

A New Taxonomic Treatment for the *Acer duplicatoserratum* Complex (*Aceraceae*) in China and Taiwan

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Acer duplicatoserratum var. *duplicatoserratum*, var. *chinense*, *A. ceriferum*, and *A. linganense* are distributed in China and Taiwan. Their taxonomic delimitations are obscure because the criteria used to distinguish among these taxa, mainly the degree of pubescence in leaf and petiole, is highly variable within the group. However, further examination of specimens from China led us to resolve the taxonomy in detail. *Acer ceriferum* and two varieties of *A. duplicatoserratum* show continuous variation in pubescence, which may reflect a lack of divergence between them. Also, some specimens of *A. linganense* come from locations near to Zhejiang Province of eastern China, and represent the same characteristics as the plants of *A. ceriferum*. The only vegetative morphology is the degree of leaf pubescence, which is highly variable. We could find no other characters that clearly distinguish pubescent taxon from the rest. Therefore, it is not sufficient for taxonomic splitting of these taxa. *Acer duplicatoserratum*, described by Hayata from Taiwan, is found to be synonymous with taxa from Eastern and Central China known as *A. ceriferum* and *A. linganense*. Geographically, *A. duplicatoserratum* occurs in mountain regions of Jiangsu, Anhui, Zhejiang, Hunan, Shaanxi, and Hubei extending into the west of Hubei and rarely into north and central part of Taiwan. Pubescent individuals mainly grow in peripheral populations, western Hubei and Taiwan.

Key words: *Acer duplicatoserratum*, *Acer ceriferum*, *Acer linganense*, *Acer robustum*, flavonoids, Flora of China.

Most recently Xu et al. (2008) reduced many taxa of *Acer* L. from ca. 140 species (Fang 1981) to ca. 100 species in *Flora of China*. Compared with Fang's treatments (1981), nearly 20 species within sect. *Palmata* Pax were reduced as synonyms, but without providing any reliable taxonomic evidence for these treatments.

There is a clear need for a study of these species that goes beyond the limited work

previously undertaken as small parts of a major classification of *Acer* (Fang 1981, Xu et al. 2008). In addition, during the past few decades further examination of specimens obtained from China allowed us to resolve the taxonomy of sect. *Palmata* in detail. As a part of the systematic revision, a new taxonomic treatment of *Acer duplicatoserratum* Hayata is proposed here.

The *Acer duplicatoserratum* complex in China and Taiwan is quite variable, and two infraspecific taxa, namely var. *duplicatoserratum* and var. *chinense* C. S. Chang, have been recognized (Chang 1990). The *Acer duplicatoserratum* complex is similar in a number of respects to *A. palmatum* Thunb. occurring in Korea and Japan but the complex is distinguished from *A. palmatum* by the possession of a pubescent ovary and petiole and the presence of flavonol *O*-glycosides (= *japonicum*-type) without *O*- and *C*-glycosyl flavones (= *palmatum*-type) (Delendick 1990, Chang 1990, Chang and Giannasi 1991).

The taxonomic delimitation of *A. duplicatoserratum* var. *chinense* has been described previously (Chang 1990) based on a single character, pubescent to glabrous petioles. Criteria classically used to distinguish between these two infraspecific taxa concerned the degree of pubescence in leaf and petiole (Chang 1990). Chinese populations were predominantly glabrous, while pubescent individuals were prevalent in Taiwan (Hayata 1911). Limited number of specimens (14) from China available in the 1980s suggested that a new variety was appropriate for the Chinese populations. The previous approach consisted of a study of individuals in China and individuals in Taiwan that we had classified, a priori, as var. *chinense* and var. *duplicatoserratum*, respectively.

Before this treatment (Chang 1990), only one collection of *A. ceriferum* Rehder, which was very pubescent along the veins and petiole including twigs was described by Rehder (1911) based on a collection (Wilson no. 1934) from western Hubei. When *A. duplicatoserratum* var. *chinense* was described, the close relationships between var. *duplicatoserratum* and *A. ceriferum* in terms of morphology (pubescence in leaves and twigs) and between var. *chinense* and *A. ceriferum* with respect to identical chemical profile were previously indicated (Chang 1990). There was only a single compound difference (myricetin 3-*O*-rhamnoside) even between var.

duplicatoserratum and var. *chinense* (Chang 1990).

Recent observations showed that this morphological character separating the taxa was minor, and showed some overlap. For both pubescent taxa, *A. ceriferum* was apparently restricted to western Hubei, while var. *duplicatoserratum* was restricted to Taiwan (Chang 1990, Xu et al. 2008). Previous Chinese specimens treated as var. *chinense*, from Hunan, Anhui, Jaingxi and Zhejiang, lacked pubescence on mature leaves. However, a recent examination of specimens from additional herbaria showed that the degree of pubescence was continuous across the geographic range of the complex. Many taxa of sect. *Palmata* in China also have wide ecological ranges like *A. ceriferum*. For example, *Acer sinense* Pax occupy a wide geographic range from west to east, but the amount of morphological variation within the taxon differs. This species (including *A. pubinerve* Rehder, *A. kweiliense* W. P. Fang & M. Y. Fang, *A. elegantulum* W. P. Fang & P. L. Chiu, and *A. bicolor* F. Chun) shows considerable morphological variation which at least in the degree of pubescence in leaf and ovary is partly correlated with geography. Unfortunately details of the ecology of the highly variable taxa in China are practically unknown now. As is clear from this distribution pattern, the *A. ceriferum* and *A. duplicatoserratum* complex are not narrow endemics and these taxa occur throughout eastern China and Taiwan.

The previous study pointed out that flower color may be a significant distinguishing character for certain taxa as was the case of *A. sieboldianum* Miq. and *A. pseudosieboldianum* (Pax) Kom. However, this characteristic was not found within the *A. duplicatoserratum* complex and *A. ceriferum*.

Since this taxon has been given two names, namely *A. ceriferum* and *A. duplicatoserratum*, the correct name should be the first that was validly published. The dates of publication for both names were investigated, and it was found

that *A. duplicatoserratum*, which was published by Hayata on June 20, 1911 has priority over *A. ceriferum* by Rehder on July 31, 1911.

Besides these taxa, some individuals that come from locations of Zhejiang Province in eastern China, morphologically match plants of *A. duplicatoserratum*. *Acer linganense* W. P. Fang & P. L. Chiu was described by Fang and Chiu (Fang 1979) as having 7–9-lobed and tomentose leaf vein axils and yellowish pubescent ovary (Xu et al. 2008). Xu et al. (2008) insisted that this species was distributed in Zhejiang and Anhui, while *A. ceriferum* was found only in Hubei. It is not difficult to find typical forms of *A. duplicatoserratum* var. *chinense* with 7–9-lobed leaves and yellowish pubescent ovary in Hubei as well as other parts of eastern China. There was virtually no separation of taxa with respect to the degree of pubescence and the number of leaf lobes. Therefore, *A. linganense*, the *A. duplicatoserratum* complex, and *A. ceriferum* overlapped considerably for this character and should be treated as one species. Current results of flavonoid analyses showed that *A. linganense* from Zhejiang collections including other related taxa belong to the *japonicum*-type (Chang and Woo unpublished data).

Recent studies of Chinese *Acer* in *Flora of China* revised by Xu et al. (2008) caused further taxonomic confusion. Specifically, Chen (from Xu et al. 2008) characterized *A. robustum* Pax and *A. ceriferum* as resembling forms and merged the two names to *A. ceriferum*. *Acer robustum* is abaxially pubescent along the main veins and show tufts of hairs at vein axils and no hair on ovary, while *A. ceriferum* is abaxially pubescent and densely villous, and has a pubescent ovary. Also, the flavonoid complement of *A. robustum* is quite distinct in comparison to *A. ceriferum* due to the presence of flavones unlike the *japonicum*-type dominated by flavonol-*O*-glycosides. Xu et al.'s (2008) treatment should not be accepted for reasons of these evidences. Therefore,

Xu et al. (2008) misapplied *A. robustum* to *A. ceriferum*, and to the best of our knowledge, *A. robustum* should be considered to represent an independent species with respect to chemistry as well as leaf morphology. However, *A. robustum* Pax was found to be a later homonym of *A. robustum* Opiz (Xu et al. 2008). Because of this reason, *A. anhweiense* W. P. Fang & M. Y. Fang should be selected and used as a correct name for this taxon.

The evidence presented here can be best be accommodated by treating *A. duplicatoserratum* var. *chinense* as synonyms of var. *duplicatoserratum*. The following is a taxonomic treatment for *A. duplicatoserratum* in China and Taiwan.

Acer duplicatoserratum Hayata in J. Coll. Sci. Imp. Univ. Tokyo **30**: 65 (1911).

Type: TAIWAN. Taitung Hsien, Nataianchi, June, 1902, N. Konishi s.n. (TI–holotype, seen as a photo).

Acer ceriferum Rehder, Pl. Wilson. **1**: 89 (1911). **Type:** CHINA. Hubei. Fang Hsien (= Fangxian), alt. 5000 feet (ca. 1524 m), 10 July 1907, E. H. Wilson 1934 (A !–holotype).

Acer duplicatoserratum Hayata var. *chinense* C. S. Chang in J. Arn. Arb. **71**:555 (1990). **Type:** CHINA. Anhui. Mt. Chang-gon-shan, Wu-yuan, ca. 2500 ft (820 m), 17 Aug. 1925, R. C. Ching 3243 (A !–holotype).

Acer palmatum Thunb. subsp. *matsumurea* Koidz. var. *spontaneum* Koidz. subvar. *formosanum* Koidz. in J. Coll. Sci. Imp. Univ. Tokyo **32**: 50 (1911) – *Acer ornatum* Carr. var. *matsumurea* Koidz. var. *spontaneum* (Koidz.) Nemoto subvar. *formosanum* (Koidz.) Nemoto, Fl. Jap., Suppl.: 454 (1936). **Type:** TAIWAN. June 1902, N. Konishi s.n. (TI !–holotype).

Acer palmatum Thunb. var. *pubescens* H. L. Li in Pacific Sci. **6**: 293 (1952) – *Acer palmatum* Thunb. subsp. *pubescens* (H. L. Li) E. Murray in Kalmia **8**(2–3): 20 (1978). **Type:** TAIWAN. Tarana, Bunzan-gun, Taihokushu, 7 Apr. 1937, T. Sukuzi 17859 (A !–holotype; isotype–PE !, TAI,

not seen).

Acer linganense W. P. Fang & P. L. Chiu in Acta Phytotax. Sin. **17**: 70 (1979). Type: CHNA. Zhejiang. Lin'an, 9 Apr. 1957, Y. Y. Ho 20991 (HHBG—holotype, seen as a photo).

Specimens examined: CHINA. **Anhui**: Mt. Hwan-shan, Shihszelin to Sungku-an, 21 Aug. 1935, T. N. Liu & P. C. Tsoong 2931 (YL, PE); Mt. Hwan-shan, Shihszelin, 15 Aug. 1935, T. N. Liu & P. C. Tsoong 2785 (YL); Tientai, Chihwa-shan, 28 June 1925, R. C. Ching 2828 (A); Mt. Changgon-shan, Wu-yuan, ca. 2500 ft (ca. 820 m), 17 Aug. 1925, R. C. Ching 3243 (A). **Jiangsu**: Wuxi city, the south foot of Mt. Liuding-shan, at the edge of the forest, alt 800 m, 8 April 1994, W. X. Wu 9523 (MO). **Jiangxi**: Yongxiu city, Mt. Yun-shan, 25 May 1998, S. S. Lai & H. S. Shan 4034 (MO); Ruichang city, Mt. Qing-shan, in the forest on the mountain, alt. 800 m 15 Sept. 1998, S. S. Lai & H. S. Shan 3837 (MO); Pengze city, Haixing county, in the foresee on the mountain, alt 800 m, 5 May 1998, S. S. Lai & H. S. Shan 2559 (MO); Wuyuan county, Mt. Zhanggong, in the foresee on the mountain, alt. 800 m, 5 Sept. 1998, S. S. Lai & H. S. Shan 2560 (MO); 10 May 1998, S. S. Lai & H. S. Shan 4754 (MO); Lushan Co., Biyunan, alt. 850 m, 9 July 1995, C. M. Tan 95471 (MO); Lushan Co. Huanglongan, alt. 700 m, 23 May 1995, C. M. Tan 95224 (MO, CA); Lushan Co., Aug. 1934, H. H. Hu 2414 (A); Lushan, 4 July 1922, N. K. Ip s.n. (A); Kuling, 31 July 1909, E. H. Wilson 1504 (A); Kuling, 31 July 1909, E. H. Wilson 1505 (A); Lushan Co., Lanheba, alt. 700 m, 7 June 1992, M. X. Nie 92173 (MO); Lushan Co., alt. 700 m, 14 July 1992, M. X. Nie 91084 (MO); Wuning county, Mt. Jiuling, in the foresee on the mountain, alt 1300 m, 20 Aug. 1996, C. M. Tan 960114 (MO). **Hubei**: Tongshan city, Mt. Jiugong-shan, alt. 1300 m, 18 Oct. 1996, C. S. Ye 3335 (MO). **Hunan**: Mt. Mofou-shan, Niushiungan, 10 Sept. 1947, Y. K. Hsiung 05824 (A). **Zhejiang**: Lin'an city, Mt. Tianmu-shan, Unknown collector 312 (YL); West of Mt. Tianmushan, 7 June 1972, Zeibo 3245 (Y); Mt. Tianmu-shan, alt. 600–1200 m, 5–18 May 1924, R. C. Ching 1417, 1515 (A); Mt. Tianmu-shan, alt. 600–1200m, 28 Sept. 1963, X. Y. He 30012 (MO); Mt. Tianmu-shan, alt. 2700 ft (= ca. 900 m), 21 July 1927, C. Y. Chiao s.n. (A); Huating, alt. 3000 ft (= ca. 1000 m), 20 July 1927, C. Y. Chiao s.n. (A).

TAIWAN. **Hualien** Co.: Tzuen, alt. ca. 2000 m, 21 June 1982, M. J. Lai & C. J. Liang-Lai 13414 (A); Tayulien (= Tayuling) to Tsuen (= Tzuen), 8 Oct. 1983, Huang 166 (TAI, TUS); Mt. Houshao-shan, Daroko (Tailuko) Forest, 30 Aug. 1953, Liu & Liu 135 (TAI); Tarokotai-zan (= Tailukota-shan), 14 June 1933, T. Suzuki 9478 (TAI); Hopinglintao, 24 May 1993, S. F. Huang, K. C. Yang & M. J. Wu 5164 (TAI). **Nantou** Co.: Mt. Tan-da, alt. 1200 m, 24 Aug. 1988, C. S. Chang 1374 (PE); Mt. Tan-da, C. S. Chang 1376 (PE, GA, A). **Taichung** Co.: Lishan, 5 May

1984, Tang 437 (TAI). **Taipei** Co.: Taihokusyuu, Bunzangun, Habun, Babo kuru (= Papokulu-shan), 20 April 1937, T. Suzuki 6490 (TAI, PE). **Taoyuan** Co.: Paling to Tamanshan, 6 April 1983, K. C. Yang 1273 (TAI); Paling to Lala-shan, 8 April 1990, P. F. Chiang 46 (TAI). **Yilan** Co.: Taihei-zan (= Taiping-shan), 2 Sept. 1925, S. Sasaki s.n. (A, TAI), Chililo-shan, 1 July 1938, S. Hibino, R. Kikukawa & K. Joen s.n. (TAI); Wanjungsiang, Wanjung forest road to Chitsaihu, alt. 1800 m, 27 May 1999, S. H. Wu 1341 (CA, MO).

Distribution: It occurs in mountain regions of Jiangsu, Anhui, Zhejiang, Hunan, Shaanxi (Yi 1998) and Hubei extending into the west of Hubei and rarely (Fig. 1) north and central Taiwan (Fu et al. 2001). It has been collected from 700 to 1300 m (2000 m in Taiwan) a.s.l. in mountainous areas. Pubescent individuals mainly grow in peripheral populations, western Hubei, Zhejiang and Taiwan, while those with glabrous leaves, fruits, and twigs are predominantly found in Jiangsu, Anhui and Hunan.

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Literature Cited

- Chang C. S. 1990. A reconsideration of the *Acer plamatum* complex in China, Taiwan, and Korea. J. Arn. Arb. **71**: 553–565.
- Chang C. S. and Giannasi D. E. 1991. Foliar flavonoids of *Acer* sect. *Palmata*, series *Palmata*. Syst. Bot. **16**: 225–241.
- Delendick T. J. 1990. A survey of foliar flavonoids in the *Aceraceae*. Mem. New York Bot. Gard. **54**: 1–129.
- Fang W. P. 1979. Praecursores Florae Aceracearum Sinensium. Acta Phytotax. Sin. **17**: 60–86.
- Fang W. P. 1981. *Aceraceae*. Flora Republicae Popularis

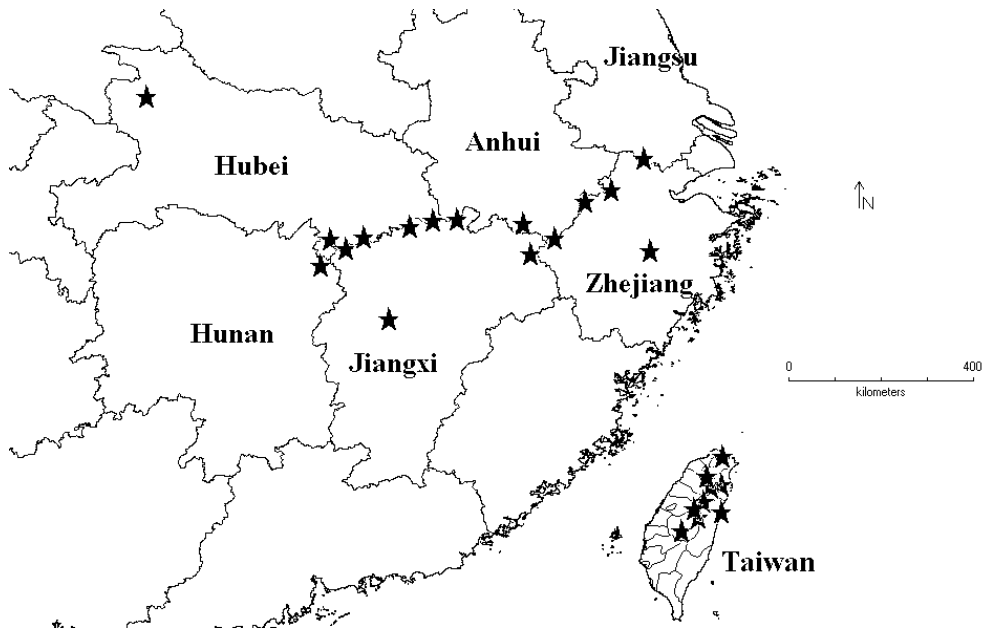


Fig. 1. Distribution of *Acer duplicatoserratum* in China and Taiwan. The range of *A. duplicatoserratum* is indicated as star marks and is based on all herbarium specimens (A, CA, MO, PE, TAI and YL) examined in this study.

Sinicae 46: 66–273. Science Press, Beijing (in Chinese).

Fu L. K., Chen T. Q., Lang K. Y., Hong T. and Lin Q. 2001. Higher plants of China. Vol. 8. Qingdao Publishing House, Qingdao (in Chinese).

Hayata B. 1911. Materials for a Flora of Formosa. J. Coll. Sci., Imp. Univ. Tokyo 30: 1–471.

Rehder A. 1911. An enumeration of the woody plants collected in western China for the Arnold Arboretum of Harvard University during the years 1907, 1908, and 1910 by E. H. Wilson. In: Sargent C. S. (ed.), *Plantae*

Wilsonianae 1(1): 1–144. Cambridge University Press, Cambridge.

Xu T.-Z., Chen Y.-S., de Jong P.-C., Oterdoom H. J. and Chang C.-S. 2008. *Aceraceae*. In: Wu Z.-Y., Raven P. H. and Hong D. Y. (eds.), *Flora of China (Oxalidaceae through Aceraceae)* 11: 515–553 Science Press, Beijing, Missouri Botanical Garden Press, St. Louis.

Yi R. 1998. Plants of Giant Panda's habitat of Qinling mountains. Shaanxi. Shaanxi Science and Technology Press, Xian, Shaanxi (in Chinese).

張 珍 成, 禹 光 復: 中 国 と 台 湾 に 分 布 す る *Acer duplicatoserratum* 複 合 体 (カ エ デ 科) の 分 類 学 的 再 検 討

中国と台湾に分布するカエデ科の *Acer duplicatoserratum* Hayata (var. *chinense* C. S. Chang を含む), *A. ceriferum* Rehder と *A. linganense* W. P. Fang & P. L. Chiu について分類学的再検討を行った。 *A. ceriferum* と *Acer duplicatoserratum* (var. *chinense* を含む) は葉の有毛性 *pubescens* に連続的な変異を示した。また、中国東部・浙江省産 *A. linganense* のいくつかの標本はその有毛性において *A. ceriferum* と同一の特徴を示した。問題とする3種を区別する唯一の栄養的形質は葉の有毛性の程度であるが、この形質は変異の幅が広いことが明らかになった。した

がって、上記の3種を独立した分類群として認めることは適当ではないと考えられる。この結果、中国東部と中部からそれぞれ記載された *A. ceriferum* と *A. linganense* は、台湾から記載された *A. duplicatoserratum* の異名として扱うことが適当である。 *A. duplicatoserratum* は中国・江蘇、安徽、浙江、湖南、山西、湖北各省の山岳地帯に分布し、北は河北省西部に及び、南は台湾の北部と中部に稀産する。このうち葉が有毛の個体は、分布域の周辺部に当たる河北省西部と台湾に見られる。

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