9.	Inflorescence 2–4-flowered; stem 5–14 cm long; leaves 1–4; perigone 6–8 mm long.....	<i>H. ginfushanicum</i>
-	Inflorescence 1-flowered; stem 5–35 mm long; leaf usually 1, rarely 2; perigone 9–12 mm long.....	<i>H. xui</i>

Acknowledgements

I thank Bjørnar Olsen for his extraordinary and immeasurable assistance and discussion of *Heteropolygonatum* and *Polygonatum*, Koen van Poucke, Yijia Wang, and B. Olsen for material used in molecular analyses, Dr. Joe Williams lab for the reagents used in chromosome analyses, Dr. E.E. Schilling for a initial edit of the draft, and I also thank the curators of their respective herbaria for access to, or the digitization of their collections.

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