A REVISION OF THE GENUS *TRIPTERYGIUM* (*CELASTRACEAE*)

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To better understand the genus *Tripterygium* for the *Flora of China*, the history of the genus and its species is summarized and characters traditionally used to divide the genus re-examined. Because no reliable differentiating characters were found, all of the previously named taxa in the genus are reduced to the single species, *Tripterygium wilfordii* Hook.f. The range of this monospecific genus is typical of many in the East Asian flora.

Keywords. Flora of China, Flora of East Asia, *Tripterygium wilfordii*.

INTRODUCTION

The genus *Tripterygium* (*Celastraceae*) was described by J.D. Hooker (1862), based on material from Taiwan (Formosa) collected by Wilford in 1858, and the single species was then named *T. wilfordii* Hook.f. Since then, researchers have created a multitude of names and synonymies based on collections from throughout East Asia.

Later, Hance (1880) described *T. bullockii*, based on material collected by Bullock in 1878 from Hunan, China. In 1886, Hemsley (in Forbes & Hemsley, 1886–88: 125) recognized *T. wilfordii*, but reduced *T. bullockii* to synonymy, and first reported its occurrence in Korea. Takeda (1912) agreed with Hemsley in recognizing *T. wilfordii* (including the synonym *T. bullockii*) and described a new variety *T. wilfordii* var. *exesum* Sprague & Takeda from Yunnan and a new species *T. regelii* Sprague & Takeda from Japan and Korea. The latter included the material reported as *T. wilfordii* by Regel (1896) from Japan.

Léveillé (1911) described *Aspidopterys hypoglauca* H. Lév. (*Malpighiaceae*) which Hutchinson (1917) transferred into the *Celastraceae* as *T. hypoglaucum*. Léveillé described three additional species as *Pentace esquirolii* H. Lév., *Pentace virginis* H. Lév., and *Microrhamnus franchetiana* H. Lév., which were sunk into *T. hypoglaucum* by Handel-Mazzetti (1933). Meanwhile, Loesener (1913) named a Forrest collection (no. 4290) from Yunnan as *T. forrestii* Loes. Later, Rehder & Wilson (1927: 161) reduced *T. wilfordii* var. *exesum* into *T. forrestii* and acknowledged that *T. forrestii* and *T. bullockii* were possibly identical.

The genus was then revised by Loesener (1932) and Hsiung-Hsiang Lin (1932) as well as Rehder (1933, 1934, 1937), with three species accepted: *T. hypoglaucum* from Yunnan, Hunan, and Zhejiang; *T. wilfordii* from Hunan, Zhejiang, and Taiwan; and *T. regelii* from Japan and Korea. However, the characters they used to separate the

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three species were overlapping and continuous. Although incomplete, most researchers, especially within East Asia, have since followed this revision.

Ohwi (1932) described *T. doianum* from Japan and treated it in his *Flora of Japan* (Ohwi, 1956). However, it is impossible to use his key to separate the species because of overlapping characters, for example, one species, 'leaves 5–15cm long, flowers 5–6mm across, fruit cordate at base' whilst another, 'leaves 5–10cm long, flowers 4–5mm across, fruit truncate to rounded at base'. Recently, T. Yamazaki (1993) described yet another new variety, *T. regelii* var. *occidentale*, from southern Japan and Korea, and recognized *T. doianum* from southern Japan.

Hundley & Chit Ko Ko (1961: 50) recorded *T. wilfordii* from Kangfang (26°8–9′N 98°35–36′E, Myanmar (Burma)). This is perhaps the first record of the genus from this country, and was recognized by Thomas (1992). However, we have not seen any specimens from Myanmar during this study.

Since the 1950s, authors of *Tripterygium* accounts for Chinese provincial floras have mostly agreed on three species in the genus, but the differentiating characters were not clear, even for a single province or a single species. For example in Guizhou, Q.H. Chen (1985) recorded only one species for the province whilst H.S. Chen (1995: 291) recorded two species and distinguished them by the colour of the lower leaf surface.

Whilst preparing an account of the genus for the *Flora of China* at Harvard University Herbaria, the senior author observed that there was no clear division between the species using the materials from several herbaria, i.e., Arnold Arboretum (A), Gray Herbarium (GH), Missouri Botanical Garden (MO), New York Botanical Garden (NY), and the Institute of Botany, Chinese Academy of Sciences, Beijing (PE). To better understand the genus, we examined the characters traditionally used to separate the putative species.

MATERIALS AND METHODS

From the above taxonomic history and our study of the genus, the major characters traditionally used to differentiate the species focused on: (1) leaf shape and size, and particularly the presence or absence of white powder on the lower leaf surface; (2) branches and branchlets, mainly their modification and whether verruculose or not; (3) size of inflorescences; and (4) fruit colour, shape, and size.

In addition, other characters were considered in this work, such as indumentum and texture of leaves, and pubescence of branches and branchlets. We examined 251 specimens (cited below) and attempted to find any significant morphological differences between them.

RESULTS AND DISCUSSION

Character analysis

(1) White powder on lower leaf surface. The white powder on the leaves was first used by Léveillé (1911), and followed by others. From our observations, some

specimens from south-western as well as eastern China do have white powder on the lower leaf surface, especially when dried, but its presence varies depending upon where the specimen was collected and its habitat. Some lack white powder and more importantly, some are in between, with little or inconspicuous powder. Previous researchers (Rehder & Wilson, 1927; Handel-Mazzetti, 1933) indicated that this indistinct character is of no taxonomic value because of much variability. The presence or absence of powder is apparently a morphological trait related to habitat (C.H. Wang, 1936, 1939; Bold, 1973).

(2) Pubescence of branches. The pubescence of branches and branchlets was observed to be variable even on the same plant so it cannot be used to divide the genus. This character is largely influenced by habitat, resource availability (Gosler *et al.*, 1994), and the position on the plant from which the specimen was taken. Light availability likely plays an important role in the expression of this character since some pubescence can be found on plants from the open but not from shaded habitats.

(3) Leaves. Leaves ranged in size, (4.6–)8.6–12.8(–18.4)cm long, (3.1–)5.7–8.9(–12.3)cm wide (Table 1A), and shape, usually ovate or round-ovate, sometimes oblong to oblong-ovate or elliptic-ovate. This variability is attributed to habitat and time of collection. Leaf sizes across the distributional range were continuous (Table 1B).

(4) Inflorescences. Thyrses ranged in size: (4.5–)12.5–23.6(–38)cm long, (2.3–)4.7–9.3(–15)cm diam. (Table 1A), particularly due to the time of collection but also habitat. Some inflorescences were very small because of collection early in the season before they had fully developed. Sizes of inflorescences across the distributional range were continuous (Table 1B). The thyrse is elongated and composed of a number of 'thyrselets' that are constant in shape and size (2–4.5cm long and 2–2.5cm diam.).

(5) Fruit. Samaras, the three-winged fruit, ranged in size: (1–)1.3–1.9(–2.3)cm long, (0.7–)1.2–1.5(–1.9)cm wide (Table 1A) due to time of collection and habitat. Fruit

TABLE 1A. Measurements (cm) of characters of *Tripterygium* specimens and site elevations (m) overall ($n=251$).

Character	Minimum	Maximum	Mean	S.E.
Leaf length	4.6	18.4	10.15	±0.14
Leaf width	3.1	12.3	5.91	±0.09
Inflorescence length	4.5	38	15.72	±0.47
Inflorescence width	2.3	15	7.14	±0.19
Fruit length	1	2.3	1.52	±0.02
Fruit width	0.7	1.9	1.27	±0.02
Elevation	150m	3450m		

TABLE 1B. Measurements (cm) of characters of *Tripterygium* specimens (mean ± S.E., sample size) and site elevations (m) by geographic region.

Geographic Region	Leaf length	Leaf width	Inflorescence length	Inflorescence width	Fruit length	Fruit width	Elevation (minimum)	Elevation (maximum)
Anhui	9.28 ± 0.53 (12)	4.97 ± 0.22 (12)	10.00 ± 1.34 (8)	5.74 ± 0.76 (8)	1.31 ± 0.05 (8)	1.03 ± 0.05 (8)	550	1600
Fujian	7.00 ± 2.40 (2)	4.40 ± 0.70 (2)	8.10 ± 1.40 (2)	4.10 ± 0.30 (2)	1.35 ± 0.05 (2)	1.15 ± 0.05 (2)	750	1130
Guangdong	9.68 ± 0.59 (10)	5.85 ± 0.30 (10)	18.98 ± 2.16 (5)	7.38 ± 1.23 (5)	1.60 ± 0.05 (6)	1.28 ± 0.05 (6)	850	950
Guangxi	9.50 ± 0.29 (5)	5.24 ± 0.09 (5)	15.08 ± 0.78 (4)	7.78 ± 1.54 (4)	2.00 (1)	1.60 (1)	1300	1450
Guizhou	9.84 ± 0.36 (8)	5.21 ± 0.21 (8)	12.33 ± 1.06 (7)	6.63 ± 0.95 (7)	1.60 ± 0.06 (6)	1.42 ± 0.08 (6)	750	1400
Hunan	10.35 ± 0.47 (13)	6.11 ± 0.19 (13)	14.74 ± 2.05 (7)	7.07 ± 1.03 (7)	1.74 ± 0.11 (11)	1.40 ± 0.08	550	1700
Japan	10.99 ± 0.30 (62)	6.84 ± 0.22 (62)	17.38 ± 0.81 (47)	7.97 ± 0.29 (47)	1.45 ± 0.03 (39)	1.24 ± 0.03 (39)	250	1900
Jiangxi	9.27 ± 0.43 (12)	4.90 ± 0.27 (12)	9.92 ± 1.15 (6)	5.23 ± 0.76 (6)	1.34 ± 0.09 (5)	1.08 ± 0.13 (5)	990	1930
Jilin	11.83 ± 0.39 (15)	6.41 ± 0.24 (15)	11.77 ± 0.72 (11)	5.90 ± 0.48 (11)	1.50 ± 0.04 (7)	1.49 ± 0.06 (7)	880	1700
Korea	12.12 ± 0.65 (9)	7.02 ± 0.37 (9)	16.94 ± 1.47 (8)	8.63 ± 0.77 (8)	1.72 ± 0.13 (6)	1.50 ± 0.12 (6)	150	1845
Sichuan	9.20 ± 0.46 (6)	5.07 ± 0.36 (6)	9.18 ± 0.27 (5)	3.80 ± 0.29 (5)	1.50 ± 0.06 (3)	1.30 ± 0.06 (3)	1500	2500
Taiwan	7.90 ± 0.28 (20)	4.89 ± 0.18 (20)	14.00 ± 0.86 (13)	5.46 ± 0.42 (13)	1.40 ± 0.04 (11)	1.21 ± 0.03 (11)	250	570
Yunnan	10.07 ± 0.26 (47)	5.67 ± 0.06 (47)	20.17 ± 1.19 (31)	8.18 ± 0.43 (31)	1.65 ± 0.05 (19)	1.25 ± 0.05 (19)	1300	3450
Zhejiang	8.76 ± 0.53 (5)	4.86 ± 0.29 (5)	12.13 ± 1.16 (4)	6.68 ± 1.16 (4)	1.30 ± 0.10 (3)	1.00 ± 0.10 (3)	800	1500

sizes across the distributional range were continuous (Table 1B). In addition, the apex and base of the fruit were used as characters by past researchers who ignored the variability among the fruit. Even on one sheet, the fruit apices and bases can vary from deeply serrate or slightly serrate to slightly emarginate and finally to entire. From the entire range of fully mature samples available to us (Fig. 1), we could not find any definite character states to segregate them. The colour of the fruit varied due to the degree of maturation, type of habitat, and resource availability.

For the above characters, it is not surprising that the sizes of leaves, inflorescences, and fruit were quite variable since determinant plant growth is dependent upon habitat and resource availability (Fitter & Hay, 1987), and because morphological adaptations are closely related to plant habitats (Bold, 1973). Even on a large geographic scale, there are no clear differences (see Table 1B).

In summary, re-examination of the traditional characters used to divide the genus revealed that these characters are highly variable and cannot be used to separate any species within it. Therefore, in our opinion, the genus comprises only one variable species.

Taxonomic treatment

Tripterygium Hook.f. in Benth. & Hook.f., Gen. Pl. 1: 368 (1862). Type: *T. wilfordii* Hook.f.

Tripterygium wilfordii Hook.f. in Benth. & Hook.f., Gen. Pl. 1: 368 (1862). Type: China, Formosa (Taiwan), *C. Wilford s. n.* (n.v., photo A).

Syn.: *T. bullockii* Hance, J. Bot. 259 (1880); *T. wilfordii* var. *bullockii* (Hance) Matsuda, Bot. Mag. (Tokyo) 24: 286 (1910). Type: China, Hunan, aest. 1878, *Bullock* Herb. propor. n. 20692 (n.v., photo A).

Aspidopterys hypoglauca H. Lév., Repert. Spec. Nov. Regni Veg. 9: 458 (1911); *T. hypoglaucum* (H. Lév.) Hutch., Bull. Misc. Inform. 1917: 101 (1917).Type: China, Kouy-Tcheou (Guizhou), Ma-Jo, *J. Cavalerie* 3316 (n.v., photo A).

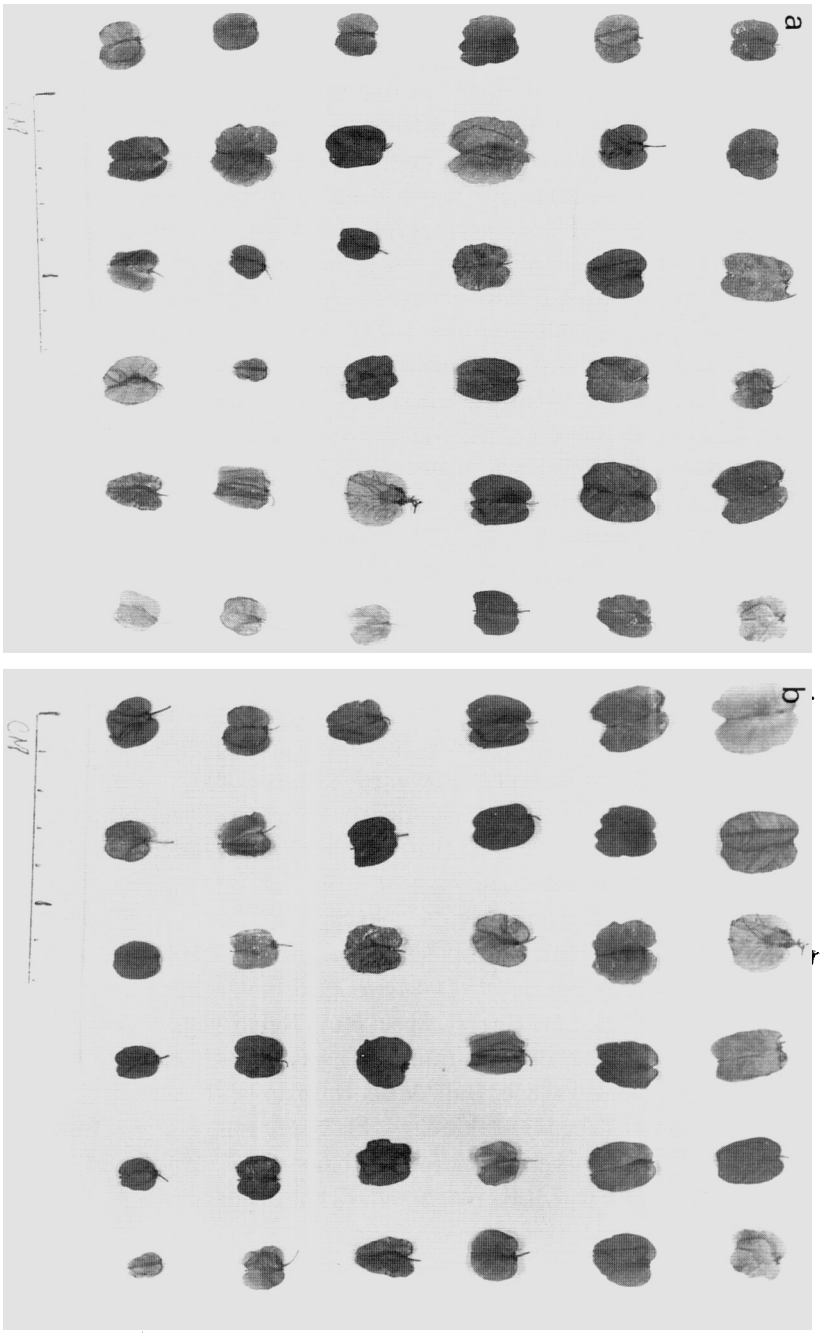
Pentace esquirolii H. Lév, Repert. Spec. Nov. Regni Veg. 10:147 (1911). Type: China, Kouy-Tcheou (Guizhou), Lo-Fou, *J. Cavalerie* 2648 (n.v.).

T. regelii Sprague & Takeda, Bull. Misc. Inform. 1912: 223 (1912); *T. wilfordii* var. *regelii* (Sprague & Takeda) Makino, Ill. Fl. Nipp. 360, t.1079 (1940). Syntypes: Japan, Kyushu, *J. Maximowicz*, 1863 (n. v.); Hondoji, *R. Yatabe*, 1887 (n.v.); Mt. Chokai, *M. Komai*, 1906 (n.v.); Korea, Seoul, *Carles*, 1884 (n.v.), *V. Komarov*, 1897 (n.v.); (? all in K).

T. wilfordii var. *exesum* Sprague & Takeda, Bull. Misc. Inform. 1912: 222 (1912). Type: China, Yunnan, Mengtze (Mengzhi), N. Mts., alt. 1520m, *A. Henry* 10203 (n.v.).

T. forrestii Loes., Notes Roy. Bot. Gard. Edinburgh 8: 4, t. 2 (1913). Type: China, Yunnan, *G. Forrest* 4290 (n.v., photo A).

Pentace virginis H. Lév., Monde Pl. sér. 2, 18: 28 (1916). Type: China, Yunnan, Ie-Ma-Tchouan, *E.E. Maire s. n.* (n.v., photo A).


a
b

Microrhamnus franchetiana H. Lév., Bull. Acad. Int. Géog. Bot. 25: 26 (1915). Syntype: China, Kweichou (Guizhou), Siao-Ou-Long, *E.E. Maire s. n.* (n.v., photo A), excl. fruiting branch.

T. doianum Ohwi, Acta Phytotax. Geobot. 1: 140 (1932); *T. regelii* var. *doianum* (Ohwi) Masam., Mem. Fac. Sci. Taihoku Imp. Univ. 11, Bot. 4: 280 (1934). Type: Japan, Kiushiu, Takakuma in Ohsumi in 1930, *Y. Doi s.n.* (n.v.)

T. regelii var. *occidentale* T. Yamazaki, J. Jap. Bot. 68: 6, 363–366 (1993). Type: Korea, Seoul, Pukanshan, *T. Uchiyama s.n.* (n.v.).

Shrublike on open ground or scandent and scrambling over other vegetation, or sometimes semiwoody vines, 2–6(–10)m. *Branches and branchlets* mostly in upper part, slender or scrambling, minutely pubescent when young or in open sunlight, becoming glabrous when old or in shade, slightly angled, verrucose or not. *Leaves* alternate, deciduous; petiole 1–2cm long; stipules linear, caducous; leaf blade usually ovate or round-ovate, sometimes oblong or elliptic-ovate, papery, herbaceous (in shade or low light) to leathery (in direct sunlight or in very dry conditions), glabrous or sparsely scurfy tomentose with reddish brown hairs, abaxially with white powder ± evident, or absent; base broadly cuneate or round to cordate or emarginate at base, margin entire or less often crenulate, apex short to long acuminate or acute, with tip often blunt. *Thyrse* terminal, large, composed of several to dozens of thyrselets 2–4.5 × 2–2.5cm. *Flowers* polygamous with one normal and the other unfertilized male, whitish, small, 5–6 × 5–6mm. *Calyx* 5-lobed, hemispherical, c.1mm long. *Petals* 5, oblong to subovate, slightly narrowed to base, c.2–2.5mm long, apex rounded. *Stamens* 5, inserted at margin of cup-shaped disc. *Disc* bright green, fleshy, c.2mm diam. *Ovary* superior, triquetrous, incompletely 3-locular, with 3 prominent c.1mm lobes, with a short style at apex; stigma capitate, bright purple; ovules 2 per locule, erect. *Fruit* a 3-winged samara, usually green or greenish-brown when mature, sometimes pink or pinkish purple; seed usually 1, erect, compressed and trigonous, c.5 × 1.5–3mm, without aril; embryo small.

FIG. 1. A. Photo of mature fruit of *Triptergygium.* From left to right, top to bottom: 1. *Kanai* 3971, Japan; 2. *Muroi* 5430, Japan; 3. *Jack s.n.*, Korea; 4. *Seto* 311667, Japan; 5. *Uno* 23415, Korea; 6. *Ikegami* 5424, Japan; 7. *Togashi* 531, Japan; 8. *Nemoto* 1733, Japan; 9. *Funakoshi* 1002, Japan; 10. *Hatusima* 16234, Japan; 11. *Wilson* 8868, Korea; 12. *Watanabe s.n.*, Japan; 13. *Uno s.n.*, Japan; 14. *Sino-Amer. Bot. Exped.* 1060, Guizhou; 15. *Ando et al.* 92, Taiwan; 16. *Fan & Li* 141, Anhui; 17. *R.C. Ching* 3358, Anhui; 18. *Chow* 161, Anhui; 19. *Forrest* 11647, Yunnan; 20. *Tsang* 28202, Kuangxi; 21. *Schneider* 2483, Yunnan; 22. *Cavalerie* 3316, Yunnan; 23. *C.W. Wang* 76806, Yunnan; 24. *E.E. Maire s.n.*,Yunnan; 25. *1984 Sino-Amer. Bot. Exped.* 801, Yunnan; 26. *H.T. Tsai* 54767, Yunnan; 27. *R.C. Ching* 22050, Yunnan; 28. *K.M. Feng* 11192, Yunnan; 29. *1984 Sino-Amer. Bot. Exped.* 1438, Yunnan; 30. *Schneider* 2755, Yunnan; 31. *Taoda* 3885, Japan; 32. *Wilson* 8911, Korea; 33. *Mizushima* 11675, Japan; 34. *Muroi* 5689, Japan; 35. *Sakurai s.n.*, Japan; 36. *Shiota s.n.*, Japan.

B. Rearrangement of the fruits according to size: large to small (from left to right, top to low).

Distribution and habitat

Tripterygium wilfordii occurs in a wide variety of habitats, being usually found in forests and at the edges of woodlands, occasionally in open grasslands or farmlands. The plants also occur in valleys, roadsides, maple forests, open canopy gaps in forests, along brushy and open forest slopes, among dense climbing shrubs, mountain summits, open thickets, mixed broad-leaved evergreen forests with tree ferns, heavily disturbed broad-leaved forests, open fields, and above other vegetation on mountain slopes.

Collection sites for specimens range in elevation from 150–3450m. There are no correlations between elevation and measurements of leaves, inflorescences, and fruit as might be expected (Nobel & Hartsock, 1986; Totland & Birks, 1996). The sizes of plant organs of these specimens appear to be more indicative of the time of collection and differing habitats and resource availability (see Table 1).

Generally, the genus is typical of the East Asian flora, occurring from Japan, to Korea as well as eastern to south-western China, and to northern Myanmar and south-eastern Xizang (Fig. 2). From a floristic viewpoint, there are numerous species with such a distribution (W.T. Wang, 1992).

Relationship in the family

This genus is similar in morphology to *Wimmeria* from Mexico and Central America. The major differences are that the inflorescences are axillary and the number of ovules is 6–8 per cell in *Wimmeria*, whilst the inflorescences are terminal and the number of ovules 2 per cell in *Tripterygium* (Loesener, 1942; Hou, 1963: 231).

Chemical elements and economic uses

In China, *T. wilfordii* has been used in traditional medicine since ancient times (Ku, 1936). The plant has a long history in traditional Chinese herbal medicine for treating fever, chills, oedema, and inflammation (X.Y. Li, 1993) and also has been used widely in agriculture as an insecticide. Modern pharmaceutical research has found that chemicals extracted from the leaves of *T. wilfordii* have shown very strong anti-inflammatory (Zheng, 1994), immunosuppressive, antirheumatic (Gu *et al.*, 1995), antibiotic, and male contraceptive (Zhen *et al.*, 1995; Ma *et al.*, 1996) properties, and antiviral (Hayashi *et al.*, 1996), anticancer, and immunosuppressive activities (Kutney, 1997; Bell *et al.*, 1998). Results from biochemical studies have shown that wilforine found in *T. wilfordii* (Beroza, 1951, 1953; Tin-Wa, 1971) is also present in *T. hypoglaucum* (Wu *et al.*, 1981; Wu, 1986; herein = *T. wilfordii*). This biochemical evidence further supports our combining the latter into synonymy.

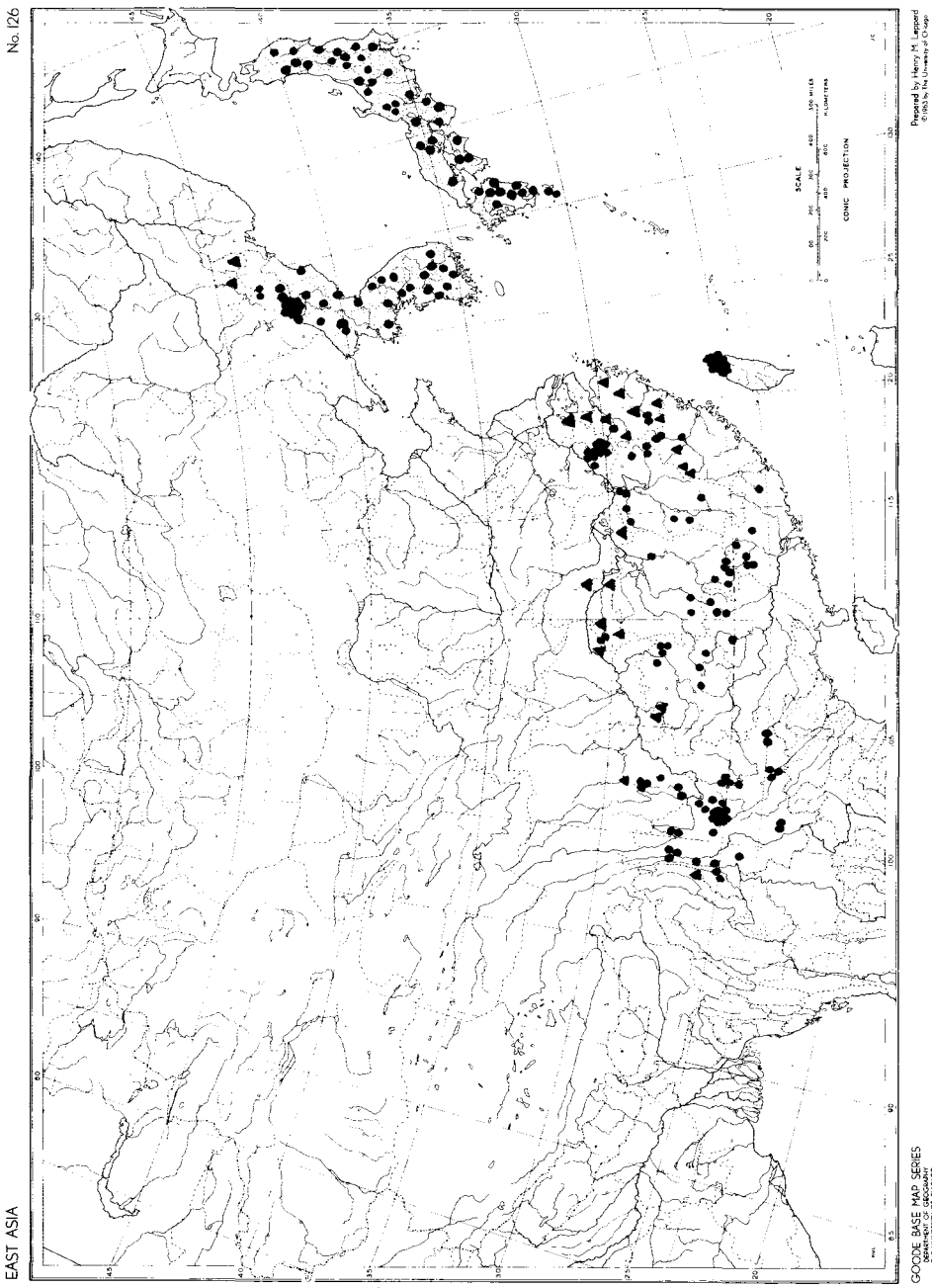


FIG. 2. Distribution of natural populations of *Tripterygium* (●, from specimens; ▲, from records only).

Chromosomes

Only one cytological report exists for the genus: $2n=24$ (Hsu, 1968).

Specimens studied (alphabetically by country, province, location, collector; each followed by the herbarium abbreviation, see Fig. 2): JAPAN: Akita, *T. Nemoto & H. Hoshi* 4529 (A); Echigo, *T. Yamazaki* 6717 (A); Ehime, *J. Murata* et al. 56028 (A), *M. Takahashi* 1803 (A, PE); Fukushima, *T. Yamazaki* 937 (A), *M. Furuse s.n.* (A), *K. Im & N. Kawahara* 7743 (A); Hyogo, *T. Muroi* 5671 (A), *T. Muroi* 5430 (A), 5689 (A), *E. Wood* et al. 3896 (A); Iwate, *S. Suzuki s.n.* (A); Kagoshima, *T. Tanaka* 90 (GH), *T. Mitsuta & Y. Doei* 941 (A), *T. Muroi* 582 (A); Kyushu, *E.H. Wilson s.n.* (collected in 1917, A), *C.J.I. Maximowicz s.n.* (collected in 1863, A), *M. Kawahara* et al. 34 (PE); Miyazaki, *K. Funakoshi* 1002 (A), *T. Kawahara* et al. 34 (A, NY), *J. Murata* 7895 (PE); Mie, *T. Muroi* 699 (A), *K. Seto* 31667 (A); Nagasaki, *C.J.I. Maximowicz s.n.* (GH); Nagano, *H. Koyama* 8090 (A), *S. Suzuki s.n.* (A), *M. Togashi* 531 (A, NY, PE), *K. Uno s.n.* (A); Nara, *T. Muroi* 1007 (A); Niigata, *S. Ikegami* 5424 (A), *P. Taoda* 3885 (A), *Y. Tateishi* et al. 8840 (A, 2 sheets), *Y. Tateishi* 1805 (A), *S. Ikegami* 12649 (A); Shikoku, *D. Ikkaku* 9475 (A), N. *Kawahara & H.T. Im* 162 (PE); Tochigi, *G. Murata* 18402 (NY), *S. Suzuki* 444021 (A), *F. Yamazaki* 9376 (PE); Tokushima, *F. Yamazaki* 1089 (A); Tottori, *T. Muroi* 5368 (A), *H.T. Im & N. Kawahara* 3358 (A, NY, PE); Toyama, *H. Kanai* 3971 (A); Wakayama, *T. Muroi* 472 (A); Yakushima, *S. Hatusima* 16234 (A), *G. Masamune s.n.* (NY), *T. Motozi* 1770 (NY); Yamagata, *D.E. Boufford* 22302 (GH), *S. Kurosawa* et al. 3601 (A), *T. Nemoto* 1733 (A, PE), *S. Tsugaru & M. Takahashi* 13485 (A), 13503 (A), *K. Uno s.n.* (A); Yamato, *S. Kitamura & J. Murata* 1504 (A); Without exact locality: Hondo, *E.H. Wilson* 7206 (A), *M. Mizushima* 262 (A), *M. Mizushima* 11675 (A), *T. Shiota* 150 (A); Honshu, *J. Ohwi s.n.* (PE), *H. Ohba* et al. 73108 (A), *T. Shiota* 6559 (A), *T. Hurusawa* 1310 (A), *H. Ohba* et al. 73111 (A), *T. Tanaka s.n.* (PE), *T. Katanabe s.n.* (GH), Mt Kunosho, *K. Miyabe s.n.* (A), *T. Kirishima s.n.* (A), *T. Sakurai s.n.* (A). KOREA: Chisan Keisyonando, *K. Uno* 23415 (NY); North Hankyo, *E.H. Wilson* 8911 (A); North Heian, *E.H. Wilson* 8640 (A); Hogen, *E.H. Wilson* 10424 (A); Kankyo, *E.H. Wilson* 9185 (A); Keisho, *E.H. Wilson* 9621 (A); Seoul, *J.G. Jack s.n.* (A, 2 sheets); South Cholla, *R.K. Smith s.n.* (A); South Hankyo, *E.H. Wilson* 8868 (A); South Chungchong, *K. Uno* 23415 (A); Without exact locality, *U.J. Faurie* 470 (A), *V. Komarov* 1046 (A, NY), *R.G. Mills* 2586 (PE).

CHINA (by province): ANHUI: Huangshan, *BNU Team* 643087 (BNU), *M. Chen* 1084 (PE), *R.C. Ching* 3012 (A), *G.S. Chow* 161 (A, MO, PE), 463 (PE), *A.N. Steward* 7139 (A, NY), *T.N. Liou & P.C. Tsoong* 2053 (PE), *H.Y. Zou & F.Y. Yuan* 847049 (A); Jiuhuashan, *R.C. Ching* 2806 (A), *C.S. Fan & Y.Y. Li* 141 (A), *S.C. Sun* 1353 (A, NY); Chihche, *R.C. Ching* 3358 (A); Se Xian, *K.J. Kuan* 75240 (PE). FUJIAN: Congan, *C.P. Jian* 400452 (PE), 400557 (PE); Gutian, *H.H. Chung* 4018 (A), photo of *Chung* 4018 under name of *Celastrus chungii* Merr. n. sp. by Ding Hou (A). GUANGDONG: Liannan, *Z.Y. Li* 321 (MO), *P.X. Tan* 58893 (MO, PE); Lunghaolung, *H. Handel-Mazzetti* 890 (A); Ruyuan, *Y.G. Liu* 549 (MO), *C. Wang* 42216 (MO); Wuhua, *X.G. Li* 201578 (PE); Xinfeng, *Y.W. Taam* 883 (A); Yangshan, *L. Deng* 192 (MO, PE). GUANGXI: Guilin, *W.T. Tsang* 28202 (A); Lingchuan, *W.T. Tsang* 27939 (A); Lucheng, *R.C. Ching* 6093 (A, NY, PE); Tzuyuen, *T.S. Tsong* 83422 (A); Xingan, *Guangxi Exped.* 4195 (PE). GUIZHOU: Majo (South of Longli), *Cavalerie* 3316 (A, **Type** of *Aspidopteris hypoglauca*); Jiangkou, *Sino-Amer. Guizhou Bot. Exped.* 1060 (A, MO, NY, PE); Dejiang, *P.T. Tsoong* 683 (PE); Fanjingshan, *P.T. Tsoong* 864 (PE); Kaili, *South-Guizhou Exped.* 3911 (PE); Leigongshan, *Z.Y. Cao* 3687 (PE); Yinjiang, *Sino-Amer. Guizhou Bot. Exped.* 1792 (A, NY, PE). HUBEI: Lichuan, *F.X. Fu & Z.S. Zhang* 1759 (PE), *W.B. Lin* 364 (PE). HUNAN: Changsha, *K.J. Kuan* 74620 (PE); Jianghua, *B.G. Li & S.B. Wan* 5238 (PE); Mongshan, *M.X. Huang* 112176 (MO), 112507 (MO), 112665 (MO), Siang, *Bullock* 20692 (Holotype photo of *T. bullockii* Hance, A). Xinning, *C.S. Fan & Y.Y.*

Li 499 (A); Yizhang, *S.Q. Chen* 2537 (MO, 2 sheets), *B.H. Lian* 83595 (MO), *X.Q. Liu* 28888 (MO); Ningyuan, *P.X. Tan* 62708 (MO); Wugang, *L.H. Liu* 16328 (PE); Yunschan, *H. Handel-Mazzetti* 411 (A). JIANGXI: Anfu, *T.S. Yao* et al. 3107 (PE); Dexin, *K. Yao* 11487 (A, NY); Jinggangshan, *T.S. Yao* et al. 5476 (PE); Lushan, *K.S. Chow* 159 (A, MO, PE), *K.J. Kuan* 74185 (PE); Qianshan, *C.P. Jian* et al. 400784 (PE), 401204 (PE); Qian Xian, *Z.B. Yang & G. Yao* 1024 (PE); Wunin, *S.K. Lai* 2749 (PE); Xingguo, *W.H. Wan* 1812 (PE); Xiushui, *Y.K. Hsiung* 5510 (A). JILIN: Antu, *P.Y. Fu* et al. 1280 (PE), 1394 (PE); Changbaishan, *BNU Team* 13667 (BNU), *T.N. Liou* et al. 1808 (PE), *Temp. Forest Group* 428 (PE), 455 (PE), *Tonghua Group* 48 (PE), *Yanbian 1st Group* 278 (PE), 377 (PE); Fusong, *Kitagawa* 164 (PE), *T.N. Liou* et al. 1241 (PE), 1879 (PE); Helong, *C.S. Wang* et al. 2529 (PE), *Yanbian 2nd Group* 934 (PE), 942 (PE); Linjiang, *T.N. Liou* et al. 1095 (PE). SICHUAN: Dokou, *Qinghai-Xizang Exped.* 11605 (PE); Hechang, *T.T. Yü* 1147 (A); Hsichong, *T.T. Yü* 1205 (A); Liangshan, *S.K. Wu* 5425 (PE); Mianning, *S.K. Wu* 1995 (PE), 2202 (PE), *T.S. Ying* 4308 (PE); Miyi, *Qinghai-Xizang Exped.* 11734 (PE). TAIWAN: Kilong, *Ford* 21 (A), 58 (GH), *T. Tanaka & Y. Shimada* 17800 (A, 4 sheets, NY), *U.J. Faurie* 75 (A), *D.E. Boufford & B. Bartholomew* 25016 (A); Taipei, *H. Ando* et al. 92 (A), *C.C. Hsu* 5427 (MO, 2 sheets), *M.T. Kao* 10117 (A, MO), 10261 (A), *C.I. Peng* 5994 (MO), 12856 (MO), *C.C. Wang* 1378 (A), *K.C. Yang* 2014 (A), 2041 (A); Tamsuy, *Oldham s.n.* (A, GH). YUNNAN: Dali, *G. Forrest* 4290 (A), *H. Li & V. Soukup* 954 (A), *F.A. McLure* 205 (A), *J. Murata* et al. 10 (A), 17 (A), *J.F. Rock* 6110 (A), 6378 (A), *C. Schneider* 2755 (GH), 2948 (A), *1981 Sino-British Exped. to Cangshan* 708 (A), 1126 (A), *1984 Sino-Amer. Bot. Exped.* 801 (A), 831 (A), *H.T. Tsai* 53811 (A), 53841 (A), *C.W. Wang* 63146 (A), 63225 (A, PE), 63339 (A, PE), 63458 (A, PE), 63482 (A, PE), *H.C. Wang* 1032 (PE), *South Water-North Transf. Exped.* 10480 (PE); Dayao, *D.D. Tao* 121 (NY), 466 (NY), Eshan, *H.T. Tsai* 53475 (A); Fugong, *Qinghai-Xizang Exped.* 24 (PE); Lanping, *Hengduanshan Exped.* 1078 (PE); Lantsang, *C.W. Wang* 76806 (A, PE); Lijiang, *R.C. Ching* 22050 (A), *C. Schneider* 2483 (GH); Longling, *South China Exped.* 110 (PE); Lushui, *South Water-North Transf. Exped.* 10338 (PE); Kunming, *S.Y. Hu & P. But* 20908 (A), *P.Y. Qiu* 60001 (A), *1984 Sino-Amer. Bot. Exped.* 1438 (A, MO); Mengtze, *A. Henry* 10203 (A, NY), 10203a (A, MO), 10203b (A, MO); Shangpa, *H.T. Tsai* 54767 (A), 58737 (A); Shunning, *T.T. Yü* 16137 (A), 16177 (A), 16178 (A); Szemao, *A. Henry* 12024 (A, MO, NY), 12024a (A, MO); Tengyuh, *P.S. Ten* 186 (A); Tengyuh and Lungling, *J.F. Rock* 7130 (A, NY); Wenshan, *K.M. Feng* 11192 (A), 11397 (A); Weixi, *Hengduanshan Exped.* 1603 (PE); Xiaguan, *Qinghai-Xizang Exped.* 512 (PE); Yangbi, *J.F. Rock* 6266 (A); Yungjen, *H.T. Tsai* 52809 (A), 52851 (A); Without exact localition, *H. Handel-Mazzetti* 8574 (A), *G. Forrest* 7106 (PE), 7661 (A), 7872 (A), 8764 (A), 11644 (PE), 11647 (A), 11677 (A), 12000 (A, PE), 24319 (PE), 24753 (NY), (PE), 28135 (PE), *E.E. Maire* 11 (A), 127 (A), 173 (A), 746 (A, **merotype** of *Pentace virginis* H. Lév.), 833 (A, **merotype** of *Microrhamnus franchetiana* H. Lév.), *O. Schoch* 267 (A), *P.S. Ten* 525 (A). ZHEJIANG: Changhua, *Y.C. Jia* 26774 (PE), *Zhejiang Exped.* 29821 (PE); Chunan, *Zhejiang Exped.* 27515 (PE); Longquan, *R.C. Ching* 2545 (A), *S.Y. Zhang* 3017 (E)

Notes on above citations for China: Specimens from a few Chinese provinces were not available for this work. In these cases, we consulted the local floras and have included information below. These include: Anhui: reported from South of the province (see Anonymous, 1988, *Fl. Anhui* 3: 374–375); Fujian: reported from North of the province (see Fujian Normal University, 1987, *Fl. Fujian.* 3: 292–293); Heilongjiang: reported from Dongning Xian and Ningan Xian in the SE corner of the province (Y.L. Zhou, 1986), located at Lao Ye Ling Mountain of the eastern part of the ChangBai Mountains situated between north-eastern China and North

Korea; Hubei: recorded from South and South-west of this province (Hubei Institute of Botany, 1979, *Fl. Hubei.* 2: 448–449); Jiangsu: recorded from the mountains of Yixing District, the south-eastern part of this province (see Jiangsu Institute of Botany, 1982, *Fl. Jiangsu* 2: 444); Liaoning: no plants in the wild but some are cultivated at the botanical gardens of An Shan City and Shen Yang City (Y.S. Li, 1991: 300); Sichuan: reported from South and South-west of the province (see Z.R. Chang, 1988, *Fl. Sichuan.* 4: 343–346); Xizang: no official report from this area at present; however, several specimens from Medog County, SE Xizang were collected in the early 1990s during a special botanical expedition to the area (Sun, H., pers. comm.); Zhejiang: recorded from most parts of this province (see H.S. Guo, 1993, *Fl. Zhejiang.* 4: 42–44).

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