

Research paper

Two new species of *Yushania* (Poaceae: Bambusoideae) from South China, with a taxonomic revision of related speciesXia-Ying Ye^{a, b}, Yu-Xiao Zhang^c, De-Zhu Li^{a, *}^a Germplasm Bank of Wild Species, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, Yunnan 650201, China^b Agronomy and Life Science Department, Zhaotong University, Zhaotong, Yunnan 657000, China^c Yunnan Academy of Biodiversity, Southwest Forestry University, Kunming, Yunnan 650224, China

ARTICLE INFO

Article history:

Received 12 October 2020

Received in revised form

8 March 2021

Accepted 16 March 2021

Available online 24 March 2021

Keywords:

Arundinarieae

Yushania

Hunan

New species

Taxonomy

ABSTRACT

Two new species of *Yushania* (Poaceae, Bambusoideae, Arundinarieae) are described and illustrated from Hunan, China. *Yushania longshanensis* D.Z. Li & X.Y. Ye is distinguished from related species (*Y. confusa*, *Y. angustifolia* and *Y. pachyclada*) by having a thinner culm (0.2–0.3 cm in diameter), glabrous sheath scar, no oral setae, a large glabrous leaf blade (10–20 × 0.9–1.3 cm) and 3–4 pairs of secondary veins. *Yushania stoloniforma* D.Z. Li & X.Y. Ye has a distinctive scrambling habit, which differs from its putative close allies. Both of these two new species have a solitary branch at the basal nodes and can be assigned to *Yushania* sect. *Yushania* based on morphological features. Additionally, we treated *Yushania gigantea* T.P. Yi & L. Yang as a new synonym of *Y. elevata* T.P. Yi and renamed *Y. microphylla* T.P. Yi & L. Yang as *Y. weiningensis* D.Z. Li & X.Y. Ye.

Copyright © 2021 Kunming Institute of Botany, Chinese Academy of Sciences. Publishing services by Elsevier B.V. on behalf of KeAi Communications Co. Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Yushania P.C. Keng (1957) belongs to the subtribe Arundinarieae and is one of the most species-rich genera in the temperate woody bamboos (Poaceae, Bambusoideae) (Li et al., 2006; Vorontsova et al., 2017; Yi et al., 2008; Zhang et al., 2020). Species of *Yushania*, which are mainly distributed in China but also in the Himalayas, Indo-China and the Philippines, are morphologically diverse, shrubby or arborescent bamboos, with culm height ranging from 0.35 m to 7 m (Li et al., 2006). *Yushania* have long necked pachymorph rhizomes (up to 100 cm), branches at each node range from solitary to many, and some of which are as thick as the culm or have no secondary branches. The inflorescence is semelactant, open and paniculate, with three stamens. *Yushania* was previously divided into two sections based on culm height and branch number: *Yushania* sect. *Brevipaniculatae* T.P. Yi and *Y. sect. Yushania* (Yi, 1986, 1995). Section *Brevipaniculatae* is characterized by taller culms, many and subequal branches at each node, which are obviously thinner than the culm, and terminal racemes or panicles. In contrast, species of section *Yushania* are shorter and have only one branch at each node or one branch at lower nodes but more

than three branches at upper nodes; the diameter of branches are usually as thick as culms when only one at the node, and terminal panicles.

Yushania is distributed in the mid-elevation and subalpine mountain areas, from low hills at 500 m to high elevation mountains (up to 3800 m), and its center of diversity is in Southwest China (Keng and Wang, 1996; Li et al., 2006; Ohrnberger, 1999; Vorontsova et al., 2017; Yi, 2000; Yi et al., 2008). The species of *Yushania* are ecologically important because they play a role in water and soil conservation and provide food and habitat for many endangered animals, including the giant panda (Yi and Jiang, 2010).

Because of infrequent flowering (Janzen, 1976), the inflorescence of only 11 species of *Yushania* have been hitherto described; thus, most of the taxa are described based on the vegetative morphology (Li et al., 2006; Yang and Yi, 2013, 2014; Yi et al., 2008; Yi and Yang, 2016; Zhang et al., 2019). In 2015, several species in *Yushania* without flowers were collected by the authors during field investigations in Hunan Province, south-central China. The morphological character of several taxa could not be matched to any described species, and molecular analyses demonstrated that their positions on phylogenetic trees were unique (Ye et al., 2019). Here, we described two new species (referred to as *Y. sp.3* and *Y. sp.4*, respectively, in Ye et al., 2019) based on the morphological and phylogenetic evidence, with comments on morphologically

* Corresponding author.

E-mail address: dzl@mail.kib.ac.cn (D.-Z. Li).

Peer review under responsibility of Editorial Office of Plant Diversity.

and phylogenetically related species. In addition, we revised the taxonomy of two *Yushania* species based on morphological comparisons in the field and herbaria, and our phylogenetic results.

2. Materials and methods

Molecular phylogeny of *Yushania* was reconstructed based on ddRAD-seq data (Ye et al., 2019). Measurements and morphological character assessments of the putative new species were carried out on living plants in the field and herbarium specimens. Related species were chosen from morphological comparisons and phylogenetic results, with the morphological features of these species culled from specimens and descriptions in previous studies (Keng and Wang, 1996; Li et al., 2006; Yi et al., 2008).

3. Results

In the ddRAD phylogeny of alpine bamboos with a broad sampling, *Yushania* is represented by 74 samples of 70 species covering 87.5% of the global species. A simplified phylogeny of *Yushania* is presented in Fig. 1, showing the phylogenetic position of the putative new species and *Yushania tongpeii* D.Z. Li, Y.X. Zhang & E.D. Liu, a species described recently based on the vegetative morphology (Zhang et al., 2019).

3.1. Taxonomic treatment

Yushania longshanensis D.Z. Li & X.Y. Ye, *sp. nov.*

Figs. 2–4.

Diagnosis. Similar to *Yushania confusa* (McClure) Z.P. Wang & G.H. Ye, *Y. angustifolia* T.P. Yi & J.Y. Shi and *Y. pachyclada* T.P. Yi, but differs by having a thinner culm with only 0.2–0.3 cm in diameter,

glabrous sheath scar, oral setae absent, longer leaf blade (up to 20 cm) and fewer secondary veins.

Type. CHINA, Hunan, Longshan County, Da'an Township, Wanbaoshan Forest Farm Department, 29°34'10"N, 109°40'15"E, 1256 m, 19 July 2015, X.Y. Ye & J.X. Liu YXY222 (holotype & isotype: KUN!).

Description. Rhizomes pachymorph, culm neck 18–30 cm long, 0.3–0.4 cm in diameter, solid. Shrubby bamboo, 1–1.5 m tall, 0.2–0.3 cm in diameter; internodes terete, 12–23 cm long, initially sparsely purple spotted, with a white powdery ring below nodes, glabrous, nearly solid; nodes with weakly prominent supra-nodal ridge; sheath scar prominent, with persistent remains of sheath base. Branches 1 at lower nodes, up to 80 cm long, 3 at upper nodes, bearing secondary branches or sometimes none. Culm sheaths persistent, yellow-brown, 1/4–1/3 as long as internode, cartilaginous, sparsely yellow-brown setose, readily deciduous, margins brown setose; auricles and oral setae absent; ligules truncate, ca. 1 mm; blades reflexed, linear-lanceolate, deciduous. Foliage leaves 2–4 per ultimate branch; sheaths 3–5 cm long, glabrous, margins glabrous; auricles and oral setae absent or 2–3, deciduous; ligules truncate, ca. 1 mm; petioles 2–6 mm long, glabrous; blades lanceolate, 10–20 × 0.9–1.3 cm, wavy when dry, glabrous, secondary veins 3–4 pairs, transverse veins conspicuous, apex tapering, base cuneate, margins serrate. Inflorescence unknown.

Phenology. New shoots June to July.

Etymology. The specific epithet refers to the type locality, Longshan county.

Vernacular name. Lóng Shān Yù Shān Zhú (Chinese Pin-Yin transliteration); 龙山玉山竹 (Chinese name).

Distribution and habitat. To date, this species is only found in Longshan County, northwest Hunan, China. This species grows with miscellaneous shrubs (Fig. 2A) from 1200 m to 1300 m in the Wanbaoshan Forest Farm.

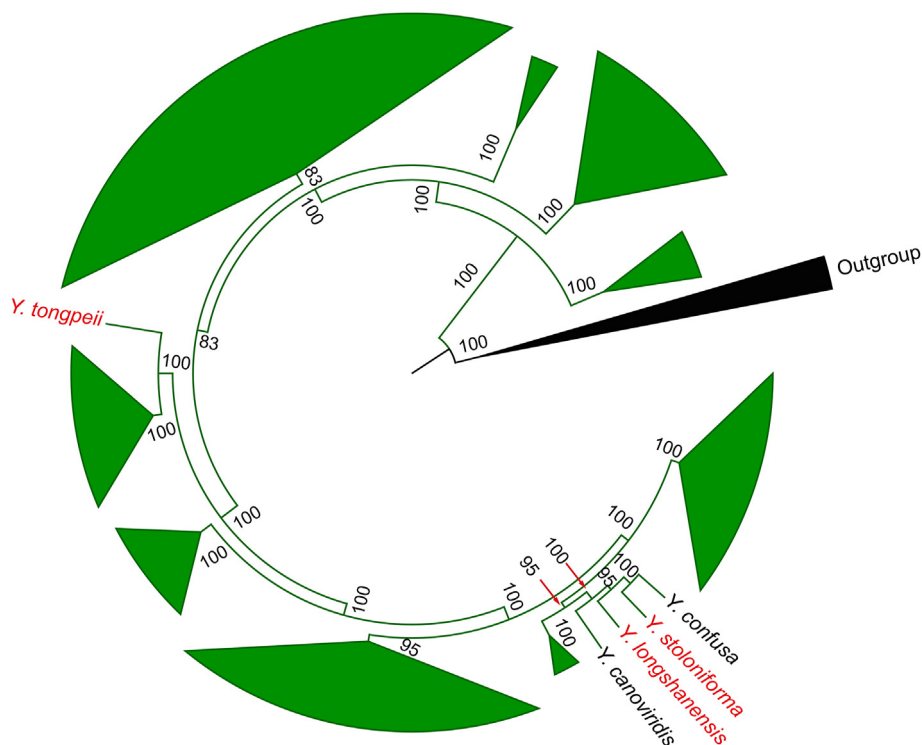


Fig. 1. The simplified phylogeny of *Yushania* based on ddRAD-seq data (adapted from Ye et al., 2019), highlighting the position of the two putative new species and *Y. tongpeii*, a species described recently.

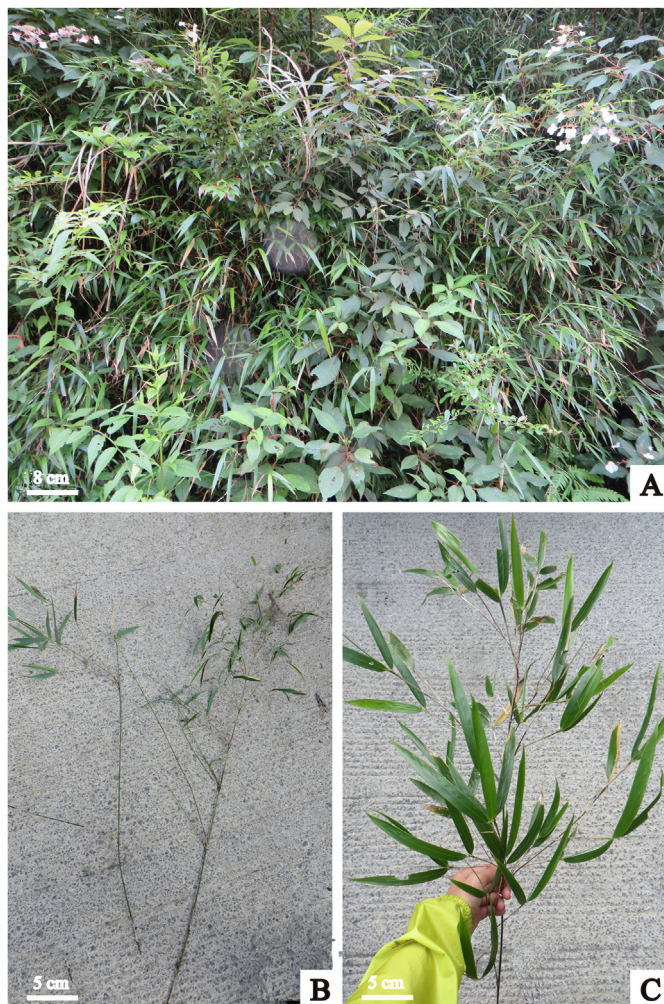


Fig. 2. *Yushania longshanensis* D.Z. Li & X.Y. Ye. A. Habitat B & C. Individuals.

Notes. Morphological comparison between *Y. longshanensis* and morphologically and phylogenetically related species (Fig. 1), *Y. confusa*, *Y. angustifolia* and *Y. pachyclada* is provided in Table 1.

***Yushania stoloniforma* D.Z. Li & X.Y. Ye, sp. nov.**
Figs. 5 and 6.

Diagnosis. Similar to *Yushania confusa*, *Y. pingshanensis* T.P. Yi and *Y. auctiaurita* T.P. Yi, but differs in having shrubby scrambling clumps, thinner culm, shorter leaf sheath and fewer secondary veins.

Type. CHINA, Hunan, Longshan County, Maoping Township, Shazipo Forest Farm, 29°21'44"N, 109°30'47"E, 1094 m, 20 July 2015, X.Y. Ye & J.X. Liu YXY224 (holotype & isotype: KUN!).

Description. Rhizomes pachymorph, culm neck 20–40 cm long, 0.3–0.5 cm in diameter, internodes 0.8–0.9 cm long, solid. Culms scrambling, 2–2.5 m, 0.2–0.5 cm in diameter; internodes terete, 16–28 cm long, initially densely purple spotted, sparsely powdery white with a dense ring below nodes, glabrous, nearly solid; nodes with weakly prominent supra-nodal ridge; sheath scar prominent, with persistent remains of sheath base. Branches 1 at lower nodes, as thick as culms, 3–5 at upper nodes, have secondary branches. Shoots green, brown setose; culm sheaths persistent or tardily deciduous, leathery, longitudinal ribs prominent, triangularly narrowly rounded, 1/3–1/2 as long as internode, brown setose, margins densely brown setose; auricles falcate; oral setae 4–7, 3–4 mm long, radiating; ligules truncate, ca. 1 mm; blades erect or

reflexed, linear-lanceolate. Foliage leaves 5–6 per ultimate branch; sheaths 2–4 cm long, glabrous, margins white ciliate; auricles elliptic or absent, oral setae several, 2–5 mm long, yellow, radiating; ligules truncate, ca. 1 mm; petioles 1–3 mm long, glabrous; blades lanceolate, 5–11 × 0.7–1.5 cm, wavy when dry, glabrous, secondary veins 3–4 pairs, transverse veins conspicuous, apex tapering, base cuneate, margins serrate. Inflorescence unknown.

Phenology. New shoots July.

Etymology. The specific epithet refers to the scrambling habit.

Vernacular name. Pú Fú Yù Shān Zhú (Chinese Pin-Yin transliteration); 匍匐玉山竹 (Chinese name).

Distribution and habitat. To date, this species is only found in Longshan County, northwest Hunan, China. This species lives in the understory of cultivated fir forests at an elevation of 1100 m in the Shazipo Forest Farm.

Notes. Morphological comparison between *Yushania stoloniforma* and morphologically and phylogenetically related species (Fig. 1), *Y. confusa*, *Y. pingshanensis* and *Y. auctiaurita* is provided in Table 2.

3.2. Taxonomic revision

***Yushania weiningensis* D.Z. Li & X.Y. Ye, nom. nov.**

Yushania microphylla T.P. Yi & L. Yang, J. Bamboo Res., 32: 5. 2013. nom. illeg.

Type: CHINA, Guizhou, Weining County, Xiaohai Town, Xiaozhangguan Village, 26°56'29"N, 104°6'17"E, 2300 m, 15 November 2005, Yi Tongpei 05111 (holotype, SIFS). Non *Y. microphylla* (Munro) R.B. Majumdar in S. Karthikeyan & al., Fl. Ind. Enum. - Monocot.: 283 (1989); non *Y. microphylla* (Munro) Ohrenb., Bamboos of the World Intro. 2 10 (1996), **isonym.** Basionym: *Arundinaria microphylla* Munro, Trans. Linn. Soc. London 26(1): 32 (1868).

Distribution. To date, this species is only found in Weining, Guizhou, China.

Notes. Yang and Yi described a new *Yushania* species from Guizhou, China, in 2013, named as *Y. microphylla* T.P. Yi & L. Yang (Yang and Yi, 2013). However, we found that this name (*Y. microphylla* (Munro) R.B. Majumdar) has been used to describe a small and shrubby bamboo distributed in northeast India, Sikkim, Khasi Hills in Meghalaya and Bhutan (Munro, 1868; Noltie, 2000; Seethalakshmi and Muktesh Kumar, 1998; Stapleton, 1994; Vorontsova et al., 2017). According to the International Code of Nomenclature for algae, fungi, and plants (Turland et al., 2018), *Y. microphylla* T.P. Yi & L. Yang is a latter homonym and is illegitimate. This species was sister to *Yushania maculata* T.P. Yi in phylogenetic trees (Ye et al., 2019). We confirmed that *Y. microphylla* T.P. Yi & L. Yang is an independent species after morphological comparisons of closely related species (Table 3). Therefore, we propose *Y. weiningensis* D.Z. Li & X.Y. Ye as a new name for *Y. microphylla* T.P. Yi & L. Yang. The specific epithet of the new name refers to the type locality, Weining County.

Specimens examined. CHINA, Guizhou, Weining County, Xiaohai Town, Xiaozhangguan Village, 26°56'46"N, 104°4'58"E, 2363 m, 13 May 2015, X.Y. Ye & M.Y. Zhou YXY180 (KUN!).

***Yushania elevata* T.P. Yi**

Yushania elevata T.P. Yi, J. Bamboo Res., 5 (1): 17. 1986. **Type:** CHINA, Yunnan, Tengchong County, 20 August 1983, Yi Tongpei 83142 (holotype, SIFS!).

Yushania gigantea T.P. Yi & L. Yang, Bull. Bot. Res., 31 (1): 1. 2014. **syn. nov. Type:** CHINA, Yunnan, Lushui County, 25°59'47"N, 98°39'41"E, 2300 m, 26 October 2005, Yi Tongpei 05080 (holotype, SIFS).

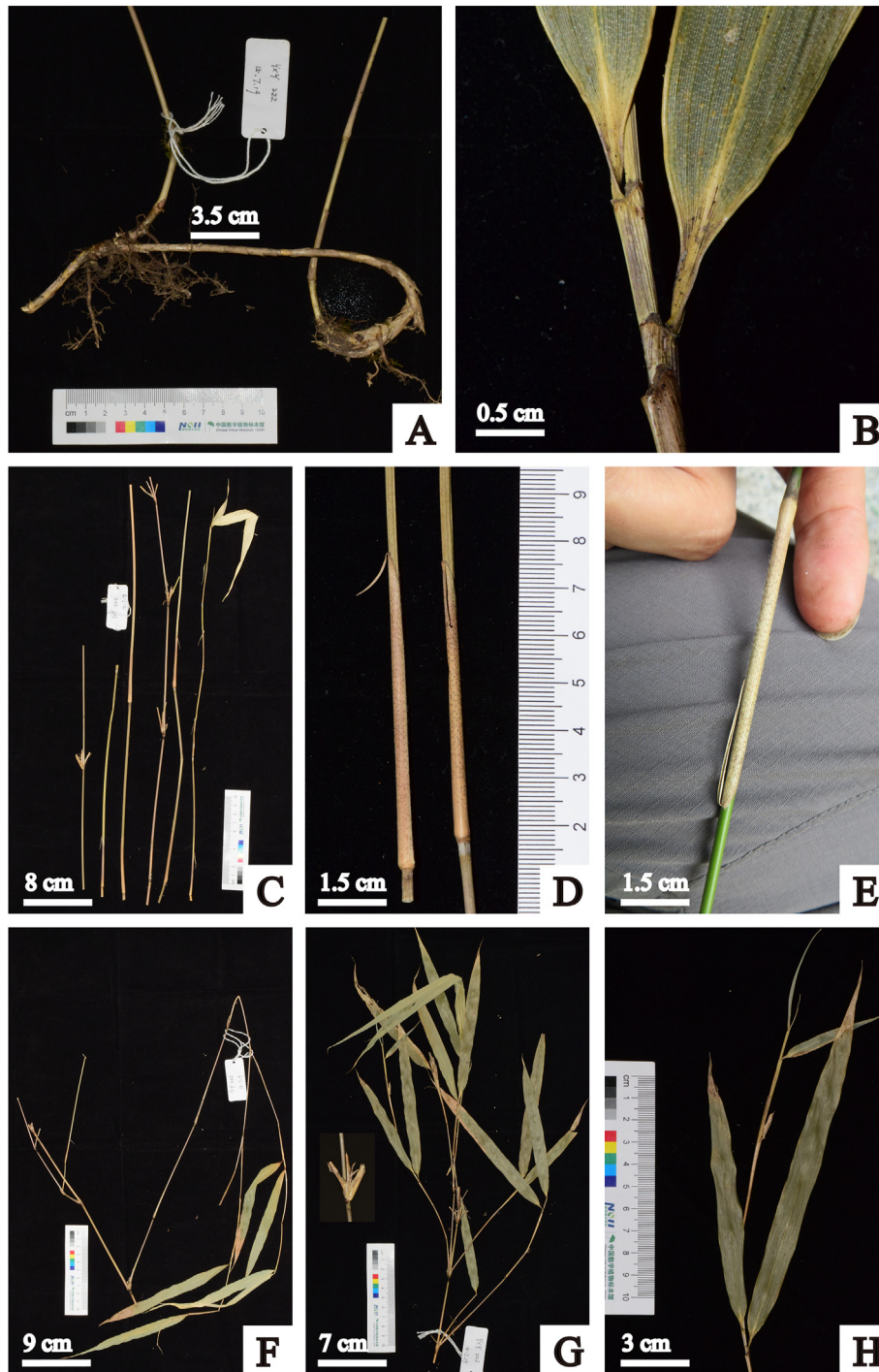


Fig. 3. *Yushania longshanensis* D.Z. Li & X.Y. Ye. **A.** Rhizome **B.** Leaf sheaths **C.** Culms, showing branches and culm sheaths **D. & E.** Culm sheaths with a powdery white ring, showing sparsely yellow-brown setose **F.** Branches at lower nodes, showing 1 with long length **G.** Branches at upper nodes, showing 3 with no secondary branches **H.** Foliage leaves.

Description. Culm neck to 70 cm; internodes solid. Culms 4–7 m, 1.4–6 cm in diameter; internodes terete, 15–60 cm, glabrous or initially brown setulose below nodes; wall 3–8 mm thick; nodes with weakly prominent to prominent supra-nodal ridge; sheath scar prominent, initially brown setose. Branches 8–20, solid or nearly so. Culm sheaths persistent or gradually

deciduous, narrowly triangular, ca. $1/2$ – $2/3$ as long as internodes, leathery to cartilaginous, densely yellow-brown woolly setose, margins densely brown setose, longitudinal ribs prominent; auricles absent; oral setae absent or gradually deciduous; ligules convex or rarely truncate, 1–2 mm tall, glabrous; blades linear-lanceolate, 2 – 7×0.3 – 0.6 cm, revolute, glabrous. Foliage leaves

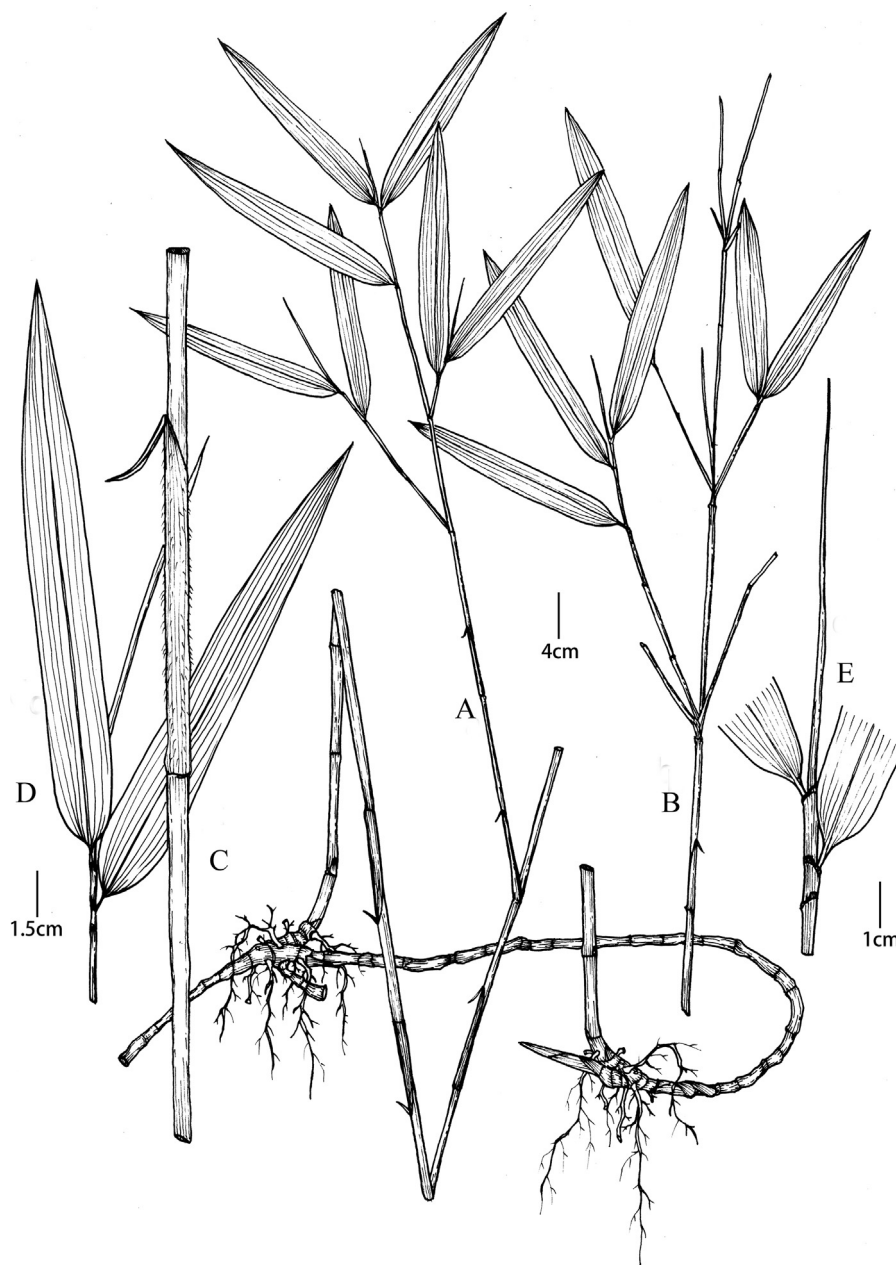


Fig. 4. *Yushania longshanensis* D.Z. Li & X.Y. Ye. **A.** Individual **B.** Branches at the upper nodes **C.** Culm sheaths with sparsely yellow-brown setose **D.** Foliage leaves **E.** Leaf sheaths.

Table 1
Morphological comparison of *Yushania longshanensis* and its related species.

Character	<i>Yushania longshanensis</i>	<i>Y. confusa</i>	<i>Y. angustifolia</i>	<i>Y. pachyclada</i>
Culm height	1–1.5 m	1–2 m	1.5–2 m	1–2 m
Culm diameter	0.2–0.3 cm	0.2–1 cm	0.5–0.7 cm	0.3–1 cm
Internode	12–23 cm long, a ring of white powder below nodes	10–33 cm long, initially powdery white	(6) 16–22 cm long, a ring of white powder below nodes	20–30 cm long, a ring of white powder below nodes
Branch complement	1–3	1–5	1–3	1–5
Sheath scar	Prominent, glabrous, with persistent remains of sheath base	Prominent, initially yellow setose	Slightly prominent, glabrous	Prominent
Culm sheath	Cartilaginous, sparsely yellow-brown setose, margins setose	Leathery, brown setose, margins setose	Densely brown setose, densely ciliate	Leathery, usually glabrous, margins glabrous
Culm sheath oral setae	Absent	Several, 1–2 mm long, readily deciduous	1–2, 1–3 mm long, deciduous early	Absent
Culm sheath blade	Reflexed, linear-lanceolate, deciduous	Reflexed, linear-lanceolate or linear	Erect or reflexed, linear-lanceolate, glabrous	Reflexed, conical or linear-lanceolate, glabrous
Leaf number of the ultimate branch	2–4	2–5 (7)	4–8	2–5
Leaf sheath	3–5 cm long, glabrous, margins glabrous	(2) 3–6.5 cm long, glabrous, margins white-gray ciliate	Glabrous	–
Leaf oral setae	Absent or 2–3, deciduous	Several, 2–5 mm long, gray-yellow	2–3, 3–8 mm long, erect, purple	Absent
Petiole	Glabrous	Densely pubescent, rarely glabrous	Glabrous	–
Leaf blade	10–20 × 0.9–1.3 cm, glabrous, secondary veins 3–4 pairs	(3) 8–13 (21.5) × 0.6–1.5 (2.1) cm, abaxially basally gray hairy, secondary veins 4–6 pairs	10–13 × 0.6–1 cm, glabrous, secondary veins 3–4 pairs	6–14 × 1.1–2 cm, glabrous, secondary veins 4–6 pairs
Habitat	Growing with miscellaneous shrubs from 1200 m to 1300 m, Longshan, Hunan.	Widely distributed, usually under forest at elevations of 1000–2300 m.	Cultivated, 1160 m, Guiyang, Guizhou.	Usually under broadleaved evergreen forest on mountain ridges, 1700–1800 m, southern Sichuan and northeastern Yunnan.

4–7 per ultimate branch; sheaths 2–5.5 cm long, longitudinal ribs prominent, glabrous; auricles absent; oral setae absent or several, erect or curved, brown, 0.5–6 mm; ligules convex, 0.5–1 mm tall, glabrous; petioles 1–2.5 mm long, glabrous; blades narrowly lanceolate, 3.5–20 × 0.4–1.8 cm, glabrous, secondary veins 2–4 pairs, transverse veins distinct, base cuneate, one margin serrulate, another margin smooth, apex acuminate.

Phenology. New shoots July.

Distribution and habitat. *Yushania elevata* occurs under the broadleaved forest or *Pinus yunnanensis* Franch. forest in western Yunnan, at the elevations of 2000–2300 m.

Notes. *Yushania gigantea* was described in 2014 by Yang and Yi (2014), and included in our phylogenetic analyses based on ddRAD-seq data (Ye et al., 2019). Results show that this species is sister to *Y. elevata* and obtained 100% bootstrap support. Morphological comparison of the two species revealed that they were very similar, differing only in two ambiguous features: *Y. gigantea* has persistent culm sheaths and a longer leaf blade (3.5–20 cm), whereas *Y. elevata* is tardily deciduous and has a shorter leaf blade (4.5–9.5 cm) (Keng and Wang, 1996; Li et al., 2006; Yang and Yi, 2014). Most *Yushania* species are short and shrubby; only few can grow into arborescent plants (about six species). Moreover, the holotype specimen of *Y. gigantea* was collected from Lushui, western Yunnan, China, at an elevation of 2300 m, which is in the distribution range of *Y. elevata* (2000–2300 m in western Yunnan) (Keng and Wang, 1996; Li et al., 2006). It is unlikely that two arborescent species occur in a narrow area. Together with their close relationship and similar morphology, we conclude that *Y.*

gigantea and *Y. elevata* are conspecific, and *Y. gigantea* is treated to be a new synonym of *Y. elevata*.

Specimens examined. CHINA, Yunnan, Lushui County, Wuzhong Village, 26°07'03"N, 98°35'43"E, 2061 m, 8 May 2011, ZXZ11010 (KUN!); CHINA, Yunnan, Lushui County, Wuzhong Village, 26°03'12"N, 98°36'53"E, 2206 m, 8 May 2011, ZXZ11012 (KUN!); CHINA, Yunnan, Lushui County, along the Pianma Road between 72 and 73 km, 25°59'55"N, 98°39'39"E, 2429 m, 6 August 2014, X.Y. Ye & W.H. Wang YXY134 (KUN!).

4. Discussion

Yushania longshanensis (i.e., *Y. sp.3* in Fig. 2 in our previous work) (Ye et al., 2019) and *Y. stoloniforma* (i.e., *Y. sp.4* in Fig. 2 in our previous work) (Ye et al., 2019) are here assigned to *Yushania* sect. *Yushania* based on morphological features: solitary branch at the base nodes and three to five branches at the upper nodes, and culms with short or medium height.

Yushania longshanensis is most similar to *Y. angustifolia* and *Y. pachyclada* according to morphological characteristics, but can be distinguished by some subtle features: thinner culms (only 0.2–0.3 cm in diameter), sparsely yellow-brown setose, larger leaf blade and type of habitat where distributed. Moreover, molecular phylogenetic analyses indicate that *Y. longshanensis* is distantly related to *Y. angustifolia* (Ye et al., 2019). In addition, phylogenetic analysis shows that *Y. longshanensis* is related to *Y. stoloniforma* and *Y. confusa*. However, *Y. longshanensis* and *Y. stoloniforma* have different growth habit; furthermore, *Yushania longshanensis* and

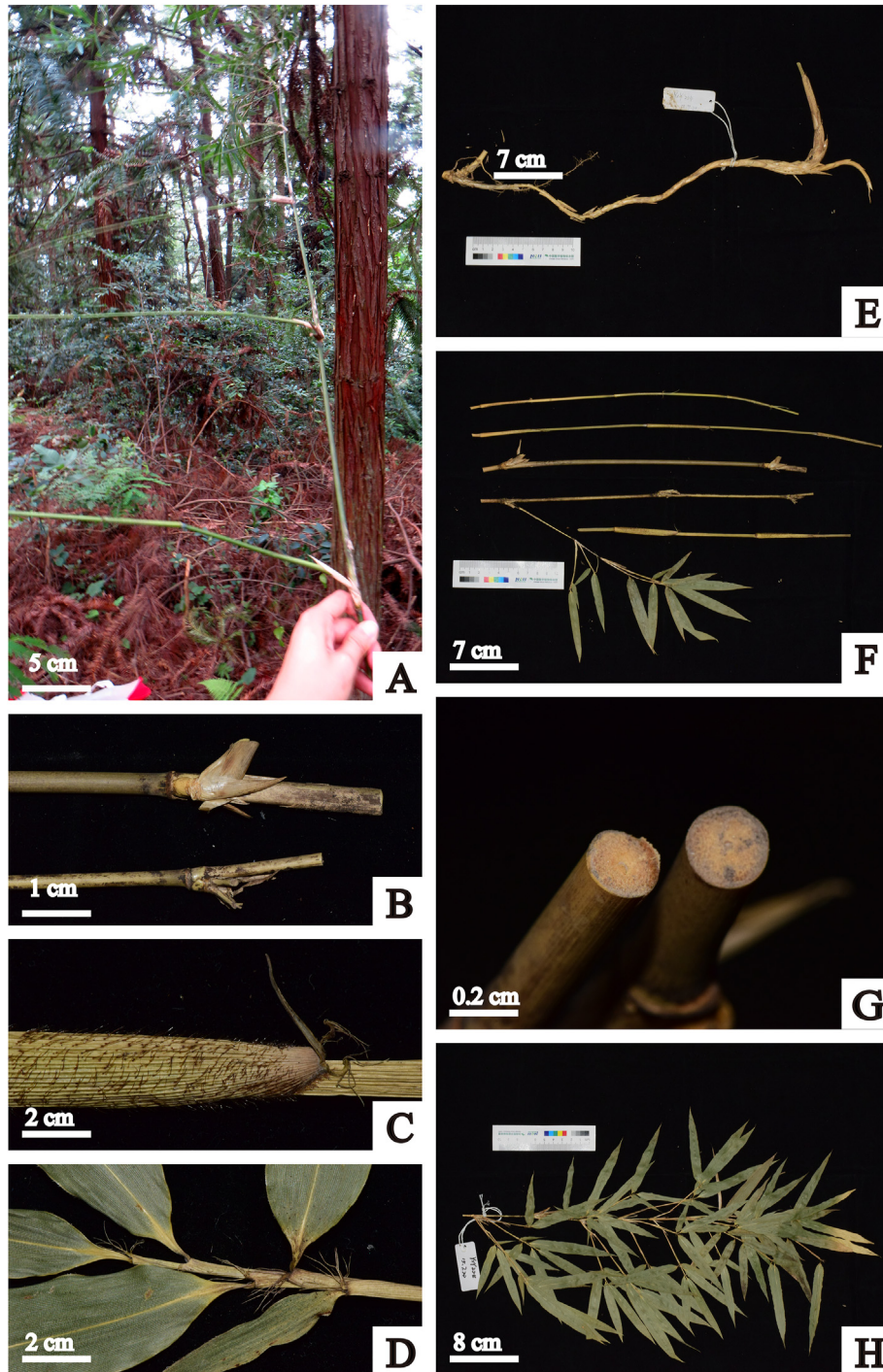


Fig. 5. *Yushania stoloniforma* D.Z. Li & X.Y. Ye **A.** Individual, showing 1 branch at lower nodes and scrambling character **B.** Branches, showing solitary branch at the basal nodes and three branches at the upper nodes **C.** Culm sheath with falcate auricles **D.** Leaf sheath, showing developed auricles and oral setae **E.** Rhizome **F.** Culms, showing branches and culm sheaths **G.** Nearly solid internodes **H.** Branchlet.

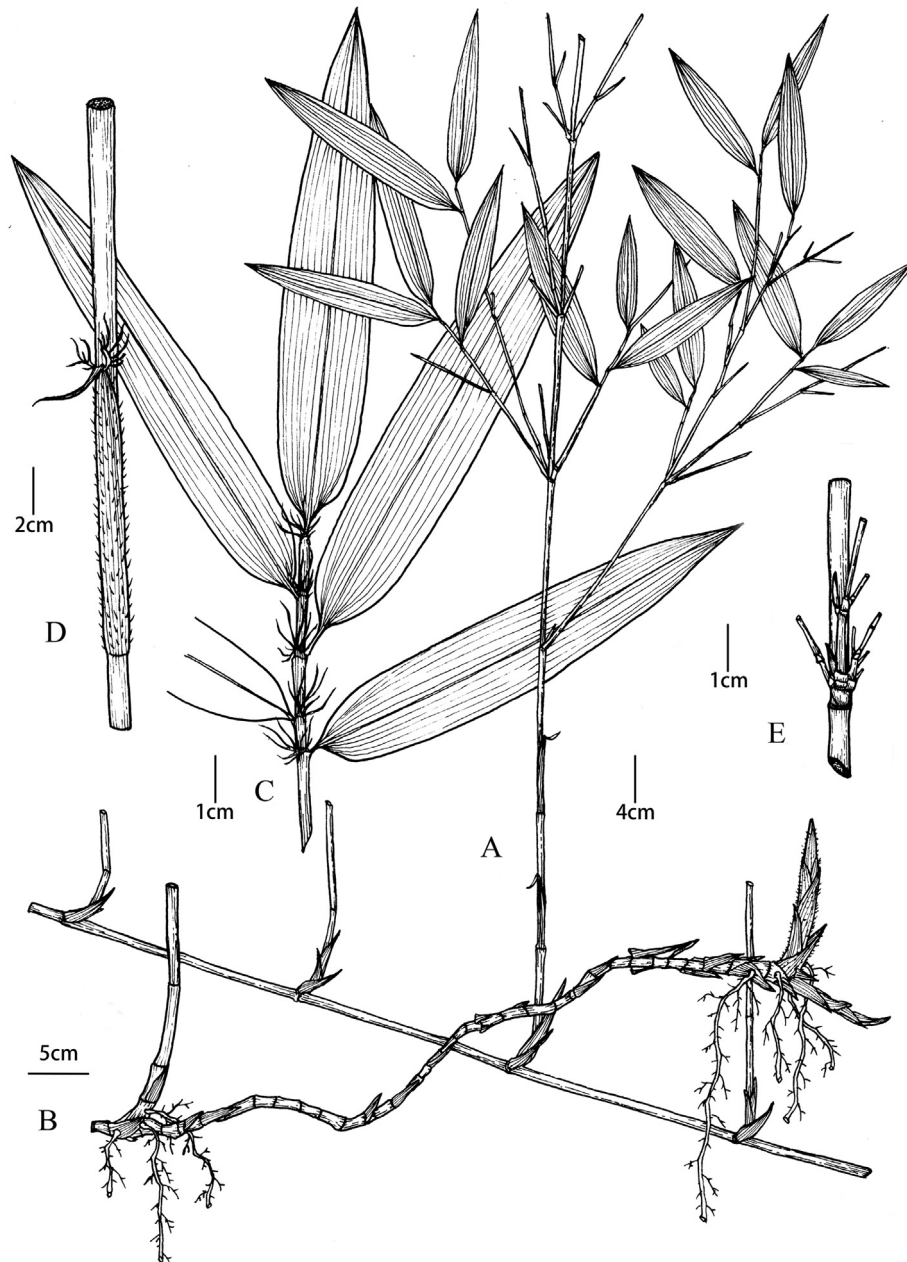


Fig. 6. *Yushania stoloniforma* D.Z. Li & X.Y. Ye **A.** Individual, showing solitary branch at the basal nodes and scrambling character **B.** Long-necked rhizome **C.** Foliage leaves **D.** Culm sheath with falcate auricles **E.** Nodes with branches.

Y. confusa can be distinguished by the presence versus absence of hair on the sheath scar, petiole and leaf blade.

Yushania stoloniforma is morphologically similar to *Y. pingshanensis* and *Y. actiaurita*. They all have less than five branches at the node, medium culm height, prominent sheath scar, persistent culm sheath, several radiating culm sheath oral setae and reflexed culm sheath blade, but *Y. stoloniforma* can be easily distinguished from them by its different growth habit, the smaller leaf size and the different arrangement of the leaf blade. Phylogenetic topology indicates that *Y. stoloniforma* has a sister relationship with *Y. confusa* (Ye et al., 2019) although the two species have different morphological features, with *Y. stoloniforma* having scrambling growth habit, glabrous sheath scar, developed culm sheath auricles with radiating oral setae, and glabrous petiole and leaf blade.

Most species of *Yushania* are distributed in the Hengduan Mountains region and may have begun migrating southward during the late Pliocene (Ye et al., 2019). The migration route of *Yushania* passes through the Yunnan-Guizhou Plateau, adjacent to Hunan province. Therefore, the discovery of *Y. longshanensis* and *Y. stoloniforma*, which are endemic to the Hunan province, provides a means for studying the origin and diversification of *Yushania*, and may also help to understand the evolutionary history of bamboos distributed in southwestern China. In addition, the discovery of *Y. longshanensis* and *Y. stoloniforma* calls attention to these two ecologically important species, which play a role in soil protection and provide food and habitat for animals, including many endangered species.

Table 2
Morphological comparison of *Yushania stoloniforma* and its related species.

Character	<i>Yushania stoloniforma</i>	<i>Y. confusa</i>	<i>Y. pingshanensis</i>	<i>Y. auctiaurita</i>
Clumps	Scrambling	Erect	Erect	Erect
Culm height	2–2.5 m	1–2 m	1.2–2 m	1–2.5 m
Culm diameter	0.2–0.5 cm	0.2–1 cm	0.5–0.75 cm	0.3–0.8 cm
Internode	16–28 cm long, sparsely white powder with a densely ring below node, nearly solid	10–33 cm long, initially white powder, nearly solid	13–35 cm long, a ring of white powder below nodes, wall 1.5–2.5 mm thick	16–22 cm long, white powder below nodes, wall 1–3 mm thick
Branch complement	1–5	1–5	1–3	1–3
Sheath scar	Glabrous, with persistent remains of sheath base	Initially yellow setose	Glabrous	Initially retrorsely brown setose, with persistent remains of sheath base
Culm sheath	Persistent or tardily deciduous, leathery, brown setose, margins setose	Persistent, leathery, brown setose, margins setose	Persistent, densely light yellow verrucose setose abaxially, margins densely ciliate	Persistent, cartilaginous, yellow-brown setose, margins densely ciliate
Culm sheath auricle	Falcate	Absent	Small, oblong or falcate	Falcate, large
Culm sheath oral setae	4–7, 3–4 mm long, radiating	Several, 1–2 mm, readily deciduous	3–5, 3–6 mm long	Many, 3–6 mm long, radiating, yellow-brown
Culm sheath ligule	Truncate, ca. 1 mm	Truncate, ca. 1 mm	Truncate or arcuate, ca. 0.6 mm	Arcuate, ca. 0.5 mm
Culm sheath blade	Erect or reflexed, linear-lanceolate	Reflexed, linear-lanceolate or linear	Reflexed, triangular-linear or linear-lanceolate	Erect or decumbent, narrowly triangular or lanceolate, glabrous, margins serrulate
Leaf number of the ultimate branch	5–6	2–5 (7)	5–9	3–8
Leaf sheath	2–4 cm long, glabrous, margins white ciliate	(2) 3–6.5 cm long, glabrous, margins white-gray ciliate	5.2–6.5 cm long, glabrous, margins glabrous	Glabrous or gray pubescent, apically white powder, margins yellow-brown ciliate
Leaf auricle	Elliptic	Absent	Small, purple	Purple, falcate
Leaf oral setae	Several, 2–5 mm long, yellow, radiating	2–5 mm long	4–8, yellow, 3–8 mm long	Many, 2–7 mm long
Leaf ligule	Truncate, ca. 1 mm	Truncate, glabrous, ca. 1 mm	Truncate, glabrous, ca. 0.3 mm	Arcuate, ca. 1 mm
Petiole	Glabrous	Densely pubescent, rarely glabrous	Glabrous	Abaxially occasionally white powder
Leaf blade	5–11 × 0.7–1.5 cm, glabrous, secondary veins 3–4 pairs	(3) 8–13 (21.5) × 0.6–1.5 (2.1) cm, abaxially basally gray hairy, secondary veins 4–6 pairs	9–17 × 1.3–2.2 cm, glabrous, secondary veins 6–8 pairs	8–16 × 1.3–3 cm, glabrous, secondary veins 5–9 pairs
Habitat	Under the cultivated fir forest, 1100 m, Longshan, Hunan.	Widely distributed, usually under forest at elevations of 1000–2300 m.	Under broadleaved evergreen forest on mountain ridges, 1500–2000 m, Pingshan, Sichuan.	Under broadleaved forest, 1700–1800 m, southeast Guizhou.

Table 3
Morphological comparison of *Yushania weiningensis*, *Y. microphylla* and *Y. maculata*.

Character	<i>Yushania weiningensis</i>	<i>Y. microphylla</i>	<i>Y. maculata</i>
Culm neck	Solid	Hollow	Solid
Culm height	3–4 (5) m	1.2 m	2–3.5 m
Internode	(10) 28 (35) cm, glabrous, initially white powdery	ca. 7 cm long, glabrous	10–30 (40) cm, brown or light yellow setose, initially densely white powder
Nodal sheath scar	Weakly prominent	Prominent	Level or weakly prominent
Branches	5–8	Many	7–12
Leaf sheath	Striate, light-green, glabrous	Striate, dark, scabrous, fimbriate at the top	Glabrous
Leaf blade	3.8–8.5 × 0.4–0.7 cm, linear-lanceolate, apex acuminate, secondary veins 2–3 pairs	3 × 0.3 cm, linear-lanceolate, acute; secondary veins 2 pairs, inconspicuous	9–15 × 0.9–1.1 cm, linear-lanceolate, apex acuminate, secondary veins 4 pairs
Distribution	Weining, Guizhou, China	Bhutan and India	Southwest Sichuan, northeast Yunnan, China

Author contributions

YYY conducted the field and phylogenetic work and drafted this paper; YXZ revised the draft; DZL conceived and wrote this paper.

Declaration of competing interest

The authors have no conflicts of interest to declare.

Acknowledgements

We thank Jing-Xia Liu of Kunming Institute of Botany, Chinese Academy of Sciences, and staff of Wanbaoshan Forest Farm and Shazipo Forest Farm for their assistance in the fieldwork. The study was funded by the National Natural Science Foundation of China (nos. 31800315, 31430011), and the Applied and Fundamental Research Foundation of Yunnan Province (2019FD059).

References

- Janzen, D.H., 1976. Why bamboos wait so long to flower. *Annu. Rev. Ecol. Systemat.* 7, 347–391.
- Keng, P.C., 1957. One new genus and two new species of Chinese bamboos. *Acta Phytotaxon. Sin.* 6, 355–360.
- Keng, P.C., Wang, Z.P., 1996. *Flora Reipublicae Popularis Sinicae*, vol. 9. Science Press, Beijing, China (1).
- Li, D.Z., Wang, Z.P., Zhu, Z.D., et al., 2006. Tribe bambuseae. In: Wu, Z.Y., Raven, P.H., Hong, D.Y. (Eds.), *Flora of China*, vol. 22. Science Press, Beijing and Missouri Botanical Garden Press, St. Louis, pp. 7–180.
- Munro, W., 1868. A Monograph of the Bambusaceae, Including Descriptions of All the Species. Transactions of the Linnean Society of London, London.
- Noltie, H.J., 2000. *Flora of Bhutan*. Royal Botanic Garden Edinburgh and Royal Government of Bhutan, The Charlesworth Group, Huddersfield, UK.
- Ohrnberger, D., 1999. *The Bamboos of the World: Annotated Nomenclature and Literature of the Species and the Higher and Lower Taxa*. Access Online via Elsevier.
- Seethalakshmi, K.K., Muktesh Kumar, M.S., 1998. *Bamboos of India: A Compendium*. Bamboo Information Centre-India, Kerala Forest Research Institute, Peechi And International Network For Bamboo And Rattan, Beijing, Eindhoven, New Delhi.
- Stapleton, C.M.A., 1994. The bamboos of Nepal and Bhutan. Part II: *Arundinaria*, *Thamnocalamus*, *Borinda*, and *Yushania* (Gramineae: Poaceae, Bambusoideae). *Edinb. J. Bot.* 51, 275–295.
- Turland, N.J., Wiersma, J.H., Barrie, F.R., et al. (Eds.), 2018. International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) Adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. *Regnum Vegetabile* 159. Koeltz Botanical Books, Glashütten.
- Vorontsova, M., Clark, L., Dransfield, J., et al., 2017. *World Checklist of Bamboos and Rattans*. Science Press, Beijing.
- Yang, L., Yi, T.P., 2013. Two new species of *Yushania* Keng f. (Poaceae) from Guizhou, China and the name about *Bashania faberi* (Rendle) Yi. *J. Bamboo Res.* 32, 5–8.
- Yang, L., Yi, T.P., 2014. Two new species of *Yushania* Keng f. (Poaceae) from western slope of Gaoligongshan, Yunnan, China. *Bull. Bot. Res.* 34, 1–5.
- Ye, X.Y., Ma, P.F., Yang, G.Q., et al., 2019. Rapid diversification of alpine bamboos associated with the uplift of the Hengduan mountains. *J. Biogeogr.* 46, 2678–2689.
- Yi, T.P., 1986. Studies on the genus *Yushania*. *J. Bamboo Res.* 5, 8–66.
- Yi, T.P., 1995. A new species of *Yushania* and changed the name of section *Confusae*. *J. Bamboo Res.* 14, 1–5.
- Yi, T.P., 2000. Some new taxa of Bambusoideae in western Sichuan, China. *J. Sichuan For. Sci. Technol.* 21, 13–23.
- Yi, T.P., Jiang, X.L., 2010. Staple food bamboo species of the giant panda and their biodiversity. *J. Sichuan For. Sci. Technol.* 31, 1–20.
- Yi, T.P., Shi, J.Y., Ma, L.S., et al., 2008. *Iconographia Bambusoidearum Sinicarum*. Science Press, Beijing.
- Yi, T.P., Yang, L., 2016. Two new species of *Yushania* Keng f. (Poaceae) from north-western Yunnan in China. *J. Sichuan For. Sci. Technol.* 37, 23–26.
- Zhang, Y.X., Guo, C., Li, D.Z., 2020. A new subtribal classification of Arundinarieae (Poaceae, Bambusoideae) with the description of a new genus. *Plant Divers.* 42, 127–134.
- Zhang, Y.X., Ye, X.Y., Liu, E.D., et al., 2019. *Yushania tongpeii* (Poaceae, Bambusoideae), a new bamboo species from north-eastern Yunnan, China. *PhytoKeys* 130, 135–141.