

Correction of Confusions Regarding the Identity and Synonymy of *Youngia* (Asteraceae: Tribe Cichorieae) in Taiwan

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Abstract—*Youngia japonica*, the type species for its genus, has the widest distribution in the genus and is invasive worldwide. Recent molecular phylogenetic analysis supported recognition of three ecologically differentiated entities: *Y. japonica* subsp. *formosana*, *Y. japonica* subsp. *japonica*, and an undescribed morphological variant thought to be a new subspecies in Taiwan. These are the only infraspecific taxa currently recognized in this morphologically variable species. Use of proper names for these taxa and related species is important for future revision of *Y. japonica* in other regions, for nomenclature and biogeography of the genus, and for activities to control its invasiveness. Careful examination of the holotype of *Y. japonica* subsp. *formosana* and relevant literature revealed that the name has long been misapplied to *Youngia* in mountain ranges in Taiwan; it should be applied to the morphological variant growing on littoral, raised coral reefs in southwestern Taiwan. The misidentified entity is here described as *Youngia japonica* subsp. *monticola*. In addition, *Y. taiwaniana* was treated as a synonym of *Y. longiflora* ($\equiv Y. japonica$ subsp. *longiflora*) in the *Flora of Taiwan*, but the holotype has achenes with a long beak and does not belong to *Youngia*. It is here treated as a synonym of *Ixeridium laevigatum*. A key to *Youngia* in Taiwan is provided.

Keywords—*Crepis formosana*, *Ixeridium laevigatum*, misapplication, *Youngia japonica* subsp. *monticola*, *Youngia longiflora*, *Youngia taiwaniana*.

Youngia Cass. (Asteraceae tribe Cichorieae) comprises 30–40 species and is widely distributed in Asia (Ling and Shih 1997; Shi and Kilian 2011). It is a heterogeneous and taxonomically confusing genus (Yahara 1995). *Youngia japonica* (L.) DC., commonly known as oriental hawkbeard or Asiatic hawkbeard, is the type of the genus (Babcock and Stebbins 1937). Occurring in China, India, Japan, Korea, the Malay Peninsula, Philippines, and Taiwan, it is the most widely ranging species in the genus (Ling and Shih 1997) and invasive worldwide (e.g. Botha 2001; Botond and Zoltán 2004; Barker et al. 2005; Global Compendium of Weeds 2012; Pacific Island Ecosystems at Risk 2012). As currently circumscribed, *Youngia japonica* is highly polymorphic and taxonomically difficult (Babcock and Stebbins 1937; Ling and Shih 1997; Peng et al. 1998). Our recent molecular phylogenetic analysis (Nakamura et al. 2012) supported recognition of two subspecies, *Y. japonica* subsp. *formosana* (Hayata) Kitam. and *Y. japonica* subsp. *japonica*, plus an undescribed morphological variant thought to be a new subspecies (Fig. 1). These three taxa grow in different habitats – mountain ranges, lowland regions with a broad range of environmental conditions, and littoral, raised coral reefs, respectively. The latter two taxa are endemic to Taiwan (Nakamura et al. 2012). Shi and Kilian (2011) in the *Flora of China* recognized an endemic *Y. japonica* subsp. *elstonii* (Hochr.) Babc. & Stebbins, which had been treated previously as a synonym of *Y. pseudosenecio* (Vaniot) C. Shih (Ling and Shih 1997). However, the *Flora of China* treatment improperly synonymized *Y. pseudosenecio* with *Y. japonica* subsp. *elstonii* (Shi and Kilian 2011) because the basionym of *Y. pseudosenecio*, *Lactuca pseudosenecio* Vaniot, was published earlier (Vaniot 1903) than the basionym of *Y. japonica* subsp. *elstonii*, *Crepis japonica* var. *elstonii* Hochr. (Hochreutiner 1934). In addition, our molecular phylogenetic study indicated that *Y. pseudosenecio* is a different lineage from *Y. japonica* (Nakamura et al. 2012). Thus, we consider that *Y. japonica* subsp. *elstonii* should be treated as a distinct species, *Y. pseudosenecio*. Accordingly, *Y. japonica* subsp. *formosana*, *Y. japonica* subsp. *japonica*, and the undescribed morphological variant are the only infraspecific taxa currently recognized in *Y. japonica*. Use of proper names for these ecologically differentiated subspecies and related species is

important for future taxonomic revision of *Y. japonica* in other regions, for nomenclature and biogeography of the genus, and for activities to control its invasiveness.

In the course of describing the morphological variant as a new subspecies of *Y. japonica*, we noticed the long-standing confusion regarding the identity of *Y. japonica* subsp. *formosana* (Hayata 1911; Yamamoto 1936; Kitamura 1937; Li 1978; Yang 1982; Peng et al. 1998; Peng and Chung 1999). Our molecular phylogenetic analysis (Nakamura et al. 2012) verified that *Y. japonica* subsp. *longiflora* Babc. & Stebbins, described from China (Babcock and Stebbins 1937; Shi and Kilian 2011) and found also in Taiwan and Korea (Peng et al. 1998; Pak et al. 2000), is a different lineage from *Y. japonica* and should be treated as a distinct species *Y. longiflora* (Babcock & Stebbins) C. Shih (Ling and Shih 1997). Meanwhile, *Youngia taiwaniana* S.S. Ying was described from northern Taiwan (Ying 1980). In the second edition of the *Flora of Taiwan*, Peng et al. (1998) synonymized *Y. taiwaniana* with *Y. japonica* subsp. *longiflora*, although detailed comparison between materials from Taiwan and China has not been conducted based on morphology or molecular phylogeny and their identity awaits further analysis (Nakamura et al. 2012). Examining the holotype of *Y. taiwaniana*, however, we found that the name should be synonymized with a species of *Ixeridium* (A. Gray) Tzvelev.

Here we correct these confusions based on materials used in original descriptions (Hayata 1911; Ying 1980) and other related literature. We propose a new name for the taxon that bears a misapplied name and describe its morphological and cytological features. A key to the *Youngia* taxa in Taiwan is provided.

MATERIALS AND METHODS

Specimen Examination—The holotype of *Youngia japonica* subsp. *formosana* in NTUF, additional specimens of *Y. japonica* subsp. *formosana* in the herbaria at HAST, KYO, NTUF, and TAIF, and specimens of the undescribed morphological variant in HAST were studied. These specimens covered the entire ranges of the two entities and collection sites were used to construct a distribution map. The holotype of *Youngia taiwaniana* in TAIF was also examined.

Literature Search—Literature concerning *Y. japonica* subsp. *formosana* published during the Japanese colonial period (Yamamoto 1936; Kitamura

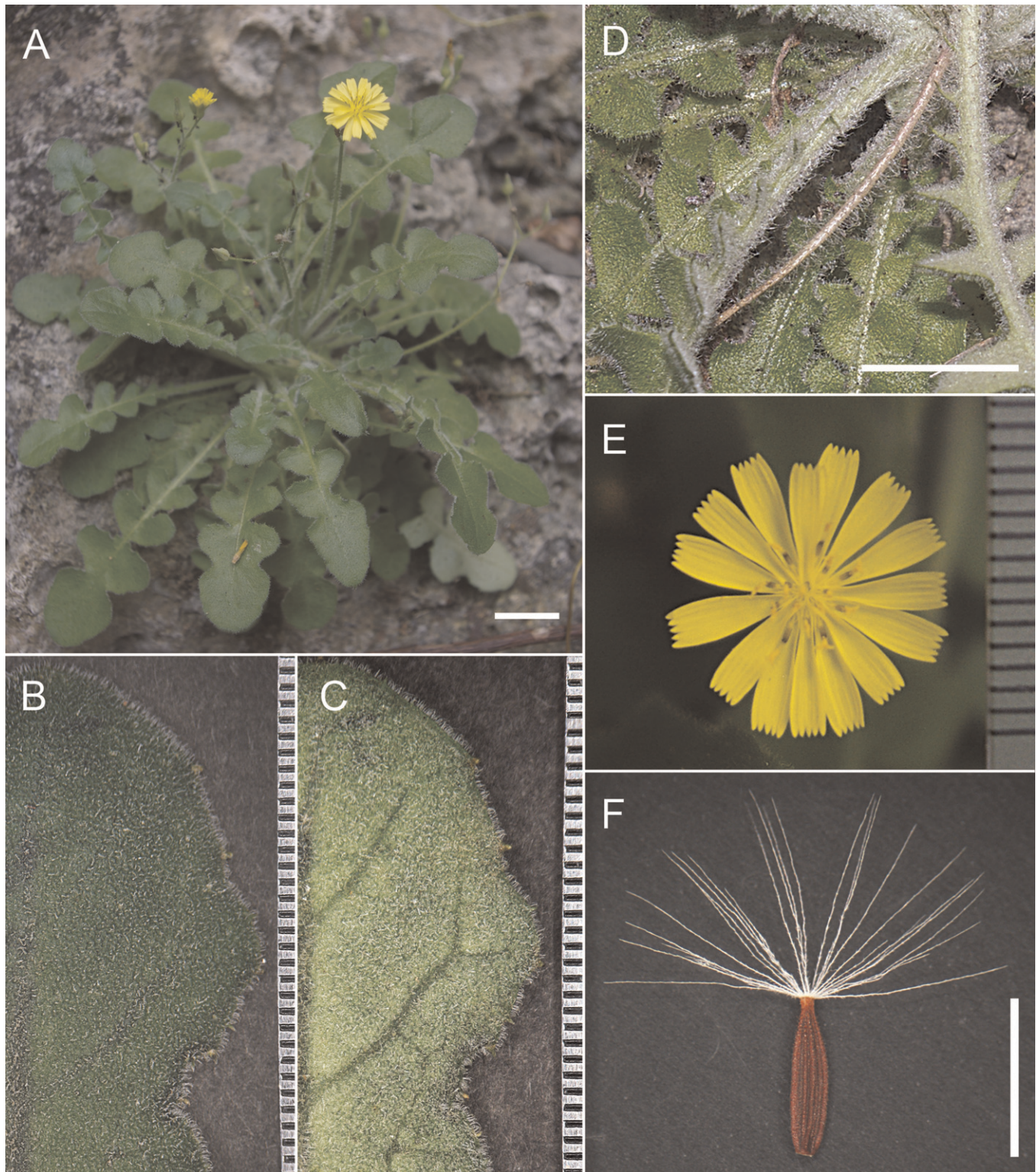


FIG. 1. Morphological variant of *Youngia japonica*, previously neglected but actually genuine *Y. japonica* subsp. *formsana*. A. Habit. B. Adaxial surface of radical leaf. C. Abaxial surface of radical leaf. D. Base of inflorescence axis. E. Flower head. F. Achene with pappi. All photos from Nakamura 20100319 (HAST). Scale bars: 10 mm in A and D; 2 mm in F. Ruler in B, C, and E with 1 mm increments.

1937) has notes in Japanese in addition to English descriptions. These Japanese notes were carefully reexamined to elucidate the identity of the taxon.

Chromosome Cytology—Somatic chromosome morphology was studied for *Y. japonica* subsp. *formsana*, *Y. japonica* subsp. *japonica*, and the undescribed morphological variant. Fresh root tips were col-

lected, pretreated in 2 mM 8-hydroxyquinoline at 15–18°C for 6 h, and then fixed overnight in a 3:1 ethanol-acetic acid solution at 4°C. Chromosomes were stained in 2% acetic orcein with 1N hydrochloric acid (10:1) and observed. Classification of chromosome morphology was based on the position of the centromere, following Levan et al. (1964).



FIG. 2. Holotype of *Youngia japonica* subsp. *formosana* (\equiv *Crepis formosana*; G. Nakahara 825, TAIF). A. Whole plant and specimen label. B. Radical leaves. C. Base of inflorescence axis. D. Flower head and involucre. E. Achene without pappi. Scale bars: 30 mm in A; 10 mm in B–D. Ruler in E with 1 mm increments.

RESULTS AND DISCUSSION

Taxonomic problems of *Youngia japonica* subsp. *formosana*—

Major references for the flora of Taiwan (Li 1978; Yang 1982; Peng et al. 1998; Peng and Chung 1999) have long recognized *Youngia japonica* subsp. *formosana* as a taxon endemic to mountain ranges (ca. 1,500–2,500 m), while *Y. japonica* subsp. *japonica* is documented as occurring in lowlands to hilly ranges (below ca. 1,000 m). *Crepis formosana* Hayata, the basionym of *Youngia japonica* subsp. *formosana*, was published based on a specimen collected in “Hoduan” of “Takao” (Hayata 1911). “Takao” is an old name of Kaohsiung in southwestern Taiwan Island. Careful examination of the

holotype revealed that it is morphologically sharply distinct from what is currently called *Y. japonica* subsp. *formosana*. The holotype specimen was ca. 7 cm tall with less than 10 heads per inflorescence axis (Fig. 2A), radical leaves are lyrate-pinnatifid, thick, and velvety on both surfaces (Fig. 2B), and inflorescence axes are densely puberulous at base (Fig. 2C). In what has been known as *Y. japonica* subsp. *formosana*, however, plants are usually more than 25 cm tall with more than 20 heads per inflorescence axis (Fig. 3A), radical leaves are runcinate-pinnatifid (Fig. 3B), comparatively thin, and glabrous or slightly puberulous, especially on the abaxial surface (Figs. 3C, D), with the inflorescence axes glabrous or slightly puberulous at base (Fig. 3E).

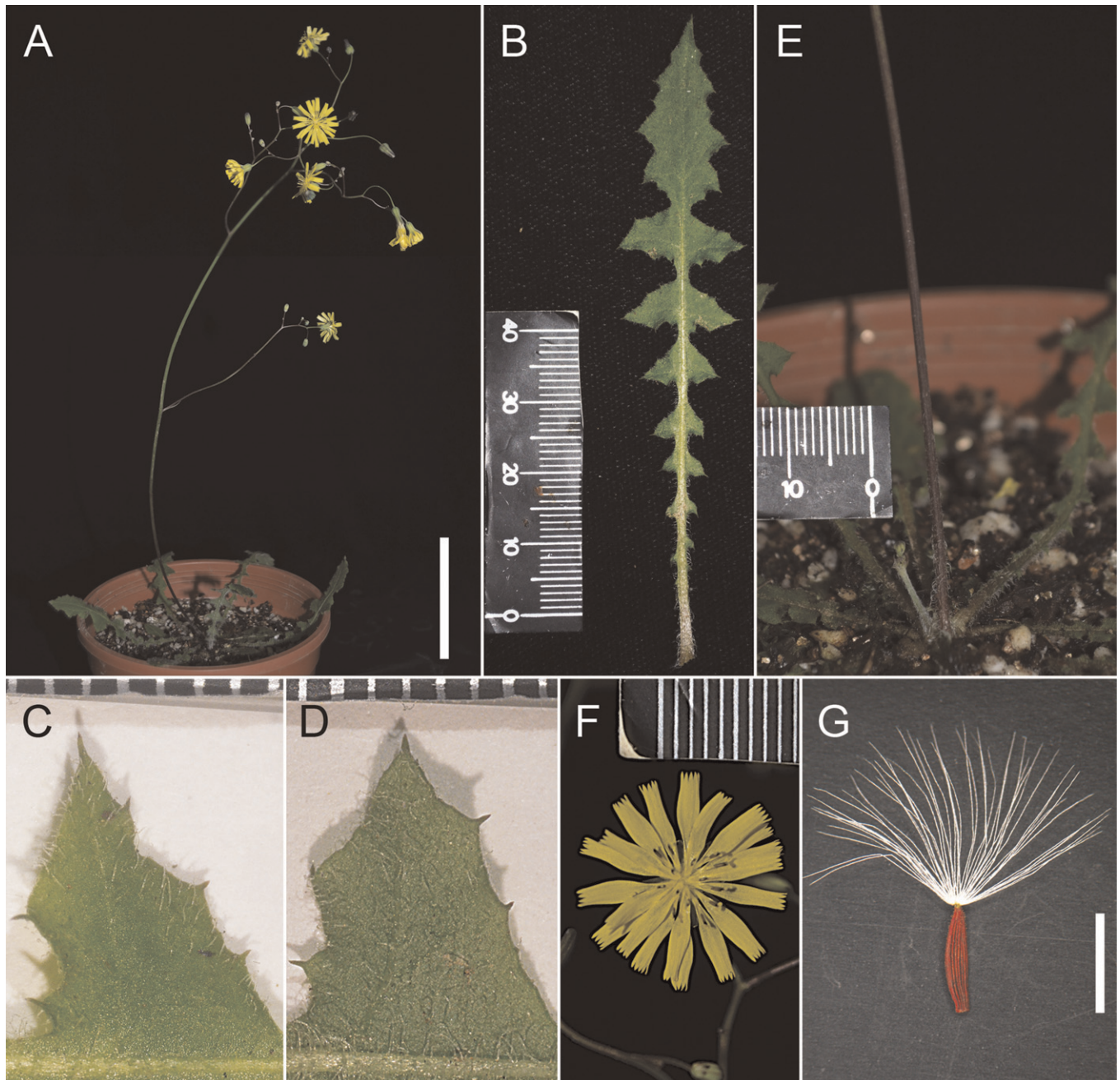


FIG. 3. *Youngia japonica* subsp. *monticola*, previously misidentified as *Y. japonica* subsp. *formosana*. A. Habit. B. Radical leaf. C. Adaxial surface of radical leaf. D. Abaxial surface of radical leaf. E. Base of inflorescence axis. F. Flower head. G. Achene with pappi. All photos from the holotype, Peng 23629 (HAST). Scale bars: 50 mm in A; 2 mm in G. Ruler in B–F with 1 mm increments.

Flower head width (less than 15 mm; Figs. 2D, 3F), and achene color and length (reddish brown to dark purplish brown, 2–2.5 mm; Figs. 2E, 3G) were similar in both taxa. Based on morphology, we recognized that the holotype is the same entity as the morphological variant (Fig. 1), which we recently collected from coastal regions of Kaohsiung and its off-shore islet Hsiao Liuchiu, and studied via molecular analysis (Nakamura et al. 2012). The type locality name “Hoduan” during the Japanese colonial period is near the coastal area around present-day “Shoushan”, which is a limestone hill of about 350 m elevation. At exactly the foothill, we collected this morphological variant. In addition, Kitamura (1937) noted in Japanese that *C. formosana* Hayata was found at the summit of “Kotobuki-yama”, which is an old name of Shoushan. Yamamoto (1936: 359) also noted in Japanese that “Hayata’s species, *C. formosana*” grows in coastal habitat. Hosokawa (1933: 238) called plants he collected from Hsiao Liuchiu Islet *C. formosana* Hayata. In light of this information we conclude that the name *Y. japonica* subsp. *formosana* should be correctly applied to the coastal morphological variant, and it has been misapplied to *Youngia* plants in mountain ranges in Taiwan.

To our knowledge, the misapplication started with the publication of the first edition of the *Flora of Taiwan* (Li 1978). We think that the following conditions likely caused this misapplication. The genuine *Y. japonica* subsp. *formosana*

is very rare and only occurs in limited littoral areas of raised coral reefs in southwest Taiwan (Fig. 4; Nakamura et al. 2012), while misidentified *Y. japonica* subsp. *formosana* is commonly seen in mountain ranges in Taiwan (Fig. 4). Radical leaves of the holotype are thick and velvety on both surfaces and young radical leaves of the misidentified “*Y. japonica* subsp. *formosana*” are also thick and velvety on both surfaces, although its mature leaves are not. The locality name “Hoduan” is not used today, and the notes indicating the type locality is a coastal region of Kaohsiung were written in Japanese (Yamamoto 1936; Kitamura 1937) and have likely been overlooked subsequently. In the first edition of the *Flora of Taiwan*, Li (1978) published a name at new rank, *Youngia japonica* var. *formosana* (Hayata) H.L. Li, based on *Crepis formosana*. Li (1978) clearly intended to apply the name *Y. japonica* var. *formosana* to the *Youngia* taxon that occurs in the mountain ranges in Taiwan by citing two specimens collected from those mountain ranges. Nevertheless, this name must be treated as a homotypic (nomenclatural) synonym of the genuine *Y. japonica* subsp. *formosana* because the author properly referenced the basionym *C. formosana* (Art. 7.4 of *International code of botanical nomenclature (ICBN)*; McNeill et al. 2006). The second edition of the *Flora of Taiwan* (Peng et al. 1998), citing Yamamoto (1936), listed a name *Y. formosana* (Hayata) Yamam. as a synonym of *Y. japonica* subsp. *formosana*, but this name is not found in Yamamoto

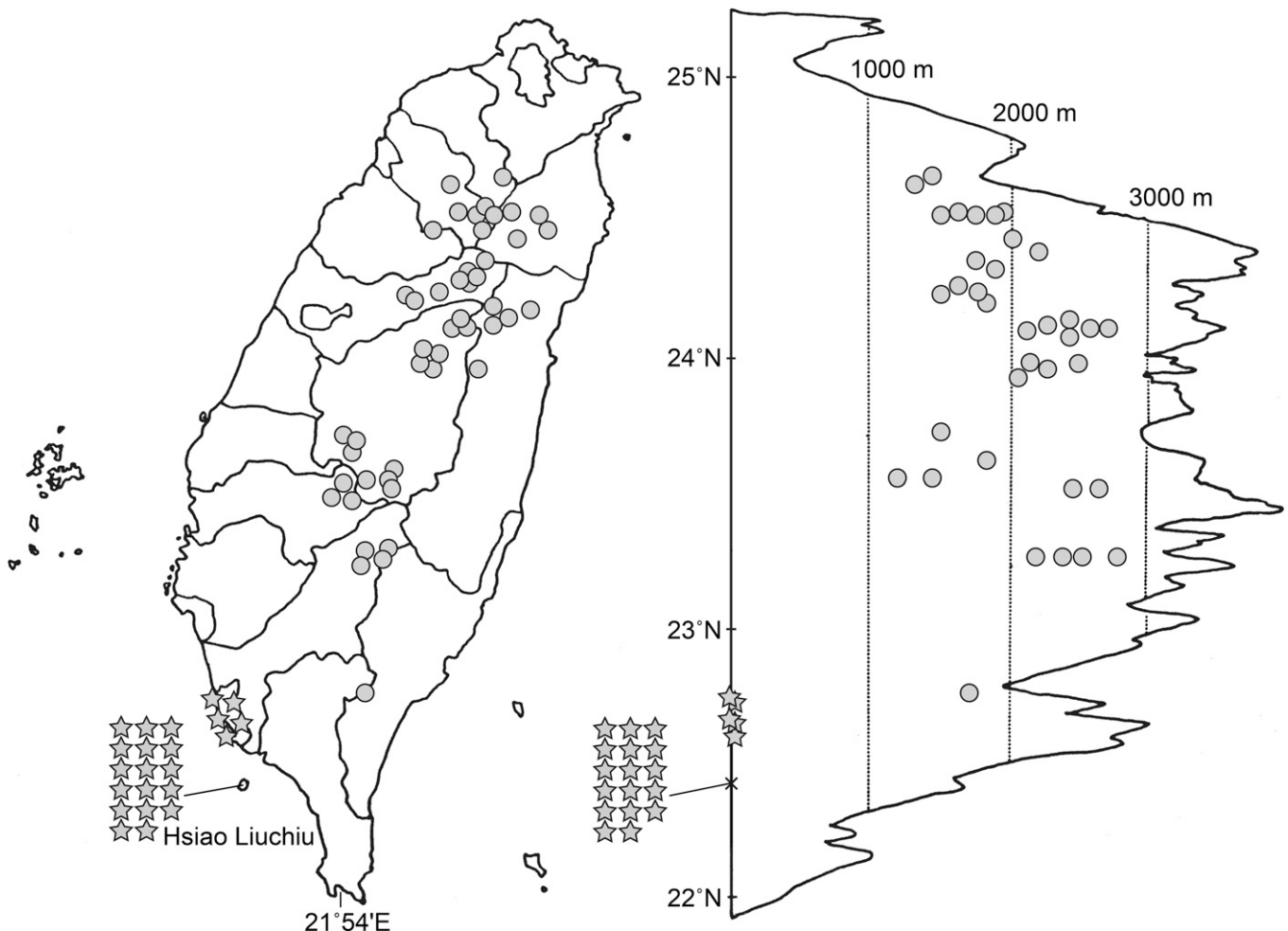


FIG. 4. Geographical distribution of *Youngia japonica* subsp. *monticola* (circles) and *Y. japonica* subsp. *formosana* (stars) in Taiwan.

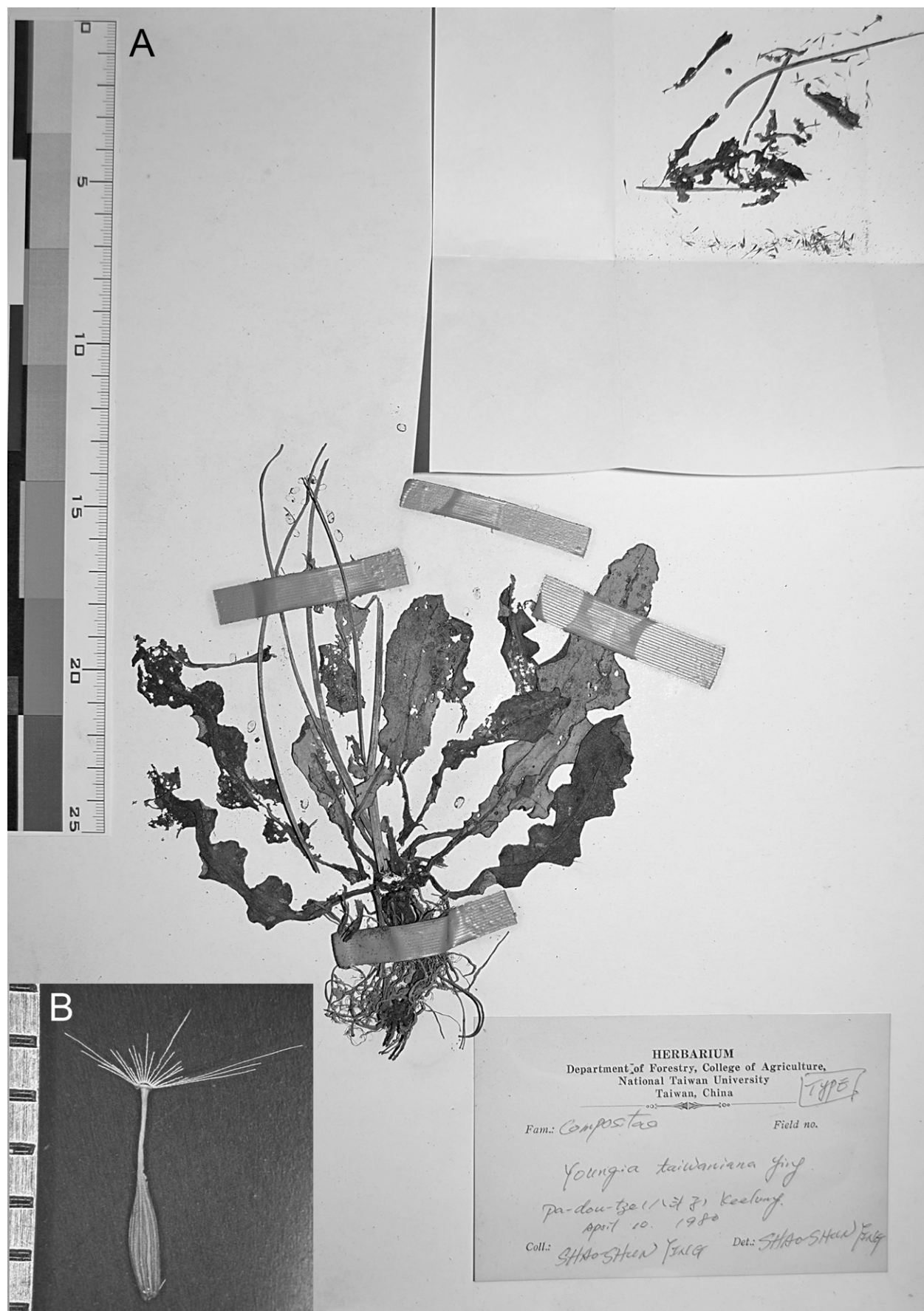


FIG. 5. Holotype of *Youngia taiwaniana* (S.S. Ying s. n., NTUF). A. Whole plant with specimen label. B. Achene with damaged pappi. Ruler in A and B with 1 mm increments.

(1936). The name *Y. formosana* was published by Hara (1938). We provide a full synonymy for *Y. japonica* subsp. *formosana* in the taxonomic treatment section below.

Plants from the mountains misidentified as *Y. japonica* subsp. *formosana* have a unique combination of reproductive (wide flower heads, long and reddish brown to dark purplish brown achenes) and vegetative traits (runcinate-pinnatifid radical leaves) (Li 1978; Peng et al. 1998; Peng and Chung 1999; see taxonomic key below), and the molecular phylogenetic analysis supported its status as an infraspecific taxon of *Y. japonica* (Nakamura et al. 2012). This entity is described as a new subspecies, *Y. japonica* subsp. *monticola*, in the taxonomic treatment section below.

Taxonomic Problems of *Youngia taiwaniana*—*Youngia taiwaniana* was described based on a specimen collected from “Keelung, padou-tze” at the northern tip of Taiwan Island (Ying 1980). The second edition of the *Flora of Taiwan* (Peng et al. 1998) and the *Flora of China* (Shi and Kilian 2011) synonymized *Y. taiwaniana* with *Y. japonica* subsp. *longiflora* (or *Y. longiflora*), and the identity of samples from Taiwan and the type locality in China have yet to be tested using molecular techniques (Nakamura et al. 2012). In Taiwan, *Y. longiflora* is restricted to a very narrow coastal area at the northern tip of the island, and the type locality of *Y. taiwaniana* is located in the same area. Although the holotype of *Y. taiwaniana* (Fig. 5A) is damaged, careful examination indicates that it is markedly different from other species of *Youngia* because

the achenes have a long beak (Fig. 5B); this contrasts with the very short beak that distinguishes *Youngia* from its allied genera (Babcock and Stebbins 1937). Based on this achene character and gross morphology of the plant, we have identified the holotype as *Ixeridium laevigatum* (Blume) Pak & Kawano, which frequently occurs in coastal regions in Taiwan. In the description of *Y. taiwaniana*, Ying (1980) noted about the achenes “apice leviter attenuata truncata”, and this description fits achenes of *Youngia* but not those of *Ixeridium*. On the other hand, descriptions of leaf size (“15–35 cm longa, 5–12 cm lata”) and corolla length (“2–4.5 cm longa”) are apparent mistakes and do not fit either *Youngia* or *Ixeridium*. However, in the protologue, he clearly cited the holotype as “S.S. Ying s.n., April 1980 (NTUF)”. In the herbarium at NTUF there is only one specimen identified as *Y. taiwaniana* and collected by S.S. Ying in April, 1980, and on the label Ying’s handwriting of “type” is shown (Fig. 5A). Therefore, the name *Y. taiwaniana* should be treated as a synonym of *I. laevigatum* (Art. 9.1 of ICBN; McNeill et al. 2006) as indicated in the following taxonomic treatment.

Chromosome Cytology—The chromosome number of *Youngia japonica* subsp. *monticola* was revealed to be $2n = 16$ (Fig. 6A, D). The 16 chromosomes gradually varied from ca. 2.0–3.5 μm long. Twelve (nos. 5–16), two (nos. 3 and 4), and two (nos. 1 and 2) chromosomes had a centromere at the median, median and/or submedian, and submedian positions, respectively. In the two submedian chromosomes

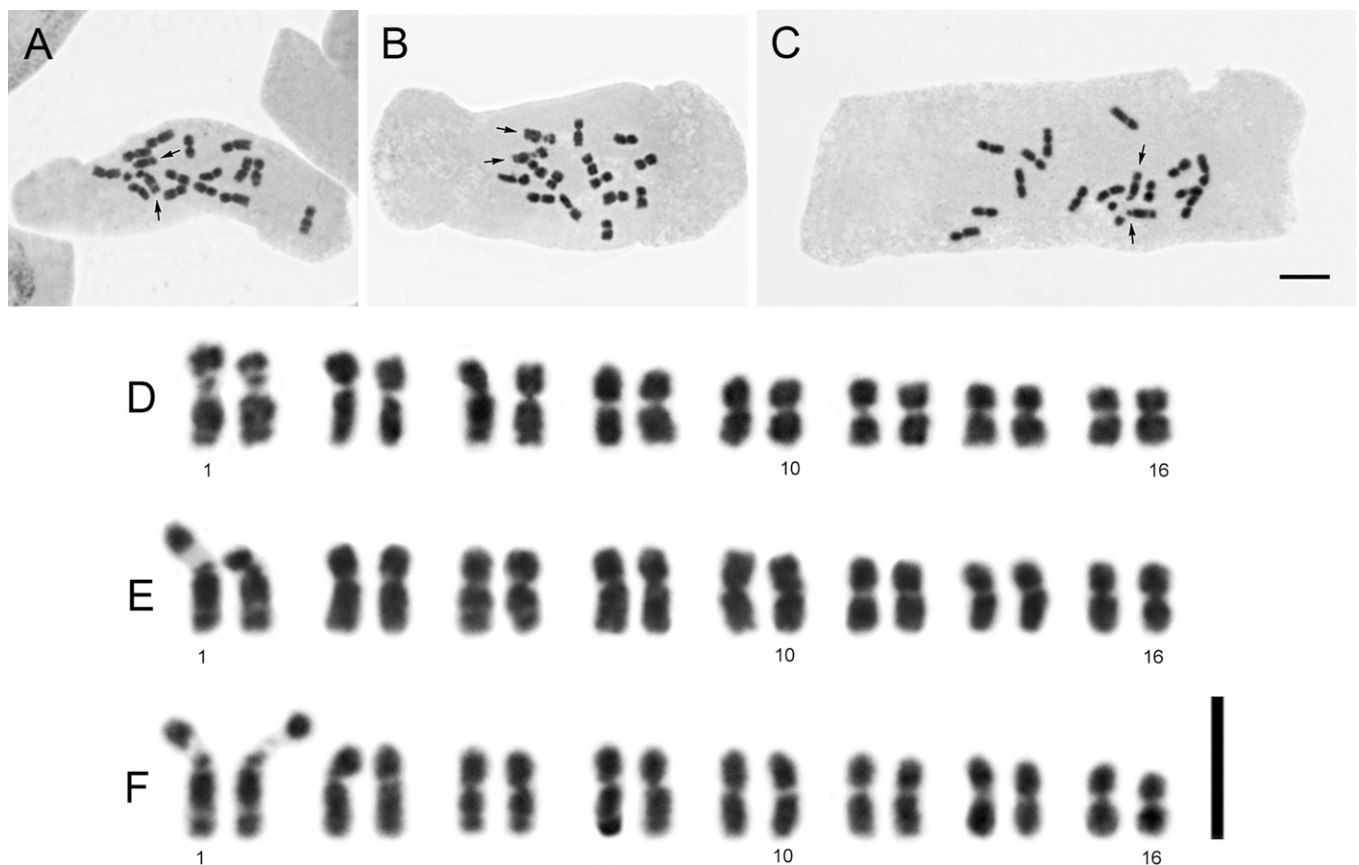


FIG. 6. Somatic chromosomes at metaphase of three subspecies of *Youngia japonica*. A–C. Microphotographs. D–F. Serial arrangements of chromosomes by their length and position of centromeres. A and D. *Y. japonica* subsp. *monticola* ($2n = 16$; Peng 22472, HAST); B and E. *Y. japonica* subsp. *formosana* ($2n = 16$; Huang 3183, HAST); C and F. *Y. japonica* subsp. *japonica* ($2n = 16$; Nakamura 20100140, HAST). Arrows indicate submedian chromosomes with satellites. Scale bars = 5 μm .

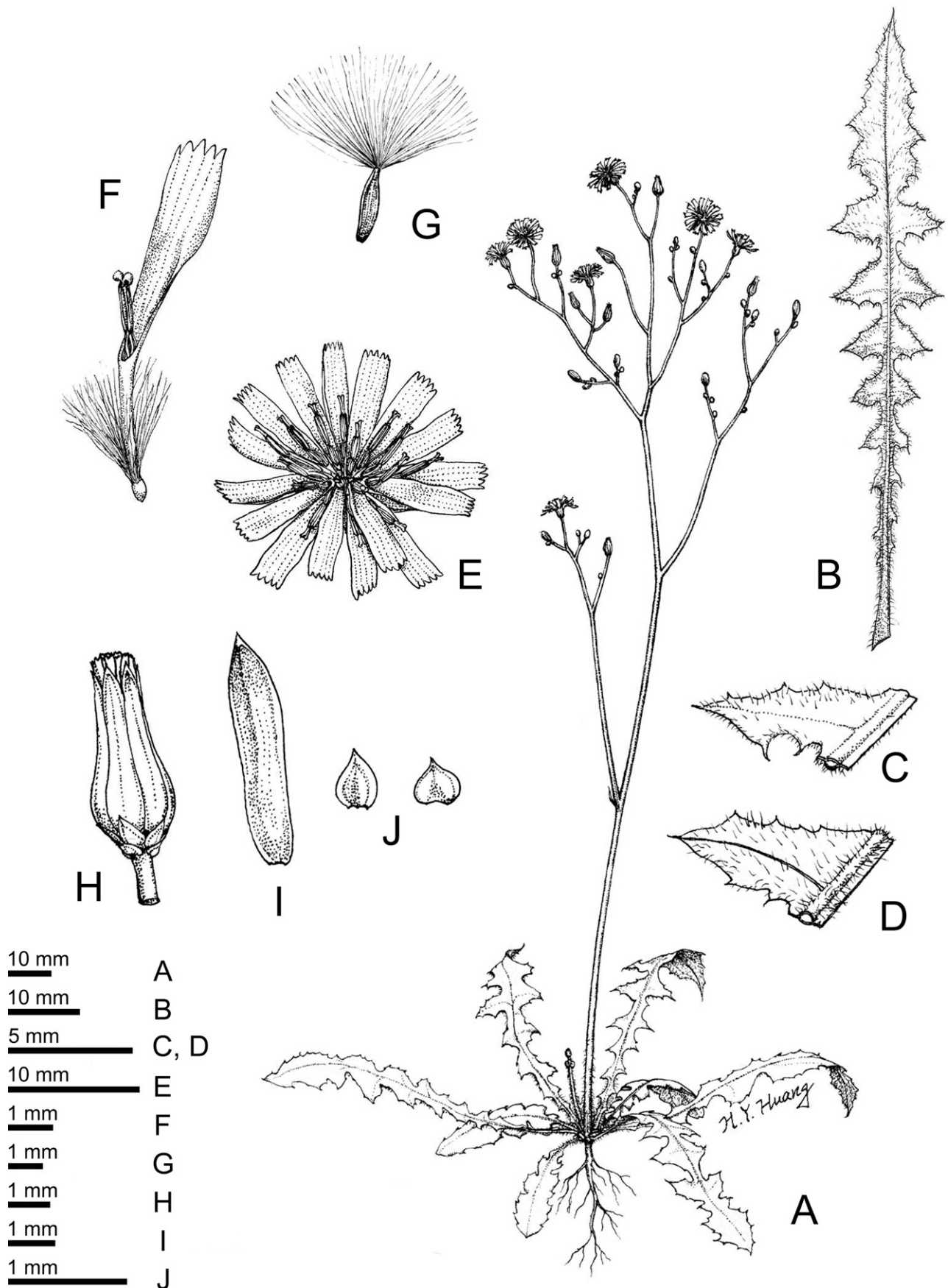


FIG. 7. *Youngia japonica* subsp. *monticola*. A. Habit. B. Radical leaf. C. Adaxial surface of radical leaf. D. Abaxial surface of radical leaf. E. Flower head. F. Floret. G. Achene with pappi. H. Involucre. I. Inner phyllary. J. Outer phyllaries. A. drawn from photograph taken from type population, 16 May 2012; B–J. drawn from the holotype, Peng 23629 (HAST).

(nos. 1 and 2), satellites (sat) were observed at the interstitial region of the short arms (arrows in Fig. 6A). Small constrictions were observed at the interstitial region of the long arms in the two submedian (nos. 1 and 2) and two median (nos. 5 and 6) chromosomes. Hence, the karyotype formula was determined as $2n = 16 = 12m + 2m-sm + 2sm^{2sat}$. This karyotype was different from that of the genuine *Y. japonica* subsp. *formosana*, which had 14 m-chromosomes (nos. 3–16) and two sm-chromosomes (nos. 1 and 2) ($2n = 16 = 14m + 2sm^{2sat}$; Fig. 6B, E), but was similar to that of *Y. japonica* subsp. *japonica*, $2n = 16 = 12m + 2sm + 2sm^{2sat}$ (Fig. 6C, F). These data provide support for the taxonomic hypothesis based on our previous molecular phylogenetic analysis (Nakamura et al. 2012) that *Y. japonica* subsp. *monticola* and the genuine *Y. japonica* subsp. *formosana* are separate taxa.

TAXONOMIC TREATMENT

1. *YOUNGIA JAPONICA* (L.) DC. subsp. *FORMOSANA* (Hayata) Kitam. in Acta Phytotax. Geobot. 6: 234. 1937 \equiv *Crepis formosana* Hayata in J. Coll. Sci. Tokyo 30: 163. 1911 [Hayata in Icon. Pl. Formos. 8: 78–79. 1919; Hosokawa in Trans. Nat. Hist. Soc. Formosa 23: 238. 1933] \equiv *Crepis japonica* Benth. var. *formosana* (Hayata) Yamam. in J. Trop. Agric. 8: 357. 1936 \equiv *Youngia formosana* (Hayata) H. Hara in J. Jap. Bot. 14: 53. 1938 \equiv *Youngia japonica* (L.) DC. var. *formosana* (Hayata) H.L. Li in Fl. Taiwan (first ed.) 4: 965. 1978.—TYPE: TAIWAN. Kaohsiung; Hoduan, Feb. 1906 (fl, fr), *G. Nakahara 825* (holotype: TAIF!).

Distribution and Habitat—Endemic to littoral areas in southwest part of Taiwan Island and Hsiao Liuchiu Islet (Fig. 4; Appendix 1), on raised coral reefs, rare.

Representative Specimens Examined—TAIWAN. Kaohsiung: Chaishan port, 5 m, 18 May 2010, *Nakamura 20100325* (HAST); Kotobukiyama at the top, 13 Feb 1932, *Kitamura s. n.* (KYO). Pingtung: Hsiao Liuchiu, near Huapingyan, 30 Mar 1930, *Hosokawa 1998* (TAI); Hsiao Liuchiu, Meirendong, 20 m, 17 May 2010, *Nakamura 20100296* (HAST); Hsiao Liuchiu, Wuguidong, 10 m, 17 May 2010, *Nakamura 20100306* (HAST); Hsiao Liuchiu, near Huapingyan, 20 m, 17 May 2010, *Nakamura 20100319* (HAST).

2. *Youngia japonica* (L.) DC. subsp. *monticola* Koh Nakam. & C.I. Peng, subsp. nov.—TYPE: TAIWAN. Hualien: Hsiulin Hsiang, at road marker 128 km on Prov. Road no. 8, near Pilu Sacred Tree, 24°10'50.6" N, 121°24'10.3" E, 2,232 m, 16 May 2012 (fl, fr), *Peng 23629* (holotype: HAST!; isotypes: TAIF!, TNM!).

Youngia japonica (L.) DC. var. *formosana* auct. non (Hayata) H.L. Li; Yang, A List of Plants in Taiwan: 1280. 1982.

Youngia japonica (L.) DC. subsp. *formosana* auct. non (Hayata) Kitam.; Peng et al. Fl. Taiwan (second ed.) 4: 1101. 1998; Peng and Chung, Manual of Taiwan Vascular Plants 4: 290. 1999.

Perennial herb up to 50 cm tall; main stem 2–6 mm long; flowering branches 1–several, glabrous or slightly puberulous toward base. Leaves radical or rarely a few cauline; radical leaves rosulate, narrowly oblanceolate, 3–25 \times 0.7–6 cm, apex acute, base narrowed to petiole, runcinate-pinnatifid, loosely mucronulate-dentate, the terminal segments largest, deltoid-ovate, lateral segments gradually smaller toward base, puberulous on both surfaces when young, but glabrous or slightly puberulous, especially on abaxial surface when mature. Inflorescence paniculate to corymbose, many-headed, the axis glabrous or slightly puberulous at base. Heads 9–13 mm diam; peduncle 5–28 mm long, slender. Involucre calyculate, 4–6 \times 2–4 mm; phyllaries in 2 series, outer phyllaries 5, ovate, ca. 0.5 mm long, inner phyllaries 8, 4–6 mm long, lanceolate, obtuse. Flowers 17–20 per head, ligulate, yellow, corolla ca. 7.5 mm long. Achenes oblong, ca. 2–2.5 mm long, reddish brown to dark purplish brown, apex gradually narrowed into very short beak, with scaberulous ribs. Pappus white, ca. 3 mm long, persistent. Figure 7.

Distribution, Habitat, and Phenology—Endemic to mountain ranges (1,200–2,850 m) on Taiwan Island (Fig. 4; Appendix 1), common. Flowering and fruiting March–July, infrequently in other months except November and December.

Representative Specimens Examined—TAIWAN. Chiayi: Yuanyang lake nature reserve, ca. 1,670 m, 27 Jul 2010, *Nakamura 20101034* (HAST). Hualien: Taroko road no. 8, 2,502 m, 13 Feb 2012, *Nakamura 12178* (HAST). Ilan: Taipingshan, ca. 1,950 m, 8 Jun 1985, *Peng 7852* (HAST). Kaohsiung: Tienchih bridge, 2,350 m, 19 Jun 2002, *Liu 5* (HAST). Miaoli: Kuanwu, 2,000 m, 2 Apr 1992, *Peng 14934* (HAST). Nantou: Shemu village, 1,200 m, 28 Jun 1987, *Peng 10897* (HAST). Pingtung: Chihpenchushan, 1,900 m, 10 Mar 1990, *Lin 400* (HAST). Taichung: Ssuyuanakou, 1,917 m, 14 Feb 2012, *Nakamura 12201* (HAST). Taitung: Kuanshanling, 2,850 m, 20 Jun 2002, *Liu 69* (HAST). Taoyuan: Pafu history road, 1,650 m, 27 Feb 2008, *Huang 3274* (HAST).

3. *IXERIDIUM LAEVIGATUM* (Blume) Pak & Kawano in Mem. Fac. Sci. Kyoto Univ., Ser. Biol. 15: 45. 1992. \equiv *Prenanthes laevigata* Blume, Bijdr. Fl. Ned. Ind. 15: 886. 1826.

= *Youngia taiwaniana* S.S. Ying in Coloured Ill. Herbac. Pl. Taiwan 1: 186–187. 1980.—TYPE: TAIWAN. Keelung: padou-tze, Apr. 1980 (fr), *S.S. Ying s. n.* (holotype: NTUF!).

KEY TO YOUNGIA TAXA IN TAIWAN

The key to *Youngia* in Taiwan in previous references (Li 1978; Peng et al. 1998; Peng and Chung 1999) is problematic due to misapplication of the name *Y. japonica* subsp. *formosana* for the mountain taxon *Y. japonica* subsp. *monticola* described herein, and neglect of genuine *Y. japonica* subsp. *formosana* in littoral areas. Thus, we present a new key to *Youngia* taxa in Taiwan to facilitate identification.

1. Heads more than 15 mm wide; involucre 6–8 mm long *Y. longiflora*
1. Heads less than 15 mm wide; involucre 4–6 mm long 2
2. Achene brown, less than 2 mm long *Y. japonica* subsp. *japonica*
2. Achene reddish brown to dark purplish brown, 2–2.5 mm long 3
3. Plants usually less than 25 cm tall with fewer than 20 heads per inflorescence axis; radical leaves lyrate-pinnatifid, velvety; inflorescence axes densely puberulous at least at base *Y. japonica* subsp. *formosana*
3. Plants usually more than 25 cm tall with more than 20 heads per inflorescence axis; radical leaves runcinate-pinnatifid, glabrous or slightly puberulous; inflorescence axes glabrous or slightly puberulous at base *Y. japonica* subsp. *monticola*

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Youngia japonica subsp. *formosana* from southern Taiwan, which triggered us to investigate the taxonomic problem of the genus on this island. We

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APPENDIX 1. Additional specimens examined for mapping collection sites.

Youngia japonica subsp. *formosana*. TAIWAN. Kaohsiung: North-face of Chaishan port, 5 m, 4 May 2007, *Huang 3183* (HAST); Chaishan port, 5 m, 18 May 2010, *Nakamura 20100326* (HAST). Pingtung: Hsiao Liuchiu, Wukueitung, 14 Feb 1987, *Chaw 360* (HAST); Hsiao Liuchiu, Meijen cave recreation area, 20 m, 3 May 2007, *Huang 3168* (HAST); Hsiao Liuchiu, Wukuei cave scenic area, 10 m, 3 May 2007, *Huang 3176* (HAST); Hsiao Liuchiu, near Huapingyan, 20 m, 17 May 2010, *Huang 4582* (HAST); Hsiao Liuchiu, Meijen cave recreation area, 20 m, 17 May 2010, *Huang 4600* (HAST); Hsiao Liuchiu, Meijen Tung, 0 m, 2 May 1990, *Lin 470* (HAST); Hsiao Liuchiu, 0–80 m, 17 Mar 2007, *Lu 13344* (HAST); Hsiao Liuchiu, Meirendong, 20 m, 17 May 2010, *Nakamura 20100297, 20100298, 20100299, 20100300* (HAST); Hsiao Liuchiu, near Huapingyan, 20 m, 17 May 2010, *Nakamura 20100315* (HAST). *Youngia japonica* subsp. *monticola*. TAIWAN. Chiayi: Alishan, 2,230–2,400 m, 12 Aug 1969, *Kuoh s. n.* (TAI). Hsinchu: Yuanyang lake nature reserve, 1,695 m, 29 Jul 2010, *Huang 4771* (HAST); Chenhsipao, 22 Apr 2008, *Jung 2719* (TAIF); Chipping road, 1,425 m, 26 Mar 2010, *Peng 22472* (HAST). Hualien: Kuaillin to Wuchiapengshan, 2,000–2,100 m, 22 May 1993, *Liao 1428* (HAST); Pilushan sacred tree, 2,400 m, 13 Feb 2010, *Nakamura 12170* (HAST); Tayuling, 2,400–2,500 m, 4 Jul 1986, *Peng 9148* (HAST); Taroko road no. 8, 2,050 m, 25 Oct 1995, *Peng 16525* (HAST); Tayuling, 2,650 m, 16 Jun 1999, *Peng 17389* (HAST). Ilan: Szuyuanyakou, ca. 1,900 m, 10 May 2001, *Huang 382* (HAST); Chilan no. 100 forest road, 1,825 m, 28 Jul 2010, *Huang 4690* (HAST); Szuchi, 2,200 m, 21 Aug 2000, *Lin 605* (HAST); Szuyuanyakou, 3 Jun 2007, *Lu 13917* (HAST); Taipingshan, ca. 1,950 m, *Nakamura 12597* (HAST); Tatung, 1,580 m, 26 Mar 1993, *Peng 15264* (HAST). Kaohsiung: Tienchih, 2,100–2,500 m, 24 Feb 1975, *Kuo et Peng 15828* (TAI). Miaoli: Kuanwu to Kuaishan shenmu, 2,000–2,200 m, 19 Jul 1986, *Peng 9443* (HAST). Nantou: Shanlinhsi, 4 Jul 2006, *Chen 151* (TAIF); Tunyuan to Yunhai, 4 Apr 2007, *Lu 13500* (HAST); Hehuanshan, 13 Jun 2010, *Nakamura 20100577* (HAST); Chi-tou and Sunlinksea, 29 Jul 1983, *Peng 5403* (HAST); Tungpu hot spring to Rainbow waterfall, 13 Apr 1984, *Peng 6534* (HAST); Tungpu to Kuankao, 1,850 m, 3 Jul 1985, *Peng 8033* (HAST); Mayfeng, 2,400 m, 20 Jun 1986, *Peng 9124* (HAST); between Tzuchung and Fuchishu, 2,350–2,650 m, 23 Apr 1988, *Peng 11412* (HAST); Hsitou to Shanlinhsi, 1,600–1,650 m, 7 Apr 1994, *Peng 15924* (HAST); Meifeng, 2,100 m, 20 Jan 1998, *Wu 819* (HAST); Meifeng, 2,200 m, 2 Jul 1987, *Yen 1346* (HAST). Taichung: Wuling Farm, 1,800 m, 4 May 2000, *Lin 259* (HAST); Mt. Tahsueh logging trail, 28 Apr 2007, *Lu 13679* (TAIF); Wuling Farm, 1,600 m, 23 Aug 1988, *Peng 11992* (HAST); Techii, 1,500 m, 17 Feb 1989, *Peng 12474* (HAST); Tahsuehshan 200 forest road, 1,900 m, 14 May 2003, *Wang 6760* (HAST). Taitung: Haituan, Hsiangyang, 2,400 m, 24 Jul 1988, *Peng 11890* (HAST). Taoyuan: Papokulushan to Mingchi, 1,400 m, 12 Apr 2002, *Leong 2930* (HAST).