

Arundinella stenostachya (Arundinella, Poaceae), a reevaluated new species from SE Asia

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Abstract: *Arundinella stenostachya*, a new species, is described and illustrated. It is morphologically similar to *A. decempedalis* and *A. bengalensis*, but differs from the former species by the length of panicle branches, type of trichome on nodes and pedicels length, and from the latter in height and diameter of culms, the length and width of leaf blades, pedicels length, and the length of panicles and branches. The new species has been mistakenly identified as *A. decempedalis* and *A. bengalensis*. Molecular analyses based on ITS sequences also support *A. stenostachya* as a distinct species.

Key words: *Arundinella*, morphology, phylogeny, Poaceae, taxonomy

1. Introduction

Arundinella Raddi is a tropical and subtropical genus with about 50–60 species mainly distributed in Asia (Sun & Phillips 2006, Veldkamp 2015). There are 20 *Arundinella* species recorded in China, of which eight are endemic (Sun & Phillips 2006). It is characterized by 2-flowered spikelets disarticulated above the glumes, upper lemmas scabrid, hilums punctiform, and membranous ligules short (Teerawatananon et al. 2009). Currently, the treatment on *Arundinella* by Keng (1936) and Phipps (1967) are two main taxonomic systems. Keng (1936) divided the genus into four subgenera and recognized 39 species in Asia, while Phipps (1966, 1967) separated the genus into 15 series and recognized 47 species in the world.

Series *Bengalenses* Phipps, characterized by its medium to large perennial grasses with long narrow inflorescences, spikelets somewhat plump and awn lacking or extremely reduced, was firstly published by Phipps (1967: 1050). Previously, only two species, viz., *A. decempedalis* Janowski and *A. bengalensis* (Sprengel) Druce, were recognized in the series (Phipps 1967). *Arundinella decempedalis* is distributed in China, India, and Myanmar, and *A. bengalensis* has more widely distributed in China, Bangladesh, Bhutan, India, Myanmar, Nepal, Thailand, and Vietnam.

In the process of examining the specimens of *Arundinella* from the Asia, we found that there are certain unique specimens, which are distinct from *A. decempedalis*

or *A. bengalensis*, that were misidentified as *A. decempedalis* or as *A. bengalensis*. Furthermore, the descriptions of *A. decempedalis* in *Flora Reipublicae Popularis Sinicae* (Sun & Hu 1990) and *Flora Illustralis Plantarum Primarium Sinicarum – Gramineae* (Keng 1959) are not consistent with what the type specimens (holotype: C.E.O. Kuntze 6581, NY 00414089 & NY00414090) shows in the length of panicle branches, type of trichome on nodes and pedicels length. Treats of *A. bengalensis* described in *Flora Reipublicae Popularis Sinicae* (Sun & Hu 1990), *Flora Illustralis Plantarum Primarium Sinicarum – Gramineae* (Keng 1959), and *Flora of China* (Sun & Phillips 2006) differ in the protologue on height and diameter of culms, the width and length of leaves, the panicle length, branches length and pedicels length (Table 1). During a field work in Malipo County and Jiangcheng County, Yunnan, China and Chiang Mai, Thailand, we collected those unique specimens. After carefully examining, and based on the literature and our molecular phylogenetic data, we conclude that those unique specimens should be recognized as a new species *Arundinella stenostachya*. The morphological traits distinguishing these three species are listed in Table 1.

2. Materials and methods

2.1. Morphological studies

Morphological comparisons among *Arundinella stenostachya* and other taxa of *Arundinella* were carried

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Table 1. Morphological features distinguishing *Arundinella stenostachya*, *A. decempedalis* and *A. bengalensis*.

Characters	<i>A. stenostachya</i>	<i>A. decempedalis</i>	<i>A. bengalensis</i>
Height	1–2.5 m	up to 2.5 m	0.5–1.2 m
diam of Culms	3.5–8 mm	7–10 mm	1.5–4 mm
Base of rhizome	whitish pubescent and scaly	–	whitish pubescent and scaly
Nodes	bearded or glabrescent	densely pubescent, glabrescent	bearded or glabrescent
Leaf blades	13–70 cm × 3–16 mm, tuberculate-hispid on both surfaces	30–60 cm × 10–25 mm, glabrous or tuberculate-hispid	1–33 cm × 3–8 mm, tuberculate-hispid on both surfaces
ligule	0.5–1 mm	0.5–1 mm	0.3–0.5 mm
Panicles	narrowly cylindrical, dense, 9.5–42 cm	loosely contracted, (20–)30–70 cm	narrowly cylindrical, loose to dense, 4–25 cm
Axil of rachis	usually villous	scabrid or villous	usually villous
central axis	Sparsely pubescent, scabrid	almost smooth	scabrid
Branches of panicle	numerous, erect, 1.8–10 (11.5) cm	numerous, slender, 10–25 cm	spikelike, erect, 1–5 cm,
spikelets	2.5–3.7 mm	3–4 mm	2.5–3.5 mm
pedicels	0.3–2.2 mm	0.5–3.5 mm	0.3–3.5 mm
Lower glumes	1.9–3.1 mm, 3–5-veined, scabrous on nerves	2.5–3 mm, 3–5-veined, scabrous on nerves	2–2.5 mm, 3-veined, scabrous or hispidulous on veins
Upper glumes	5-veined, glabrous	5–7-veined, scaberulous on the nerves	5-veined, usually tuberculate-setose on veins
awn	soon deciduous, up to 2 mm	soon deciduous, up to 2.5 mm	soon deciduous, 1–1.5 mm
Callus hairs	1/10–1/5 length of lemma	2/5 length of lemma	ca. 1/5 length of lemma

out based on our field observations and specimen from 56 herbaria (A, AD, B, BAA, BM, BR, BRI, C, CANB, CNS, CORD, COL, DNA, E, FI, FR, G, GH, GOET, HEID, HOH, IBSC, JE, K, KFTA, KUN, L, LG, MA, MEL, MEXU, MO, MPU, MVFA, NSW, NT, NU, NY, P, PE, PH, PRE, REG, RSA, S, SI, SP, SYS, TCD, TUB, U, US, W, WU, YU, and YUKU; abbreviations follow Thiers (2021). We selected height and diam of culms, type of trichome on nodes, length and width of leaf blades, ligule length, panicles length, length of panicle branches, spikelets length, pedicels length, two glumes traits, awn length and proportion of calluses hairs to upper lemma from each of these specimens (94 specimens for *A. stenostachya*, 73 for *A. bengalensis* and 9 for *A. decempedalis*) and measured the quantitative traits. Detailed locality information of the examined specimens is given in the Appendix. Meanwhile, protologues of all published names and all other taxonomic literatures for *Arundinella* were reviewed.

2.2. Molecular methods

2.2.1. Taxon sampling and DNA amplification

The placement of the new species was explored based on a sampling comprising 23 accessions of 20 taxa (17 species and 3 varieties) of *Arundinella*, including three accessions of *A. stenostachya* collected from Malipo County and Jiangcheng County in Yunnan Province

of China and Chiang Mai of Thailand (Table 2). Based on previous studies (Teerawatananon et al. 2011, Grass Phylogeny Working Group II 2012, Bianconi et al. 2020), three accessions from *Garnotia* Brongn. and *Arthraxon* P. Beauv. were selected as outgroups (Table 2). Vouchers and GenBank accession numbers are listed in Table 2.

Total genomic DNA was extracted from 15–25 mg silica-gel-dried leaves or herbarium specimens using the modified CTAB method (Doyle & Doyle 1987). For polymerase chain reaction (PCR) amplification, the nuclear ribosomal internal spacer (ITS) was amplified using the primer pairs 17SE/26SE (Sun et al. 1994). PCR mixtures and procedures of the marker followed those described in Chen et al. (2016). Amplified PCR products were checked on 1% TAE agarose gels and sequenced by an ABI-PRISM3730 sequencer after purification with a QIAquick PCR purification Kit (BioTeke Corp., Beijing, China).

2.2.2. Sequence alignment and phylogenetic analyses

Sequences were assembled and edited using Sequencher 4.1.4 (Gene Codes, Ann Arbor, Michigan, USA), and then both aligned and manually adjusted in MEGA v.7.0 (Kumar et al. 2016.). Gaps were treated as missing data and ambiguously aligned regions were removed directly. Bayesian inference (BI) and maximum likelihood (ML)

Table 2. Taxa and their ITS sequences used in this study. For newly generated sequences, indicated with an asterisk, while for sequences downloaded from GenBank, their accession numbers are provided.

Taxon	Voucher	Locality	GenBank accession
<i>Arundinella barbinodis</i> Keng ex B.S. Sun & Z.H. Hu	Y.P. Chen & Y. Zhao EM1426 (KUN)	Huidong, Guangdong, China	*MZ233650
<i>Arundinella bengalensis</i> (Spreng.) Druce 1	L.Q. Jiang & Y.Y. Li jlq310 (KUN)	Tengchong, Yunnan, China	*MZ233651
<i>Arundinella bengalensis</i> (Spreng.) Druce 2	Y.C. Liu 783 (CSH)	Xingyi, Guizhou, China	MZ326746
<i>Arundinella cochinchinensis</i> Keng	L.Q. Jiang & Y.Y. Li jlq220 (KUN)	Shidian, Yunnan, China	*MZ233652
<i>Arundinella decempedalis</i> (Kuntze) Janowski	Y.P. Chen & L.Q. Jiang EM1447 (KUN)	Mengla, Yunnan, China	*MZ233653
<i>Arundinella fluviatilis</i> Hand. - Mazz.	B.S. Sun et al. 78766 (YUKU)	Xinhua, Hunan, China	*MZ233654
<i>Arundinella grandiflora</i> Hack.	Y.P. Chen & L.Q. Jiang EM1780 (KUN)	Xiangyun, Yunnan, China	*MZ233655
<i>Arundinella hirta</i> (Thunb.) Tanaka var. <i>hirta</i>	Y. Yang OYY00276 (KUN)	Lianshan, Guangdong, China	*MZ233656
<i>Arundinella hirta</i> var. <i>hondana</i> Koidzumi	L.Q. Jiang jlq325 (KUN)	Ruian, Zhejiang, China	*MZ233657
<i>Arundinella hookeri</i> Munro ex Keng	Y.P. Chen et al. EM1147 (KUN)	Nielamu, Tibet, China	*MZ233658
<i>Arundinella khaseana</i> Nees ex Steud.	Y.P. Chen et al. EM1193-1 (KUN)	Jilong, Tibet, China	*MZ233659
<i>Arundinella longispicata</i> B.S. Sun	L.Q. Jiang & Y.Y. Li jlq289-1 (KUN)	Yongde, Yunnan, China	*MZ233660
<i>Arundinella nepalensis</i> Trin.	Y.P. Chen et al. EM1192-2 (KUN)	Jilong, Tibet, China	*MZ233663
<i>Arundinella nodosa</i> B.S. Sun & Z.H. Hu	Z.H. Hu et al. 7900700 (YUKU)	Jinghong, Yunnan, China	*MZ233662
<i>Arundinella parviflora</i> B.S. Sun & Z.H. Hu	74-level classification group 77236 (YUKU)	Ruili, Yunnan, China	*MZ233664
<i>Arundinella rupestris</i> A. Camus	B.S. Sun et al. 78968 (YUKU)	Sandu, Guizhou, China	*MZ233665
<i>Arundinella setosa</i> Trin. var. <i>setosa</i>	L.Q. Jiang jlq322 (KUN)	Dongtou, Zhejiang, China	*MZ233669
<i>Arundinella setosa</i> var. <i>esetosa</i> Bor ex S.M. Phillips & S.L. Chen	Y.P. Chen & L.Q. Jiang EM1318-1 (KUN)	Eryuan, Yunnan, China	*MZ233666
<i>Arundinella setosa</i> var. <i>tengchongensis</i> B.S. Sun & Z.H. Hu ex S.L. Chen	L.Q. Jiang & Y.Y. Li jlq298 (KUN)	Tengchong, Yunnan, China	*MZ233671
<i>Arundinella stenostachya</i> H. Peng & L.Q. Jiang 1	Z.S. Zhang 20200930-19 ((KUN)	Puer, Yunnan, China	MZ326747
<i>Arundinella stenostachya</i> H. Peng & L.Q. Jiang 2	L.Q. Jiang et al. jlq284 (KUN)	Malipo, Yunnan, China	MZ326748
<i>Arundinella stenostachya</i> H. Peng & L.Q. Jiang 3	A.Teerawatananon & S.Sungkaew 546 (THNHM)	Chiang Mai, Thailand	GQ870150
<i>Arundinella yunnanensis</i> Keng	P.M. Peterson & H. Sun R.J. Soreng 5606 (KUN)	Bomi, Tibet, China	*MZ233674
<i>Arthraxon hispidus</i> (Trin.) Makino	L.Q. Jiang et al. jlq287-1 (KUN)	Malipo, Yunnan, China	*MZ233648
<i>Arthraxon microphyllus</i> (Trin.) Hochst.	H. Peng et al. jlq265 (KUN)	Jingdong, Yunnan, China	*MZ233649
<i>Garnotia tenella</i> (Arnott ex Miquel) Janowski	H. Peng et al. jlq281 (KUN)	Jingdong, Yunnan, China	*MZ233675

analyses were conducted to reconstruct the phylogeny of *Arundinella*, using MrBayes v.3.2.6 (Ronquist et al. 2012) and RAxML-HPC2 v.8.2.12 (Stamatakis 2014) on the Cyberinfrastructure for Phylogenetic Research Science (CIPRES) Gateway v.3.3 (<http://www.phylo.org/>; Miller

et al. 2010), respectively. For ML analyses, 1000 bootstrap iterations were conducted, whilst all other default settings were used, including selection of the GTRCAT model in RAxML-HPC2. For BI analyses, jModeltest 2.1.10 (Darriba, 2012) was used to select an evolutionary model of

nucleotide substitution that best fits these data, as selected by the Akaike information criterion (AIC) (Posada & Buckley, 2004). The best-fit models selected were TIM3+G for the combined matrices. The MCMC analysis was executed for 20 million generations with four chains (one cold and three heated chains; TEMP = 0.05). Tracer was used to graphically assess the convergence of runs, and to check the effective sampling size (ESS) for all parameters (convergence indicated by ESS >200) (Rambaut et al. 2018). Trees were sampled every 1000th generation and the first 25% of sampled trees of each run were discarded as “burn-in”. A 50% majority-rule consensus tree with posterior probabilities (PP) was generated from the remaining trees. TreeGraph v.2 (Stover & Müller 2010) was used to visualize the topology of phylogenetic trees with PP and bootstrap support (BS) values.

3. Results

3.1. Phylogenetic analyses

The ITS dataset comprised 745 aligned nucleotide characters, of which 562 characters were constant and 183 variable sites. Since the BI and ML analyses yield similar topologies, only the ML tree of the ITS data set (Figure 1) is presented here, with support values of BI trees being indicated.

In Figure 1, *A. stenostachya* formed a clade with *A. setosa* var. *tengchongensis*, *A. longispicata*, *A. cochinchinensis*, *A. nepalensis*, and *A. decempedalis* (Figure 1; bootstrap = 63 / posterior probability = 0.81); three individuals of the new species formed together with well support (Figure 1; BS = 87 / PP = 1.00). The two accessions of *A. bengalensis* which is morphologically similar to the new species are recovered in another clade with highly support values (Figure 1; BS = 100 / PP = 1.00).

3.2. Taxonomy

Arundinella stenostachya H. Peng & L.Q. Jiang *sp. nov.* (窄序野古草), (Figures 2–4)

Type: China. Yunnan: Malipo County, Mengtung Township, Bazi Village, in the roadside grass, 22°54'33"N, 104°44'4"E, elev. ca. 1070m, 23 November 2019, L.Q. Jiang et al. jlq284 (holotype KUN-1511702!; isotype: KUN!, PE!). **Paratype:** Malipo County, Mengtung Township, Bazi Village, in the roadside grass, 22°54'37"N, 104°45'37"E, elev. ca. 1111 m, 23 November 2019, L.Q. Jiang et al. jlq285 (KUN!)

Diagnosis: The new species is morphologically similar to *Arundinella decempedalis* and *A. bengalensis*, but differs from the former in its erect, 1.8–10 (11.5) cm long panicle branches (vs. slender, 10–25 cm long), nodes bearded or glabrescent (vs. densely pubescent, glabrescent), and 0.3–2.2 mm long pedicels (vs. 0.5–3.5 mm long), and from the latter in height and diameter of culms 1–2.5 m, 3.5–8 mm in diameter (vs. 0.5–1.2 m, 1.5–4 mm), 13–70 cm × 3–16

mm leaf blades (vs. 1–33 cm × 3–8 mm), 0.3–2.2 mm long pedicels (vs. 0.3–3.5 mm long), 9.5–42 cm long panicles (vs. and 4–25 cm), and 1.8–10 (11.5) cm long branches (vs. 1–5 cm long). (Table 1; Figures 2 and 3).

Description: Perennial, creeping rhizomes with whitish pubescent and scaly. Culms solitary or branched, erect or short ascending, 1–2.5 m tall, 3.5–8 mm in diameter, nodes bearded or glabrescent. Leaf-sheaths 9–38 cm long, glabrous to pilose on the back, margins densely hairy. Ligule a short membrane, 0.5–1 mm long. Leaf-blades broadly linear, flat, 13–70 cm × 3–16 cm, tuberculate-hispid on both surfaces, rarely subglabrous, midrib broad, white, apex finely acuminate, Panicles narrowly cylindrical, dense, 9.5–42 cm long, axis terete, striate, scabrid, branch axil usually villous; branches spikelike, numerous, erect, usually crowded in whorls, 1.8–10 (11.5) cm, usually simple or occasionally secondary branches, 0.5–2 cm, Spikelets green to purple, ovate-oblong, 2.5–3.7 mm long, glabrous; pedicels 0.3–2.2 mm long, scabrous or hispid; lower glumes ovate, 1.9–3.1 mm, 3–5-veined, scabrous on nerves; upper glumes ovate-oblong to ovate-lanceolate, 5-veined, glabrous; lower florets male or barren; lower lemmas ovate-oblong to ovate-lanceolate, 1.9–2.9 mm long, acute, 3–5-nerved; lower paleas ovate-lanceolate, 1.5–2.4 mm long; upper lemmas ovate-oblong, 1.6–2.3 mm long, apex narrowed into a poorly developed awn or awnless, awn soon deciduous, geniculate with brown twisted column, up to 2 mm long; upper paleas ovate-oblong, 1.6–2.1 mm long, acute; callus hairy, hairs 0.2–0.4 mm long, ca. 1/10–1/5 length of lemma; stamens 3, anthers yellow to purple, ca. 0.7–1.1 mm long.

Phenology: Flowering and fruiting from July to December.

Distribution and habitat

Currently, *Arundinella stenostachya* is known from the Guangxi Province, Hainan Province, Shanxi Province and Yunnan Province of China, Thailand, Laos, Vietnam and India. It is a perennial herb growing in the roadsides, plains, ridge, mountainsides, hill thickets, and open grassy pine forest at altitudes of 40–1500 m, together with *Bidens pilosa* L., *Thysanolaena latifolia* (Roxburgh ex Hornemann) Honda, *Gelsemium elegans* (Gardn. et Champ.) Benth., *Chromolaena odorata* (Linnaeus) R. M. King & H. Robinson, *Ageratum conyzoides* L., *Blumea megacephala* (Randeria) Chang et Tseng, *Trema tomentosa* (Roxb.) Hara, *Galinsoga parviflora* Cav., etc.

Conservation status

Arundinella stenostachya is distributed in China, Thailand, Laos, Vietnam, and India. We failed to conduct field investigations in all of the above countries. Therefore, we cannot determine the about current status of this new species. Following the IUCN (2019), *A. stenostachya* could be considered DD in a preliminary conservation statement.

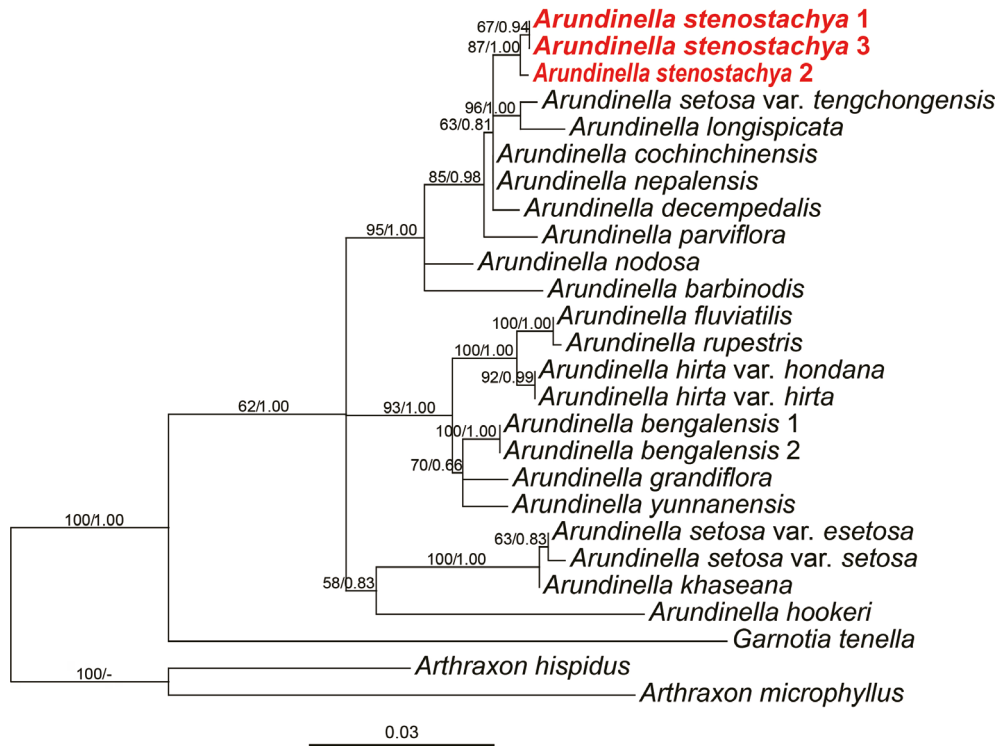


Figure 1. Maximum Likelihood phylogram based on nrDNA ITS data matrix showing placement of *A. stenostachya* within *Arundinella*. Support values $\geq 50\%$ BS or 0.50 PP are displayed above the branches (“-” indicates a support value of <0.50 PP). *Arundinella stenostachya* labeled in bold by red color. Multiple accessions of the same species are numbered according to Table 2.

Etymology: The specific epithet comes from its narrow dense panicles.

Vernacular name: ‘窄序野古草’ (zhai xu ye gu cao) in Chinese.

4. Discussion

Although a few representative species were sampled, our phylogenetic results support that *Arundinella* is a monophyletic group (Figure 1). Our molecular data demonstrate that *A. stenostachya* is closely related to *A. setosa* var. *tengchongensis*, *A. longispicata*, *A. cochinchinensis*, *A. nepalensis* and *A. decempedalis*. Morphologically, *A. stenostachya* and *A. decempedalis* have soon deciduous awn, whereas *A. setosa* var. *tengchongensis*, *A. longispicata*, *A. cochinchinensis* and *A. nepalensis* have persistent awn. This new species also differs from *A. setosa* var. *tengchongensis* in its 1–3 mm in diameter (vs. 3.5–8 mm), panicle narrowly cylindrical (vs. elliptic in outline) and branches 1.8–10 cm long (vs. 3–16 cm). *A. stenostachya* can be distinguished from *A. longispicata* by its narrowly cylindrical, dense, 9.5–42 cm long (versus large and open, 30–50 cm) panicles, branches 1.8–10 cm long (versus up to 20 cm) and 2.5–3.7 mm (versus 4.7–4.8 mm) long spikelets. Both *A. stenostachya* and *A. cochinchinensis* are large stout

grasses. The most noteworthy difference between the two species is length of spikelets, which are 2.5–3.7 mm long in *A. stenostachya*, but 4–5 mm long in *A. cochinchinensis*. Meanwhile, *A. cochinchinensis* have well-developed, persistent awn, whereas awns of *A. stenostachya* are soon deciduous; branches are 1.8–10 cm long in the new species, but generally 5–15 cm long in *A. cochinchinensis*. Although the relationships between *A. stenostachya* and *A. nepalensis* are relatively close, they can readily be distinguished morphologically by inflorescence shape, length of branches and spikelets length. The new species is characterized by having open or loosely contracted panicle, while *A. nepalensis* has narrowly cylindrical panicle. *A. nepalensis* also differs from *A. stenostachya* in its 7–20 cm long branches and 4–5.5 mm spikelets.

Morphologically, the new species is most closely related to *A. decempedalis* and *A. bengalensis*. Though *Arundinella stenostachya* resembles *A. decempedalis* in the stout culms, soon deciduous awn, they can readily be distinguished by panicle branches, type of trichome on nodes, and pedicels length (Table 1; Figures 2 and 3). The new species differs from *A. decempedalis* mainly in its erect, 1.8–10 (11.5) cm long panicle branches (vs. slender, 10–25 cm long), nodes bearded or glabrescent (vs. densely

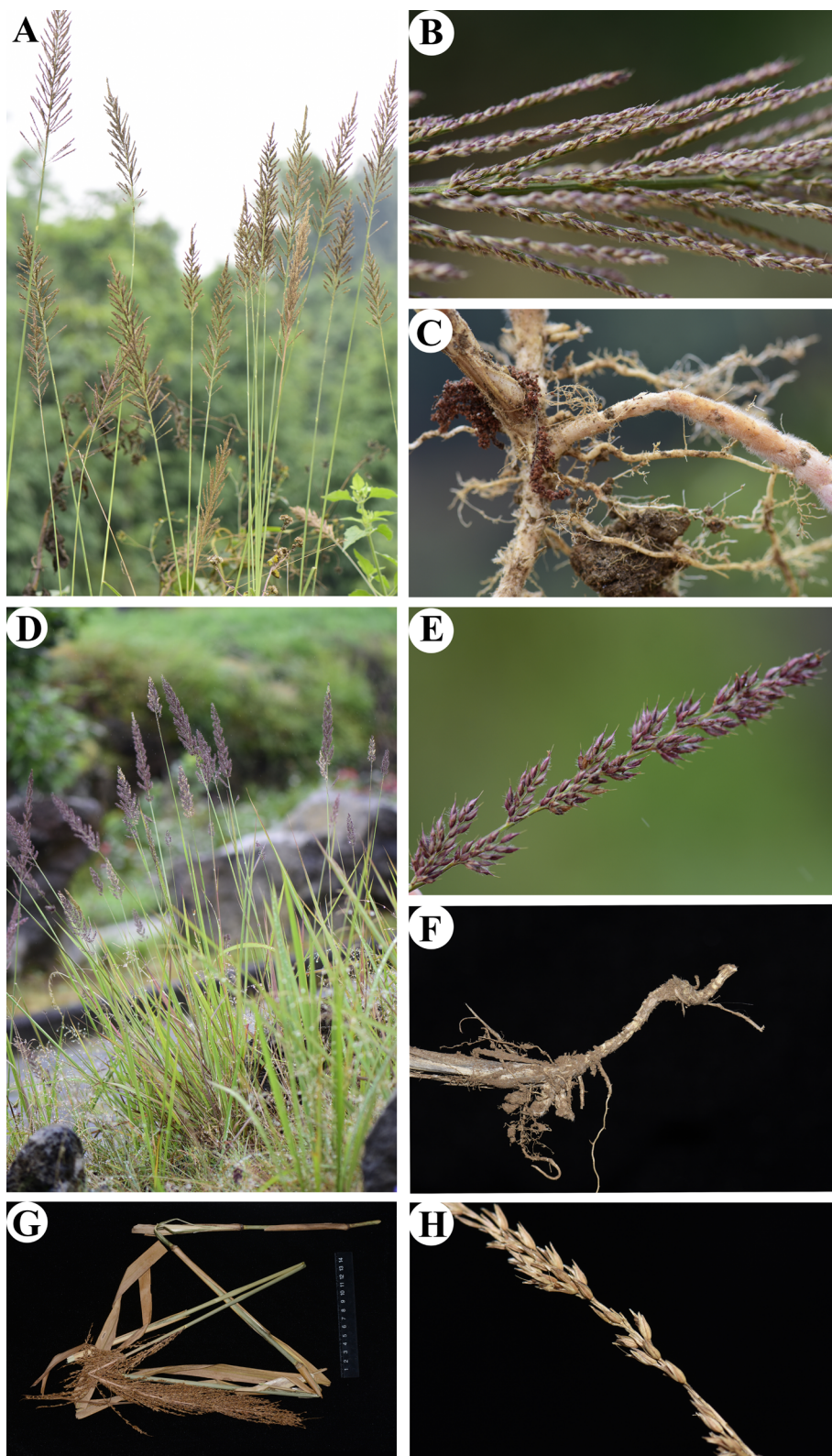


Figure 2. Morphology of plants and panicles of *Arundinella stenostachya* and its related species. (A–C) *A. stenostachya* (Jiang et al. jlq284); A: plant habit, B: panicle branches, C: rhizomes; (D–F) *A. bengalensis* (Jiang & Li jlq310); D: plant habit, E: panicle branches, F: rhizomes; (G, H) *A. decempedalis* (Chen & Jiang EM1447); G: Whole plant from a herbarium specimen, H: panicle branches. Photographed by L.-Q. Jiang.

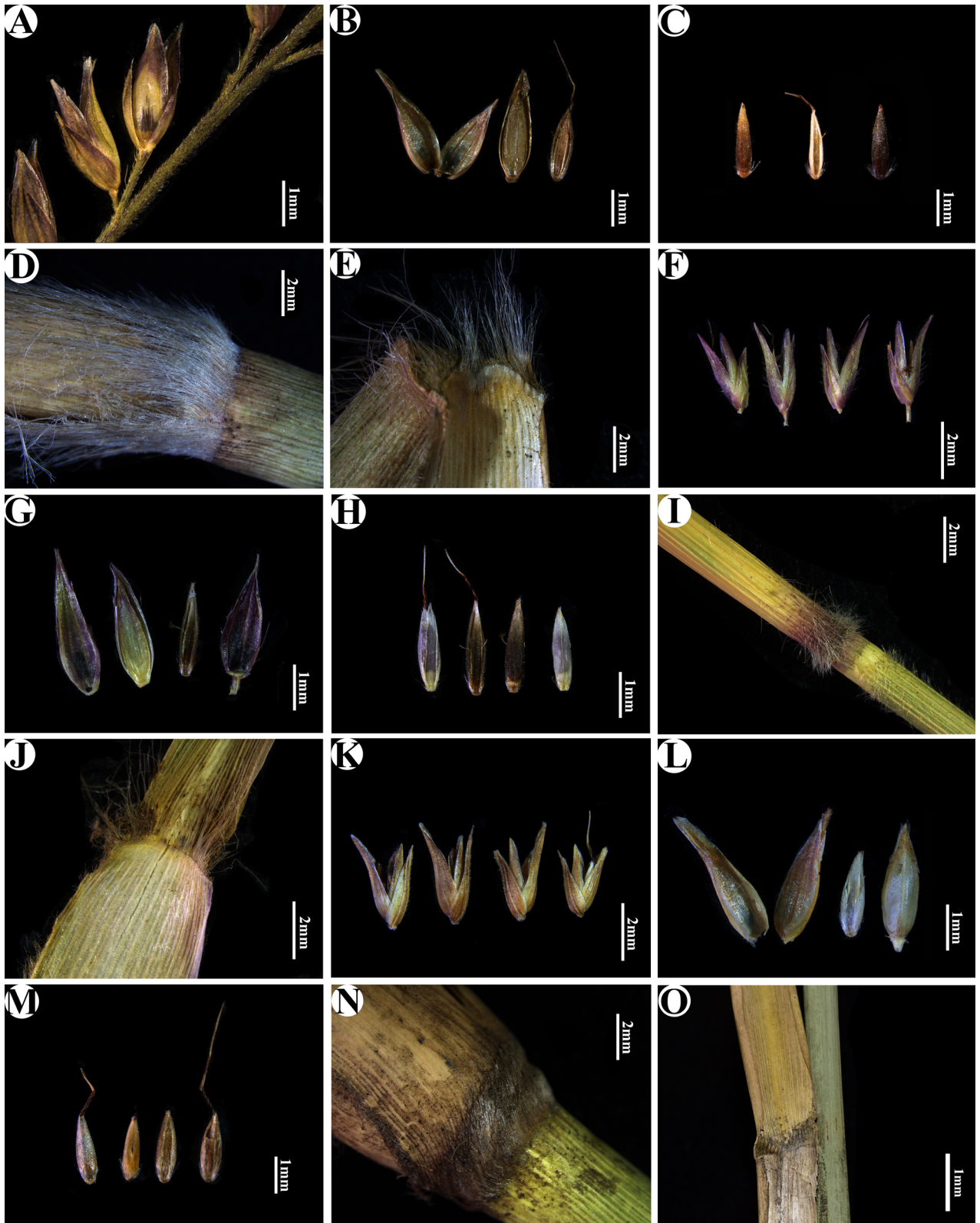


Figure 3. Morphology of spikelets, nodes and ligule of *Arundinella stenostachya* and its related species. (A–E) *A. stenostachya* (Jiang et al. jlq284); A, B: spikelets; C: upper florets; D: node; E: ligule. (F–J) *A. bengalensis* (Jiang & Li jlq310); F, G: spikelets; H: upper florets; I: node; J: ligule. (K–O) *A. decempedalis* (Chen & Jiang EM1447); K, L: spikelets; M: upper florets; N: node; O: ligule. Photographed by L.–Q. Jiang.

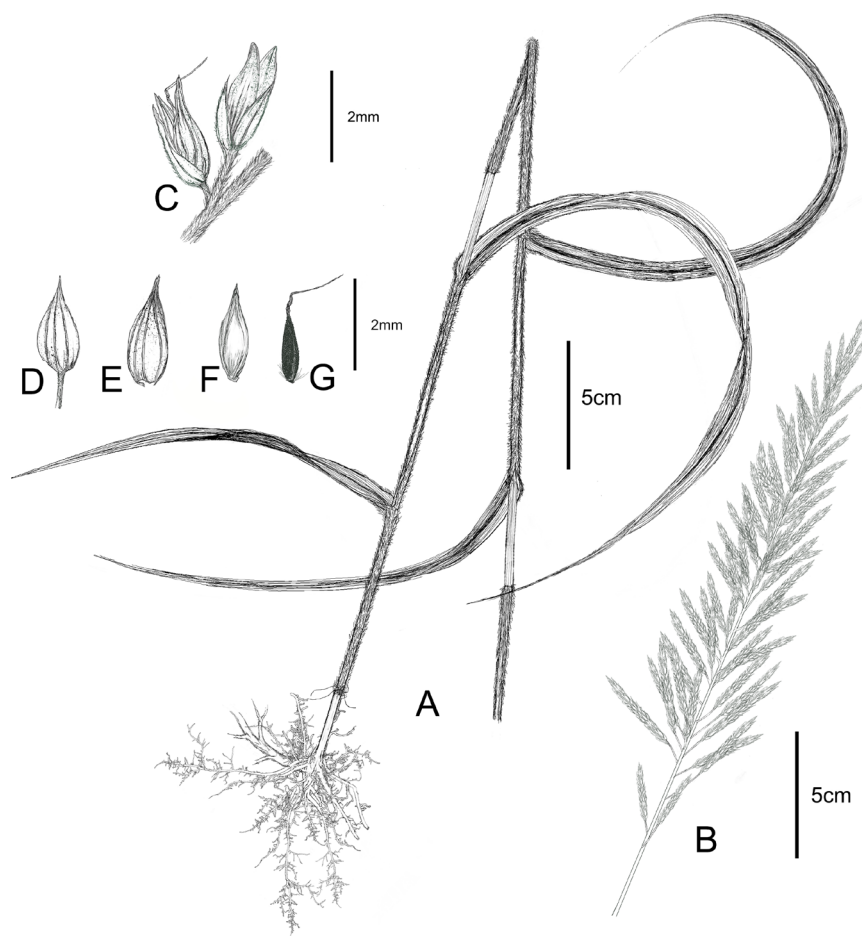


Figure 4. *Arundinella stenostachya* H. Peng & L.Q. Jiang. A: habit, B: inflorescence, C: spikelets, D: lower glumes, E: upper glumes, F: lower florets, G: upper florets. Drawn by Y. Luo from Jiang et al. jlq284 (KUN).

pubescent, glabrescent), and 0.3–2.2 mm long pedicels (vs. 0.5–3.5 mm long) (Figures 2A–2C, 2G, 2H and 3A–3E, 3K–3O). Both *A. stenostachya* and *A. bengalensis* have soon deciduous awn and bearded or glabrescent nodes. However, the two accessions of *A. bengalensis* are recovered in another clade with strong support in the nuclear tree (Figure 1). The most noteworthy difference between the two species is the height and diameter of culms, which are 1–2.5 m high, 3.5–8 mm in diameter in *A. stenostachya*, but 0.5–1.2 m tall, 1.5–4 mm in diameter in *A. bengalensis* (Table 1; Figures 2 and 3). Meanwhile, leaf blades of *A. bengalensis* are 1–33 cm long and 3–8 mm wide, whereas those of *A. stenostachya* are 13–70 cm long and 3–16 mm wide; pedicels length of *A. bengalensis* is 0.3–3.5 mm long; nevertheless, those of *A. stenostachya* is 0.3–2.2 mm long; panicles of *A. bengalensis* are loose to dense and 4–25 cm long, but panicles of this new species are dense and 9.5–42 cm long. *A. stenostachya* also differs from *A. bengalensis* in its 1.8–10 (11.5) cm long branches (vs. 1–5 cm long).

An identification key to the species in series *Bengalensis* is provided below.

Key to *Arundinella stenostachya* and related species

1. Panicle branches long, slender, 10–25 cm, nodes with densely pubescent, glabrescent *A. decempedalis*
 1. Panicle branches short, less than 10 cm, nodes with bearded or glabrescent 2
 2. Culms 0.5–1.2 m, more slender, 1.5–4 mm in diam., leaf blade 1–33 cm long, 3–8 mm wide, panicle loose to dense, 4–25 cm, branches 1–5 cm *A. bengalensis*
 2. Culms 1–2.5 m, stout; 3.5–8 mm in diam., leaf blade 13–70 cm long, 3–16 mm wide, panicle dense, 9.5–42 cm, branches 1.8–10 (11.5) cm ...
..... *A. stenostachya*
- Appendix. Examined specimens in the present study.

***Arundinella stenostachya*: China**, Guangxi: Yongning County, near Fushu Township, 150 m, 28 December 1958, Z.Q. Zhang 14408 (photo IBK [IBK00177222]!); Longzhou County, Near Nonggang Nature Reserve, 27 September

1979, *Nonggang Comprehensive Investigation Team 10518* (photo IBK [IBK00177220]!); Qinzhou City, Dongfeng Forest Farm, 28 September 1973, *C.F. Liang 33608* (photo IBK [IBK00177221]!); Fangchenggang City, Maoling Township, hillside, 4 February 2009, *Q.R. Liu & S.Y. Meng GXGS085* (photo BNU [BNU0021045]!); Beihai City, Hepu County, Roadside, 43 m, 3 February 2009, *Q.R. Liu & S.Y. Meng GXGS080* (photo BNU [BNU0021092]!); Kwangsi., 1928, *R.C. Ching 7716* (photo US [US04235644]!); Longjin County, Paizong Township, 26 August 1957, *S.Q. Chen 14005* (photo IBK [IBK00177218]!, photo HITBC [HITBC052026]!); Longlin County, near Bianya District, 500 m, 9 November 1957, *Z.Q. Zhang 10819* (photo IBK [IBK00177216]!, IBSC [IBSC0099934]!); Guangxi, September 1928, *R.C. Ching 7716* (IBSC [IBSC0099935]!); Fangcheng Autonomous County, hills, 10 m, 23 November 1989, *M.F. Qin & Z.H. Qin 00195* (photo IBK [IBK00380311]!); Shangsi County, Tanglung Village, Shap Man Taai Shan, Roadside meadow, 15 September 1934, *W.T. Tsang 24273* (SYS [SYS00012308]!); Hainan: Qiongsanling, October 1954, *South China Institute of Botany 009* (IBSC [IBSC0099933]!); Shanxi: Shanxi, hillside meadow, 180–300 m, *China-Vietnam expedition team 976* (KUN [KUN320420]!, PE [PE01662713]!, PE [PE00261263]!); Yunnan: Dahmeng-lung, Maankung-han, On the grassy slope, 900 m, September 1936, *C.W. Wang 78617* (PE [00261270]!, KUN [KUN320378]!); Xishuangbanna City, Kunluo highway, 760–930 m, 20 October 1955, *P.Y. Mao 6838* (IBSC [IBSC0099941]!, PE [PE00261277]!, PE [PE00261276]!); Xishuangbanna City, Jinghong to Menghai, 1163 m, 10 October 2011, *Y.C. Liu LYC752* (CSH [CSH0025812]!, KUN [KUN1399995]!); Xishuangbanna City, Mengyang Town, Roadside, 780 m, 9 October 1960, *B.S. Sun 6060* (YUKU [YUKU05015070]!, YUKU [YUKU05015071]!); Gongshan County, Dulongkou Commune, 1400–1500 m, 15 August 1982, *Qinghai-Tibet Team 9383* (PE [PE00261272]!, PE [PE00261273]!, PE [PE00261274]!, PE [PE00261275]!); Pu'er City, Kuan-yeang, Thickets, 1180 m, *C.W. Wang 81173* (PE [PE00261271]!, photo LBG [LBG 00094950]!); Yingjiang County, near the county, Mizobe, 800 m, 9 July 1977, *74-level classification group 77181* (YUKU [YUKU05015024]!, YUKU [YUKU05015025]!); Hekou County, Roadside grass, 140 m, 3 November 1987, *H. Peng et al. 063* (YUKU [YUKU05015031]!, YUKU [YUKU05015032]!); Pu'er City, Zhengdong Township, Taipingzhai to Hepingzhai, Arid open land, 946 m, 30 September 2020, *Z.S. Zhang 20200930-19* (KUN [KUN1511696]!); Malipo County, Songmao, Roadside, 800 m, 23 November 2019, *L.Q. Jiang et al. jlq283* (KUN [KUN1511682]!, KUN [KUN1511683]!, KUN [KUN1511684]!, KUN [KUN1511687]!, KUN [KUN1511688]!, KUN [KUN1511689]!, KUN [KUN1511690]!, KUN [KUN1511691]!); Malipo County,

Mengtung Township, Bazi Village, 1000–1110 m, 23 November 2019, *L.Q. Jiang et al. jlq284 & L.Q. Jiang et al. jlq285* (KUN [KUN1511681]!, KUN [KUN1511692]!, KUN [KUN1511693]!, KUN [KUN1511694]!, KUN [KUN1511695]!, KUN [KUN1511697]!, KUN [KUN1511698]!, KUN [KUN1511699]!, KUN [KUN1511700]!, KUN [KUN1511701]!, KUN [KUN1511702]!, KUN [KUN1511703]!).

Thailand, Chiang Mai, Chiang Dao, Ban Kae Noi., 29 April 2005, *A. Teerawatananon & S. Sungkaew 546* (photo THNHM [THNHM-P-2005-1321]!);

Northern, Chiangmai, south of Doi Suthep, agricultural land between Grasshopper Cave (Tantak Cave) and the Hmong village of Nam Soom, 27 September 2005, *H.J. Esser et al. 0516* (photo L [L.3877475]!); Chiangmai Northern Siam. Camp Hoi Chan Kiang, Doi Sooteep mountain range, 600 m, 25 October 1920, *J. Rock 110* (photo US [04235729]!); Chiang Mai, along road Mae Rim-Samoeng, 1000–1100 m, 21 October 2001, *Simon Lægaard 21770* (photo L [L.3879809]!); Chiang Mai, Above Training Center of Queen Sirikit Botanical Garden, 700–1000 m, 5 October 2001, *Simon Lægaard 21674* (photo L [L.3879808]!); Chiang Mai, Mae Dtang, Mawn Ngaw village area, Muang Guy Subdistrict, 1200 m, 21 November 2001, *J.F. Maxwell. 01-659* (photo L [L.3880235]!); Chiang Mai, Wiengbahbae/Pan, Doi Luang National Park, west side, 1225 m, 27 October 1997, *J.F. Maxwell. 97-1234* (photo L [L.1217073]!); Chiang Mai, Chiane Dao, Doi Chiang Dso Animal Sanoturay, north side of Doi Luang, 950 m, 10 October 1995, *J.F. Maxwell. 95-883* (photo L [L.1217078]!, photo L [L.1217079]!); Chiang Mai, Chiang Dao, Doi Chiang Dao Wildlife Sanctuary, north side, 775 m, 19 January 1991, *J.F. Maxwell. 91-87* (photo L [L.1217070]!, photo L [L.1217071]!); Chiang Mai, Mae Dtang, Ban Huay Taht, Chai Siam Tea Plantation, Indatin Subdistrict, 1100 m, 3 December 1990, *J.F. Maxwell. 90-1320* (photo L [L.1217072]!, KUN [KUN786343]!); Chiang Mai, Muang, Doi Sutep, south side, above Mae Heeyah Village, 600 m, 1 October 1988, *J.F. Maxwell. 88-1152* (photo L [L.1217096]!); Chiang Mai, Muang, Doi Sutep, east side, Pah Laht area, 600 m, 2 November 1988, *J.F. Maxwell. 88-1262* (photo L [L.1217095]!); Chiang Mai, en route from Sop Aep to Pha Mawn (Ban Yang), 700–900 m, 1 October 1971, *G. Murata et al. 15605* (photo MW [MW0732687]!, photo L [L.1217094]!); Nan, near village of Pa Sing, 7 December 1957, *E.H. Walker 8003* (photo US [US04235653]!); Chiang Mai, Rock Tower Mountain, Mae Sa, N. of Chiang Mai, 18 September 1995, *K. Larsen et al. 46623* (photo L [L.1217032]!); Siam, Route from Chiengmai to Chieng Rai, 420–990 m, 31 December 1921, *J. Rock 1568* (photo US [US04235650]!).

Laos, Khammouan, Tham Mot Ngam, Dry dipterocarp forest, 556 m, 6 November 2005, *M.F. Thomas et al. LAO 930* (photo L [L.1217100]!, photo L [L.1217101]!).

Vietnam, Hoa Binh, 6 September 1999, *N. M. Cuong* 488 (photo L [L.1217077]!); Ninh Binh, Cuc Phuong National Park, Secongary forest, 6 September 1999, *N. M. Cuong* 479 & *N. M. Cuong* 488 (photo L [L.1217074]!, photo L [L.1217075]!, photo L [L.1217076]!); Broussailles sur des schistes. Massif du Pia Quac. Tonkin., 1200 m, July 1922, *Pételot* 615 (photo US [US 04235651]!); Cho Ganh. Tonkin., September 1921, *A. Petelot* 632 (photo US [US 04235665]!); Yeuthae south of Dongjiao south of Hanoi, 4 October 1921, *A.S. Hitchcock* 19468 (photo US [US 04235664]!); Moist ground by track Dongjiao south of Hanoi, 4 October 1921, *A.S. Hitchcock* 19465 (photo US [US04235667]!); Broussailles. Cho Ganh. Tonkin, September 1921, *Pételot* 632 (photo US [US 04235640]!).

India, Assam, Karong, Manipur, ca. 1066 m, 29 September 1950, *W.N. Koelz* 26325 (photo MICH [MICH1486134]!) Katla Kangra Distr., East Punjab, 914 m, 11 January 1948, *Koelz* 19635 (photo US [US04235647]!); Dehra Dun, 22 September 1989, *J.F. Duthie* 9057 (photo US [US04235669]!); Shillong, Khasi hills, 1676 m, 20 September 1954, *T.R. Chand* No. 8258 (photo MICH [MICH1486136]!, photo YS [US04235666]!); Perola, Tehri. On rice field edge, 1219 m, 24 October 1948, *W. Koelz* 22275 (photo US [US04235674]!).

***Arundinella bengalensis*: China**, Guangxi: Baise City, Pianya District to Mogu, 13 October 1957, *Geobotany Group* 4569 (photo IBK [IBK00177215]!); Longlin County, Gebu District, Wuchong Township, 1000 m, 20 June 1957, *C.F. Liang et al.* 32562 (photo IBK [IBK00177219]!); Guangxi, 5 May 1965, *Southwest Comprehensive Examination Team* 65-1 (PE [PE01246505]!); Guizhou: Ceheng County, Ronggu Village, hillside grass, 1400 m, 7 September 1958, *Z.Y. Cao* 0653 (PE [PE00261230]!, PE [PE00261233]!); Xingren County, Baling Commune, by the foot of the mountain, 1300 m, 11 August 1960, *Z.S. Zhang & Y.T. Zhang* 7565 (PE [PE00261234]!); Buyi and Miao Autonomous Prefecture, Jushan Town, 1180 m, 16 October 2011, *Y.C. Liu* LYC783 (photo CSH [CSH0024519]!); Tibet: Medog County, hillside, 1000–1300 m, 24 August 1974, *Qinghai-Tibet Team* 4527 (PE [PE00261258]!, PE [PE00261259]!, KUN [KUN320418]!); Sichuan: Miyi County, Wanya, 1300 m, 14 October 1963, *Miyi Working Group* 208 (photo CDBI [CDBI0153120]!, photo CDBI [CDBI0153121]!); Huili County, Yonglang Commune, 1500 m, 5 September 1983, *T.C. Wei* 114 (photo CDBI [CDBI0153122]!, photo CDBI [CDBI0153123]!); Xichang City, Hushan, June 1957, *Sichuan Forestry Experimental Field* 2487 (photo N [N019118462]!); Liangshan Yi Autonomous Prefecture, Xichang, 16 July 1958, *10751* (photo SM [SM720600092]!, photo SM [SM720600093]!); Yunnan: Tengchong County, Wuhe Township, in sunny areas in openings in forest, 1419 m, 20 August 2003, *H. Li et al. Gaoligong Shan Biodiversity Survey* 17190 (photo

CAS [CAS296626]!); Tengchong County, Ditch side, 1960 m, 13 November 1978, *780 Vegetation Group* 0361 (PE [PE01555578]!); Tengchong County, Ma'anshan, Roadside, 1800 m, 28 November 1978, *Y.Z. Wang* Y0493 (PE [PE00261251]!); Tengchong City, Mazhan Township, Volcano Park, 1908m, 12 September 2019, *L.Q. Jiang & Y.Y. Li* j1q310 (KUN!); Yunnan, *E.E. Maire* 3084 (photo US [US04235645]!); Tengchong City, Gudong Commune, 1720 m, 14 July 1977, *74-level classification group* 77262 (YUKU [YUKU05014984]!); Weixi County, Tudi Village, 2660 m, 4 May 1965, *Southwest Comprehensive Examination Team* 053 (PE [PE01246506]!); Jingdong County, Wen Xiao Township, 1700 m, 6 October 1956, *B.Y. Qiu* 52722 (photo LBG [LBG00094960]!, KUN [KUN320383]!, photo LBG [LBG00094969]!, photo NAS [NAS00515091]!, PE [PE00261239]!); Jingdong County, Zhehou Township, 27 July 1964, *Shellac team* (PE [PE00261255]!); Kunming City, Chenggong District, November 1956, 774 (photo N [N019118463]!); Ruili City, 9 September 1977, *J.R. Xue & J.L. Sun* 14949 (photo HITBC [HITBC052025]!); Jinghong City, Puwen Township, 930 m, 12 August 1977, *G.D. Tao* 17071 & 17064 (photo HITBC [HITBC052024]!, photo HITBC [HITBC052028]!); Mang City, Roadside, 1150 m, 26 August 1977, *J.L. Sun* 14928 & 14927 (photo HITBC [HITBC052027]!, photo HITBC [HITBC052023]!); Yun County, in the forest, 1159 m, 11 September 2010, *Y.C. Liu et al.* 359 (KUN [KUN1221389]!); Shilin County, Naigu Stone Forest Scenic Area, 1858 m, 1 October 2010, *Y.C. Liu* 489 (KUN [KUN1221370]!); Pingbian County, by stream, 1000 m, 26 July 1934, *X.T. Cai* 61225 (KUN [KUN320376]!).

India, Assam, September 1859, *Jenkins* 219 (US [US04235661]!); Assam, *F. Jenkins* s.n. (photo L [L.1217083]!); Shillong, on the Roadside, 21 August 1956, *G. Panlgrahi* 2899 (photo L [L.1217093]!); Shillong, Khasi hills, Meadow, 1676 m, 28 August 1954, *T.R. Chand* No. 8075 (photo L [L.1217097]!, photo MICH [MICH1486137]!, photo US [US04235660]!); Shillong, Khasi hills, 1676 m, 15 September 1954, *T.R. Chand* No. 8197 (photo MICH [MICH1486132]!); Shillong, Khasi hills, 1524 m, 8 September 1954, *T.R. Chand* No. 8141 (photo MICH [MICH1486133]!, photo US [US04235668]!); Shillong, 19 October 1872, *C.B. Clarke* 18656 (photo US [US 04235657]!); Bóga Pam, Khasia, 17 October 1872, *C.B. Clarke* 18799B (photo US [US04235658]!); New Forest, Dehra Dun, 24 September 1934, *C.E. Parkinson* 4164 (photo US [04235656]!); Central Provinces. Pachmarhi, 19 February 1991, *J.F. Duthie* 10611 (photo US [US 04235671]!); Lechewala, U. P., 1 September 1948, *Koelz* 21560 (photo US [US04235641]!); Perola, Tehri. On rice field edge, 1219 m, 24 October 1948, *W. Koelz* 22225 (photo US [US 04235652]!); Siliguri, Bengal., 30 December 1936, *W.N. Koelz* 10647 (photo US [US04235643]!);

Mussoorie. Northwest Himalaya. Bindal Nullah, Dehra Dun., 671 m, September 1934, *R. Stewart 14674* (photo US [US04235646]!); Mussoorie, United Provinces Northwest Himalaya, Bindal Nullah, Dehra Dun., 671 m, September 1934, *R. Stewart 14674* (photo US [US04235648]!); N. W. Himalaya. District Jaunsár. Chakrata, 2134 m, October 1894, *J.F. Duthie 15130* (photo US [US04235639]!); Dehra Dun, 13 September 1888, *J.F. Duthie 7692* (photo US [US04235670]!); Pynursla, Khasi Hills, 1219 m, 12 August 1949, *W.N. Koelz 23496* (photo MICH [MICH1486135]!, photo US [US04235659]!); Pynursla, Khasi Hills, 1219 m, 11 August 1949, *T.R. Chand No. 1972* (photo MICH [MICH1486138]!, photo US [US04235636]!); Orsia, W. Sam balpar, Kharias, at Id desentre site of Sorora Village near Sonabeva, 670 m, 2 October 1949, *H.F. Mooney 3684* (photo L [L.1217099]!).

Nepal, Nepal, 1821, *N. Wallich 8669A* (photo E [E00393763]!); Nepal, 1821, *N. Wallich 8669* (photo E [E00393760]!, photo K [K000245491]!, photo K [K000943296]!); Nepal, *N. Wallich 8666* (photo E [E00393761]!).

Myanmar, Mandalay, Maymyo, 7, B. office compound., 1036 m, 14 August 1934, *Maung Kan s.n.* (photo US [US00619594]!).

Bangladesh, Silhet, *N. Wallich 8669B* (photo E [E00393764]!, photo L [L.2070078]!);

Bhutan, Tongsa District, between Kharsang and

Shingkar, 1840 m, 6 September 2002, *Kinzang Wangdi 2002.G23* (photo US [US 04235637]!).

***Arundinella decempedalis*: China**, Yunnan, Xishuangbanna City, Mengla County, On the grassy slope, 1436 m, 19 December 2019, *Y.P. Chen & L.Q. Jiang EM1447* (KUN); Southern Yunnan. Between Keng Hung and Muang Hing, 1500 m, 25 February 1922, *J. Rock 2693* (photo US [US 04235730]!).

India, Terai vor Sikkim, 15 November 1875, *C.E.O. Kuntze 6581* (photo holotype: NY [NY 00414089, NY00414090]!); Sikkim, Darjeeling terai, 2 December 1875, *C.B. Clarke 26483* (photo K [K000245959]!, photo K [K000245486]!, photo BM [BM000959689]!); Sikkim Dulkajhar, Terai, 16 October 1884, *C.B. Clarke 36758* (photo K [K000245485]!); Sikkim Terai, 15 January 1875, *C.E.O. Kuntze 6581* (photo K [K000943297]!).

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