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Astilbe longipedicellata (Saxifragaceae), a New Combination and New Status for *Astilbe thunbergii* (Siebold & Zucc.) Miq. var. *longipedicellata* Hatus. from Kyushu, Western Japan

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Abstract *Astilbe thunbergii* (Siebold & Zucc.) Miq. var. *longipedicellata* Hatus., described from Kyushu, is recognized as a distinct species. A new combination, *Astilbe longipedicellata* (Hatus.) S.Akiyama & Kadota, is proposed. Morphology, geography and other taxonomic implications are discussed.

Key words: *Astilbe*, *Astilbe longipedicellata*, *Astilbe thunbergii* var. *longipedicellata*, Kyushu, new combination, Saxifragaceae.

The genus *Astilbe* (Saxifragaceae s. lat.) is distributed disjunctly in eastern Asia and North America and is more diversified in the former. Endemic species and varieties are known in Japan and their taxonomic treatment has been attempted by several reseachers (Hara, 1939; Ohwi, 1953, 1975; Kitamura and Murata, 1961; Ohba, 1982, 2001).

Three species and varieties of *Astilbe* are recorded from Kyushu in western Japan: *A. japonica* (C.Morren & Decne.) A.Gray, *A. microphylla* Knoll var. *microphylla* and var. *riparia* Hatus., and *A. thunbergii* (Siebold & Zucc.) Miq. var. *kiusiana* (H.Hara) H.Hara ex H.Ohba (Figs. 1 left, 2) (including var. *longipedicellata* Hatus. [Figs. 1 right, 3]) (Ohba, 2001). Among them *A. microphylla* var. *riparia* and *A. thunbergii* var. *kiusiana* (including var. *longipedicellata*) are endemic to Kyushu.

Astilbe thunbergii var. *longipedicellata*, based on specimens collected from Miyazaki Prefecture (Mts. Shiraiwa-yama [Fig. 4] and Do-dake) and Kumamoto Prefecture (Mt. Kunimi-dake and Gokanosho), was characterized by having doubly serrate incised leaves, ovate terminal leaflet with cordate base, loosely flowered paniculate inflorescence, and longer pedicels (2 mm long) (Hatusima, 1968). Hatusima (1968), however, did not describe the flowers. Ohba (2001) treated var. *longipedicellata* as a synonym of *A. thunbergii* var. *kiusiana*, but without commenting on his decision. Towards a revision of the genus *Astilbe*, we are studying morphological characters and their consistency, making field observations, and determining the distribution and ecology of *A. thunbergii* var. *longipedicellata*, and how it differs from its closest ally, *A. thunbergii* var. *kiusiana*.

Materials and Methods

Field surveys were carried out in 2008. All specimens collected were deposited in the Herbarium, National Museum of Nature and Science (TNS). Data were also obtained from herbarium specimens deposited in KAG, KYO, TI, and TNS. Flowers taken from herbarium specimens were examined under a binocular microscope using camera lucida after boiling in water. The measurement of the terminal leaflet

Fig. 1. Left. *Astilbe thunbergii* (Siebold & Zucc.) Miq. var. *kiusiana* (H.Hara) H.Hara ex H.Ohba (Miyazaki Pref., Nishi-usuki-gun, Takachiho-cho, Shikimibaru, 16 July 2008). Right. *A. thunbergii* var. *longipedicellata* Hatus. (Miyazaki Pref., Nishi-usuki-gun, Gokase-cho, Mt. Shiraiwa-yama, 16 July 2008).

follows Akiyama and Kadota (2010).

Results of observations

Morphology

Observations were made on living plants and herbarium specimens. Floral, leaf, and inflorescence features are especially relevant for delimiting and separating var. *longipedicellata* from similar taxa. The characters and characteristics of var. *longipedicellata* are provided in the description.

Flowers: Flowers of *A. thunbergii* var. *longipedicellata* usually lack petals (Figs. 5 left, 6A), although rarely a few rudimentary petals (Fig. 6B), or one petal with a few rudimentary ones (Fig. 6C), are present. The petals are narrowly linear-oblanceolate, and ca. 2.8 mm long by ca. 0.3 mm wide (Fig. 6Cc far right). The rudimentary petals are filamentous and 0.3–1.5 mm long and less than 0.1 mm wide (Fig. 6Bc, Cc left and middle). The flowers of *Astilbe thunbergii* var. *kiusiana* always have five petals (Figs. 5 right and 6D, E), as in var. *thunbergii*, and the petals are narrowly spatulate, 2.6–3.8 mm long by 0.6–0.7 mm wide (Fig. 6Dc, Ec).

Fig. 2. *Astilbe thunbergii* (Siebold & Zucc.) Miq. var. *kiusiana* (H.Hara) H.Hara ex H.Ohba (Japan, Kyushu, Miyazaki Pref., Nishi-usuki-gun, Takachiho-cho, Shikimibaru, alt. 1113 m, Y. Kadota 0832073, TNS).

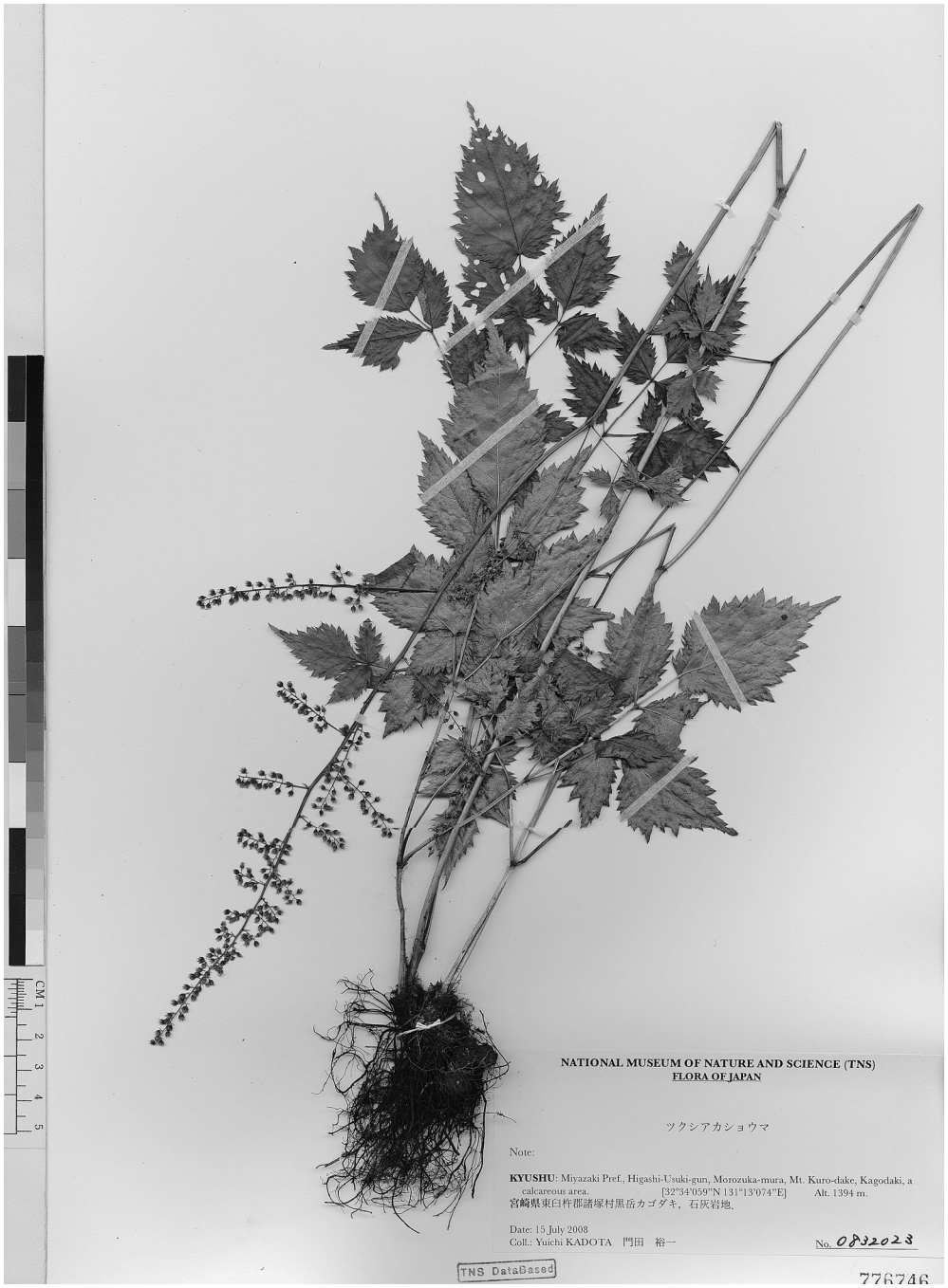

Fig. 3. *Astilbe thunbergii* (Siebold & Zucc.) Miq. var. *longipedicellata* Hatus. (Japan, Kyushu, Miyazaki Pref., Higashi-usuki-gun, Morozuka-mura, Mt. Kuro-dake, Kagodaki, alt. 1394 m, Y. Kadota 0832023, TNS).

Inflorescence: In var. *longipedicellata*, the inflorescence is 13–28 cm long, paniculate, with 7–14 lateral branches and sparsely arranged flowers. In var. *kiusiana* the inflorescence is 6–15 cm long, paniculate with 1–7 lateral branches or spike-like without lateral branches, and the flow-

Fig. 4. Holotype of *Astilbe thunbergii* (Siebold & Zucc.) Miq. var. *longipedicellata* Hatus. (Japan, Kyushu, Miyazaki Pref. (prov. Hyuga), Mt. Shiraiwa, alt. 1600 m, Hatusima & Sako 26344, KAG).

ers are compactly arranged. Figure 7 shows the number of flowers per 1 cm of inflorescence rachis (in x-axis); 4 to 6 per cm. in var. *longipedicellata* and 9 to 14 in var. *kiusiana*.

Length of pedicels: The pedicels vary from 1.5 mm to 3.8 mm in length in var. *longipedicel-*

Fig. 5. Part of inflorescence with flowers. Left. *Astilbe thunbergii* var. *longipedicellata* (Miyazaki Pref., Higashi-usuki-gun, Morodzuka-mura, Mt. Kuro-dake, 15 July 2008). Right. *A. thunbergii* var. *kiusiana* (Miyazaki Pref., Nishi-usuki-gun, Takachiho-cho, Shikimibaru, 16 July 2008).

lata and from 0.4 mm to 1.3 mm in length in var. *kiusiana*. Variety *longipedicellata* has longer pedicels than var. *kiusiana* (Fig. 7 y-axis).

Leaves: In var. *longipedicellata*, the ovate to widely ovate terminal leaflet ranges from 5.1–12.5 cm long and 3.4–7.7 cm wide, is cordate to truncate to cuneate at the base and has roughly incised, doubly serrate margins. The narrowly ovate to lanceolate terminal leaflets of var. *kiusiana* are 1.8–8.4 cm long, 0.8–3.1 cm wide, are rounded to cuneate or shallowly cordate at the base and the margins are finely serrate. Figure 8 shows the correlation between the length (excluding the apical part) and the ratio of the length (excluding the apical part) to the width of the terminal leaflet. Except in the length of the terminal leaflet, where there is an overlap, var. *longipedicellata* strongly differs from var. *kiusiana* (in Kyushu) and var. *thunbergii* (in Honshu). The terminal leaflet of var. *longipedicellata* is wider than in both var. *kiusiana* and var. *thunbergii*.

Distribution and ecology

Astilbe thunbergii var. *longipedicellata* is known from central Kyushu in Miyazaki and Kumamoto Prefectures (Fig. 9). In Miyazaki Prefecture it was found in six localities: Mt. Kuro-dake (Morozuka-mura, Higashi-usuki-gun) at the elevations between 1000 and 1394 m; Goyu-zan (Shiiba-mura, Higashi-usuki-gun) at ca. 1650 m; Mt. Shiraiwa-yama (Gokase-cho, Nishi-usuki-gun) at 1621 m; Mt. Do-dake (Hinokage-cho, Nishi-usuki-gun); Mt. Wanitsuka-yama (Kitagô-machi, Minami-naka-gun), at ca. 1000 m; and Mt. Sobo-san (Takachiho-cho, Nishi-usuki-gun) at 1020 m. In Kumamoto Prefecture it has been collected on Mt. Kunimi-dake at 900 m; Gokanosho at 900–1600 m; Mt. Ichifusa-yama, at about 1200 m and 1600 m; and Mt. Naidaijin-yama. Var. *longipedicellata* grows on steep limestone slopes.

Astilbe thunbergii var. *kiusiana* is distributed in Kyushu from Fukuoka through Saga, Oita, Kumamoto and Miyazaki Prefectures to Kagoshima Prefecture at the elevations between 540 m and 1500 m (Fig. 9). Although the ranges of the two varieties overlap at least on Mt. Wanitsuka-yama and Mt. Sobo-san in Miyazaki Prefecture, var. *kiusiana* grows along forests margins and in non-calcareous soils at the elevations below 1100 m, except on Mt. Kirishima-yama.

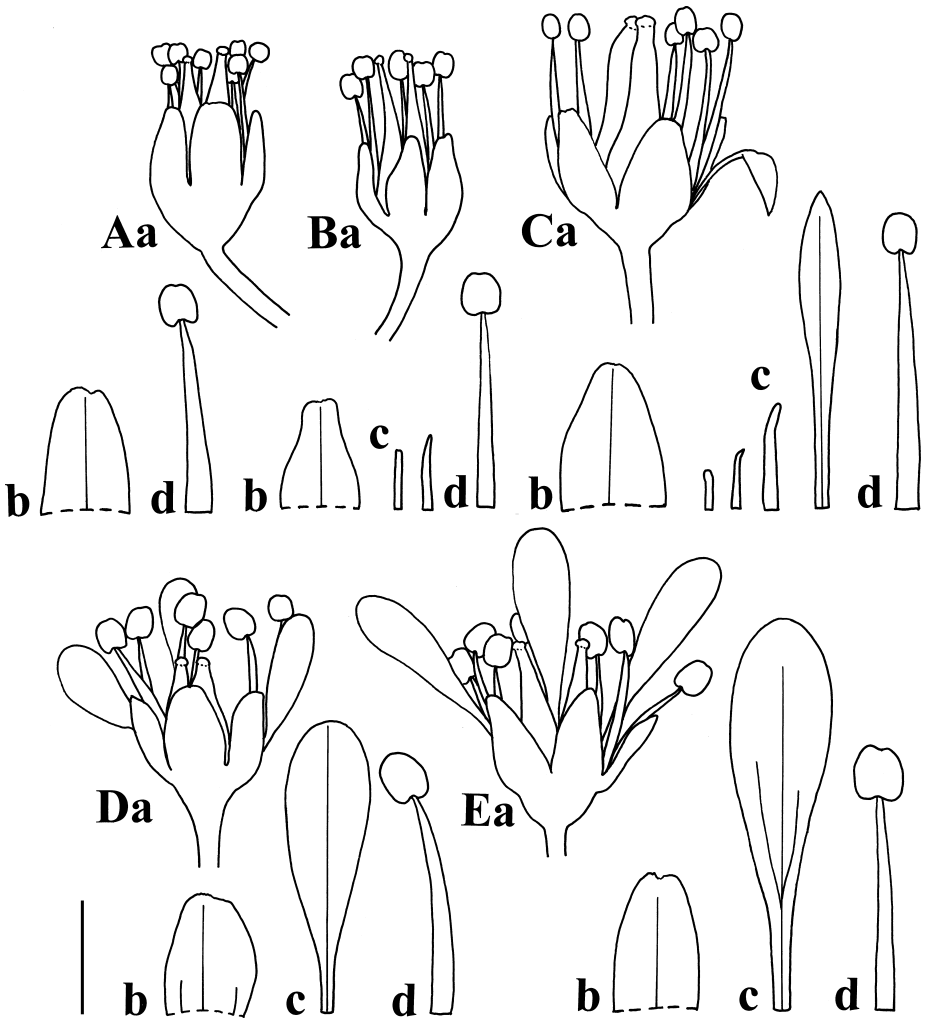

Fig. 6. Flowers of *Astilbe thunbergii* var. *longipedicellata* (A, B, C: some stamens removed) and var. *kiusiana* (D, E: two petals and some stamens removed). A: Y. Kadota 0832048, TNS. B: Y. Kadota 0832049, TNS. C: Y. Kadota 0832038, TNS. D: Y. Kadota 0832081, TNS (two petals and some stamens removed). E: M. Saito, 10 July 2006, TNS (two petals and some stamens removed). a: Flowers. b: Calyx lobes. c: Petals. d: Stamens. Bar indicates 1.5 mm for a and 1 mm for b, c, d.

Discussion

Through observations we were able to determine the morphological features, distribution, and ecology of *Astilbe thunbergii* var. *longipedicellata*. The most unique feature is the apetalous flowers. In Asian *Astilbe*, apetalous flowers were previously found only in *A. platyphylla* H.Boiss. on Hokkaido and in the Himalayan *A. rivularis* Buch.-Ham. The flowers of var. *longipedicellata* greatly differ from those of var. *kiusiana*, which normally bears petals, and also in the shape and width of the petals of var. *longipedicellata* when they are present.

The inflorescences with sparse flowers, the long pedicels, and the roughly incised doubly serrate, ovate to widely ovate, terminal leaflets are also characteristic of var. *longipedicellata*. These characters are constant and stable. Variety *longipedicellata* occurs only in the calcareous

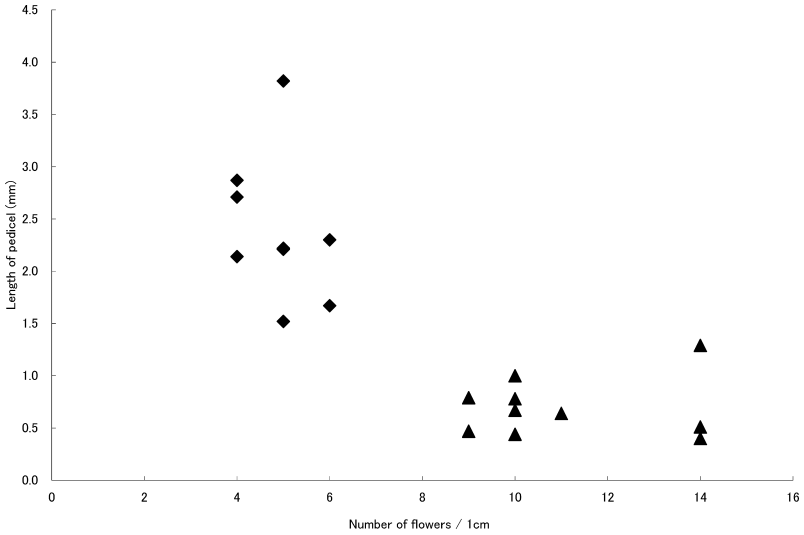

Fig. 7. Comparison of inflorescences (number of flowers per 1 cm and length of pedicels) between *Astilbe thunbergii* var. *longipedicellata* (◆) and var. *kiusiana* (▲).

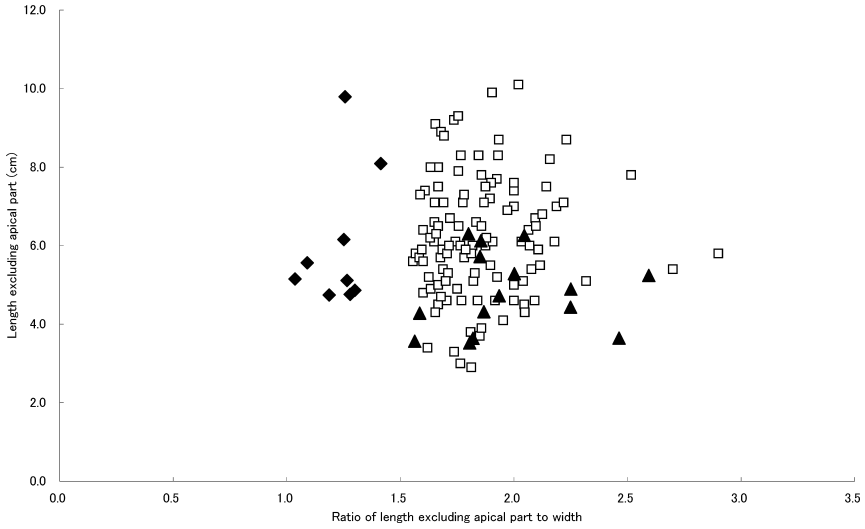

Fig. 8. Comparison of terminal leaflets (length-width ratio and length) between *Astilbe thunbergii* var. *longipedicellata* (◆), var. *kiusiana* (▲), and var. *thunbergii* (□).

areas at 900–1650 m elevation in central Kyushu. Variety *kiusiana*, also on Kyushu, grows on non-calcareous soils and usually at elevations below 1100 m.

The relatively large morphological differences clarified here, are not only between var. *longipedicellata* and var. *kiusiana*, but also between var. *longipedicellata* and var. *thunbergii*. *Astilbe thunbergii* var. *thunbergii* on Honshu exhibits a rather wide range of variation in various characters, but the features of var. *longipedicellata* are apparently beyond the range of variation of var. *thunbergii*. Based on the apetalous condition, an unusual characteristic in *Astilbe*, and the mor-

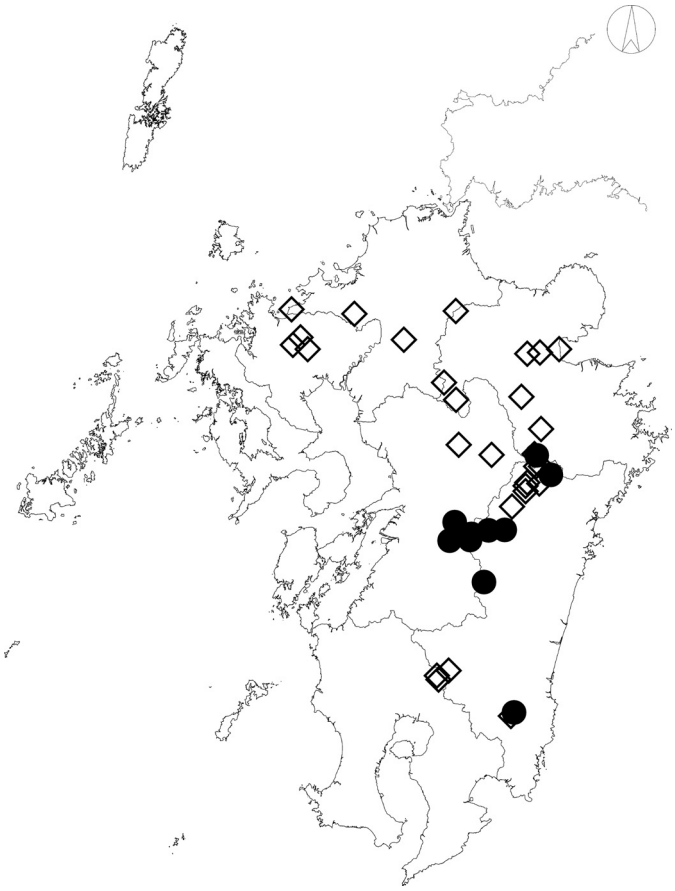

Fig. 9. Distribution of *Astilbe thunbergii* var. *longipedicellata* (●) and var. *kiusiana* (◇).

phological, ecological and distributional discontinuities, we propose that var. *longipedicellata* be recognized at specific rank as *A. longipedicellata* (Hatus.) S.Akiyama & Kadota.

Taxonomic treatments

Astilbe longipedicellata (Hatus.) S.Akiyama & Kadota, stat. nov.

A. thunbergii (Siebold & Zucc.) Miq. var. *longipedicellata* Hatus. in J. Geobot. (Kanazawa) **16**: 56 (1968).

A. thunbergii (Siebold & Zucc.) Miq. var. *kiusiana* (H.Hara) H.Hara ex H.Ohba in K.Iwats. & al., Fl. Jap. **IIb**: 45 (2001), pro parte.

Type: **Japan. Kyushu. Miyazaki Pref.** (prov. Hyuga), Mt. Shiraiwa-yama, alt. 1600 m (Hatusima & Sako 26344, KAG–holo).

Paratypes: **Japan. Kyushu. Kumamoto Pref.** (prov. Higo), Mt. Kunimi-dake, alt. 900 m (S. Sako 949, KAG); Momiki, Gokanosho, alt. 900 m (S. Sako 1012, KAG); Kureko, Gokanosho (Hatusima 15010, KAG); Mt. Karimata-yama, Nihonsugi, Gokanosho, alt. 1200 m (Hatusima & Sako 27879, KAG). **Miyazaki Pref.** (prov. Hyuga), Nishi-usuki-gun, Hinokage-cho, Mt. Do-dake (Hatusima & Sako [& K. Kawanabe] 22531, KAG).

Japanese name: Tsukushi-akashōma (Hatusima 1968).

Rhizomes thick, short creeping. Stems 50–60 cm tall, sparsely reddish brown villous basally. Radical leaves petiolate; petiole sparsely reddish brown villous basally; blade bi- or triternate; ter-

minal leaflet ovate to widely ovate, 5.1–12.5 cm long, 3.4–7.7 cm wide, base cordate to truncate to cuneate, margins with double incised serration, lower surface with appressed reddish brown straight hairs on midvein and lateral veins, upper surface with sparse white straight short hairs on veinlets. Flowers July. Inflorescence a panicle, 12–20 cm long, lower lateral axes 7–15, ca. 7 cm long, with dense short glandular hairs; flowers sparsely arranged (4–6 flowers per 1 cm). Pedicel 1.5–3.8 mm long. Calyx lobes pale green, ca. 1 mm long. Petals usually 0, very rarely 1, white, narrowly linear-oblanceolate, ca. 2.8 mm long, ca. 0.3 wide, apex acute, base attenuate. Rudimentary petals 0.3–1.5 mm long, less than 0.1 mm wide, filamentous. Stamens 10, 1.5–2.5 mm long; anthers pale purple before dehiscence. Ovary semi-inferior, nearly equal to stamens in length. Capsules ca. 3 mm long.

Habit: Calcareous mountains, in deciduous forests, 900–1600 m in elevation.

Distribution: Japan, Kyushu (endemic).

Specimens examined. Japan. Kyushu. Kumamoto Pref. Naidaijin-yama (Z. Tashiro s.n., KYO); at middle elevation of Mt. Ichifusa, about 1200 m alt. (M. Tagawa & K. Iwatsuki 3669, 6 Aug. 1960, KYO). **Miyazaki Pref.** Higashiusuki-gun, Morozuka-mura, Kuro-dake, Kagodaki, alt. 1394 m (Y. Kadota 0832023–0832027, 15 July 2008, TNS); just below the junction between Kuro-dake and Kagodaki, alt. 1388 m (Y. Kadota 0832028–0832034, 15 July 2008, TNS); 1394 m (Y. Kadota 0832035–0832339, 15 July 2008, TNS); Kuro-dake, alt. 1120 m (Koga 10735, 25 July 1993, TI); Shiiba-mura, en route from Kubikukuri to Goyuzan, alt. ca. 1650 m (M. Hotta 6554, 17 Aug. 1961, KYO); Minami-naka-gun, Kitagô-machi, Wanitsuka-yama, ca. 1000 m (Hatusima 32665, 32681, 30 July 1971, KAG); Nishi-usuki-gun, Gokase-cho (machi), Shiraiwa-yama, alt. 1620 m (Yukawa 07-23, 8 July 2007, TNS); 1621 m (Y. Kadota 0832042–0832048, 0832050, 0832051, 0832053, 16 July 2008, TNS); Takachiho-cho, Sobo-san, 1020 m (Y. Kadota 0832040, 0832049, 17 July 2008, TNS).

[Appendix]

Astilbe thunbergii (Siebold & Zucc.) Miq. var. **kiusiana** (H.Hara) H.Hara [in Nakai & Honda, Nov. Fl. Jap. **3**: 19 (1939), as syn.] ex H.Ohba in K.Iwats. et al., Fl. Jap. **2**b: 45 (2001).

Astilbe kiusiana H.Hara in J. Jap. Bot. **14**: 49 (1938).

Specimens examined. Japan. Kyushu. Fukuoka Pref. Fukuoka-shi, Sagara-ku, Itaya, alt. 540 m (Koga 10715, 19 July 1993, KYO, TI); Itoshima-gun, Mt. Uki-dake (S. Hatusima s.n., 16 July 1933, KAG); Yame-gun, Hoshino-mura, Mt. Takatori-yama, alt. 750 m (Koga 11917, 23 July 1995, KYO). **Saga Pref.** Higashimatsu-ura-gun, Hamatama-cho, Torisu, alt. 620 m (Koga 11909, 9 July 1995, KYO); Karatsu-shi, Ouchi-cho, Mt. Sakurei-zan (N. Kuroiwa, 22 July 2007, TNS); Miyaki-gun, Nakahara-cho, Nanamagari-toge, alt. 540 m (Koga 10717, 19 July 1993, KYO); Ogishi-gun, Mt. Tenzan (T. Hashimoto 1875, 16 Sept. 1951, TI). **Oita Pref.** Mt. Sobo-san (S. Saito s.n., 25 Oct. 1926, TI; M. Arakane H-1326, 8 Aug. 1953, KAG); Kamiyufu (T. Senzan s.n., 18 Aug. 1925, TI); Mt. Katamuki-yama (M. Arakane H-1329, 3 Aug. 1962, KAG); Beppu-shi, Mt. Tsurumi-dake (M. Arakane H-1288, 9 July 1988, KAG), Shidaka-ko (M. Arakane H-1324, 1 July 1962, KAG); Hida-shi, Mt. Shutendoji-yama (N. Kuroiwa, 20 July 2007, TNS); Mt. Okouchi-yama (M. Ono, 15 Sept. 1980, KAG); Kusu-gun, Kokonoe-machi, Amagaike-goe (M. Arakane H-1325, 24 July 1965, KAG); Tono-machi, Kamagase (N. Kuroiwa, 16 Aug. 2007, TNS); Ono-gun, Ogata-cho, Kawakami-keikoku, 605 m (Koga 11871, 25 June 1995, KYO); Taketa-shi, Ogi-machi, Yamazaki (M. Arakane H-1289, H-1290, 3 July 1988, KAG). **Kumamoto Pref.** Aso-gun, Minenoshyuku, alt. 800 m (M. Sato 2638, 3 July 1963, KAG), Kusakabe-mura (Naito s.n., 18 July 1923, KAG); Kikuchi-shi, Kyokushi, Mt. Kura-take, alt. ca. 1050 m (C. Sato, 9 June 2007, TNS). **Miyazaki Pref.** Minami-naka-gun, Kitagô-machi, Mt. Wanitsuka-yama, alt. ca. 1000 m (Y. Kadota 0832011–0832013, 14 July 2008, TNS); Nishi-usuki-gun, Gokase-cho, Iiboshi-toge, alt. ca. 1000 m (M.

Saito, 10 July 2006, TNS); Takachiho-cho, Gokasho-kôgen, alt. 834 m (Y. Kadota 0832078, 17 July Aug., TNS); Kurobaru, alt. 430 m (Koga 11867, 25 June 1995, KYO); Shikimibaru, alt. 1100 m (M. Saito, 10 July 2006, TNS); alt. 1113 m (Y. Kadota 0832069–0832077, 16 July 2008, TNS); Mt. Amenokagu-yama (Naito s.n., 15 July 1923, KAG); Between Gokasho and the summit of Mt. Sobo-san, alt. 800 m (S. Hatusima, S. Sako & K. Kawanabe 22603, 9 Oct. 1958, KAG); Mt. Sobo-san, alt. 1020 m (Y. Kadota 0832081, 17 July 2008, TNS); (S. Sako s.n., 11 Oct. 1955, KAG); Hōri and Mt. Ōkue-yama (S. Hatusima & S. Sako 25181, 16–20 Aug. 1960, KAG); Mt. Kirishima-yama, Mt. Karakuni-dake (K. Kondo s.n., 21 Oct. 1926, TI). **Kagoshima Pref.** Kirishima-yama (Hosoyamada s.n., 15 Oct. 1925, KAG); (C. Honda s.n., 13 July 1929, KAG); (S. Sako & Kawanabe 1708A, 16 July 1958, KAG); Onami-ike (S. Okamoto, 5 Aug. 1951, KYO); Yunoya-onsen, alt. 700 m (Hatusima 41422, 11 Aug. 1986, KAG).

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