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Notes on taxonomy of *Paeonia* sect. *Moutan* DC. (Paeoniaceae)

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Abstract In this paper we argue for the specific status of *Paeonia suffruticosa* Andrews, for the rationality of *P. suffruticosa* ssp. *yinpingmudan* D. Y. Hong, K. Y. Pan & Z. W. Xie and its wildness, and for the treatment of *P. suffruticosa* ssp. *atava* (Brühl) S. G. Haw & Lauener as a subspecies of *P. rockii*, *P. rockii* ssp. *atava* (Brühl) D. Y. Hong & K. Y. Pan. *P. jishanensis* T. Hong & W. Z. Zhao is justified as a legitimate name, while *P. spontanea* (Rehder) T. Hong & W. Z. Zhao is recognized as a superfluous name. Halda's four combinations and two new hybrid names in sect. *Moutan* DC. were treated as synonymy. As a result, one new combination is made and five new synonyms are proposed here in this paper.

Key words *Paeonia*, *Paeonia suffruticosa*, *Paeonia suffruticosa* ssp. *yinpingmudan*, *Paeonia rockii* ssp. *atava*, new combination, new synonymy.

In the 1990s we published several papers dealing with taxonomy of tree peonies (Hong, 1996, 1997a, b, 1998; Hong & Pan, 1999a, b; Hong et al., 1998a, b; Zhou et al., 2003; Hong et al., 2004). Haw (2001) basically accepted our taxonomy of the eight species in sect. *Moutan*, but he held different views in three points. He recognized *Paeonia suffruticosa* Andrews as a hybrid, treated *P. suffruticosa* ssp. *yinpingmudan* D. Y. Hong, K. Y. Pan & Z. W. Xie as a synonym of *P. ostii* T. Hong & J. X. Zhang, and he still considered *P. moutan* Sims ssp. *atava* Brühl (=*P. suffruticosa* ssp. *atava* (Brühl) S. G. Haw & Lauener) as a doubtful taxon. Halda (1997) made a number of new combinations in sect. *Moutan* and described two new hybrids, which were unfortunately neglected by us. This paper is to address Haw's three questions, and deal with Halda's combinations and hybrid names.

1 On *Paeonia suffruticosa* Andrews

1.1 Subspecies *yinpingmudan* D. Y. Hong, K. Y. Pan & Z. W. Xie—a wild form of *P. suffruticosa* distinct from *P. ostii*

Paeonia suffruticosa ssp. *yinpingmudan* (Hong et al., 1998a) was treated by Haw (2001) as a synonym of *P. ostii*, and the two specimens cited in the protologue were suspected by him to be escaped. However, *P. ostii* is characterized by having bipinnate lower leaves with 15 leaflets, which are mostly entire, ovate or ovate-lanceolate, and hirsute at the base above, but glabrous beneath, whereas the type specimen of ssp. *yinpingmudan* is characterized by having biternate lower leaves with 9 leaflets, which are oblong to ovate-orbicular, all divided or lobed, and glabrous on both sides. Anyone who has compared the type specimen of ssp. *yinpingmudan* (Mt. Yinping, Chaohu, Anhui Province, K. Y. Pan & Z. W. Xie 9701 (PE)) with the type of *P. suffruticosa* (Andrews' plate) (Fig. 1), would say that the identification of the collection K. Y. Pan & Z. W. Xie

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9701 as an element of *P. suffruticosa* is justifiable. From a comparison between Hong and Pan's (1999a) figures 1 and 4 (Fig. 2), *P. suffruticosa* ssp. *yinpingmudan* cannot be confused with *P. ostii*.

Fig. 1. A comparison between the type of *Paeonia suffruticosa* Andrews and that of *P. suffruticosa* ssp. *yinpingmudan* D. Y. Hong, K. Y. Pan & Z. W. Xie. **A,** The type of *P. suffruticosa* (Bot. Rep. 6: t. 373. 1804). **B,** The type of *P. suffruticosa* ssp. *yinpingmudan* (K. Y. Pan & Z. W. Xie 9701(PE)).

We are not yet sure whether the material from Henan of ssp. *yinpingmudan* (Hong et al. H97010 (PE)) is cultivated or introduced from a nearby mountain as Mr. Yang, our local guide in the field, told us, but the type specimen of this subspecies (K. Y. Pan & Z. W. Xie 9701 (PE)) is quite certainly a wild one, because, first, it grew 30-40 m above the ground on a cliff nearly 100 m high; second, the cliff is in a hilly area, far from cities or towns, and there was no park or garden there; and third, it was said by local people that the peony had existed there at least for 500 years. Therefore, we are not convinced that the peony was escaped from cultivation. Our experience in 1985 on the Taibai Mountain, the Qinling Range, perhaps could give us an implication. On the mountain we spent two days searching for *P. rockii* (S. G. Haw & Lauener) T. Hong & J. J. Li ex D. Y. Hong, but only three individuals were found, with two adults on cliffs and one young in a forest. A local person told us, however, that about 25 years ago (i.e. around 1960) the peony was so common that 30-50 kg of fresh "Dan Pi" (bark of roots and stems) could be harvested a day by a single person. There is possibility that wild *P. suffruticosa* (the subspecies *yinpingmudan*) was more frequent in ancient time in mountainous or hilly areas of Anhui, Henan and some other provinces. Due to the loss of its habitats and random harvest for medicinal and ornamental purposes, it became rarer and rarer, reaching an extent that only the plant on cliffs has survived.

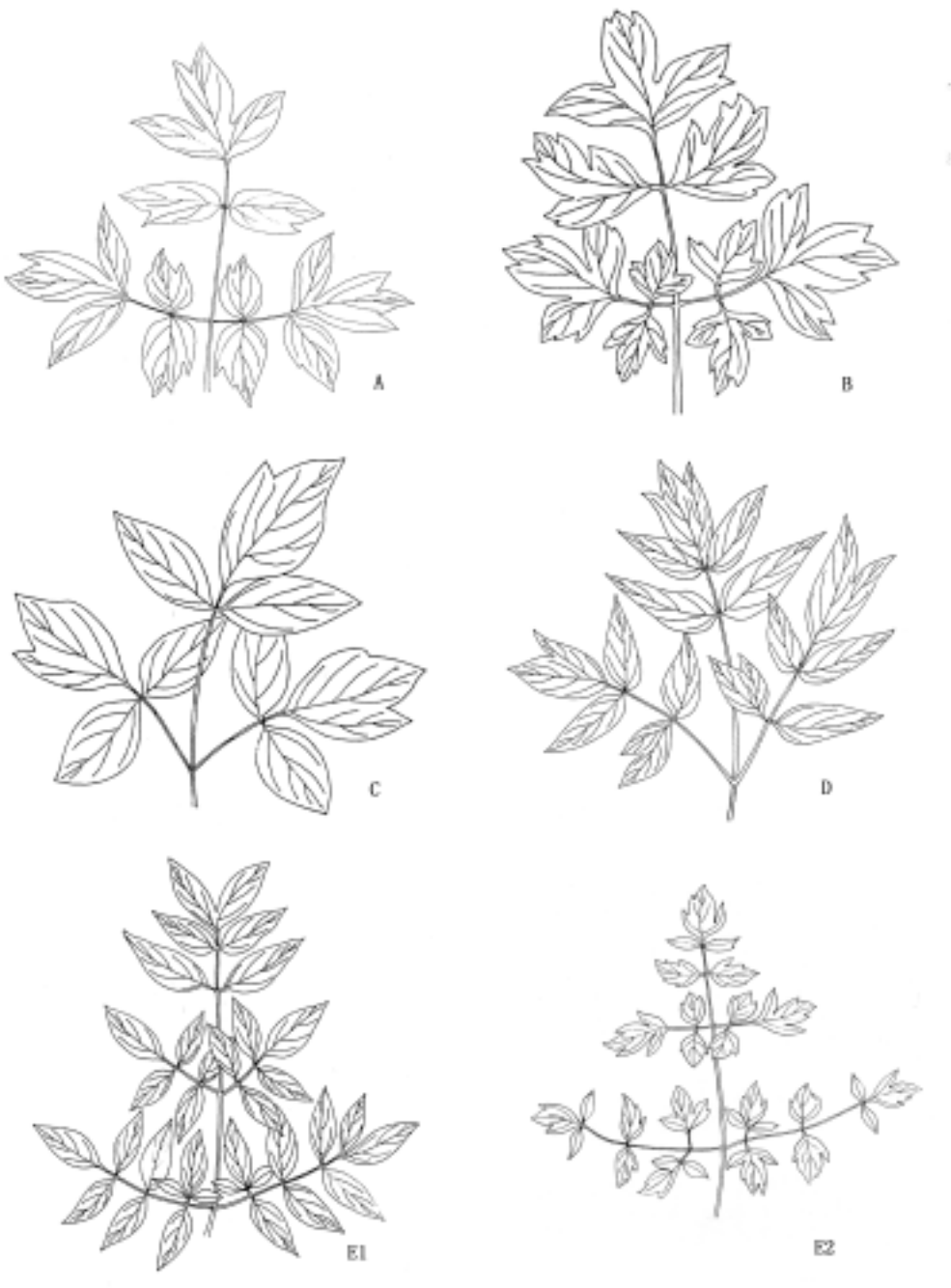

Fig. 2. The lower (the best developed) leaves of the five species in the *Paeonia suffruticosa* Andrews complex. **A,** *P. suffruticosa* ssp. *yinpingmudan* D. Y. Hong, K. Y. Pan & Z. W. Xie (type). **B,** *P. jishanensis* T. Hong & W. Z. Zhao. **C**, *P. qiui* Y. L. Pei & P. Y. Hong. **D,** *P. ostii* T. Hong & J. X. Zhang. **E1,** *P. rockii* (S. G. Haw & Lauener) T. Hong & J. J. Li ex D. Y. Hong ssp. *rockii*. **E2,** *P. rockii* ssp. *atava* (Brühl) D. Y. Hong & K. Y. Pan (syn. *P. rockii* ssp. *taibaishanica* D. Y. Hong). Assembled from the figures 1-6 of Hong & Pan (1999a).

1.2 *Paeonia suffruticosa* is not a hybrid

Haw (2001) recognized *P. suffruticosa* Andrews as a hybrid, but he did not give substantial evidence to support his point of view. As we have pointed out (Hong et al., 2004), cultivated tree peonies are polyphyletic, comprising hundreds of cultivars. Single-flowered tree peonies cultivated for medicinal purpose belong to *P. ostii*. Ornamentally cultivated tree peonies have been derived from different sources; some from wild *P. jishanensis* T. Hong & W. Z. Zhao (cv. "Yi Ping Zhu Yi ", "Chun Hong Jiao Yan" in Luoyang peony gardens), some from wild *P. rockii* (a cultivar in Pengzhou peony gardens), some from wild *P. suffruticosa*, i.e. ssp. *yinpingmudan* (see below), and many others seem to have originated from hybridization between them. We consider that ornamentally cultivated tree peonies comprise at least four species, *P. suffruticosa*, *P. jishanensis*, *P. rockii*, and *P. ostii*, and numerous hybrids, and that not all of cultivars are of hybrid origin. For example, the cultivars "Jin Yao Lou", "Hong Dan Lan" in Pengzhou peony gardens, Sichuan, and "Ge Jin Zi", "Wang Hong" in Luoyang peony gardens, Henan, are extremely similar to both the type of *P. suffruticosa* and the type specimen of *P. suffruticosa* ssp. *yinpingmudan*, with no indication of involvement of *P. jishanensis*, *P. rockii* or *P. ostii* in their origin.

1.3 Molecular data

On our molecular tree of *Paeonia* sect. *Moutan* constructed using GPAT gene sequences, *P. suffruticosa* ssp. *yinpingmudan* and *P. ostii* form a clade, which is separated from the *P. jishanensis*-*P. qiui* Y. L. Pei & D. Y. Hong clade with the bootstrap value as high as 100%, but within the clade, ssp. *yinpingmudan* and *P. ostii* form two separate clades with the bootstrap value as high as 96% (Zhao et al., 2004). This fact clearly indicates that *P. suffruticosa* ssp. *yinpingmudan* is distinct from *P. ostii*, *P. jishanensis* and *P. qiui*. We have also constructed a reduce-medium (RM) network of wild tree peonies using PCR-RFLP data of 12 restriction enzymes. In the network *P. suffruticosa* ssp. *yinpingmudan* forms an independent branch, which also shows the distinctness of *P. suffruticosa* ssp. *yinpingmudan* from the other species (Zhao et al., 2004).

Twelve cultivars identified as *P. suffruticosa* based on morphology were compared with *P. suffruticosa* ssp. *yinpingmudan* using PCR-RFLP profiles of 12 restriction enzymes. Six of the 12 cultivars were found very similar to the subspecies, but none of them was identical with it. The result indicates that ssp. *yinpingmudan* is not an escape, but is a wild peony, from which many cultivars of *P. suffruticosa* have been derived (Zhou et al., unpublished).

All the lines of evidence indicate that *P. suffruticosa* is an independent species with ssp. *yinpingmudan* as its wild form. The species has been involved in the formation of many, but not all of ornamentally cultivated tree peonies. The other species, *P. rockii*, *P. jishanensis* and *P. ostii*, have been also involved in the origins of ornamentally cultivated tree peonies. Cultivated tree peonies are polyphyletic in origin, comprising at least four species, *P. suffruticosa*, *P. jishanensis*, *P. rockii* and *P. ostii*, and their hybrids. Therefore, *P. suffruticosa* is an important component of the *P. suffruticosa* complex, and it still has a wild form, ssp. *yinpingmudan*, from which many cultivars have been derived, and it has been involved in the origin of many hybrid cultivars.

2 *Paeonia qiui* Y. L. Pei & D. Y. Hong—an independent species

The specific status of *P. qiui* has been recognized since its description in 1995. However, Halda (1997, 2004) treated *P. qiui* as a variety of *P. suffruticosa* ssp. *spontanea* (Rehder) S. G. Haw & Lauener.

Paeonia qiui is characterized by having lower leaves biternate, leaflets 9, ovate or broadly ovate, mostly entire (Fig. 2), often purple above, and densely villose in axils of major veins beneath, and petals whitish pink or pink, with a red or reddish blotch at the base (Hong & Pan, 1999a, fig. 3, pl. 5). These characters clearly distinguish it from all the other species, and thus *P. qiui* is a distinct species. Halda's (1997) combination is not justifiable.

3 *Paeonia jishanensis* T. Hong & W. Z. Zhao—a legitimate name

Haw (2001) still used the name *P. spontanea* (Rehder) T. Hong & W. Z. Zhao (Hong & Osti, 1994), while treated *P. jishanensis* T. Hong & W. Z. Zhao (Hong et al., 1992) as its synonym. *P. jishanensis* T. Hong & W. Z. Zhao was considered by him as an illegitimate name, because, according to him, the type of *P. suffruticosa* var. *spontanea* Rehder was included in the concept of *P. jishanensis* T. Hong & W. Z. Zhao. However, T. Hong & Zhao's (Hong et al., 1992) *P. jishanensis* does not include the type of *P. suffruticosa* var. *spontanea*, buy instead T. Hong & Zhao indicated in both Chinese and Latin that *P. jishanensis* differs from *P. suffruticosa* var. *spontanea* by having white petals but no petaloid stamens (Hong et al., 1992). These authors did state (in Chinese) that petaloid stamens in ssp. *spontanea* is an important character induced by domestication of wild tree peonies, and thus ssp. *spontanea* should be reduced into a cultivar, "cv. *spontanea*", but they did not say that "cv. *spontanea*" was an element of *P. jishanensis*. Therefore, we cannot see the reason to recognize *P. jishanensis* T. Hong & W. Z. Zhao as an illegitimate name. It was two years later that they raised ssp. *spontanea* (Rehder) S. G. Haw & Lauener to specific rank and treated *P. jishanensis* as its synonym. Thus, they created a superfluous name, *Paeonia spontanea* (Rehder) T. Hong & W. Z. Zhao.

4 *Paeonia ostii* T. Hong & J. X. Zhang—a species distinct from *P. suffruticosa*

As described by T. Hong & J. X. Zhang (Hong et al., 1992) in the protologue, and shown in their figure (Fig. 1), *P. ostii* has lower leaves bipinnate and leaflets mostly entire, lanceolate or ovate-lanceolate, which match those of widely cultivated tree peonies for the medicinal purpose. Hong and Pan (1999a, Fig. 4 & pl. 6) described and illustrated the characters of *P. ostii* clearly. However, *P. suffruticosa*, as shown in the type (see Hong & Pan, 1999a, pl. 1.), has lower leaves biternate with 9 leaflets, which are all divided or lobed. Therefore, Halda's (1997) treatment of *P. ostii* as a subspecies of *P. suffruticosa* is unacceptable.

5 *Paeonia suffruticosa* ssp. *atava* (Brühl) S. G. Haw & Lauener—a subspecies of *P. rockii*

Haw (2001) insisted his opinion that *P. moutan* ssp. *atava* Brühl as a doubtful taxon (Haw & Lauener, 1990). The first author of the present paper thought after his expedition to Tibet that the peony belonged to *P. rockii*, which was also cultivated in the Tashihungpo Temple in Xigazê City, Tibet, and might well be introduced by Buddhist monks from the Qinling Range, Shaanxi Province (Hong, 1997a). He also examined the type specimen in the Royal Botanic Gardens, Kew (K) and found no difference between it and the tree peony on Mt. Taibai, the Qinling Range, except in the petal colour. Haw & Lauener (1990) and Haw (2001) emphasized the character of petals of ssp. *atava*, "entirely unblotched", "unblotched…, quite unlike those of *P. rockii*". However, the blotched colour fades with time if the specimen is not well preserved, a phenomenon we observed both in the field and

herbarium. The type specimen of ssp. *atava* (King's collector 549) does not show "blotched petals" now, but in the protologue of this subspecies the petals were indeed described as "white with a rosy hue, with a large dark-purple spot near the base". This character is typical of *P. rockii*. Anyone who compares Brühl's (1896) pl. 126 with Hong's (1998) figure 2 (based on the type of ssp. *taibaishanica*) will find that ssp. "*atava*" is extremely similar to ssp. "*taibaishanica*", without significant difference between them. Therefore a new combination, *P. rockii* ssp. *atava* (Brühl) D. Y. Hong & K. Y. Pan, is made below and ssp. *taibaishanica* D. Y. Hong should be treated as its synonym.

6 *Paeonia delavayi* Franch.—a highly variable species

Haw (2001) agreed with us (Hong et al., 1998b) that *P. delavayi* is a very variable species, including "the several formally recognized species and varieties...", and "only one, variable, species can be recognized…" We agree with him that " for horticultural purposes, it would be useful and appropriate for clones within this species to be given forma or cultivar names".

Since we recognize *P. delavayi* as one variable species, with *P. lutea* Delavay ex Franch. and *P. potanini* Kom. treated as its synonyms, we naturally do not recognize *P.* ×*franchetii* and *P.* ×*handel-mazzettii* described by Halda (1997) as real hybrids. They are just two of the innumerable forms in *P. delavayi*.

7 *Paeonia ludlowii* (Stern & Taylor) D. Y. Hong—a distinct species

When Hong (1997a) separated "*ludlowii*" from *P. lutea* and treated it as a new species, he clearly indicated the differences between *P. ludlowii* and *P. lutea* (a synonym of *P. delavayi*). One year later Hong and his co-workers (Hong et al., 1998b) showed strong evidence that *P. delavayi* was a highly variable species with surprising polymorphism in petal colour, and *P. lutea* was just one of the innumerable petal colour forms of *P. delavayi*.

Halda (1999) surprisingly still treated the entity as a subspecies in *P. lutea*, *P. lutea* ssp. *ludlowii* (Stern & Taylor) J. J. Halda.

However, Haw (2001) fully supported Hong's (1997a) separation of var. *ludlowii* Stern & Taylor from *P. lutea* and elevation of the entity to specific rank. The following revised key clearly distinguishes *P. ludlowii* from *P. lutea* (=*P. delavayi*).

1a. Carpels 1, rarely 2; follicles 4.7-7 cm long, 2-3.3 cm broad; seeds ca. 1.3 cm diam.; petals, filaments and stigmata always pure yellow; leaf segments and lobes with acuminate teeth; plants congested, 1.5-3.5 m tall ……**P. ludlowii**

1b. Carpels 2-5; follicles less than 3.5 cm long, 1.5 cm broad; seeds less than 1 cm diam., petals, filaments and stigmata variable in colour; leaf segments and lobes mostly entire; plants scattered, less than 2 m tall……**P. delavayi**

8 Taxonomic treatments

1. Paeonia suffruticosa Andrews in Bot. Rep. 6: t. 373. 1804; Stern, Stud. Gen. *Paeonia*, 40. 1946, quoad nom.; D. Y. Hong & K. Y. Pan in Nord. J. Bot. 19: 291, pl. 1. 1999; D. Y. Hong, K. Y. Pan & Z. Q. Zhou in Acta Phytotax. Sin. 42: 275-283. 2004. Type: Andrews' plate cited (!).

Paeonia×*suffruticosa* S. G. Haw in the New Plantsman, 8 (3): 166. 2001, syn. nov.

1a. ssp. ***suffruticosa***

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1b. ssp. ***yinpingmudan*** D. Y. Hong, K. Y. Pan & Z. W. Xie in Acta Phytotax. Sin. 36: 515. 1998. ——*P. yinpingmudan* (D. Y. Hong, K. Y. Pan & Z. W. Xie) B. A. Shen in Lishizhen Medic. Mater. Med. Res. 12: 330. 2001. Type: China. Anhui (安徽): Chaohu (巢湖), Mt. Yinping, on cliff, 1997-04-28, K. Y. Pan & Z. W. Xie 9701 (holotype, PE!).

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2. Paeonia jishanensis T. Hong & W. Z. Zhao in Bull. Bot. Res. (Harbin) 12: 225. 1992; D. Y. Hong & K. Y. Pan in Nord. J. Bot. 19: 292. 1999; S. G. Haw in The New Plantsman 8 (3): 163. 2001, pro syn. ——*P. suffruticosa* Andrews ssp. *spontanea* (Rehder) S. G. Haw & Lauener var. *jishanensis* (T. Hong & W. Z. Zhao) J. J. Halda in Acta Mus. Richnov. Sect. Nat. 4 (2): 30. 1997. Type: China. Shanxi (山西): Jishan (稷山), Xiqiu, alt. 1200 m, 1991-05-10, T. Hong 915010 (CAF).

Paeonia spontanea (Rehder) T. Hong & W. Z. Zhao in Bull. Bot. Res. (Harbin) 14: 238. 1994; S. G. Haw in The New Plantsman 8 (3): 163. 2001; D. Y. Hong & K. Y. Pan in Nord. J. Bot. 19: 292. 1999, pro syn. ——*P. suffruticosa* Andrews var. *spontanea* Rehder in J. Arn. Arb. 1: 193. 1920, p.p. excl. specim. Tai-Pei-Shan, Purdom s.n. (A). ——*P. suffruticosa* Andrews ssp. *spontanea* (Rehder) S. G. Haw & Lauener in Edinb. J. Bot. 47: 278. 1990. Type: China. Shaanxi (陕西): "50 li W of Yenanfu" (Yan'an, 延安), 1910, Purdom 338 (holotype, A!; isotypes, E!, K!, P!).

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3. Paeonia rockii (S. G. Haw & Lauener) T. Hong & J. J. Li ex D. Y. Hong in Acta Phytotax. Sin. 36: 539. 1998; T. Hong & J. J. Li in Bull. Bot. Res. (Harbin) 12: 227. fig. 4. 1992, comb. invalid. ——*P. suffruticosa* Andrews ssp. *rockii* S. G. Haw & Lauener, in Edinb. J. Bot. 47: 279. fig. 1a. 1990. Type: China. Gansu (甘肃): Wudu (武都), Farrer no 8 (holotype, E!; photo, PE!).

Paeonia papaveracea auct. non Andrews: Anonymous in Icon. Cormophyt. Sin. 1: 652, fig. 1303. 1972.

3a. ssp. **rockii**

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Paeonia rockii ssp. *linyanshanii* T. Hong & G. L. Osti in Bull. Bot. Res. (Harbin) 14: 237. figs. 1, 2. 1994. ——*P. suffruticosa* ssp. *rockii* var. *linyanshanii* (T. Hong & G. L. Osti) J. J. Halda in Acta Mus. Richnov., Sect. Nat. 4 (2): 30. 1997, syn. nov. Type: China. Gansu (甘肃): Wen Xian (文县), Baimahegou (白马河沟), alt. 1570 m, Q. R. Zhang 19930428 (CAF).

3b. ssp. ***atava*** (Brühl) D. Y. Hong & K. Y. Pan, comb. nov. ——*P. moutan* Sims ssp. *atava* Brühl in Ann. Bot. Gard., Calcutta, 5 (2): 114. t. 126. 1896. ——*P. suffruticosa* Andrews ssp. *atava* (Brühl) S. G. Haw & Lauener in Edinb. J. Bot. 47: 280. 1990, syn. nov. Type: China. Xizang (西藏): Chumbi, Tuk Chang, 1884-06, King's Collector 549 (holotype, K!).

Paeonia rockii (S. G. Haw & Lauener) T. Hong & J. J. Li ex D. Y. Hong ssp. *taibaishanica* D. Y. Hong in Acta Phytotax. Sin. 36: 542. fig. 2. 1998. syn. nov. Type: China. Shaanxi (陕西): Mt. Taibai (太白山), Shangbaiyun, alt. 1750 m, 1985-05-24. D. Y. Hong & X. Y. Zhu PB85061 (holotype, PE!).

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Paeonia×*handel-mazzettii* J. J. Halda (*P. delavayi* Franch.×*P. lutea* Franch.) in Acta Mus. Richnov., Sect. Nat. 4 (2): 31. 1997, syn. nov.

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芍药属牡丹组分类新注

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摘要 自我们近年发表一系列牡丹组分类文章以来, 国内外基本上赞同我们8个种的分类系统,但对一些问题仍有不同见解。本文进一步申述牡丹*Paeonia suffruticosa* Andrews 是一个独立的种而不是人工杂种, 以及银屏牡丹*P. suffruticosa* ssp. *yinpingmudan*是牡丹*P. suffruticosa*的野生类型而不是逸生的*P. ostii*的理由。上述论点也得到了分子树的支持。*P. jishanensis* T. Hong & W. Z. Zhao是一个合法名称, 而*P. spontanea* (Rehder) T. Hong & W. Z. Zhao则确实是一个多余名。太白山紫斑牡丹的学名应是*P. rockii* ssp. *atava* (Brühl) D. Y. Hong & K. Y. Pan, 因此*P. moutan* Sims ssp. *atava* Brühl不应是可疑的分类群。本文还对Halda的6个组合和两个杂交种名作了处理。结果, 本文包括了5个新异名和一个新组合。

关键词 芍药属; 牡丹; 银屏牡丹; 太白山紫斑牡丹; 新组合; 新异名