

A NEW SPECIES OF *HETEROPOLYGONATUM* (ASPARAGACEAE: CONVALLARIOIDEAE, POLYGONATEAE) FROM THE GAOLIGONGSHAN IN EASTERN MYANMAR AND WESTERN CHINA

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A new species of *Heteropolygonatum*, *H. farreri*, is described from the easternmost part of Myanmar and western Yunnan in a limestone region of the Gaoligongshan. It is morphologically similar to *Heteropolygonatum marmoratum* but differs by its shortly scabrous stem, narrowly cylindrical perianth with lanceolate tepals, red-orange fruit, and diploid chromosome count. An illustration of the new species is provided, as is a map of its distribution and that of its closest relative, *Heteropolygonatum marmoratum*, showing their disjunction. Chromosome counts for *Heteropolygonatum farreri* ($2n = 32$) and a second count for *H. marmoratum* ($2n = 4x = 64$) are given.

Keywords. Asparagaceae, China, chromosome, endemic, *Heteropolygonatum*, Myanmar

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Introduction

Heteropolygonatum M.N.Tamura & Ogisu is a recently described small genus of about 12 species in the Asparagaceae with imbricate tepals and a base chromosome number of $x = 16$ (Tamura *et al.*, 1997; Yamashita & Tamura, 2001; Floden, 2014; Xiao *et al.*, 2017). Nearly half the species were first described in *Polygonatum* Mill. and later transferred to *Heteropolygonatum* (Floden, 2014). Several recent discoveries have been found and described, and all the species except *Heteropolygonatum marmoratum* (H.Lév.) Floden and *Heteropolygonatum alte-lobatum* (Hayata) Y.H.Tseng *et al.* are known from a single locality or from fewer than six locations (Chao *et al.*, 2013; Floden, 2014). Most recently, *Heteropolygonatum hainanense* Floden from Hainan at higher elevations, and *Heteropolygonatum wugongshanense* G.X.Chen *et al.* from Jiangxi Province, China, have been described.

Samples of the new species of *Heteropolygonatum* were first reported by Floden (2014) as *H. marmoratum*, with the caveat that the tepals were narrower than those of comparable cultivated plants of *H. marmoratum*. Since that report, molecular, chromosome and additional herbarium specimen data have shown that these western populations are, in fact, a novel species.

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Materials and methods

Specimens were studied from numerous herbaria including as specimen loans (CAS, F, H, MI, MO, NY and PE; acronyms follow Thiers, [continuously updated](#)) and images of digital specimens (BM, E, HITBC, IBSC, K, KUN, L, LBG, P and SZ). Examination of herbarium specimens revealed several additional collections from eastern Myanmar and westernmost Yunnan, China, and several duplicate sheets of *Heteropolygonatum marmoratum*. In total, more than 200 specimens of *Heteropolygonatum* were examined.

Chromosome counts followed the methods of Floden ([2014](#)), using cultivated specimens and somatic counts from root tips of a single genet each of the new species and *Heteropolygonatum marmoratum*.

Results

Reginald Farrer made the earliest collection of this novel *Heteropolygonatum* in Myanmar, near its border with China, in 1919 (Farrer 850, E), and this specimen, together with Forrest 29843 (E), are the only known flowering specimens. All other samples observed in herbaria have been in fruit or sterile, but those fruiting plants were noted to have the distinctly reddish fruits of *Heteropolygonatum* species. Red fruits are unknown from alternate-leaved species of *Polygonatum* in the region (see [Figure 1B](#)) although many *Heteropolygonatum* have often been placed in synonymy with *Polygonatum punctatum* (Floden, [2014](#)) and are still often erroneously identified as that species.

The mitotic chromosome count of the new species of *Heteropolygonatum* was found to be $2n = 32$ ($x = 16$), a diploid and of a standard bimodal karyotype exhibited in the genus (see [Figure 3](#)). A second count of *Heteropolygonatum marmoratum* corroborated an earlier tetraploid count (Floden, [2014](#)).

Discussion

This new species of *Heteropolygonatum* is endemic to the middle Gaoligongshan near Fugong, China, and Hpimaw, Myanmar. The species is supported by morphological examination of numerous specimens and by cytological data. It is further supported by the results of molecular analyses, in which it is not placed with other samples of *Heteropolygonatum marmoratum* (see Floden, [2017](#)).

The morphology of the new species clearly separates it from the similar *Heteropolygonatum marmoratum*. The latter has a hirsute to scabrous indumentum on the stem and often also on the peduncles across most of its distribution, a greenish-white campanulate perianth with the tepals ovate to broadly lanceolate, and the filaments abruptly tapered near the anther and lightly papillose. The new species has a shortly scabrous stem, a narrow cylindrical greenish-yellow perianth with lanceolate tepals, and distinctly papillose filaments evenly tapered to the anther. The fruits of the new species are red to red-orange,

whereas the fruits of *Heteropolygonatum marmoratum* mature to ochre-yellow to orange-red, which matches the label data of numerous exsiccatae as well as the protologue of Lévillé (1909), although this character was not mentioned by Jeffrey (1980). The seeds of this new species and other *Heteropolygonatum* species are ovoid and vary in colour from a light tan to pale brown. Ovoid seeds have been observed in other species of *Heteropolygonatum* cultivated by one of the authors (A.J.F., unpublished), and the shape and surface characters may be of generic value when compared with *Polygonatum*, but additional data on the other taxa are first required to confirm this.

Cytotaxonomy of *Heteropolygonatum* shows a base number of $x = 16$ for all taxa that have been cytologically examined (Tamura *et al.*, 1997; Yamashita & Tamura, 2001; Floden, 2014; Xiao *et al.*, 2017). The chromosome number reported here for the new species (see Figure 3) is diploid ($2n = 2x = 32$), with five longer chromosomes and the remaining short and predominantly metacentric. A second count for *Heteropolygonatum marmoratum* is reported as tetraploid, $2n = 4x = 64$ (see Figure 3), confirming an earlier tetraploid count (Floden, 2014).

Two samples cited by Floden (2014) were included in *Heteropolygonatum marmoratum* as outlying samples. These were also disjunct from the Yungui Plateau and edge of the Sichuan Basin where most collections of *Heteropolygonatum marmoratum* have been made (VN 5819, Heng 12249; both MO). The former is from Vietnam and is interesting given its morphology, which includes a glabrous stem and ovate leaves, and its disjunction, but it is known from only a single sterile collection from which attempts at DNA extraction were unsuccessful. The other is a sterile collection from the eastern Gaoligongshan and is the novel species described here.

Taxonomic treatment

Species description

***Heteropolygonatum farreri* Floden, sp. nov.**

Heteropolygonatum farreri differs from its most morphologically similar species, *H. marmoratum*, by its shortly scabrous stem (vs hirsute and scabrous), lanceolate tepals (vs ovate to broadly lanceolate), and red to reddish orange fruit (vs ochre-yellow to orange-red). – Type: Myanmar. Kachin, Hpimaw, 1830–2290 m, on granitic rocks or trees, 18 iv 1919, RA [R. Farrer] 850 (holotype E00846369!). Figure 1.

Perennial, epiphytic and/or lithophytic. *Rhizome* moniliform to torulose, c.1 cm in diameter; roots thick, to 1 mm diameter; stem erect to leaning, 15–50 cm long, shortly scabrous. *Leaves* alternate, lanceolate to elliptic, apex acuminate, base cuneate to rounded, lustrous adaxially, dull abaxially, 5–14 × 3–8 cm, pseudopetioles 2–3 mm long and distinctly curved upwards so that the leaves are held at about 45° relative to the stem, margins minutely

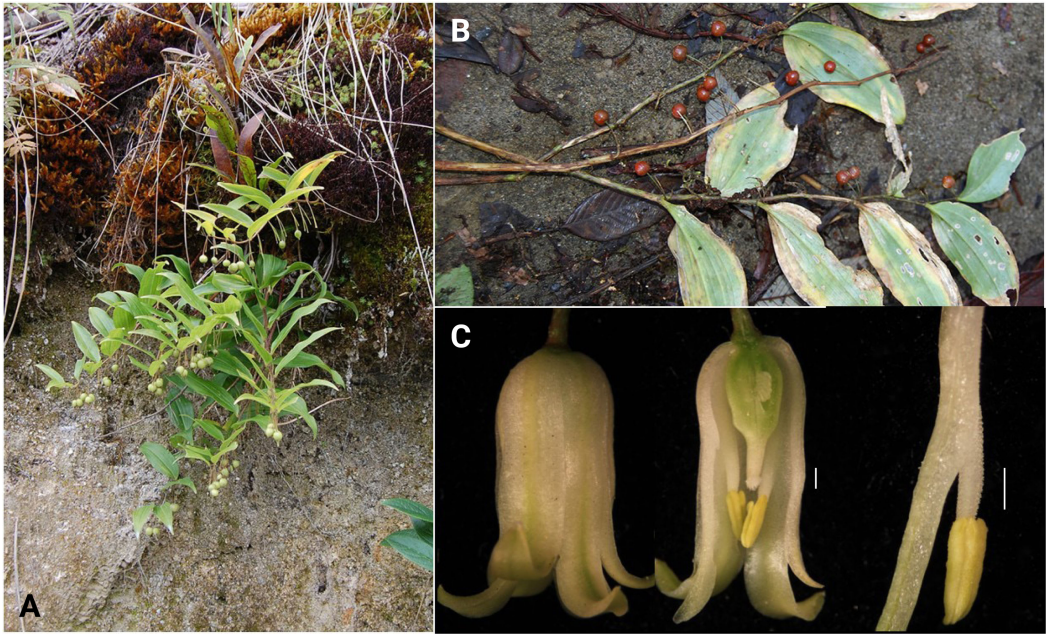


Figure 1. *Heteropolygonatum farreri* Floden, sp. nov. A, Habit in the field in Myanmar; B, a leafy stem with fruit; C, the perianth (outer surface; dissected, showing the insertion level of the filaments, and the lengths of the ovary and style; and showing the filament shape and lightly papillose surface ornamentation). Scale bars in C: 1 mm. All photographs of *B. Olsen* s.n. (TENN), taken by B. Olsen (A and B) and A. J. Floden (C).

papillose-scabrous. *Inflorescence* terminal and axillary, 1- to 5-flowered, pedunculate or fasciculate, peduncles 1–2 cm when present, pedicels 0.5–2 cm; perianth c.8–12 mm long, tube c.4–6 mm long, greenish to yellowish white, tepals imbricate, lanceolate, free part 2–6 × 1–1.5 mm, apex erect to spreading or reflexed, filaments inserted distal of middle of perianth tube, 1.5–2 mm long, abruptly tapered to anther, minutely papillose, anthers c.1.5–3 mm long. *Ovary* ovoid, 2–4 mm, style 2–3 mm, tapered to a capitate apex. *Fruit* c.6–10 mm in diameter, red to red-orange, many seeded, seeds ovoid, light brown, smooth, c.1 mm long.

Distribution. China, Yunnan, Gaoligongshan near Fugong, and Myanmar, Shan State, Hpimaw, on the western slope of the Gaoligongshan from 2200 m to approximately 3300 m, although most collections observed do not provide an elevation (Figure 2).

Habitat and ecology. Grows as an epiphyte or as a lithophyte and has been collected from mossy tree trunks and from moss-covered granitic rocks. Flowering April–May, fruiting September–December.

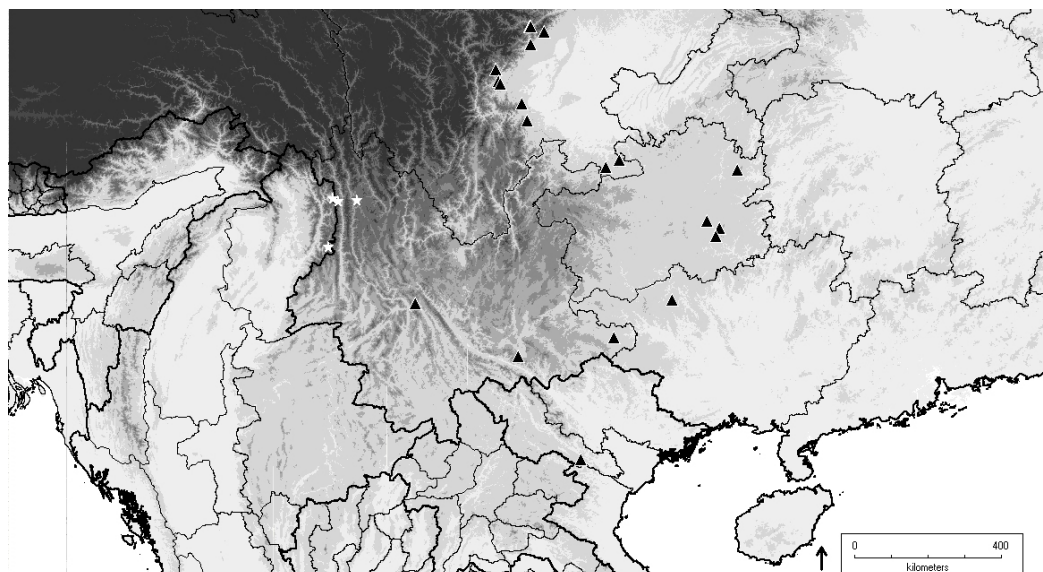


Figure 2. The distributions of *Heteropolygonatum farreri* Floden (☆) and *H. marmoratum* (H.Lév.) Floden (▲) in China and Myanmar.

Etymology. This species is named for the collector and well-known gardener Reginald Farrer. His last collection trip was in Myanmar (Burma) and was based out of Hpimaw for the first of the 2 years he planned on spending there. It was during this trip that he died, aged 40, during a field expedition in northern Myanmar. His collection of this species is one of two so far observed in herbaria in a flowering condition.

Proposed IUCN conservation category. Only five collections of *Heteropolygonatum farreri* have been made, but these have been collected from near Pianma north to the upper Nujiang spanning approximately 250 km. It has been observed in Myanmar (B. Olsen, [Figure 1A,B](#)) just outside Hpimaw, opposite from Pianma in Yunnan, China. No collections from the intervening regions have been observed, although it should be expected to occur in similar habitats at similar elevations. Logging is recorded in the region, but at none of the locations where this species has been collected. Based on the limited data available, we suggest a Data Deficient (DD) category at this time, following IUCN guidelines (IUCN, [2019](#)).

Notes. Regarding taxonomic relationships, *Heteropolygonatum farreri* is morphologically similar to *H. marmoratum*, and the two are not readily separable in sterile states without knowing a specimen's provenance. The range of variation of the scabrous or hirtellous stems of *Heteropolygonatum marmoratum* and the scaberulous to nearly glabrous stems in *H. farreri* are not easily characterised, but the perianth characters, and in late season

specimens, the red colour of the fruit, serve to distinguish the species. Both have alternate, coriaceous leaves and greenish white flowers. More importantly, the two differ in their chromosome number, with *Heteropolygonatum farreri* a diploid, and *H. marmoratum* thus far known only as a tetraploid (Figure 3; also see below, and Floden, 2014). Preliminary molecular data place *Heteropolygonatum farreri* outside samples of *H. marmoratum*, which are sister to *H. alte-lobatum* (Floden 2014, 2017).

The description of *Heteropolygonatum farreri* includes one of the morphological and geographically distinctive entities mentioned and figured in Floden (2014). With the description of *Heteropolygonatum farreri*, the total distribution of *H. marmoratum* is now reduced to the Yungui Plateau (from Kunming eastwards), the mountains surrounding the Sichuan Basin, eastern Guizhou (see below), and one disjunct location in northern Vietnam (Floden, 2014). This broad distribution still encompasses a large amount of variation that should be investigated. Specimens of *Heteropolygonatum marmoratum* from southwest Sichuan and adjacent Guizhou tend to have powdery white abaxial leaf surfaces, which is a character absent from Yunnan (the type gathering is presumably near Kunming; see below) and Vietnam locations. Thus far two chromosome counts for *Heteropolygonatum marmoratum* from Yunnan are both tetraploid, but additional counts from the several disjunct centres of distribution could reveal consistent regional differences in ploidy. In contrast to other species of *Heteropolygonatum*, which have narrow distributions and few

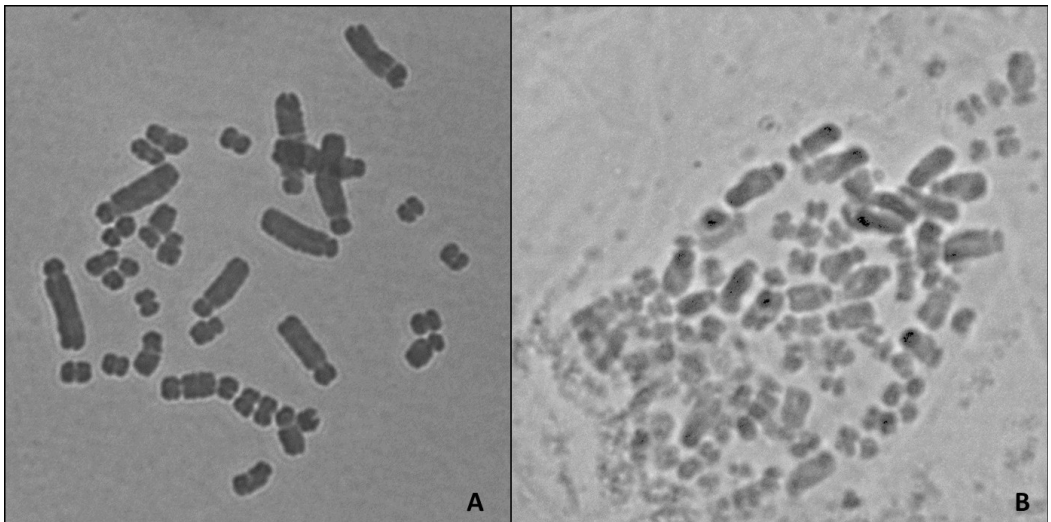


Figure 3. A, Chromosome count of *Heteropolygonatum farreri* Floden for plants from Fugong, Yunnan, China, showing 32 chromosomes ($2n = 2x = 32$ [$x = 16$]); B, chromosome count of *H. marmoratum* (H.Lév.) Floden for plants from Xishan, Yunnan, China, showing 64 chromosomes (both from the collection B.Olsen s.n. [TENN]). Squash preparation and photographs: A. J. Floden.

known populations, *H. marmoratum* is broadly distributed and disjunct, and it may be that it is currently comprised of one or more cryptic species.

Most other species of *Heteropolygonatum* are readily separated from *H. farreri* and *H. marmoratum* by their wholly pink to partially pink-coloured perianth (*H. anomalum* (Hua) Floden, *H. ogisui* M.N.Tamura & J.M.Xu, *H. parcefolium* (F.T.Wang & Tang) Floden, *H. roseolum* M.N.Tamura & Ogisu, *H. xui* W.K.Bao & M.N.Tamura), by their pendent habit (*H. pendulum* (Z.G.Liu & X.H.Hu) M.N.Tamura & Ogisu), by their leaf apices cirrhose (*H. alternicirrhosum* (Hand.-Mazz.) Floden), or by the small plant size at maturity (*H. ginfushanicum* (F.T.Wang & Tang) M.N.Tamura, S.C.Chen & Turland and *H. xui*). The species most similar in morphology to *Heteropolygonatum farreri* and *H. marmoratum* are *H. hainanense*, which is known only from Hainan Island; *H. alte-lobatum*, which is known from Taiwan; and *H. wugongshanensis*, known from only a single population that is about 1 m² in Jiangxi Province. Each of these can be readily separated from *Heteropolygonatum farreri* and *H. marmoratum* by their smooth stems and peduncles (vs hirtellous, scabrous or scaberulous stems and peduncles).

Phylogenetic data (Floden, 2017) provide only preliminary relationships due to the limited taxon sampling and the quality of DNA extracted from herbarium material. In that phylogeny, *Heteropolygonatum alternicirrhosum* was the earliest lineage. In the remaining species, *Heteropolygonatum marmoratum* samples were placed into two different places. One clade of two samples, comprising what we describe here as *Heteropolygonatum farreri*, was sister to a clade comprising all the other species, including two samples of *H. marmoratum* (both tetraploid), which were sister to *H. alte-lobatum*. These were, in turn, sister to *Heteropolygonatum anomalum*, *H. ginfushanicum* and *H. pendulum*. Further sampling of recently described species, and rediscovery of and sampling of *Heteropolygonatum parcefolium* and *H. hainanense*, would provide a better inference of relationships.

Additional specimens examined. CHINA. Yunnan: E side of Gaoligongshan, W of Gongshan [27.707222, 98.544722], 10 vii 2000, L. Heng 12249 (E00134123, MO); *ibid.*, Liou 20264 (PE!); Gongshan Dulong Autonomous County Bar-ru-lah, Salween-Chu-kiang divide, under forest [Bingzhongluo], 2800 m, x 1935, C.W. Wang 67583 (PE); West Yunnan, *sine loc.*, *sine dat.*, Forrest 29843 (E01360152) [adjacent coll. numbers are from Nujiang to Tengchong on the Myanmar border].

Key to the species of *Heteropolygonatum*

This key requires floral characters, including the colour of the tepals, and/or provenance of the collection to identify most species. The distribution of most species is very limited and often restricted to a single location or a few mountains within a mountain range, but there are several that occur sympatrically in Sichuan.

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- 1a. Leaf apices cirrhose [Sichuan, Kangding] _____ *H. alternicirrhosum*
- 1b. Leaf apices acute, sometimes falcate to uncinat, but never cirrhose _____ 2
- 2a. Stem pendulous, 50–100 cm. Leaf blades fasciate-falcate, 20–40 cm [Sichuan, Moxi] _____ *H. pendulum*
- 2b. Stem ascending, 5–50 cm. Leaf blades elliptic, lanceolate, oblong, ovate-oblong or oblanceolate, 3.5–14 cm _____ 3
- 3a. Stem and pedicels villosulous, hirtellous or scaberulous, especially in young growth _ 4
- 3b. Stems and pedicels glabrous _____ 7
- 4a. Flowers greenish to yellowish white _____ 5
- 4b. Flowers pink _____ 6
- 5a. Tepals ovate to broadly lanceolate. Leaves obovate, apex emarginate __ *H. marmoratum*
- 5b. Tepals narrowly lanceolate. Leaves lanceolate to elliptic, apex acuminate __ *H. farreri*
- 6a. Inflorescences 1 (or 2)-flowered. Stem scaberulous [Sichuan, Moxi] ____ *H. anomalum*
- 6b. Inflorescences of multiple flowers borne on peduncles. Stem hirtellous [Chongqing, unknown] _____ *H. parcefolium*
- 7a. Leaves 1–3(or 4). Stem 0.5–14 cm, typically prostrate. Flowers typically < 12 mm long _____ 8
- 7b. Leaves 3–9. Stem 10–40 cm, erect or lax. Flowers typically > 12 mm long _____ 9
- 8a. Inflorescence 1- to 4-flowered. Stem 5–14 cm. Leaves 1–4. Flowers 6–8 mm long [Chongqing, Hubei, Guizhou; Dabashan] _____ *H. ginfushanicum*
- 8b. Inflorescence 1-flowered. Stem 0.5–3.5 cm. Leaf usually 1, rarely 2. Flowers 9–12 mm long [Sichuan, Wawushan] _____ *H. xui*
- 9a. Flowers greenish white throughout, or greenish white with reddish purple tessellation at the apex of the tepals, 6–15 mm long _____ 10
- 9b. Flowers pink or pink with green lobes; 11–16 mm long _____ 12
- 10a. Tepals 6–8 mm long [Taiwan] _____ *H. alte-lobatum*
- 10b. Tepals > 8 mm long _____ 11
- 11a. Tepals 12–15 mm long [Jiangxi] _____ *H. wugongshanensis*
- 11b. Tepals 8–12 mm [Hainan] _____ *H. hainanense*
- 12a. Stem 20–40 cm. Leaves 6–9, shiny, pale green abaxially, petiolate. Flowers cylindrical, 14–16 mm long, lobes greenish [Guangxi, Hunan] _____ *H. roseolum*
- 12b. Stem 10–22 cm. Leaves 3–5, whitish abaxially, sessile. Flowers campanulate, 11–13 mm long, lobes pink [Sichuan, Wawushan] _____ *H. ogisui*

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