



Three large-stature bamboo species of *Dendrocalamus* (*Poaceae: Bambusoideae*) from northern Vietnam

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Key words

Bambusoideae
Dendrocalamus
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Abstract Three large bamboo species of genus *Dendrocalamus* from northern Vietnam are described and discussed: *D. cauhaensis*, *D. multiflosculus* and *D. taybacensis*. All three species belong to subgenus *Sinocalamus*, with large culms, basal nodes without branches, and bearing 5–10 perfect flowers.

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INTRODUCTION

Genus *Dendrocalamus* was described in 1834 by Nees von Esenbeck based on *Dendrocalamus strictus* (Roxb.) Nees and currently comprises about 52 species (Ohrnberger 1999). They are widely distributed in the tropical and subtropical regions of Asia from India and Nepal to South China, Myanmar, Thailand, Cambodia, Laos, Vietnam, Malaysia, and Papua New Guinea (Munro 1868, Gamble 1896, Stapleton 1994, Dransfield & Widjaja 1995, Seethalakshmi & Kumar 1998, Ohrnberger 1999, Li & Stapleton 2006).

Camus (1913) was the first person to enumerate species of *Dendrocalamus* from Vietnam and he recorded three species (*D. brandisii*, *D. giganteus*, *D. latiflorus*). Camus & Camus (1923) continued to work extensively on bamboos of Vietnam as well as of Indochina and recorded another three species of *Dendrocalamus* (*D. flagellifer*, *D. hamiltonii*, *D. patellaris*). T.Q. Nguyen worked on this group of bamboo for some time and published 6 new species (*Sinocalamus bachtaiensis*, *S. maiensis*, *S. nhatrangensis*, *S. rugosiglumis*, *S. sang*, *S. yentuensis*) (Nguyen 1989, 1990, 1991), although she described them in the genus *Sinocalamus* McClure, which is widely reduced to a synonym of *Dendrocalamus* Nees based on florets of the type species, *Sinocalamus latiflorus* (Munro) McClure, without lodicules (Chia & Fung 1980, Stapleton 1994, Dransfield & Widjaja 1995, Wong 1995, Hsueh & Li 1996, 2003, Seethalakshmi & Kumar 1998, Li & Stapleton 2006, Yi et al. 2008). Currently in Vietnam, there are considered to be 29 candidates for specific status in this genus, only 14 of them having been described (Nguyen 2006).

During revisional investigations into the bamboos of northern Vietnam, specimens of three distinctive bamboo species were

collected in Phu Tho, Yen Bai, Son La, Dien Bien provinces, under the local names 'May pua pung', 'Pua mon' and 'Maicay'. Flowering specimens of them are characterized by 5–10 perfect flowers, very short and not disarticulated rachilla-internodes, 1-keeled prophyll, free filament, one stigma, and basal nodes of culm without branches. Based on the morphological characters of culms, leaves, culm sheaths and flowers, and referring to the publications by Camus (1913), Camus & Camus (1923), Nguyen (1989, 1990, 1991), Stapleton (1994), Dransfield & Widjaja (1995), Hsueh & Li (1988a, b, 1996), Seethalakshmi & Kumar (1998), Li & Stapleton (2006), Yi et al. (2008), Nguyen et al. (2011), we confirm that these species are clearly members of the genus *Dendrocalamus* and belong to subg. *Sinocalamus* according to the subgeneric classification of *Dendrocalamus* (Hsueh & Li 1988a, 1996).

This genus contains the largest-sized species of all bamboos, and these three species of this group are very large in stature also. All three have a culm sheath blade that is c. 1/5 as long as sheath proper. Both 'May pua pung' and 'Pua mon' have paleas with 2 veins between keel and edge, and 'Maicay' has subfalcate culm sheath auricles with several setae, and 9–11 mm long, fimbriate culm sheath ligules. 'Maicay', 'Pua mon', and 'May pua pung' are similar to *D. yunnanicus* Hsueh & D.Z.Li, *D. calostachyus* (Kurz) Kurz and *D. sinicus* L.C.Chia & J.L.Sun in certain characters, but differ in others. After carefully comparing their morphological characters with type specimens and pictures of type specimens on websites of several herbaria, particularly those of the inflorescences, we drew the conclusion that all three of these large-stature species from Vietnam are new to science.

Further investigation is required to determine the distribution, local uses, and conservation status of these species. They are likely to represent remnants of the original natural broadleaved forest that once covered the area before it was developed for agricultural use, and may persist either in degraded forest areas or as adopted cultivated plants around farms and villages. Currently they have only been collected in a very limited number of localities. They may be more widespread, or they may be endangered. Such bamboo species are of considerable utility, providing edible shoots, and general purpose material for construction and tools. They can also provide raw material for production of paper pulp and other forest products, when available in sufficient quantity.

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Fig. 1 *Dendrocalamus cauhaiensis* N.H.Xia & V.T.Nguyen. a. Culm and dominant bud; b. culm sheath, abaxial view; c. culm sheath, adaxial view; d. culm sheath ligule; e. leaf; f. leaf ligule; g. flowering branch; h. pseudospikelet; i. prophyll; j. glume; k. lemma; l. palea; m, n. lodicules; o. pistil; p. anther (a–f: Van Tho Nguyen NVT162, g–p: Van Tho Nguyen NVT20091215; all FSIV). — Drawn by V.T. Nguyen.

MATERIALS AND METHODS

This study is predominantly based on plant material newly collected in northern provinces of Vietnam, Son La, Dien Bien, Phu Tho, Yen Bai province, and the specimens in the herbaria CPNP, FSIV (Forest Science Institute of Vietnam), FSIV-CH (Cau Hai Silvicultural Research and Experimental Centre of

FSIV), HN, HNU and VNM. Vegetative parts were measured in the field, and the reproductive parts were analysed under a stereomicroscope (Olympus SZZ16) linked with a computer in IBSC.

Our observations were compared with type specimens in herbaria (CANT, HITBC, IBSC, KUN, LE, P, PE, SWFC, SYS), pictures of the type specimens on websites of herbaria (E, K,



Fig. 2 *Dendrocalamus cauhaiensis* N.H.Xia & V.T.Nguyen. a. Clump; a1. dominant bud; b. young shoot; c. culm sheath; d. ligule and auricle of culm sheath; e. flowering branch; f. pseudospikelet; g. prophyll; h. palea; i. lemma; j. pistil. — Photos by V.T. Nguyen.

L, P, US, W), and the publications by Munro (1868), Gamble (1896), Camus (1913), Camus & Camus (1923), Nguyen (1989, 1990, 1991, 2006), Stapleton (1994), Dransfield & Widjaja (1995), Hsueh & Li (1988a, b, 1996), Seethalakshmi & Kumar (1998), Li & Stapleton (2006), Yi et al. (2008).

NEW SPECIES OF DENDROCALAMUS

1. *Dendrocalamus cauhaiensis* N.H.Xia & V.T.Nguyen, sp. nov. — Fig. 1, 2; Map 1

Species nova *D. yunnanico* Hsueh & D.Z.Li affinis, sed paleis 8–12 mm longis, et lemmatibus fertilibus 12–15 mm longis, culmorum vaginis dorsaliter apertis atheris pilosis, auriculis subfalcatis, setis oralibus hirsutis, setis 2.5–3 mm longis, ligulis 11 mm longis, fimbriatis, fimbriis irregularibus et glabris differt. — Typus: *Van Tho Nguyen NVT 20091215* (holo FSIV; iso FSIV-CH, IBSC), Vietnam, Yen bai, Tran Yen, Luong Tinh, cultivated near stream, N21°39.931', E104°48.535', alt. 48 m asl, 15 Dec. 2009.

Etymology. The specific epithet refers to the place where this species has been planted for conservation, Cau Hai bamboo garden, located in a district where this species is indigenous. The garden is the oldest bamboo garden in Vietnam.

Arborescent bamboo, rhizomes pachymorph, short-necked. *Culms* erect, 18–20 m tall and 10–17 cm diam, apex erect or slightly nodding; internodes terete, up to 42–57 cm long, wall 1.5–2 cm thick, initially covered with white powder and glabrous, green when old, sheath scars not prominent and glabrous, intranode velutinous with a 9 mm high ring of rusty-coloured hairs, infranode glabrous; dormant bud small, triangular, 9–12 by 8–11 mm; aerial roots developed at supranodal ridges. *Branches* several at each node, central dominant, no branches below 9–10 node, c. 4–4.2 m above ground. *Culm sheaths* caducous, distinctly leathery, abaxial with densely appressed black hairs, margins glabrous; apex broadly rounded; auricles subfalcate, 5–6 by 1–2 mm, exserted from the sheath margin, bearing several 2.5–3 mm long setae; ligule 9–11 mm high, margin irregularly fimbriate, glabrous; blade reflexed, nar-

rowly lanceolate, c. 1/5 as long as sheath proper, apex acuminate, adaxially white-tawny hispid, abaxially glabrous. *Leaves* (5–)7–9 per ultimate branch, sheath yellowish hispid; auricles absent; ligules truncate, c. 3 mm high, entire; pedicel 9–11 by 3 mm; leaf blade oblong-lanceolate, 28–33(–50) by 4.5–6.7(–12) cm, apex acute, base widely cuneate or nearly rounded, adaxially glabrous, abaxially rough, secondary veins 13–18 on each side of midrib. *Inflorescence* iterant, flowering branch with leaves, pendulous, with 1–3 clustered pseudospikelets at each node; pseudospikelet ovate-lanceolate, 1.5–1.7 by 0.6–0.7 cm, apex acute; prophyll triangular, 1-keeled, 4 mm long, abaxially pubescent, adaxially thinly tomentose; florets 6–7, all florets fertile, open when mature; rachilla-internodes short and not disarticulating. *Glumes* 1–2, 4–6 by 4–6 mm, abaxially puberulent in the middle, adaxially pubescent, margins long-ciliate, apex acute or blunt; lemmas broadly ovate, 12–15 by 8–12 mm, both sides puberulent, margins ciliate, apex mucronate or acute; palea oblong-lanceolate, 8–12 by 2–2.5 mm, densely bristly on both sides, margins and keels pilose, 2-keeled, 2–3-veined between and 2-veined on either side of keels, apex mucronate, apex of uppermost palea usually acute; lodicules 0–1, usually on uppermost floret. *Anthers* yellowish, 5–5.5 mm long, exserted, apex acuminate with few hairs; filaments distinct, separate; stamens 6. *Ovary* ovoid, hairy; stigma 1, hairless; pistil 15–17 mm long. *Flowering* observed in December, *fruit* unknown.

Distribution & Habitat — *Dendrocalamus cauhaiensis* is now commonly found in the remnants of degraded natural forest and cultivated in household gardens, near stream or hill base, between 50 and 100 m asl, in Tan Son, Cam Khe district, Phu Tho province, and Tran Yen district, Yen Bai provinces.

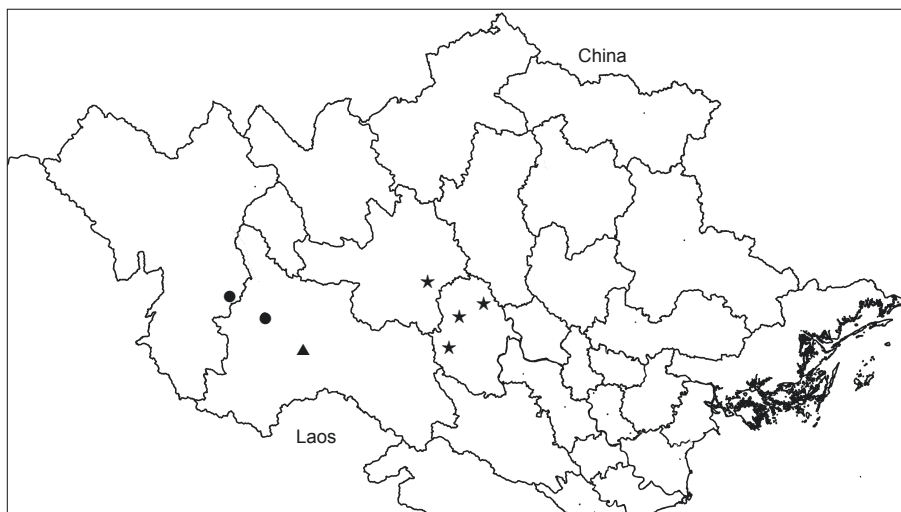
Phenology — Shooting season is from July to September.

Uses — Young shoots are sweet and used for food at the local and the culms are used for house construction as well as providing the raw material for making mat, chopstick.

Vernacular name — Mai cây.

Table 1 Comparison of *Dendrocalamus cauhaiensis* with *D. yunnanicus*.

Character	<i>D. cauhaiensis</i>	<i>D. yunnanicus</i>
Culm sheath	appressed black hairs	hispidulous
Culm sheath auricle	subfalcate, exserted from the margins of culm sheath, with several 2.5–3 mm long setae	inconspicuous, with several deciduous setae
Culm sheath ligule	9–11 mm high, irregularly fimbriate and glabrous	5–8 mm high, serrulate
Palea	8–12 mm long, apex mucronate	4–8 mm long, apex concave
Lemma	12–15 by 8–12 mm, apex acuminate or acute	5–9 by 5–8 mm, apex with 0.2–0.4 mm long awn



Map 1 Distribution of *Dendrocalamus cauhaiensis* N.H.Xia & V.T.Nguyen (★), *D. multiflosculus* H.N.Nguyen, N.H.Xia & V.T.Nguyen (▲) and *D. taybacensis* N.H.Xia, V.T.Nguyen & V.L.Le (●) in Vietnam.

Additional specimens examined. VIETNAM, Phu Tho, Doan Hung, Chan Mong, cultivated in Cau Hai bamboo garden, *Van Tho Nguyen NVT162* (FSIV, FSIV-CH, IBSC), N21°31.895', E105°11.872', alt. 50 m asl, 5 Sept. 2010; Tan Son, Thu Cuc, *Van Tho Nguyen NVT 211* (FSIV, IBSC), N21°14.709', E104°56.928', alt. 143 m asl, 17 Sept. 2010; Cam Khe, Phuong Vy, *Van Tho Nguyen NVT 217* (FSIV, FSIV-CH, IBSC), N21°26.263', E105°01.466', alt. 106 m asl, 17 Sept. 2010.

Note — *Dendrocalamus cauhaiensis* bears a close resemblance to *D. yunnanicus* in general appearance, but it is distinct in its culm sheath auricles subfalcate, culm sheath ligules 11 mm high, irregularly fimbriate, culm sheath proper covered with appressed black hairs, palea 8–12 mm long, and fertile lemma 12–15 mm long. The distinguishing characters are presented in Table 1.

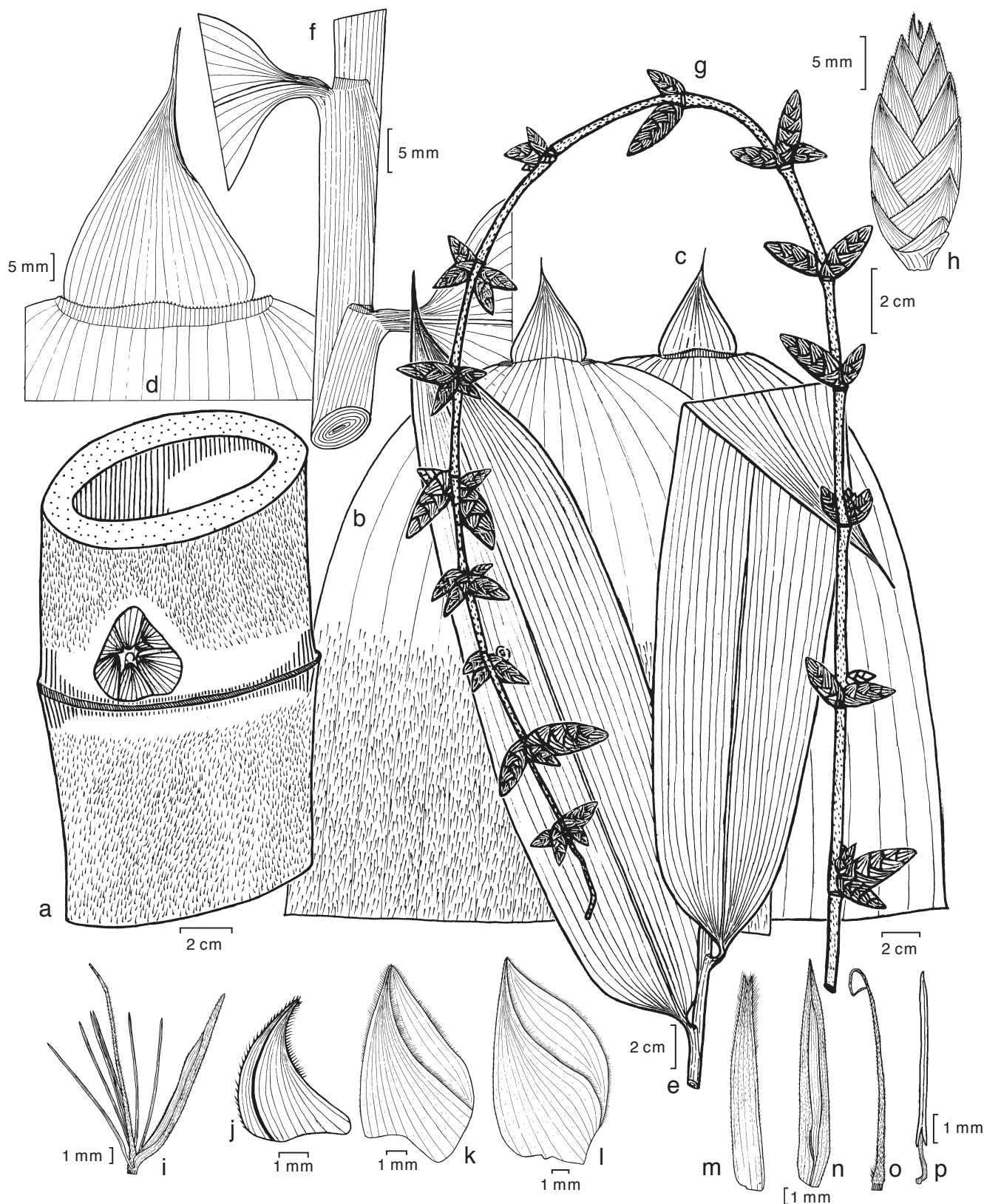


Fig. 3 *Dendrocalamus multiflosculus* H.N.Nguyen, N.H.Xia & V.T.Nguyen. a. Culm and dominant bud; b. culm sheath, abaxial view; c. culm sheath, adaxial view; d. culm sheath ligule; e. leaf; f. leaf ligule; g. flowering branch; h. pseudospikelet; i. floret; j. prophyll; k. glume; l. lemma; m. palea; n. palea of uppermost floret; o. pistil; p. anther (all: *Van Tho Nguyen NVT139*, FSIV). — Drawn by V.T. Nguyen.



Fig. 4 *Dendrocalamus multiflosculus* H.N.Nguyen, N.H.Xia & V.T.Nguyen. a. Clump; b. culm sheath; c. pseudospikelet; c¹. anther; c². palea; c³. prophyll; d. culm bearing flower. — Photos by V.T.Nguyen.

2. *Dendrocalamus multiflosculus* H.N.Nguyen, N.H.Xia & V.T.Nguyen, *sp. nov.* — Fig. 3, 4; Map 1

Species nova *D. calostachyo* (Kurz) Kurz affinis, sed pseudospiculis flosculas maturas usque 9–10 ferentibus, paleis 12–13.8 mm longis, 2-nervatis extra carinas, antheris 8–9.2 mm longis, culmorum vaginis dorsaliter dense brunneis tomentosus ad inferior 1/3 partem differt. — Typus: *Van Tho Nguyen NVT139* (holo FSIV; iso FSIV, FSIV-CH, IBSC), Vietnam, Son La, Mai Son, Chieng Ban, cultivated in household garden, N21°13.436', E103°57.397', alt. 768 m asl, 22 Aug. 2010.

Etymology. The specific epithet refers to the many perfect florets.

Arborescent bamboo, rhizomes pachymorph, short-necked. *Culms* erect, 20–24 m tall, 12–17 cm diam, apex erect or slightly nodding; internode terete, (15–)23–30(–39) cm long, wall 1.8–2 cm thick, initially densely brown tomentose and white powdery, becoming glabrous with age, both intranode and infranode glabrous, dormant bud triangular, basal internodes normal. *Branches* several, central dominant, branching from 32–34 node up, c. 12 m above ground. *Culm sheaths* caducous, leathery, lower third densely brown tomentose, entirely covered with thinly white powder when young, becoming glabrous when old, margins glabrous; apex nearly rounded; auricles absent; ligule c. 4 mm high, serrulate; blade lanceolate, horizontal or nearly erect, c. 1/5 as long as sheath proper, adaxially setose, abaxially glabrous, base extended toward both sides and joined with auricles, margins setose, apex acuminate. *Leaves* (7–)8–10(–11) per ultimate branch; sheath brown-hairy; auricles lacking; ligule truncate, c. 2 mm long, entire, glabrous; pedicel c. 6 by 3 mm, brown velvety at joint with sheath; leaf blade lanceolate, 36–43.6 by (4.8–)7–9.2 cm, base cuneate, abaxially glabrous, adaxially rough, apex acuminate, secondary veins 13–14 pairs. *Inflorescence* itercaucant; flowering branches with leaves, pendulous, with (1–)5–7 clustered pseudospikelets at each node; pseudospikelet lanceolate, (12–)18–25 by 6–10 mm, purple-brown; prophyll triangular, 4.6–5.4 mm long, 1-keeled, margins and keel densely long-ciliate; florets 9–10, terminal floret perfect and each floret closed when mature; rachilla very short and not disarticulating. *Glumes* 5–6, 8.8–10.7 mm long, margin long-ciliate, many-veined; lemmas broadly ovate, 10.8–12.7 by 10.5–13.9 mm, apex blunt or truncate, abaxially covered with appressed bristles in the middle, margins ciliate, many-veined; palea narrowly lanceolate, 12.9–13.8 by 2.8–3.1 mm, 2-keeled, 4-veined between and 2-veined on either side of keels, abaxially densely pubescent, apex acute and sometimes bifid, apex of uppermost palea usually acute; lodicules absent. *Anthers* yellow, 8–9.2 mm long, exerted, apex acute, with several white hairs; filament free, c. 7 mm long; stamens 6. *Ovary* narrowly lanceolate, hairy, base with stalk c. 0.6–0.7 mm; stigma 1, hairless; pistil 14.7–17 mm long. *Flowering* observed in August, *fruit* unknown.

Distribution & Habitat — Currently unknown. This species is only seen in Ban Ang village, Chieng Ban commune, Mai Son district, Son La province.

Phenology — *Dendrocalamus multiflosculus* produces shoots from August to October.

Uses — Young shoots are used for food at the local.

Vernacular name — Pụa môn.

Note — *Dendrocalamus multiflosculus* is like *D. calostachyo* in general appearance, but differs in its pseudospikelets bearing 9–10 florets, palea 12.9–13.8 mm long, 2-veined between keel and edge, anthers 8–9.2 mm long, culm sheath densely brown tomentose on the lower 1/3 part. The distinguishing characters are summed up in Table 2.

3. *Dendrocalamus taybacensis* N.H.Xia, V.T.Nguyen & V.L.Le — Fig. 5, 6; Map 1

Species affinis *D. sinico* L.C.Chia & J.L.Sun et *D. calostachyo* (Kurz) Kurz, sed pseudospiculis usque 14–17 mm longis, lemmatibus 6.7–9 mm longis, paleis 9.1–10.7 mm longis, ciliatis secus nervos, 4-nervatis inter carinas, antheris 5.4–6.6 mm longis, ligulis foliorum truncatis intergras differt. — Typus: *Van Tho Nguyen NVT124* (holo FSIV; iso FSIV-CH, IBSC), Vietnam, Son La, Thuan Chau, cultivated in household garden, N21°26.305', E103°41.334', alt. 587 m asl, 21 Aug. 2010.

Etymology. The specific epithet refer to name distribution region of this species, 'tay bac' region.

Arborescent bamboo, rhizomes pachymorph, short-necked. *Culms* erect, 20–22 m tall and 15–18 cm diam, apex pendulous; internodes terete, 31–37 cm long, wall c. 3 cm thick, initially white waxy-powdery, intranode with a 4 mm high ring of orange hairs, infranode with a 2 mm high ring of orange hairs, basal culm internodes normal. *Branches* several, central dominant, up to 1–1.2 m, branches present from c. 10–14 node, c. 3–4 m above ground. *Culm sheaths* deciduous, leathery, initially with dense appressed black hairs and thinly white powder, glabrescent with age, margins deciduously ciliate; apex nearly rounded or slightly concave; oral setae several near auricles, c. 3 mm long; auricles small, reflexed, undulate, c. 0.5–1 mm high, margins with several bristles; ligule 7–8 mm high, dentate, dentations c. 1.5 mm high, even and glabrous, sometimes lightly concave in the middle; blade triangular, erect or nearly erect, c. 1/5 as long as sheath proper, adaxially densely brown-hairy, abaxially glabrous, base extended toward both sides and joined with auricles, apex mucronate. *Leaves* (8–)10–11(–13) per ultimate branchlet, sheath yellowish hispid; auricles absent; ligule truncate, c. 2 mm high, entire; petiole 9–10 mm long; leaf blade oblong-lanceolate, 42–45(–52) by 7.2–8.7(–9.8) cm, apex acute, adaxially glabrous, abaxially rough, secondary veins 14–15 each side of midrib. *Inflorescence* itercaucant; flowering branch pendulous, leafless, with (1–)3–10 clustered pseudospikelets at each node; pseudospikelet ovate-lanceolate, (7–)14–17 by (2–)5–6 mm, purple, apex acute; prophyll 1-keeled, 3.2–5 mm long, tomentose on keel and near the keel, apex blunt, margin ciliate; florets 5, terminal floret fertile with the palea 2-keeled, each floret closed when mature; rachilla very short and not disarticulating. *Glumes* 4–5, 5.5–6 mm long, yellowish brown, abaxial sparsely hispidulous in the middle, apex blunt or truncate, margins pubescent, many-veined; lemma broadly-lanceolate, 6.7–9.7 by 5–6.9 mm, sparsely tomentose, apex mucronate, margin long-ciliate, many-veined; palea long-lanceolate, 9.1–10.7 by 2.5–3.3 mm, 2-keeled, densely long-ciliate along veins abaxially, 4-veined between and 2-veined on either side of keels, apex blunt or bifid, apex of uppermost palea usually bifid; lodicules absent. *Anthers* yellow, 5.4–6.6

Table 2 Comparison of *Dendrocalamus multiflosculus* with *D. calostachyo*.

Character	<i>D. multiflosculus</i>	<i>D. calostachyo</i>
Florets	9–10	4–6
Palea	12.9–13.8 mm long, 2-veined between keel and edge	6–7 mm long, 1-veined between edge and keel
Anther	8–9.2 mm long	c. 5.5 mm long
Pseudospikelet	(12–)18–25 mm long	10–15 mm long
Culm sheath	basal third densely brown-tomentose	with appressed tawny hairs
Leaf ligule	truncate, entire	rounded, serrulate

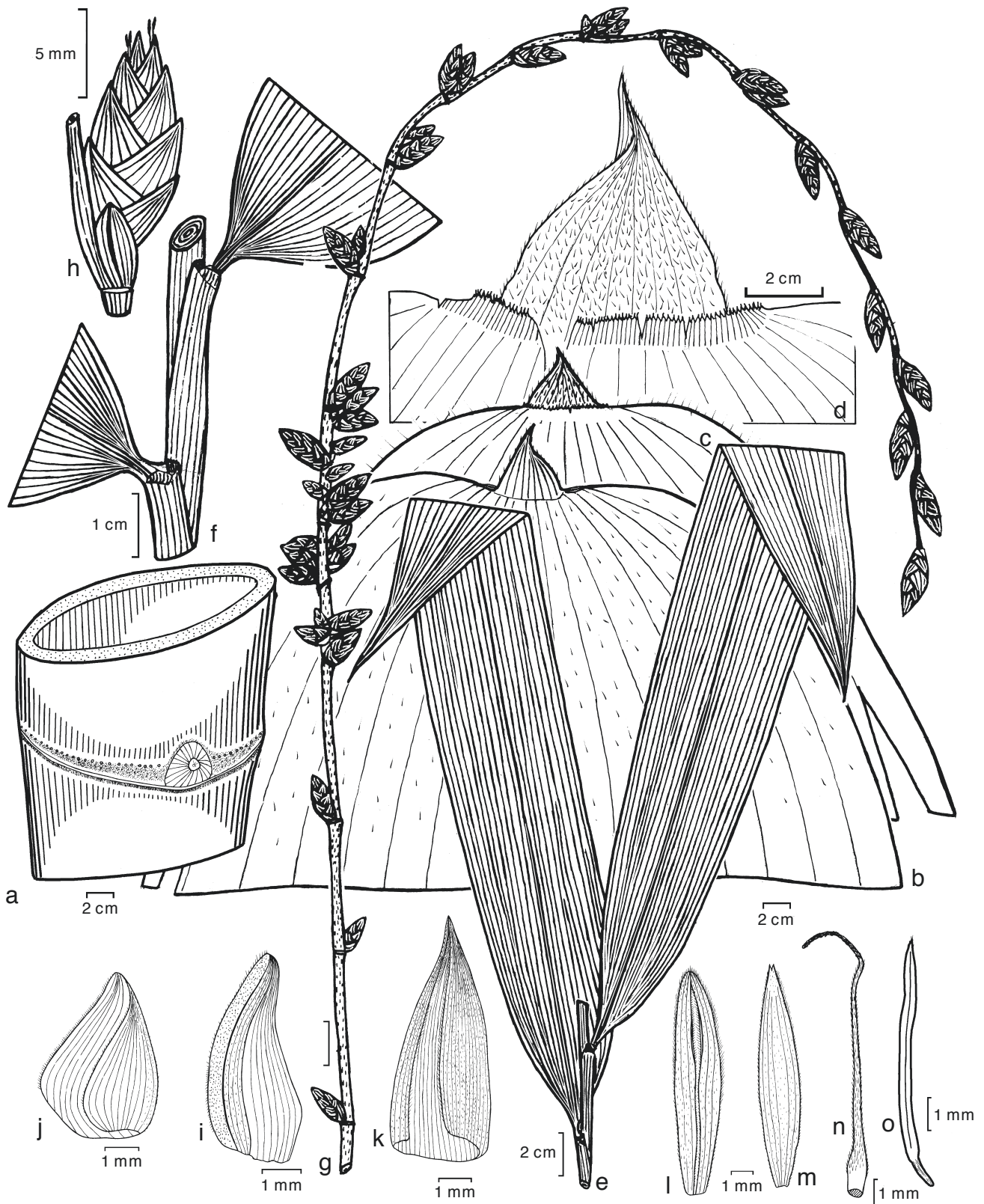


Fig. 5 *Dendrocalamus taybacensis* N.H.Xia, V.T.Nguyen & V.L.Le. a. Culm and dominant bud; b. culm sheath, abaxial view; c. culm sheath, adaxial view; d. culm sheath ligule; e. leaf; f. leaf ligule; g. flowering branch; h. pseudospikelet; i. prophyll; j. glume; k. lemma; l. palea; m. palea of uppermost floret; n. pistil; o. anther (all: *Van Tho Nguyen NVT124*, FSIV). — Drawn by V.T. Nguyen.

mm long, exerted, apex acuminate, with few hairs; filaments free; stamens 6. *Ovary* narrowly ovoid, distally hairy, proximally glabrous; stigma 1, hairless; pistil 9.4–10.3 mm long. *Flowering* observed in August, *fruit* unknown.

Distribution & Habitat — Only known from two localities, Son La, Dien Bien province, cultivated. Altitude: 580–620 m.

Phenology — The young shoots produce from August to October.

Uses — Young shoots are used for food at the local and the culms are used for house construction.

Vernacular names — *Máy púa pùng*, *Máy púa*.

Additional specimens examined. VIETNAM, Dien Bien, Tuan Giao, Quai To, *Van Tho Nguyen NVT118* (FSIV, FSIV-CH, IBSC), 21 Aug. 2010.



Fig. 6 *Dendrocalamus taybacensis* N.H.Xia, V.T.Nguyen & V.L.Le. a. Clump; b. leaf ligule; c. culm sheath; c¹. ligule of culm sheath; d. culm bud; e. clump flowering; e¹. flowering branch; e². upper palea. — Photos by V.T. Nguyen.

Table 3 Comparison of *Dendrocalamus taybacensis* with *D. sinicus*.

Character	<i>D. taybacensis</i>	<i>D. sinicus</i>
Lemma	6.7–9.7 mm long	17–25 mm long
Palea	4-veined between keels, apex blunt or bifid	5-veined between keels, apex bifid
Anther	5.4–6.6 mm long	8–12 mm long
Pseudospikelet	14–17 mm long	30–35 mm long
Leaf sheath ligule	truncate, entire	sparsely dentate

Note — *Dendrocalamus taybacensis* is similar to *D. sinicus* in general appearance; however, it is distinguished by its 14–17 mm long pseudospikelets, 6.7–9 mm long lemma, 9.1–10.7 mm long palea with 4-veined between keels, 5.4–6.6 mm long anthers, and truncate and unsplit leaf sheath ligules. The distinguishable characters are expressed in Table 3.

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