THAI FOREST BULL., BOT. 49(1): 142–150. 2021.
DOI https://doi.org/10.20531/tfb.2021.49.1.18

The ghosts of collections past: characterisation of *Neohouzeaua mekongensis* (Poaceae: Bambusoideae: Bambuseae: Melocanninae) with an epitype

SARAWOOD SUNGKAEW[1, 2, 3,*], ATCHARA TEERAWATANANON[2,3,4], WEI LIM GOH[5,*], CHAKKRAPONG RATTAMANEE[6], DIETER OHRNBERGER[7], NIANHE XIA[8] & KHOON MENG WONG[9]

ABSTRACT

Identifying a bamboo taxon from the Asian seasonal tropics is notoriously difficult, if not impossible, especially when the type material is lacking vegetative parts. This is due to the fact that old type material associated with the naming of bamboos often consists of only flowering branches and perhaps just a few leaves, and, as bamboos in the field are vegetative for prolonged periods prior to flowering, they are therefore not easily identifiable much of the time. Investigating one such bamboo, *Neohouzeaua mekongensis*, we show that previous flowering collections made during the seasonal dry (flowering) season could not have easily included key vegetative parts, such as the culm sheaths, which would have assisted in their recognition at other times. We trace this species back to its type localities and propose an epitype in order that its vegetative characteristics are made available to complement the floral characteristics of the original material.

KEYWORDS: Bamboo, Laos, Mekong River, *Schizostachyum*, Thailand, Ubon.

Accepted for publication: 8 June 2021. Published online: 14 June 2021

INTRODUCTION

Neohouzeaua A.Camus, a little-understood bamboo genus, recently treated as a synonym of *Schizostachyum* Nees by Goh *et al.* (2020), was originally described with two species, *N. mekongensis* A.Camus and *N. dullooa* (Gamble) A.Camus, both of which were partially illustrated together in the same plate. The genus was taken to be typified by *N. mekongensis* by McClure (1957), as he considered this species was treated first by her and therefore taken as her standard of comparison.

A year after the publication of *Neohouzeaua*, the great bamboo monographer Gamble (1923), accepted the genus and described a new species, *N. tavoyana* Gamble, and transferred a species he (Gamble, 1896) had placed in *Teinostachyum* Munro, as *N. helferi* (Munro) Gamble.

Camus (1922) did not indicate a specimen that could be unambiguously taken as the type of *N. mekongensis*. Instead, she only stated "Laos: Ubon, Kemmarath (Thorel)". During the revision of the bamboo collections from **P** and **K** (Thiers, 2020, continuously updated) we identified specimens determined as *N. mekongensis* by A.Camus, which are stated to be from "Ubon" and "Kemarath", with disparity in the spelling. Additionally, Thorel's name is specifically mentioned in those materials in his collections at the **P**, where Camus determined the

[1] Department of Forest Biology, Faculty of Forestry, Kasetsart University, Bangkok 10900, Thailand.

[2] Center for Advanced Studies in Tropical Natural Resources, Kasetsart University, Bangkok 10900, Thailand.

[3] Center of Excellence for Bamboos, Kasetsart University, Bangkok 10900, Thailand.

[4] Natural History Museum, National Science Museum, Technopolis, Pathum Thani 12120, Thailand.

[5] Faculty of Science, Universiti Tunku Abdul Rahman, Jalan Universiti, Bandar Barat, 31900 Kampar, Perak, Malaysia.

[6] Faculty of Agricultural Technology, Burapha University, Sa Kaeo Campus, Wathana Nakhon, Sa Kaeo 27160, Thailand.

[7] Baan Sammi Nature Resort and Bamboo Garden, Doi Saket, Chiang Mai 50220, Thailand.

[8] South China Botanical Garden, Chinese Academy of Sciences, Guangzhou, Guangdong, 510650, China.

[9] Singapore Botanic Gardens, National Parks Board, 1 Cluny Road, 259569, Singapore.

* Corresponding author: fforsws@ku.ac.th, wlgoh@utar.edu.my

species. Those materials [*M. le Dr Thorel s.n.*, 1866–1868, Expédition du Me-kong, Ubon (barcode P03652489); *M. le Dr Thorel s.n.*, 1866–1868, Expédition du Me-kong, Ubon (P03652490); and *M. le Dr Thorel 2886*, Expédition du Me-kong, Kemarath cultivi (P03652491)], however, comprise portions of synflorescences, except one (P03652490) in which the synflorescences are attached to a 3 mm diameter culm portion (presumably the distal part), with a 22.2 cm long internode.

Dransfield (1998) collected a non-flowering bamboo (*S. Dransfield SD1473* in **K**) in Phu Ruea National Park, "on the north slopes of the highest point (800 m), facing Hung River, which joins the Mekong River about 100 km to the east." and identified it as *N. mekongensis*. However, the identification was based on collections post-dating the type material that she considers corresponding to the type material.

There have been no specimens from the Mekong River that we know of, and all of the K and BKF collections have been either of flowering material mostly without leaves and always without culm shoots or sheaths, or just vegetative material consisting leafy branches and culm shoots or sheaths.

Thus, it seems there is little material from those published papers and early specimens that can be relied on to build an assured impression of what this bamboo plant may look like vegetatively, hindering efforts in taxonomic or ecological studies, particularly lectotypification and epitypification.

Still, there is no direct correspondence between the type flowering material and the culm sheaths as documented for other non-flowering collections, and the species has never been recollected along the Mekong River, specifically at the stated type localities Ubon and Kemmarath, since the type material was gathered in the 19th Century.

Considering all these questions we considered the hypothesis of lectotypification and epitypification for *N. mekongensis* and investigated the field evidence at the type localities, in order to elucidate these questions.

MATERIALS AND METHODS

Field survey and collection

In order to understand and trace the main characters of *Neohouzeaua* and its related genera in the subtribe Melocanninae Benth., many publications were studied (such as Holttum, 1946; 1956; Xia, 1993; Wong, 1995a; Dransfield *et al.*, 2003; Yang *et al.*, 2008; Sungkaew *et al.*, 2009; BPG, 2012; Goh *et al.*, 2013; Chokthaweepanich, 2014; Kellogg, 2015; Wong *et al.*, 2016). With this background to the general morphology of the Melocanninae subtribe that could help in field identification and the foregoing insights into the importance of recollecting *N. mekongensis* from its type provenance, we organized a survey along the Mekong River from Mueang Ubon Ratchathani to Khemmarat, in the Ubon Ratchathani Province ('Ubon') in eastern Thailand. The spellings used here for geographical names follow current use according to the Royal Thai General System of Transcription. Over five days (November 14–18, 2017) we travelled along the Mekong River, with stops at and in between Mueang Ubon Ratchathani, Khong Chiam and Khemmarat, altogether surveying 23 sites with bamboos.

The purpose was to collect high quality voucher material of all Melocanninae taxa we would encounter in the landscape, including that which would closely match the type material of *N. mekongensis*. These materials would provide to better understand the vegetative morphology of the species in order to facilitate identification of living plants.

For each voucher collection made, we managed to obtain and document vegetative material at a range of developmental stages (culm sheaths or shoots more than a meter high so that culm sheaths with well-developed features useful in identification were obtained, midculm branch complements with leafy branches). These were pressed in the field and dried as specimens in the Herbarium of the Faculty of Forestry, Kasetsart University, Bangkok, Thailand (acronym used here KUFF, but not registered as an international herbarium). Rhizome offsets were taken where feasible for subsequent planting at the Forestry Faculty of Kasetsart University, Bangkok, the Baan Sammi Bamboo Garden, Chiang Mai, and the Singapore Botanic Gardens.

RESULTS AND DISCUSSION

Understanding the main characters of *Neohouzeaua*

When Holttum (1958) summarized his knowledge of the bamboos of the Malay Peninsula,

he already had a broad overview of the diversity of Southeast Asian bamboos and their potential classification, based on characters of flowering material, such as the nature of the synflorescence (relatively compact and typically arising first at the apex of a leafy branch, or developing into a much-branched structure), the basic unit of the inflorescence (whether spikelets are unable to proliferate further similar units at their base, or pseudospikelets that have basal gemmiferous bracts and are able to proliferate branch-units to form a cluster of similar units) and the nature of the style (solid and flexible, or essentially with an ovary apex that is attenuate and rigid yet hollow and containing a central strand that could represent the true style) (Holttum, 1946, 1956).

From such work, it became apparent that a cluster of genera around *Melocanna* Trinius and *Schizostachyum* Nees, which also included *Neohouzeaua*, was exclusive in sharing a number of characteristics, including relatively compact synflorescences at the apex of leafy branches, pseudospikelets as the basic inflorescence units, and hollow rigid 'styles'. It was also emphasized that in this alliance the midculm branch complement consists of many slender subequal branches developing from a single branch bud, and there is a conspicuous white-waxy ring just below each culm node (Wong, 1995a). This alliance is now well recognized as the subtribe Melocanninae (Yang *et al.*, 2008; Sungkaew *et al.*, 2009; BPG, 2012; Goh *et al.*, 2013; Chokthaweepanich, 2014; Kellogg, 2015; Soreng *et al.*, 2015; 2017; Vorontsova *et al.*, 2016; Wong *et al.*, 2016).

On the basis of pseudospikelet and floral features, Holttum (1958) and Xia (1993) included *Neohouzeaua* within *Schizostachyum*, but Holttum acknowledged that the group of species that could be segregated as *Neohouzeaua* appeared to be a distinct group that differed from other *Schizostachyum* members in having a filament tube (instead of free filaments) and a lack of lodicules (most other *Schizostachyum* have three well-developed lodicules). There are also other distinctive vegetative characteristics among most of the taxa that can, by floral characteristics, be grouped with *N. mekongensis*; these include a medium-brown hairy culm sheath with very slender reflexed blades and a sheath apex with hardly developed auricles and conspicuous erect oral setae on both sides of the blade base, as found in the Malayan *Schizostachyum jaculans* Holttum (Holttum, 1958; Wong, 1995a). Such characters would have led Dransfield *et al.* (2003) to continue to recognize *Neohouzeaua*, although one of the two new species they described, *N. fimbriata* Dransfield, Pattanavibool & Sungkaew, which is now treated under *Schizostachyum* (Goh *et al.*, 2020), has large, deflexed and long-bristly culm sheath auricles. These authors also mentioned an additional character, namely the style apex being level on one side and dipping on the other which is filled with minute hairs; we have been unable to verify this fine characteristic.

The field survey

Although the trip was planned in November at the transition to the dry season with the hope of obtaining both representative vegetative and flowering material, we were unable to find the latter (see Table 1). Only one taxon of the Melocanninae, recognizable by their midculm branch complement (many subequal branches developing from a solitary primary branch bud at each node) and the presence of a white-waxy band just below each culm node, was found along the Mekong River from Mueang Ubon Ratchathani to Khemmarat. Although not flowering during our survey, the vegetative features corresponded well with those described for eastern Thai material identified as *N. mekongensis* by Dransfield (1998). Therefore, this taxon was identified as *N. mekongensis*.

Table 1. summarizes the results of our survey. Of the 23 sites with bamboos surveyed, six sites with cultivated clumps of this *N. mekongensis* were found adjacent to village houses and often within private compounds, and two sites (recorded as 'natural' populations) occurred some distance from any dwelling or private compound.

The natural populations had at least three recognizable seed cohorts (<1 m, 2–3 m, 3–5 m or taller) that were apparently established from different years of flowering/seeding, possibly in the dry season during November to April. One cultivated clump also had obvious seed regeneration separated from the presumed mother clump. A villager from Talong Village showed us how culm splits were mainly used to craft containers for steaming food as well as other ad hoc household items, and explained that in times of shortage (such as when the bamboo flowered gregariously locally and fresh culms were then not available for a prolonged period), supplies have had to be sought from across the Mekong in Laos from non-flowering populations.

Table 1. Summary of *Neohouzeaua mekongensis* surveys along the Mekong River in Ubon Ratchathani, East Thailand, in November 2017.

Date in Nov.	Starting locality	Total sites surveyed	*Neohouzeaua* sites	Regeneration	Notes / material taken
15th	Mueang Ubon Ratchathani	6	3 cultivated, 1 natural	natural popula-tion with regeneration	Vouchers: cult. *Sungkaew 1569*; wild *Sungkaew 1570*, *Sungkaew 1571*). Living specimens: from wild population. The numbers, 1570 and 1571, are from two different clumps and from the same population.
16th	Khong Chiam	6	1 cultivated	(nil)	No voucher: only DNA leaf sample taken (*Sungkaew s.n*., Talong Village, Huai Phai subdis-trict, Khong Chiam district, Ubon Ratchathani)
17th	Khong Chiam	6	1 natural	with regeneration	Voucher: *Sungkaew 1573*
18th	Khemmarat	5	2 cultivated	(nil)	

Natural history aspects

What we could surmise from the nature of the existing specimen material, observations during our survey, and information from villagers, provided valuable insights into the natural history of the bamboos. The young clumps take several years to reach maturity, during which they do not produce flowers, and finally in a flowering year would flower and seed during the dry season (November to April) as they lose all or most of their leaves, and then die down. Gregarious flowering would be frequent but not every clump will flower at the same season as not all the clumps are even-aged. New seedlings and saplings would eventually replace the mother clumps. Regeneration was seen for both wild clumps we encountered, but not for the cultivated clumps.

Such one-off flowering of mature clumps during a dry season, when vegetative production of new shoots ceases and the foliage senesces, could explain why the type and most other collections had only inflorescences, and why during our 2017 survey we were not able to obtain reproductive material during a time when culm shoots were still actively produced.

Bamboo flowering in South-East Asia has been documented as being gregarious in both seasonal and ever wet climates (Holttum, 1958; McClure, 1966; Janzen, 1976; Wong, 1995a, b) and also continuous for some *Schizostachyum* species in the ever wet Malay Peninsula (Holttum 1958, Wong 1995b). Clearly, in the case of *N. mekongensis*, it is seasonal and takes place during the dry season after maturity of a seed cohort, and at least regionally gregarious.

Quite a few bamboo taxa from the Asian seasonal tropics are similarly typified by flowering material with perhaps just a few leaves, such as in the genera *Bambusa* Schreber, *Dendrocalamus* Nees and *Gigantochloa* Kurz ex Munro. They typically flower in the dry season, when shoots and other characters, such as culm shoots and their sheath characteristics, are not produced. This hampers the identification of these bamboos, and when collections are poor and do not allow correlation between flowering and vegetative features, taxonomic progress is seriously impeded. In a number of cases, not only were the original material consisting only of flowering specimens, the descriptions of these bamboos mentioned not one, but several collections, so making way for possible mixtures and a degree of doubt regarding a specific reference.

Taxonomy and the epitypification of *Neohouzeaua mekongensis*

The original material of *N. mekongensis* did not specify a type clearly and the requirement of lectotypification following the Article 9.3 of the Shenzhen Code (Turland *et al.*, 2018). Luckily enough, lectotypification for the type species, *N. mekongensis*, has been carefully done by Goh *et al.* (2020), where

the most complete specimen P03652490 (*M. le Dr Thorel s.n.*, 1866–1868, Expédition du Me-kong, Ubon, see Fig. 1) was designated as the lectotype. Other isolectotypes and a probable isolectotype were also provided. In addition, based on a molecular phylogenetic analysis, they treated *Neohouzeaua* A.Camus as a synonym of *Schizostachyum* Nees. As all of the original material, including the lectotype, comprised only flowering material without accompanying vegetative material that could aid in the identification of the bamboo in question, we here also propose an epitype in accordance with the Article 9.9 of the Shenzhen Code. We also provide a full description of *N. mekongensis* that is hitherto not available.

Neohouzeaua mekongensis A.Camus, Bull. Mus. Hist. Nat. Paris 28 (1922) 100.— Type: Thailand, Expédition du Me-kong, Ubon, *M. le Dr Thorel s.n.* (**P**, [03652490]), lectotype, designated by Goh *et al.* (2020: 117).— Supported by epitype: Thailand, Ubon Ratchathani, Khong Chiam District, Khong Chiam Subdistrict, Woen Buek Village, transition zone between mixed deciduous forest and dry evergreen forest, *Sungkaew 1570* (epitype **BKF**, here designated, isoepitypes **KUFF**, **SING**; Herbarium, Thailand Natural History Museum, National Science Museum, Technopolis, Pathum Thani, Thailand). Figs. 1–2.

Arborescent, unarmed bamboo. *Rhizomes* pachymorph with short-necks, forming a clump usually with dense culms. *Culms* erect, 5–10 m tall, 1–4.5 cm in diameter, tips out-arching to drooping; internodes terete, 45–100 cm long, walls rather thin, dark to bluish green when young, covered with dense appressed white to pale hairs and white-waxy, yellowish green and glabrous when mature, with a narrow band of semi-persistent dense appressed pale hairs and white-waxy just below nodes; nodes not prominent. *Branch* buds at each node solitary, broadly ovate; prophyll abaxially glabrous, 2-keeled, keels ciliolate and slightly fimbriate towards apex. *Branches* usually developing from around mid-culm or higher upwards; mid-culm branch complement a cluster of (3–)5–7 (–9) to many sub-equal branches at each node, 65–90 cm long, all developing from a solitary non-dominant primary branch axis. *Culm sheaths* deciduous, ca ⅓–½ as long as internodes, subcoriaceous, apex recessed, pale green to orange-green, back covered with appressed white hairs and a thin covering of white waxy substance, margins of the culm-sheath proper drying off earlier towards the apex; culm-sheath blades narrowly linear, green, spreading to reflexed, ca ⅔ or as long as the culm-sheath proper, covered with dense pale hairs adaxially and scattered pale hairs abaxially; auricles inconspicuous or replaced by a low dark thickened rim to ca 1 mm high, with dense, relatively erect pale bristles (oral setae) in a tidy row, to ca 10 mm long; ligule ca 1 mm tall, margin irregular toothed or laciniate and fringed with pale bristles to 5 mm long. *Foliage leaves* 5–11 per branchlet; pseudo-petioles 0.2–0.8 cm long; leaf sheaths 5.5–14 cm long, back covered with scattered, appressed pale hairs to glabrous, margins ciliate to glabrous; auricles absent, replaced by low rims along both sides of sheath apex, fringed with dense, relatively erect to apically curved pale bristles (oral setae), to ca 5 mm long; ligules short, ca 0.5 mm tall, margin fringed with pale bristles to 1.5 mm long; margin of outer ligule ciliolate; leaf blades lanceolate-oblong, 10–38(–40) by 2–6.5(–9) cm, adaxially and abaxially scaberulous to glabrous, base obtuse to acute or cuneate, apex acuminate (vegetative components described primarily from *Sungkaew 1570*). *Synflorescence* fully bracteate, the subtending lanceolate sheaths/bracts usually glabrous, paniculate, 40–50 cm long, much branched and dense, glabrous, usually on leafless branches, inflorescence units iterauctant (indeterminate), composed of pseudospikelets. *Pseudospikelets* slender, oblong or fusiform, (1.9–)2.2–2.4 cm long, apices acute, glabrous, basal bracts several-nerved; empty glumes 3–4 , ovate-lanceolate, unequal, 5–9 mm long, apices mucronate or sub-aristate, glabrous; fertile floret 1, rachilla extension beyond floret absent or much reduced and slender. *Florets* with lemmas ovate-lanceolate, 1.4–1.7 cm long, margins involute, apices mucronate, glabrous, several-nerved; paleas 1.7–1.9 cm long, margins involute, apices attenuate, or bi-cuspidate with the tips 2 mm long, without keels, glabrous; lodicules absent; stamens 6, filaments connate into a narrowly cylindric tube, anthers ca 8 mm long, glabrous, apices obtuse; ovary oblong, glabrous, ending in a long rigid style ca 1.5 cm long; stigmas 3, plumose. *Caryopses* not seen. (Floral components described primarily from the lectotype)

Figure 1. The lectotype of *Neohouzeaua mekongensis* A.Camus, designated by Goh *et al*. (2020). Photograph from https://science.mnhn.fr/institution/mnhn/collection/p/item/p03652490?fbclid=IwAR3dhX09Mj5M__TVbXOoMj-omx4A1XgOSHNtHk_FgNz1GbSVuYZuzoSkIIA.

ACKNOWLEDGEMENTS

We are grateful to the Forest Herbarium (BKF), Dr Kongkanda Chayamarit and Dr Somran Suddee for facilitating study of herbarium material; Khun Thammarat Boonthammee and Jing-Bo Ni for help in field organization. For fieldwork, Kasetsart University and The Thailand Research Fund (MRG5480265) made possible the participation of S. Sungkaew, the National Parks Board, Singapore, that of K.M. Wong, and the Chinese Academy of Sciences, that of N.-H. Xia and J.-B. Ni.

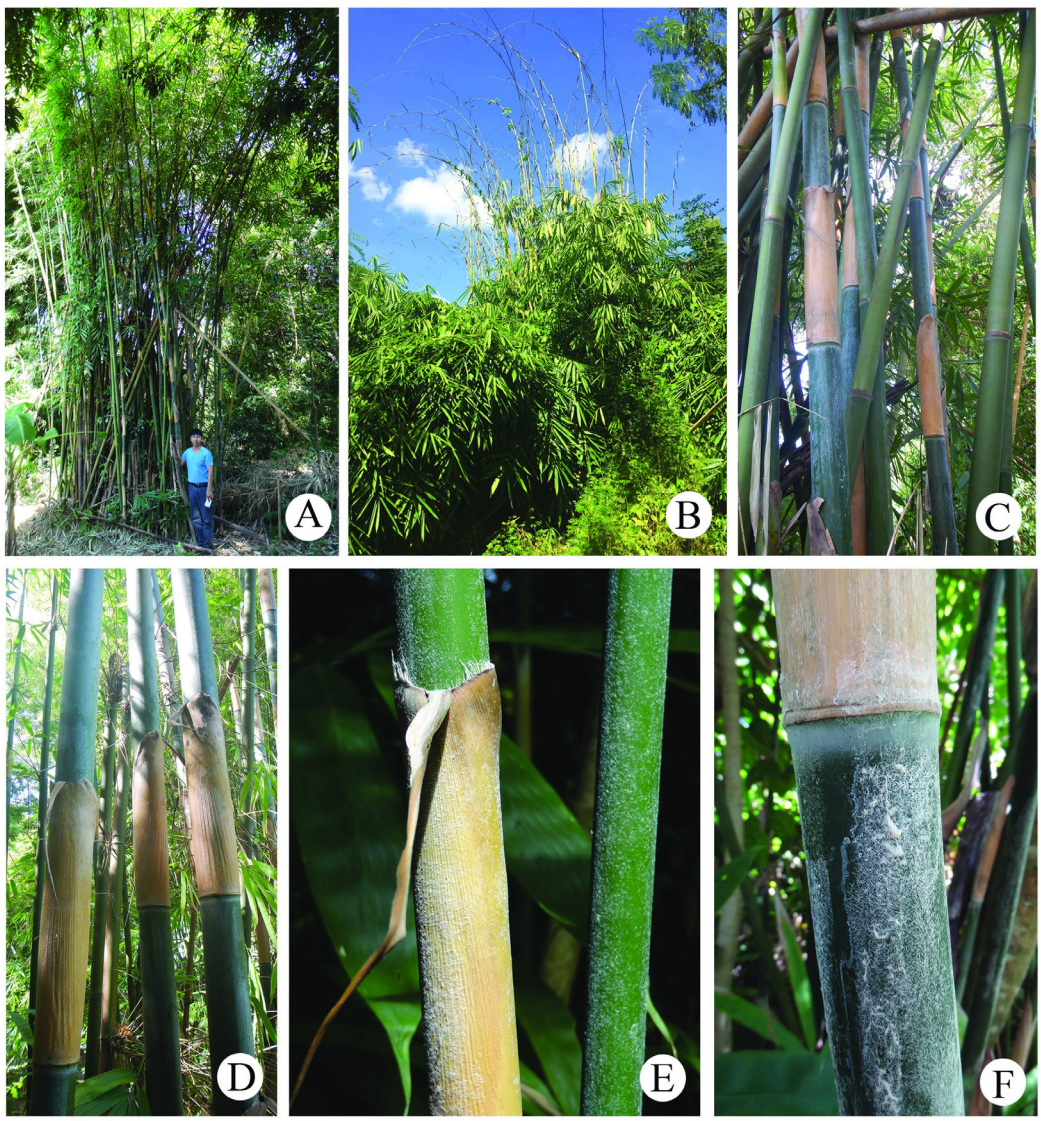

Figure 2. Habit and vegetative characteristics of *Neohouzeaua mekongensis* A.Camus: A. Clump habit, showing erect caespitose culms, B. Arching over to drooping culm tips, C. & D. Mature culms (with no culm sheaths remaining on internodes) and young culms (with attached culm sheaths), E. Culm sheath, showing reflexed culm-sheath blade, the relatively erect pale bristles (oral setae) along the low dark thickened rims, and the appressed white hairs and a thin covering of white waxy substance on the back of the sheath proper, F. Portion of a young culm, showing a narrow band of white-waxiness just below the node and a copious covering of appressed white to pale hairs all over the internode (A from *Sungkaew 1569*, E & F from *Sungkaew s.n.*, Talong Village, Huai Phai subdistrict, Khong Chiam District, Ubon Ratchathani (photographed by K.M. Wong), B from the same population, but different clump, where the *Sungkaew 1573* was collected, C & D from *Sungkaew s.n.*, Talong Village (photographed by S. Sungkaew)).

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