

# Affinities of the fern genus *Ptisana* (Marattiaceae) in the Solomon Islands, with descriptions of two new species

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## Abstract

In the process of undertaking a comprehensive review of the pteridophytes of the Solomon Islands, multiple unidentified specimens of the fern genus *Ptisana* Murdock (Marattiaceae) were collected. Morphological and molecular phylogenetic analyses as well as field observations were required to identify the Solomon Islands taxa. Four species and one variety are recognized from the Solomon Islands: *Ptisana ambulans* Murdock & C.W. Chen, **sp. nov.**, *Ptisana decipiens* Murdock & C.W. Chen, **sp. nov.**, *Ptisana decipiens* var. *delicata* Murdock & C.W. Chen, **var. nov.**, *Ptisana papuana* (Alderw.) Murdock & C.W. Chen, **comb. nov.**, and *Ptisana smithii* (Metz. ex Kuhn) Murdock. The complexities in the identification of Solomon Islands collections show the limits of morphology in the genus and illuminate a path forward for untangling the *Ptisana* taxonomy on a broader scale.

## Keywords

Ferns, Marattiaceae, pteridophytes, *Ptisana*, Solomon Islands, taxonomy

## Introduction

The country of the Solomon Islands comprises two archipelagos and nearly 1000 islands, lying to the east of Papua New Guinea and stretching across 1300 km of the Pacific Ocean to within 150 km of Vanuatu in the southeastern reaches of the country (Coleman 1966; Neall and Trewick 2008). In the course of completing a comprehensive pteridophyte flora of the Solomon Islands (Chen et al. in prep), new herbarium collections were made that included multiple unidentified members of the genus *Ptisana* Murdock, a group of large, terrestrial ferns in the Marattiaceae family, with an unsettled taxonomy in the region.

Historically, *Ptisana* was treated as part of the genus *Marattia* Sw. with a pantropical distribution. Following molecular and morphological phylogenetic analyses that found *Marattia* to be paraphyletic (Murdock 2008a), *Marattia* was split into three genera: *Ptisana*, comprising the paleotropical species, *Eupodium* J.Sm., a genus of 3–4 species in the American tropics, and *Marattia* s.s., six species restricted to the American tropics and Hawaii (Murdock 2008b). Later studies have also supported the monophyly of these genera (Senterre et al. 2014; Rothwell et al. 2018; Liu et al. 2019; Lehtonen et al. 2020). Morphologically, *Ptisana* is characterized by deeply cut, fully fused, sessile synangia, sporangial apertures that lack labia, and the presence of sutures at the attachment point of ultimate segments (Murdock 2008b).

Murdock (2008b) recognized 20 species and three varieties in *Ptisana*, placing many of the over 70 named species of Old World *Marattia* in synonymy. This was done with the caveat that some *Ptisana* species were likely overly broad as recognized, but that further work was needed to clarify some of the more challenging complexes where morphology was inconclusive. Since that time, three new species have been named in *Ptisana*, and nine new combinations have been made from earlier names in *Marattia* (Yonekura 2011; Christenhusz et al. 2011; Senterre et al. 2014; Christenhusz et al. 2018).

The prevailing challenges for taxonomists in *Ptisana* (and other marattioid genera, notably *Angiopteris*), are their size, resulting in poor, incomplete collections, and their phenotypic plasticity. Characters that are potentially taxonomically informative, e.g. ornamentation and indument of stipe bases or stipule morphology (Holttum 1978), are typically not preserved, while the easier-to-collect pinnules have characters that are often both highly labile and confusingly similar from species to species. Distinctions between many of the described species, often based on fragmentary herbarium specimens with limited comparison to other species, have long been unclear. This is especially true in the Papua New Guinea region, where a proliferation of poorly distinguished forms can be found, and no comprehensive diagnostic keys have been published. Papua New Guinea is home to the *Ptisana* with the largest segments, *Ptisana obesa* (Christ) Murdock, as well as the smallest, *Ptisana wernerii* (Rosenst.) Christenh., with an ultimate segment scarcely larger than the single synangium that it bears on its short midrib. A thorough examination of herbarium specimens by Murdock (2008b) located many intermediate forms between described species in New Guinea. The wide range of morphologies with incompletely sorted characters might indicate a recent radiation in the region and warrants further collection and study.

Compared to Papua New Guinea, *Ptisana* in the nearby Solomon Islands has been poorly collected and studied until recently. While there are 16 species of *Marattia*/*Ptisana* described from Papua New Guinea, there have been zero species described from the Solomon Islands. The lack of unique *Ptisana* species in the Solomon Islands could simply reflect reality, not lack of attention: due to the proximity of the western islands to Papua New Guinea and habitat similarity, relatively few endemic pteridophytes have been found in the Solomon Islands (Glenny unpub.).

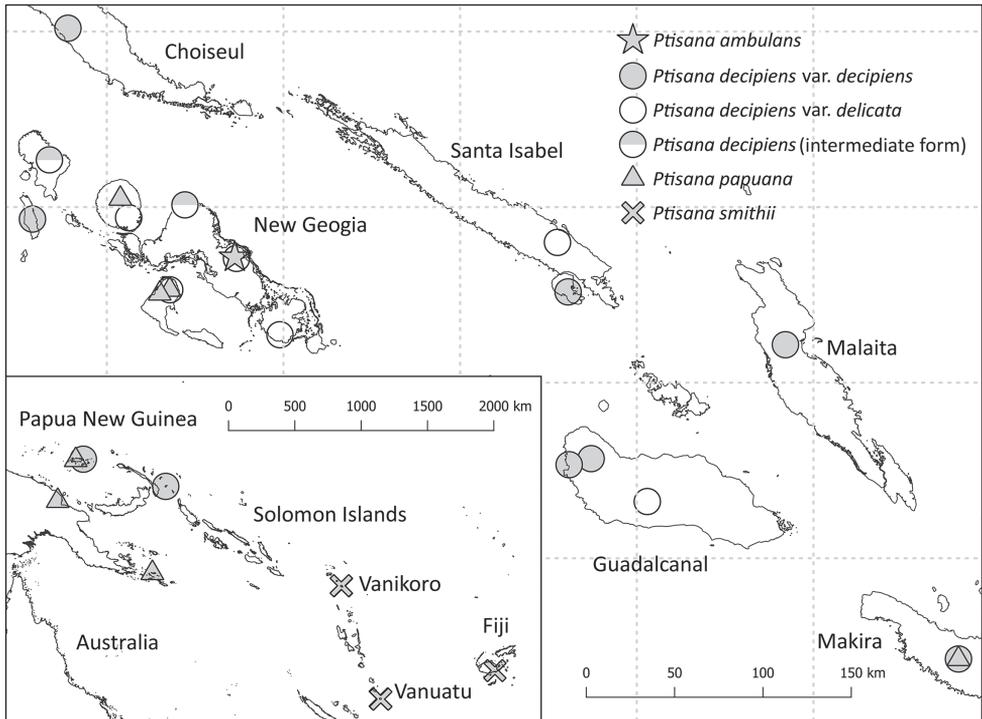
Among the pteridophytes of the Solomon Islands, the largest portion shares affinities with New Guinean and Malesian lineages, although Pacific Island taxa are also well represented, particularly in the southeast in the Santa Cruz group (Braithwaite 1975; Chen et al. 2017). Collections of *Ptisana* in the Solomon Islands, if identified beyond the genus level at all, have most commonly been identified in herbaria as *Ptisana ternatea* (de Vriese) Murdock (a 3-pinnate species described from Ternate in the Maluku islands), *Ptisana melanesica* (Kuhn) Murdock (a 3-pinnate species described from New Hanover in the Bismarck Archipelago, notable for its tiny ultimate segments), or *Marattia andaiensis* Alderw. (a 2-pinnate species described from eastern Papua New Guinea), indicating a likely affinity with Malesian and New Guinean *Ptisana* clades. Many of these identifications have been tentative or accompanied by question marks. Previous checklists (Foreman 1971; Henderson and Hancock 1988) included *Marattia* but were uncertain about the species. Glenny (unpub.) noted some clear differences between *P. ternatea* in the Maluku islands and the 3-pinnate form in the Solomon Islands, but retained the name citing the need for more evidence before adding new names to this difficult genus.

As part of a project to catalog the pteridophytes of the Solomon Islands (Chen et al., in prep.), additional collections were made from across the Solomon Islands, and further study was undertaken to determine the identity of the *Ptisana* species. Based on morphology, there were some indications that at least one species in the Solomon Islands was undescribed. Because morphology alone was insufficient, DNA sequencing was undertaken to aid identification and to clarify the taxonomy of *Ptisana* in the region.

## Methods

### Study area

Because the goal was to identify the *Ptisana* taxa for the Solomon Islands pteridophyte project, the study area was defined as the Solomon Islands in the political sense (Fig. 1), including the Santa Cruz Islands (Temotu Province). Biogeographically, Bougainville and neighboring Buka (Papua New Guinea) are the northernmost islands of the Solomon Islands archipelago, while the Santa Cruz Islands are the northernmost part of the Vanuatu archipelago. Notes on Bougainville and Vanuatu collections are included where relevant, but they are not included in the primary study area.



**Figure 1.** Map of the Solomon Islands showing the locations of the selected specimens examined for each taxon and collections sequenced for this paper. Specimens from Vanikoro (Santa Cruz Islands) and surrounding countries shown in inset map (bottom left).

## Field observations and morphology

Due to the large size of many *Ptisana* individuals, herbarium collections frequently only capture a small portion of the characters of any plant. Field observations of characters that were difficult to preserve (e.g., stipe length and indument), as well as habitat and plant associations, filled in essential details. For taxonomic identification, all type specimens and protologues were examined for all *Marattial* *Ptisana* species described from Papua New Guinea, Malesia, and Western Pacific regions, to compare with collections from the Solomon Islands collections. The type specimen of *P. melanesica* (Kuhn) Murdock, originally held at the herbarium of the Botanic Garden and Botanical Museum Berlin-Dahlem (B) was destroyed, but the description and accompanying illustration (Kuhn 1889) were sufficiently diagnostic.

## DNA extraction, amplification and sequencing

Fifteen samples from a range of locations and morphologies across the Solomon Islands and surrounding regions were selected for sequencing. Total DNA was extracted using a modified CTAB-Qiagen column protocol (Kuo et al. 2016). Two plastid DNA

regions, *rps4* plus the *rps4-trnS* GGA intergenic spacer (*rps4-trnS*) (-900 bp), and the region spanning *trnS* GCU to *trnG* UUC (including *psaM* and *ycf12*) (*trnSGG*) (-1600–2100 bp) were amplified and sequenced using previously published primers and methods (Nadot et al. 1994; Smith and Cranfill 2002; Murdock 2008a).

The PCR amplifications were performed in 16 µl reactions containing ca. 10 ng template DNA, 1×Taq DNA Polymerase Master Mix RED solution (Ampliqon, Denmark), and 1 µl each of 10 µM primers. The PCR reactions were carried out in a GeneAmp PCR System 9700 (Applied Biosystems, Carlsbad, California, USA). Thermocycling conditions were the same for PCRs of these regions and comprised an initial denaturation of 2 minutes at 94 °C followed by a core sequence of 35 repetitions of 94 °C for 1 minute, 55 °C for 1 minute, and 72 °C for 1 minute followed by a final extension of 10 minutes at 72 °C. Resulting PCR products were sequenced using the same PCR primers with BigDye™ terminator (Applied Biosystems, Carlsbad, California, USA). Sequences were deposited in GenBank. GenBank accession numbers and voucher information are provided in Appendix 1. Additional sequence data was retrieved from GenBank based on Murdock (2008a) and Lehtonen et al. (2020) for ingroup and outgroup taxa.

## DNA alignment and phylogenetic analyses

Sequence alignment was performed using MUSCLE (Madeira et al. 2019) and manually corrected using Mesquite 3.61 (Maddison and Maddison 2019). Phylogenetic analyses were performed using PhyML 3.0 (Lefort et al. 2017) and MrBayes 3.2.6 (Ronquist et al. 2012). For the Bayesian analysis, a GTR+I+G model selected by Mr-Modeltest 2.3 based on the Akaike information criterion (Nylander 2004) was used, with 1000000 generations and four parallel chains sampled every 1000 generations, with a discarded burn-in fraction of 0.25. Support for branches was estimated using ML bootstrapping (100 replicates), and Bayesian posterior probability averaged over a majority-rules consensus tree (Fig. 1). Sequence data from each gene region was analyzed separately and concatenated both for substitution model fit and phylogenetic reconstruction. Because of agreement between data sets, both in topology and model selection, the final analysis presented here is based on the full concatenated data set. Outgroup taxa were selected based on previous phylogenetic analyses of marattioid ferns (Murdock 2008a; Liu et al. 2019; Lehtonen et al. 2020).

## Results

Morphological examination of Solomon Islands *Ptisana* collections found that individual plants could be readily sorted into two categories: plants that are consistently 2-pinnate, and those that are consistently 3-pinnate. While superficially quite similar, multiple clear distinctions were found between the 2-pinnate collections from Vanikoro (Santa Cruz Islands) and those from high elevations in the western islands of

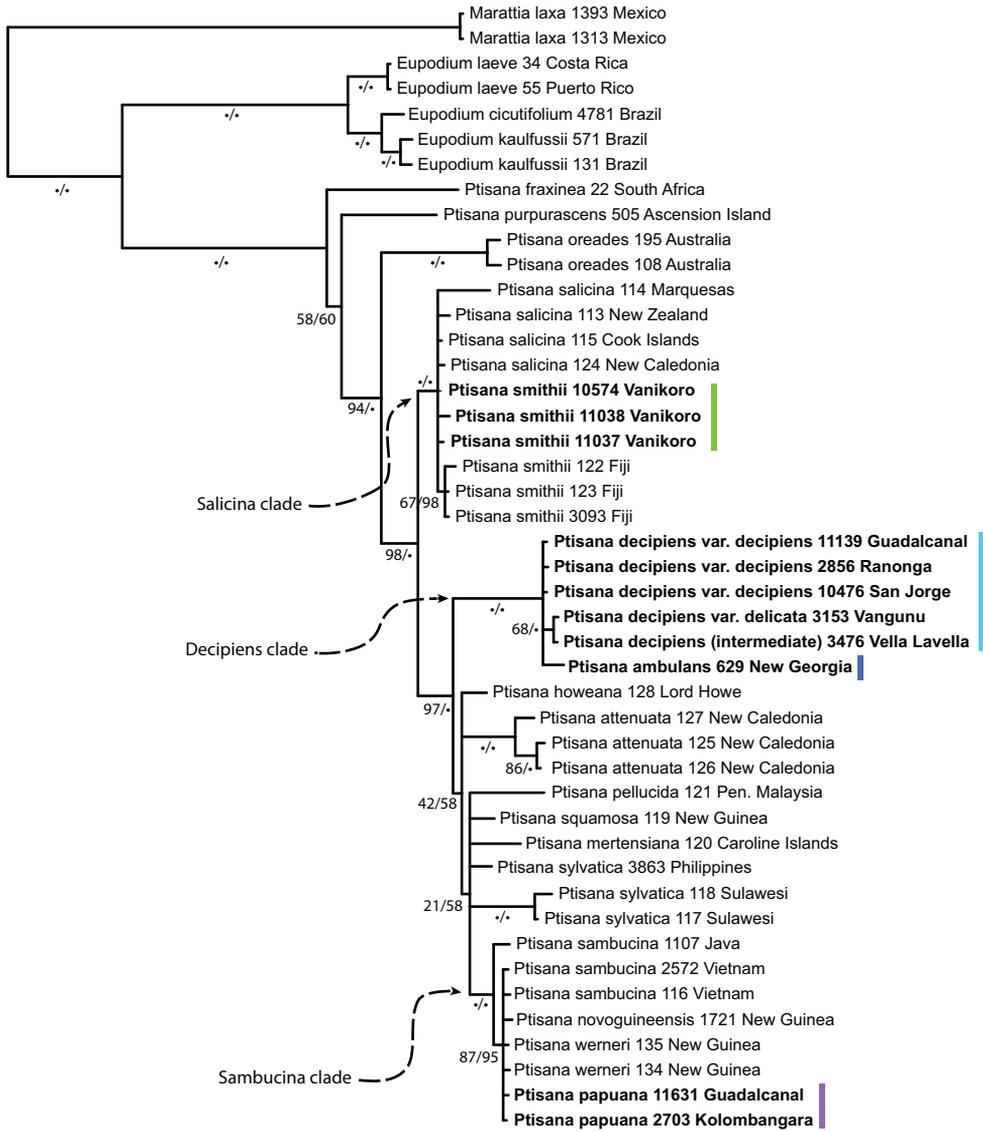
the Solomon Islands. These were identified as *Ptisana smithii* (Mett. ex Kuhn) Murdock and *Ptisana papuana* (Alderw.) Murdock, comb. nov., respectively. The common 3-pinnate collections proved more challenging to identify due to occasional intermediates between plants with small terminal segments and those with large segments. An additional 3-pinnate plant was collected from New Georgia with a suite of characters not observed in the more common forms. Based on comparison with type material and protologues, it became clear that the previous uses of *Ptisana ternatea* and *P. melanesica* were incorrect, and the Solomon Islands specimens could not be matched to any previously described species. It remained unclear how many distinct taxa were present. A full discussion of the morphological distinctions among the Solomon Islands taxa and their identification is included in the taxonomic treatment following this section.

In our molecular investigation, tree topology was consistent between ML and Bayesian analyses, recovering a monophyletic *Ptisana*. While the ML analysis showed finer resolution near the tips in some cases, these branches had uniformly low bootstrap support (<50%). While morphology can vary widely in *Ptisana*, particularly in New Guinea and Malesia, the plastid sequences across the genus are highly similar, even in the non-coding spacer regions used in this analysis, a result that is in line with previous studies (Soltis et al. 2002; Murdock 2008a; Senterre et al. 2014; Lehtonen et al. 2020). Short internal branches and polytomies were the result of limited variation in the selected sequence regions; the variation found, including insertions and deletions, was often phylogenetically uninformative.

Among the plastid sequences from Solomon Islands *Ptisana*, there were five distinct haplotypes which were resolved in three different clades of the *Ptisana* phylogeny (Fig. 2). Sequences from the 2-pinnate species found in Vanikoro, identified based on morphological characters as *P. smithii*, were resolved in the Pacific island Salicina clade (highlighted in green, Fig. 2) with *P. smithii* (type from Aneityum, Vanuatu) and *P. salicina* (type from Norfolk Island). The other 2-pinnate species, identified based on morphology as *P. papuana* (highlighted in purple, Fig. 2) from the western islands, was resolved within a clade of New Guinean taxa notable for their diverse morphologies but highly similar sequences.

Sequences from the 3-pinnate taxa (highlighted in dark blue and light blue, Fig. 2) form a well-supported clade unique to the Solomon Islands, based on current sampling. Within this clade, there are three distinct haplotypes, two corresponding to the common low-elevation taxa with winged costae and no hairs subtending the synangia (including the large-segmented form often identified as *P. ternatea* and the small-segmented form often identified as *P. melanesica*), and one corresponding to a newly collected taxon from New Georgia that lacks wings on its costae and has short, uniseriate hairs subtending the synangia.

Field observations gave the first hint that the winged 3-pinnate taxa might be more similar than they first appear. David Glenney (unpub.) noted that both morphologies were found in the same habitats, never together, occasional intermediate forms were found, and the only distinction was the size of the segments. Sequences from collections with large, small, and intermediate-sized segments (highlighted in



**Figure 2.** Phylogeny of *Ptisana* based on *rps4-trnS* and *trnSGG* plastid sequence data. Bayesian consensus tree, with branch support values (ML bootstrap support / Bayesian posterior probability); • = 100. The four species recognized in the Solomon Islands are marked by colored bars. Key clades discussed in text marked by arrows.

light blue, Fig. 2) were found to be identical or differ by only a single base pair over ~2700 bp. Based on the total evidence from morphological and molecular analyses, we describe the winged 3-pinnate taxa as a new species with two varieties (*Ptisana decipiens* var. *decipiens* and *P. decipiens* var. *delicata*), and the wingless taxon as a new species (*P. ambulans*) (see Taxonomic treatment section).

## Taxonomic treatment

### Terminology

The fused sporangia of *Ptisana* are referred to jointly as a synangium, the chambers of which are referred to as locules. Counts of locules per synangium refer to the entire synangium. The attachment point of the synangium is referred to as the receptacle. Axes of the leaf are referred to as the stipe (stalk below the leaf blade), rachis (main axis of leaf blade), costa (axis of a pinna), costule (axis of a pinnule on 3-pinnate plants), and midrib (axis of ultimate segment). The costule in some species is winged (readily apparent in live material, sometimes obscure in dried specimens). The swollen area at the base of each leaf division is referred to as a pulvinus. All BSIP collections are currently housed at SUVA.

- 1 Fronds 2-pinnate ..... **2**
- Fronds 3-pinnate ..... **3**
- 2 Stipes and laminae with rust-colored scales, synangia submarginal, margins strongly repand, gently serrate except at apex; Santa Cruz Islands ... *P. smithii*
- Stipes with both reddish-orange and darkened scales, synangia submedial-medial, margins lightly repand, conspicuously serrate; upland species, western islands..... *P. papuana*
- 3 Margins entire, serrate only at apex, costulae not winged, ultimate segments ovate, synangia nearly marginal, receptacles inconspicuously hairy, uncommon (New Georgia)..... *P. ambulans*
- Margins gently serrate, costulae winged, ultimate segments oblong acuminate, varying greatly in size from location to location, synangia submarginal, receptacles glabrous, widespread ..... **4** (*P. decipiens*)
- 4 Segments large, ultimate segments 9–18 cm long × 1.5–2.5 cm wide, 14–20 locules per synangium, fronds with 3 pairs of opposite pinnae.....  
..... *P. decipiens* var. *decipiens*
- Segments small, ultimate segments 2.5–5 cm long × 0.5–1 cm wide, 10–16 locules per synangium, fronds with 3–5 pairs of opposite pinnae.....  
..... *P. decipiens* var. *delicata*

***Ptisana ambulans* Murdock & C.W. Chen, sp. nov.**

urn:lsid:ipni.org:names:77213329-1

Figures 3, 6A, F

**Type.** SOLOMON ISLANDS. Vahole, New Georgia Island, Western Province, Solomon Islands. Under forest. 250–350 m. 28 Sep 2012. C.-W. Chen & T.-C. Hsu SITW00629.

**Holotype:** BSIP. **Isotypes:** TAIF [421080], TNM.

**Diagnosis.** Differs from *Ptisana decipiens* in having costae without prominent wings, nearly marginal synangia; ultimate segments ovate (versus elliptic to oblong),



margin entire, serrate only at apex, slightly revolute when dried. Synangia green when immature, brown after opening, one per vein, nearly marginal, set back from leaf margin by ca. 1 mm, ca. 1.5 mm long × 0.8 mm wide, 10–14 locules per synangium (Fig. 3C), receptacles bearing short, uniseriate hairs.

**Etymology.** The epithet *ambulans* (walking) refers to the wingless costae.

**Selected specimens examined.** Only known with certainty from one collection from New Georgia (see type above).

**Habitat and distribution.** Low elevation forest. Altitude range: 250–350 m. Only known with certainty from one population. Solomon Islands (New Georgia).

**Preliminary conservation assessment.** There is currently only one collection and observation of this species, but this is likely due to its similarity to the more widespread *P. decipiens*, and consequent under-collection. It is currently considered Data Deficient (DD) based on IUCN (2012).

**Note.** In the field, this species was thought to be an atypical form of *P. decipiens*, but further examination found that both morphology and sequence data are clearly distinct, and no intermediates have been found. The presence of uniseriate hairs on the receptacle in *P. ambulans* is a character that is common in *Ptisana* but notably absent in *P. decipiens*. The rigid, thickened laminae with tightly spaced veins are reminiscent of *P. rigida* (Alderw.) Murdock, a highland species from West Papua. Together with the fact that the DNA sequences from this taxon contain unique autapomorphies, we consider this taxon sufficiently distinctive to recognize as a species. However, due to the available characters apparent on the one collection, the description here is limited and further observation is needed to supplement our understanding of this species. Examination of other collections from the Solomon Islands and Papua New Guinea have so far found no other collections of this wingless species, but we anticipate that the range likely extends beyond New Georgia.

***Ptisana decipiens* Murdock & C.W. Chen, sp. nov.**

urn:lsid:ipni.org:names:77213330-1

Figures 4A–D, 6B, G

**Type.** SOLOMON ISLANDS. **Guadalcanal:** Logging site near Bomb Load Village, 300–400 m, 16 Aug 2012, C.-W. Chen & T.-C Hsu SITW00130. **Holotype:** BSIP. **Isotypes** TAIF [417070, 417072], TNM.

**Diagnosis.** Differs from *Ptisana ternatea* (de Vriese) Murdock in having glabrous receptacles, synangia that do not extend to the apex of segments, pinnules gradually reducing in size toward the base of pinnae, and pinnule apices not abruptly acuminate. Differs from *Ptisana melanesica* (Kuhn) Murdock in having larger pinnules with submarginal synangia and smaller marginal teeth. The marked variability in size of ultimate segments has not been recorded in any other *Ptisana* species.

**Description.** *Ptisana decipiens* var. *decipiens*: Fronds 3-pinnate, up to 2.5 m long. Stipe up to 1.2 m long, round in cross-section, surface green to brown, darkening with



**Figure 4.** *Ptisana decipiens* var. *decipiens*: **A** type specimen, with characteristically large segments **B** stipe showing scales **C** adaxial surface of fertile segments, showing vein spacing, synangial distance from margin, and winged costa. *Ptisana decipiens* var. *delicata*: **D** type specimen, with characteristically small segments **E** abaxial surface of fertile segment with maturing synangia. Photos: C.-W. Chen.

age, with reddish-blackish scales, the broader scales being darker in color, lenticels raised (Fig. 4B). Fronds bearing 3 pairs of similarly sized pinnae on mature fronds, the terminal pair forking dichotomously at the frond apex, each pinna up to 1 m long. Swollen pulvini present at the base of all segments, green, smooth. Ultimate segments 5–12 pairs per pinnule, alternating on the costulae, largest at apex of each pinnule, smaller at the base, ultimate segments 9–18 cm long  $\times$  1.5–2.5 cm wide, elliptic to oblong with an acuminate apex; pinnule costulae gently zigzagging and clearly winged between segments (Figs 4A, 6G). Laminae herbaceous-coriaceous, dark green above, pale below, with sparse brown-orange scales along the veins and midrib abaxially. Veins free, ca. 1.3 mm apart, rarely dividing once near the midrib (Fig. 6B). Leaf margin gently serrate, more conspicuous at apex. Synangia green when immature, brown after opening, one per vein, submarginal, set back from leaf margin by 1–2 mm, ca. 1.8 mm long  $\times$  0.8 mm wide, 14–20 locules per synangium (Fig. 4C), receptacles glabrous.

**Etymology.** The epithet *decipiens* (deceiving or misleading) refers to the morphological variation that has misled people into thinking two species were present.

**Selected specimens examined.** SOLOMON ISLANDS. **Choiseul:** Sirebe, 128 m, 4 Aug 2014, C.-W. Chen, W.-S. Wu & M. Fanerii SITW05882 (BSIP, TAIF [474134], TNM); **Ranongga:** Qiloe, 400–700 m, 16 Aug 2013, C.-W. Chen, T.-C. Hsu & M. Fanerii, SITW03102 (BSIP, TAIF [448596], TNM); **Guadalcanal:** Vunga Tubu, 100–500 m, 27 Jul 2014, C.-W. Chen, T.-C. Hsu & M. Fanerii, SITW05767 (BSIP, TAIF [472271], TNM); **Malaita:** Mt. Saranifilu, 700–800 m, 30 Jan 2015, H.-C. Hung, C.-W. Chen & M. Fanerii SITW08836 (BSIP, TAIF[501947], TNM); **Makira:** Materato to Mt. Gasi, 910 m, 1 Jul 2015, H.-C. Hung, C.-W. Chen & M. Fanerii SITW06724 (BSIP, TAIF [482700], TNM). PAPUA NEW GUINEA. **Manus Province:** Los Negros, 17 Nov 1944, W.H. Wagner Jr. 3277bis (US [1860271]); **New Ireland:** Ambitle Island, 150 m, 7 Nov 2003, W. Takeuchi 16691 (US [3481228]).

**Habitat and distribution.** Lowland forest, most commonly in gullies, also on hillsides below ridges. Commonly in association with *Angiopteris microura* Copel. Elevation range: 0–1550 m. Common. Solomon Islands (Baga, Choiseul, Guadalcanal, Santa Isabel, Makira, Malaita, Mono, New Georgia, Nggatokae, Nggela Sule, Ranongga, Rendova, San Jorge, Ulawa, Tetepare); Bougainville; New Ireland. A collection from Fergusson Island (10 Nov 76, J.R. Croft 68741, BISH, K, NSW [507470], US [3324251]) may also be this species.

**Preliminary conservation assessment.** Both *P. decipiens* var. *decipiens* and *P. decipiens* var. *delicata* are widespread in the Solomon Islands and their habitat is not currently under significant threat. This species is currently considered Least Concern (LC) based on IUCN (2012).

**Note.** There has been inconsistent use of the infraspecific ranks “subspecies” and “variety” through time, and even different preferences between pteridologists and other taxonomists (Hamilton and Reichard 1992). We follow Yatskievych and Moran (1989), who recommend the use of subspecies in situations specifically involving geographically defined variation. Because of the overlapping ranges of the two taxa

described here, and the presence of intermediate forms, which might indicate hybridization or ongoing diversification, we opted for the rank of variety in this case.

In most cases, the two varieties of *P. decipiens* are easy to distinguish based on segment size, but *P. decipiens* var. *decipiens* also has larger synangia with more locules. Occasional intermediates between the two varieties can be found, notably from Vella Lavella, New Georgia and Santa Isabel (Solomon Islands: Santa Isabel: *D. Glenney* 7211 (BSIP, W); Vella Lavella: 25 Oct 2013 *C.W. Chen, T.-C. Hsu & M. Fanerii* SITW05013 (TAIF [463907], TNM); New Georgia: 13 May 2013, *Y.-H. Chang, W.-H. Wu, C.-F. Chen, C.-H. Hung & M. Fanerii* SITW02317 (BSIP, TAIF [443219], TNM). The habitat of both varieties is the same, but the two varieties have not been observed together in any collection site. The range of the two varieties overlaps, but *P. decipiens* var. *decipiens* is more widespread, while *P. decipiens* var. *delicata* is more common in the Western Province.

The absence of indument on the receptacle is rare in *Ptisana*. This character was the basis for the obsolete genus *Gymnotheca* C.Presl, in which Presl included one species currently recognized in *Ptisana*, *P. mertensiana* (C.Presl) Murdock from the Caroline Islands.

***Ptisana decipiens* var. *delicata* Murdock & C.W. Chen, var. nov.**

urn:lsid:ipni.org:names:77213331-1

Figures 4D, E, 6C, H

**Type.** SOLOMON ISLANDS. **Santa Isabel:** Mt. Kobinitu, 600–1000 m, 16 Jul 2014, *C.-W. Chen, T.-C. Hsu, M. Fanerii* SITW05642. **Holotype:** BSIP. **Isotypes:** TAIF [473020, 473021], TNM.

**Diagnosis.** Differs from *P. decipiens* var. *decipiens* in the small size of ultimate segments, and in bearing more synangia relative to the length of the segment and synangia with fewer locules. Differs from *Ptisana melanesica* (Kuhn) Murdock in having larger pinnules with submarginal synangia, smaller marginal teeth; differs from *Ptisana kingii* (Copel.) Christenh. in having stipes without prickles or other ornamentation and having glabrous receptacles.

**Description.** Fronds 3-pinnate, up to 2 m long. Stipe up to 1 m long, round in cross-section, surface green to brown, darkening with age, with reddish-blackish scales, the broader scales being darker in color, lenticels raised. Fronds bearing 3–5 pairs of similarly sized pinnae on mature fronds, the terminal pair forking dichotomously at the frond apex, each pinna up to 80 cm long. Swollen pulvini present at the base of all segments, green, smooth. Ultimate segments 10–15 pairs per pinnule, alternating on the costulae, largest at apex of each pinnule, smaller at the base, ultimate segments 2.5–5 cm long × 0.5–1 cm wide, elliptic to oblong with an acuminate apex; pinnule costulae gently zigzagging and clearly winged between segments (Fig. 4D, 6H). Laminae herbaceous-coriaceous, dark green above, pale below, with sparse brown-orange scales along the veins and midrib abaxially. Veins free, ca. 1 mm apart, rarely

dividing once near the midrib. Leaf margin gently serrate, more conspicuous at apex (Fig. 6C). Synangia green when immature, brown after opening, one per vein, submarginal, set back from leaf margin by ca 1 mm, ca. 1.2 mm long × 0.7 mm wide, 10–16 locules per synangium (Fig. 4E), receptacles glabrous.

**Selected specimens examined.** SOLOMON ISLANDS. **Guadalcanal:** Popomanaseu, 1300–1750 m, 11 Sep 2015, *H.-C. Hung, T.-C. Hsu & M. Fanerii SITW09774* (BSIP, TAIF [515246, 515247], TNM); **New Georgia:** Vahole, 250–100 m, 25 Sep 2012, *C.-W. Chen SITW00523* (BSIP, TAIF [421034], TNM); **Vangunu:** Zaira Village to Mt. Vangunu camp site, 70–320 m, 5 Oct 2013, *C.-W. Chen, T.-C. Hsu & M. Fanerii SITW03734* (BSIP, TAIF [451625], TNM); **Rendova:** Ugehele village, 700–1000 m, 26 Aug 2013, *C.-W. Chen, T.-C. Hsu & M. Fanerii SITW03381* (BSIP, TAIF [448701], TNM); **Kolombangara:** Ringgi, KFPL Nature Trail, 13 Aug 1991, *D. Glenny 3177* (BSIP [22031], W [P017081]). PAPUA NEW GUINEA. **Bougainville:** Korpei, 570 m, 1 Nov 1961, *D.H. Nicolson 1531* (B, US [2415719]).

**Etymology.** The epithet *delicata* (delicate) refers to the less robust appearance of this variety.

**Habitat and distribution.** Solomon Islands (Choiseul, Guadalcanal, Kolombangara, Santa Isabel, New Georgia, Nggatokae, Rendova); Bougainville. Lowland forest, most commonly in gullies, also on hillsides below ridges. Commonly found in association with *Angiopteris microura* Copel. Altitude range: 0–1550 m. Common. More common in the western islands (Western Province).

**Preliminary conservation assessment.** As with the overall species, *P. decipiens* var. *delicata*, is widespread in the Solomon Islands and its habitat is not currently under significant threat. It is currently considered Least Concern (LC) based on IUCN (2012).

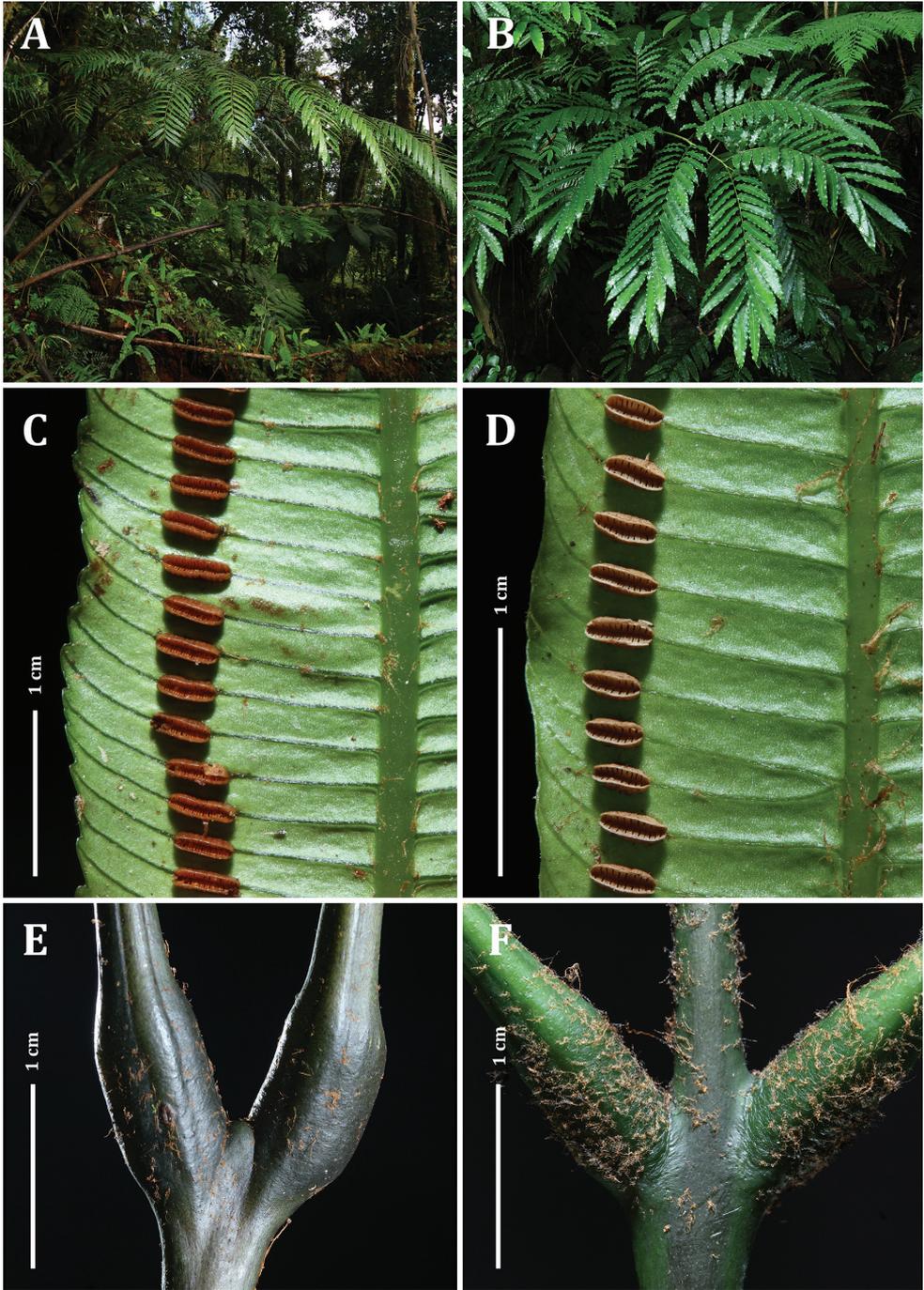
***Ptisana papuana* (Alderw.) Murdock & C.W. Chen, comb. nov.**

urn:lsid:ipni.org:names:77213332-1

Figures 5A, C, E, 6D, I

*Marattia papuana* Alderw., Bull. Jard. Bot. Buitenzorg, sér. 2, 23: 17. 1916. Type: New Guinea. Constantinhafen: *Hollrung 613* (holotype: BO, photo BM!; isotype: BM!).

**Description.** Fronds 2-pinnate, 2.4–4.0 m long, Stipe 1.5–2.0 m long, 3–6 cm diameter at the base, circular in cross-section, slightly flattened on the dorsal side, surface brown to greenish-black, densely matted with lacerate rusty orange-red scales at the base, mixed with occasional dark, undivided scales. Fronds bearing 6–8 pairs of pinnae, well-spaced on the rachis, the terminal pair forking dichotomously at the frond apex, proximal pinnae reduced in size (Fig. 5A). Swollen pulvini present at the base of all segments, dark, often with a dorsal ridge (Fig. 5E). Ultimate segments 15–18 cm long × 1.7–2.5 cm wide, narrowly oblong, base rounded but asymmetric, more cuneate acroscopically, apex acuminate (Fig. 6I). Laminae texture thick, dark green above, pale below, with occasional ragged orange scales along the veins and midrib abaxially.



**Figure 5.** Comparison of *Ptisana papuana* (left column) and *Ptisana smithii* (right column) **A, B** whole plants *Ptisana smithii* **B** showing its distinctively repand margins **C, D** fertile segments with mature synangia. *Ptisana papuana* (left) has longer synangia that reach nearly the midpoint between the margin and the midrib, and conspicuously serrate margins **E, F** Pulvini, closeup.

Veins free, ca. 1.3 mm apart, rarely dividing once near the midrib. Leaf margin strongly serrate, more pronounced at the apex, gently repand (Fig. 6D). Syngangia submedial-medial, 2.0 mm long × 0.9 mm wide, 16–24 locules per syngangium (Fig. 5C), receptacle bearing short hairs.

**Selected specimens examined.** SOLOMON ISLANDS. **Kolombangara:** Camp 3 to Mt. Veve, 1500–1790 m, 15 Oct 2013, *C.-W. Chen, T.-C. Hsu & M. Fanerii SITW04892* (BSIP, TAIF [465293], TNM); **Makira:** Materato to Mt. Gasi, 910 m, 1 Jul 2015, *C.-W. Chen, H.-C. Hung & M. Fanerii SITW06913* (BSIP, TAIF [482836], TNM); **Rendova:** Ugehele Village, 700–1000 m, 26 Aug 2013, *C.-W. Chen, T.-C. Hsu & M. Fanerii SITW03385* (BSIP, TAIF [448705], TNM); Ugehele, Rendova Peak, 11 Sep 1991, *D. Glenny 3234* (BSIP [21770], W [P017133]). PAPUA NEW GUINEA. **Madang Province:** Constantinhafen, 1887, *M.U. Holhrung 613* (BM); **Manus Province:** Manus Island, Falls of Lorengau River, Nov 1945, *D.F. Grether & W.H. Wagner Jr. 4130* (UC [UC728759], US [1918547]); **Milne Bay Province:** Misima Island, Mt. Oia-Tau, 700 m, 27 Mar 1979, *J.R. Croft 71409* (US [3341352]).

**Habitat and distribution.** Montane forest, in gullies and on hillslopes. Altitude range: 810–1550 m. Uncommon. Solomon Islands (Kolombangara, Makira, Rendova); eastern Papua New Guinea, Misima and Manus Island.

**Preliminary conservation assessment.** *Ptisana papuana* is uncommon in the Solomon Islands, but its habitat is not currently under significant threat, and additional populations exist in Papua New Guinea. It is currently considered Least Concern (LC) based on IUCN (2012).

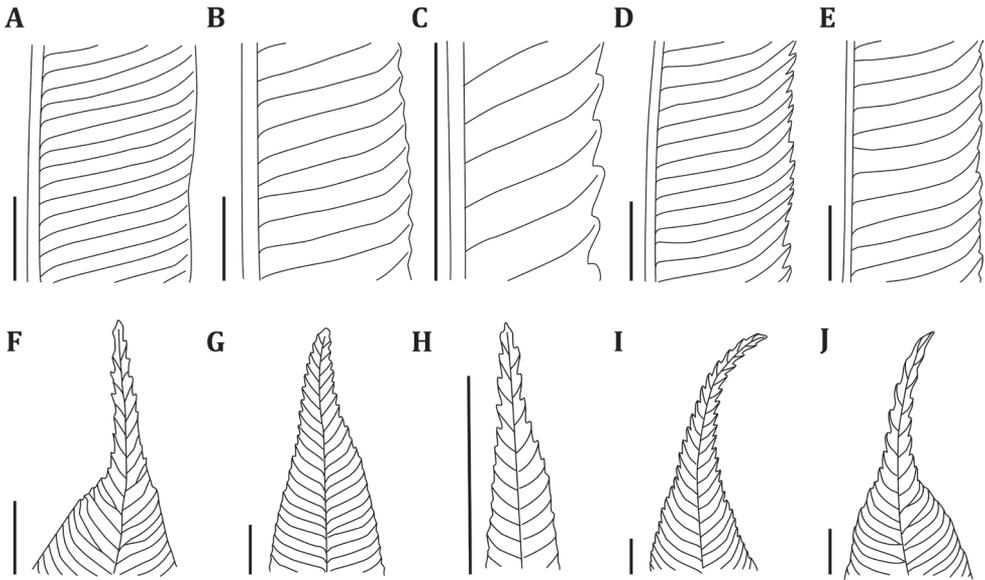
**Note.** This species has been previously identified as both *Ptisana smithii* (Mett. ex Kuhn) Murdock (type from Vanuatu) and *Marattia andaiensis* Alderw. (type from eastern Papua New Guinea). Molecular analysis confirms that this is not related to *P. smithii* but is instead nested in the Sambucina clade (Fig. 2), with Malesia/New Guinea affinities. After comparison with the type specimen and the protologue of *M. andaiensis*, Solomon Islands material is a better match instead for *Marattia papuana* Alderw., described in the same publication (Van Alderwerelt Van Rosenbergh 1916). *Marattia andaiensis* is white spotted on the underside of the pinnules, has a frond that is broadest in the middle, with smaller, submarginal sori. The type collection of *Marattia papuana* was originally identified as *Marattia smithii*, a confusion echoed in the Solomon Islands.

### *Ptisana smithii* (Mett. ex Kuhn) Murdock

Figures 5B, D, F, 6E, J

*Marattia smithii* Mett. ex Kuhn, Verh. K.K. Zool.-Bot. Ges. Wien 19: 584. 1869 (lectotype, designated by Murdock 2008b, pg. 748: Aneiteum, New Hebrides, Dec 1858, *Herus 5* (lectotype: P!; isolectotype: GH!)).

**Description.** Fronds 2-pinnate, up to 2.5 m long. Stipe up to 1.2 m long, 2–4 cm diameter at the base, circular in cross-section, surface dark brown to blackish-green,



**Figure 6.** Comparison of venation and margins (**A–E**) and apices of ultimate segments (**F, G**) of the *Ptisana* species in the Solomon Islands **A, F** *P. ambulans* **B, G** *P. decipiens* var. *decipiens* **C, H** *P. decipiens* var. *delicata* **D, I** *P. papuana* **E, J** *P. smithii*. Scale bars: 5 mm.

lighter around lenticels, with lacerate rusty scales mixed with broader brown-black scales, base of stipe bearing dense broad brown scales. Fronds bearing 5–8 pairs of pinnae, opposite to subopposite and well-spaced on the rachis, with a single terminal pinna or forking dichotomously at the frond apex, the proximal pinnae somewhat reduced in size (Fig. 5B). Swollen pulvini present at the base of all segments, pulvini of primary division often with a dorsal ridge, smooth and with a lighter color on secondary divisions (Fig. 5F). Ultimate segments 15–20 cm long  $\times$  2–2.5 cm wide, narrowly oblong, base rounded but asymmetric, more cuneate acroscopically, apex acuminate (Fig. 6J). Laminae coriaceous, dark green above, pale below, with sparse tan scales along the veins and midrib abaxially. Leaf margin lightly serrate, often strongly repand. Veins simple, ca. 1.5 mm apart, rarely dividing once near the midrib, curving toward the apex on the marginal side of each synangium (Fig. 6E). Synangia submarginal, 2.0 mm long  $\times$  0.8 mm wide, 16–20 locules per synangium (Fig. 5D), receptacles bearing short hairs.

**Selected specimens examined. SOLOMON ISLANDS. Vanikoro:** Rain forest, 100 m, 1928, *S.F. Kajewski* 677 (F, UC [UC422670, UC1007994], MICH [1177187], US [1916159]); Ngarabu camp, 120–600 m, 17 Jun 2016, *C.-W. Chen & T.-C. Hsu & M. Fanerii* SITW10574 (BSIP, TAIF [498575, 520559], TNM); Airport to Uleule River, 20–250 m, 20 Jun 2016, *C.-W. Chen & T.-C. Hsu & M. Fanerii* SITW11037 (BSIP, TAIF [498870, 498871, 498872, 498873, 498874], TNM). **VANUATU. Aneityum:** Southeast, 200 m, 26 Jul 1971, *M. Schmid* 3905 (L). **Fiji. Rewa Province:** Suva city, I-Suva Forest Park, 17 Sep 2013, *C.-W. Chen* Wade3093 (TAIF [439749, 439750, 439751, 439752]).

**Habitat and distribution.** Lowland forest, growing along streams and steep hillsides. Solomon Islands: Vanikoro, likely to be found on Nendo; Vanuatu; Fiji; Tonga; Samoa.

**Preliminary conservation assessment.** *Ptisana smithii* is only known from collections from Vanikoro in the Solomon Islands, but it is widespread in adjacent island groups. It is currently considered Least Concern (LC) based on IUCN (2012).

**Note.** The Santa Cruz group is the northern limit of the range of this species. The *Salicina* clade (Fig. 2), which includes *P. smithii*, is in need of revision. There are clear sequence and morphological differences from archipelago to archipelago across the Pacific. The Fijian collection sequenced for this study had synangia that were more medial than those from the Solomon Islands. Brownlie (1977) described Fijian species as having alternate pinnae, but examination of collections and photographs shows that Fijian plants have opposite or subopposite pinnae as observed in the Solomon Islands. We are retaining the use of the name *P. smithii* here because the morphology agrees so closely with collections from Vanuatu, the type locality, and we anticipate that future work will likely split *P. salicina* into a number of geographically distinct taxa.

## Discussion

The challenges of interpreting morphology in *Ptisana* are exemplified in the results of this regional study: morphology and sequence data can tell two different stories. Phenotypes that appear highly similar (e.g., *P. smithii* and *P. papuana*) can be distantly related according to sequence data, while phenotypes that appear to be quite divergent can be sequence-identical or nearly so (e.g., the small- and large-segmented forms of *P. decipiens*). In short, morphology is not sufficient for clarifying the taxonomy of the genus, and in some cases can be positively misleading. Rosenstock (1908) named the subgenus *Mesocarpus* after the position of the synangia proximate to the midrib in the tiny-segmented species *Ptisana weneri*. According to sequence data, *P. weneri* is scarcely different from other species with a range of synangial attachment points and both large and small segments. A combination of morphology, sequence data, and field observations was required to clarify the identities and taxonomy of Solomon Island *Ptisana*; the same will likely hold true for other regions and clades.

Based on current sampling, the *Decipiens* clade (Fig. 2) appears to be endemic to the Solomon Islands and nearby islands. Examination of herbarium specimens from eastern Papua New Guinea located no matching collections from the main island. While clearly distinct from *P. ternatea* from the Maluku islands, collections from near its type locality have not yet been included in molecular analyses, so it remains to be seen whether it is related to the *Decipiens* clade. This is a young clade that appears to be in the midst of diversification within the Solomon Islands.

The results from this study point to several groups that need additional sampling and study in the future, notably: (1) the *Sambucina* clade (Fig. 2), which includes the small-segmented forms from New Guinea that were lumped into *P. melanesica* by Murdock (2008b), as well as the more widespread Malesian species *P. sambucina*;

(2) the Salicina clade from the South Pacific is a well-supported monophyletic group including both *P. salicina* and *P. smithii*, but it contains more than two distinct genotypes and phenotypes, and there is currently no available sequence data from either type locality; (3) *P. attenuata* from New Caledonia appears to contain some cryptic diversity and bears closer scrutiny; and (4) one of the most common Malesian species, *P. sylvatica*, requires more collection and comparative sequencing across its range.

## Acknowledgements

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## Appendix I

GenBank Accession Numbers. Taxon name, origin (ID in Fig. 2), *rps4-trnS*, *trnSGG*. Missing data –. Sequences isolated from complete plastid genomes only list one accession number. Voucher details are provided for sequences generated by this study.

- Eupodium cicutifolium* (Kaulf.) Lehtonen, Brazil (4781) (MN412590.1)
- Eupodium laeve* (Sm.) Murdock, Costa Rica (34) (EU439104.1, EU439186.1)
- Eupodium laeve* (Sm.) Murdock, Puerto Rico (55) (EU439107.1, EU439189.1)
- Eupodium kaulfussii* (J. Sm.) J. Sm. in Hook., Brazil (131) (EU439106.1, EU439188.1)
- Eupodium kaulfussii* (J. Sm.) J. Sm. in Hook., Brazil (571) (MN412589.1)
- Marattia laxa* Kunze, Mexico (1313) (MN412591.1)
- Marattia laxa* Kunze, Mexico (1393) (EU439112.1, EU439194.1)
- Ptisana ambulans* Murdock & C.W. Chen, Solomon Islands, New Georgia (629) (MW051627, MW051612), Voucher: SITW00629 (TAIF, TNM, BSIP)
- Ptisana attenuata* (Labill.) Murdock, New Caledonia (125) (EU439125.1, EU439206.1)
- Ptisana attenuata* (Labill.) Murdock, New Caledonia (126) (EU439126.1, EU439207.1)
- Ptisana attenuata* (Labill.) Murdock, New Caledonia (127) (EU439127.1, EU439208.1)
- Ptisana decipiens* var. *decipiens* Murdock & C.W. Chen, Solomon Islands, Ranongga (2856) (MW051625, MW051610), Voucher: SITW03102 (TAIF, TNM, BSIP)

- Ptisana decipiens* var. *decipiens* Murdock & C.W. Chen, Solomon Islands, San Jorge (10476) (MW051626, MW051611), Voucher: SITW10476 (TAIF, TNM, BSIP)
- Ptisana decipiens* var. *decipiens* Murdock & C.W. Chen, Solomon Islands, Guadalcanal (11139) (MW051622, MW051607), Voucher: SITW11139 (TAIF, TNM, BSIP)
- Ptisana decipiens* Murdock & C.W. Chen, Solomon Islands, Vella Lavella (3476 intermediate) (MW051624, MW051609), Voucher: SITW05013 (TAIF, TNM, BSIP)
- Ptisana decipiens* var. *delicata* Murdock & C.W. Chen, Solomon Islands, Vangunu (3153) (MW051623, MW051608), Voucher: SITW03734 (TAIF, TNM, BSIP)
- Ptisana fraxinea* (Sm.) Murdock, South Africa (22) (EU439131.1, EU439212.1)
- Ptisana howeana* (W.R.B. Oliver) Murdock, Lord Howe Island (128) (EU439128.1, EU439209.1)
- Ptisana mertensiana* (C.Presl) Murdock, Caroline Islands (120) (EU439120.1, EU439201.1)
- Ptisana novoguineensis* (Rosenst.) Murdock, New Guinea (1721) (MN412592.1)
- Ptisana oreades* (Domin) Murdock, Australia (108) (EU439129.1, EU439210.1)
- Ptisana oreades* (Domin) Murdock, Australia (195) (EU439130.1, EU439211.1)
- Ptisana papuana* (Alderw.) Murdock & C.W. Chen, Solomon Islands, Kolombangara (2703) (MW051636, MW051621), Voucher: Wade2703 (TAIF, TNM, BSIP)
- Ptisana papuana* (Alderw.) Murdock & C.W. Chen, Solomon Islands, Guadalcanal (11631) (MW051635, MW051620), Voucher: SITW11631 (TAIF, TNM, BSIP)
- Ptisana pellucida* (C.Presl) Murdock, Malaysia (121) (EU439121.1, EU439202.1)
- Ptisana purpurascens* (de Vriese) Murdock, Ascension Island (505) (EU439132.1, EU439213.1)
- Ptisana salicina* (Sm.) Murdock, New Zealand (113) (EU439113.1, EU439195.1)
- Ptisana salicina* (Sm.) Murdock, Marquesas (114) (EU439114.1, EU439196.1)
- Ptisana salicina* (Sm.) Murdock, Cook Islands (115) (EU439115.1, EU439197.1)
- Ptisana salicina* (Sm.) Murdock, New Caledonia (124) (EU439124.1, EU439205.1)
- Ptisana sambucina* (Blume) Murdock, Vietnam (116) (EU439116.1, –)
- Ptisana sambucina* (Blume) Murdock, Java (1107) (MW051634, MW051619), Voucher: Wade1107 (TAIF)
- Ptisana sambucina* (Blume) Murdock, Vietnam (2572) (MW051633, MW051618), Voucher: Wade2572 (TAIF)
- Ptisana smithii* (Mett. ex Kuhn) Murdock, Fiji (122) (EU439122.1, EU439203.1)
- Ptisana smithii* (Mett. ex Kuhn) Murdock, Fiji (123) (EU439123.1, EU439204.1)
- Ptisana smithii* (Mett. ex Kuhn) Murdock, Fiji (3093) (MW051628, MW051613), Voucher: Wade3093 (TAIF)
- Ptisana smithii* (Mett. ex Kuhn) Murdock, Solomon Islands, Vanikoro (10574) (MW051630, MW051615), Voucher: SITW10574 (TAIF, TNM, BSIP)
- Ptisana smithii* (Mett. ex Kuhn) Murdock, Solomon Islands, Vanikoro (11038) (MW051631, MW051616), Voucher: SITW11038 (TAIF, TNM, BSIP)
- Ptisana smithii* (Mett. ex Kuhn) Murdock, Solomon Islands, Vanikoro (11037) (MW051629, MW051614), Voucher: SITW11037 (TAIF, TNM, BSIP)
- Ptisana squamosa* (Christ) Murdock, New Guinea (119) (EU439119.1, EU439200.1)

*Ptisana sylvatica* (Blume) Murdock, Indonesia, Sulawesi (117) (EU439117.1, EU439198.1)

*Ptisana sylvatica* (Blume) Murdock, Indonesia, Sulawesi (118) (EU439118.1, EU439199.1)

*Ptisana sylvatica* (Blume) Murdock, Philippines (3863) (MW051632, MW051617),  
Voucher: Wade3836 (TAIF)

*Ptisana weneri* (Rosenst.) Christenh., New Guinea (134) (EU439135.1, –)

*Ptisana weneri* (Rosenst.) Christenh., New Guinea (135) (EU439134.1, EU439214.1)



# Two new species of *Fargesia* (Poaceae, Bambusoideae) from southwestern China

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## Abstract

Two new species of *Fargesia*, one from Xizang (Tibet) and one from Yunnan, China, are described and illustrated. *Fargesia viridis* D.Z. Li & X.Y. Ye is characterized by its densely white powder, nearly solid internodes, yellow setose sheath scar and culm sheaths, and 4–6 leaves of large size. *Fargesia purpurea* D.Z. Li & X.Y. Ye has thinner culms (0.5–1.4 cm in diameter), a ring of 4–5 mm tall brown setae below nodes, fewer branches, glabrous sheath scar and culm sheaths, differentiated from the related species.

## Keywords

*Fargesia*, new species, southwestern China, taxonomy, temperate woody bamboos

## Introduction

Tribe Arundinarieae, i.e. the temperate woody bamboos, is one of the three tribes of the subfamily Bambusoideae (Poaceae), containing approximately 581 species in 31 genera (Bamboo Phylogeny Group 2012; Clark et al. 2015; Clark and Oliveira 2018). These bamboos are distributed primarily in the temperate to subtropical zones of the Northern Hemisphere, with nearly 90% of species distributed in East Asia (Ohrnberger 1999; Li et al. 2006).

Among the 31 genera, *Fargesia* Franchet is the largest one, consisting of more than 90 species (Li et al. 2006; Yi et al. 2008), out of which, 85 species occur in China and

83 taxa are endemic to the country (Vorontsova et al. 2016). The *Fargesia* species are mainly distributed in temperate mountain areas (alt. 800–4300 m) of East Asia (Keng 1987; Yi 1988; Ohrnberger 1999; Li et al. 2006; Vorontsova et al. 2016). This group is especially common and diverse in the high elevation ecosystem of southwest China where they have undergone rapid diversification associated with the orogeny of the Hengduan mountains (Ye et al. 2019).

*Fargesia* is characterized by the presence of short-necked pachymorph rhizomes (usually < 20 cm), unicaespitose clumps, 7–15 branches at mid-culm nodes, semelaucent inflorescence, racemose to paniculate, compressed or open, with 3 stamens (Li et al. 2006). Although reproductive features are important for bamboo classification, vegetative morphological characters are usually used to distinguish species due to long flowering cycles (Janzen 1976; Zhang and Ren 2016). Based on morphological characters of buds and culm sheaths, Yi (1988) divided the genus *Fargesia* into two sections, *F. sect. Ampullares* Yi and *F. sect. Fargesia* (Keng and Wang 1996). The section *Ampullares* is distinguished by compound buds consisting of multiple distinct buds and deciduous culm sheaths. The section *Fargesia* is characterized by compound buds composed of several obscure buds and late deciduous or persistent culm sheaths, and contains four series, namely, ser. *Murielae* Yi, ser. *Fargesia* Yi, ser. *Angustissimae* Yi and ser. *Yunnanenses* Yi. The series *Murielae* has oblong or narrowly elliptical culm sheaths, with rounded apex, as wide as the base, while in the latter three series, the shape of culm sheaths is different and featured as narrowly triangular or narrowly orbicular-triangular, apex triangular or linear, much narrower than the base. Moreover, the texture and length of culm sheaths are varied in these three series. For example, the culm sheaths of ser. *Fargesia* and ser. *Angustissimae* are longer than internodes, but shorter or equal in ser. *Yunnanenses*. The culm sheaths of ser. *Fargesia* are apically leathery and narrowed for distal ca. 1/5 of length but apically thickly papery and narrowed for distal ca. 1/3–1/2 of length for species of ser. *Angustissimae*.

Although flowering is not frequent in this genus, it shows considerable diversity in vegetative morphology and many new species continue to be described (Yi 2000a, Yi 2000b, Yi 2000c; Yi et al. 2005, 2006; Yi et al. 2007; Yang and Yi 2013a, Yang and Yi 2013b) from southwest China. During floristic surveys of bamboos between 2015 and 2018, the authors collected vast specimens of *Fargesia* from southwest China. After scrutiny of the data available (Keng and Wang 1996; Li et al. 2006; Yi et al. 2008; Vorontsova et al. 2016), we found that several specimens could not be assigned to any described species. Here, we described two new species of *Fargesia* based on morphological comparison and the phylogenetic results (Ye et al. 2019).

## Materials and methods

Observation and measurement of morphological characters were undertaken using living plants in the field and specimens in the lab. Morphological features of related species were obtained from specimens and literature (Keng and Wang 1996; Li et al. 2006; Yi et al. 2008).

## Taxonomic treatment

### *Fargesia viridis* D.Z. Li & X.Y. Ye, sp. nov.

urn:lsid:ipni.org:names:77213334-1

Figs 1, 2

**Diagnosis.** *Fargesia viridis* D.Z. Li & X.Y. Ye resembles *F. frigidis* Yi, *F. zayuensis* Yi and *F. similaris* Hsueh & Yi, but can be distinguished from *F. frigidis* by thinner and glabrous culm, more leaves on the ultimate branch, longer leaf sheath and large leaf blade, from *F. zayuensis* by shorter and thinner culm, solid internode, more leaves on the ultimate branch and broader leaf blade, and from *F. similaris* by solid internode, prominent sheath scar, setose culm sheath, glabrous petiole, more leaf number and larger leaf blade.

**Type.** CHINA, Yunnan, Gongshan County, along the road to Dulongjiang Town, 27°51'28"N, 98°26'46"E, 2667 m alt., 1 September 2015, X.Y.Ye YXY272 (holotype & isotype: KUN!).

**Description.** Rhizomes pachymorph, rhizome neck 3–6 cm long, 1–1.6 cm in diameter, solid. Culms 2–3 (4) m tall, pluricaespitose, 0.6–1.2 cm in diameter; internodes terete, 16–22 (30) cm long, densely white powdery and black when culms old, glabrous, nearly solid; nodes with weakly prominent supra-nodal ridge; sheath scar prominent, initially brown setose, with persistent remains of sheath base. Branches 8–10, fascicular, open; buds oblong, margins yellow-brown ciliolate. Culm sheaths persistent or tardily deciduous, leathery, narrowly rounded, 1/3 as long as internodes, yellow setose, densely at base and readily deciduous, longitudinal ribs prominent, margins yellow ciliolate, apex asymmetrical; auricles absent; oral setae absent or 1–2, ca. 2 mm long; ligule concave or truncate, ca. 1 mm tall, glabrous, fissured; blades erect or reflexed, linear-lanceolate, glabrous, narrower than the apex of culm sheath. Foliage leaves 4–6 per ultimate branch; sheath 3–4 cm long, glabrous, purple, margins ciliolate; auricles and oral setae absent; ligule truncate, ca. 1 mm tall; petiole 1–3 mm long, glabrous; blade lanceolate, 4–9 × 0.7–1.4 cm, glabrous, base broadly cuneate, secondary veins 2–3 pairs, transverse veins conspicuous, margins serrate. Inflorescence unknown.

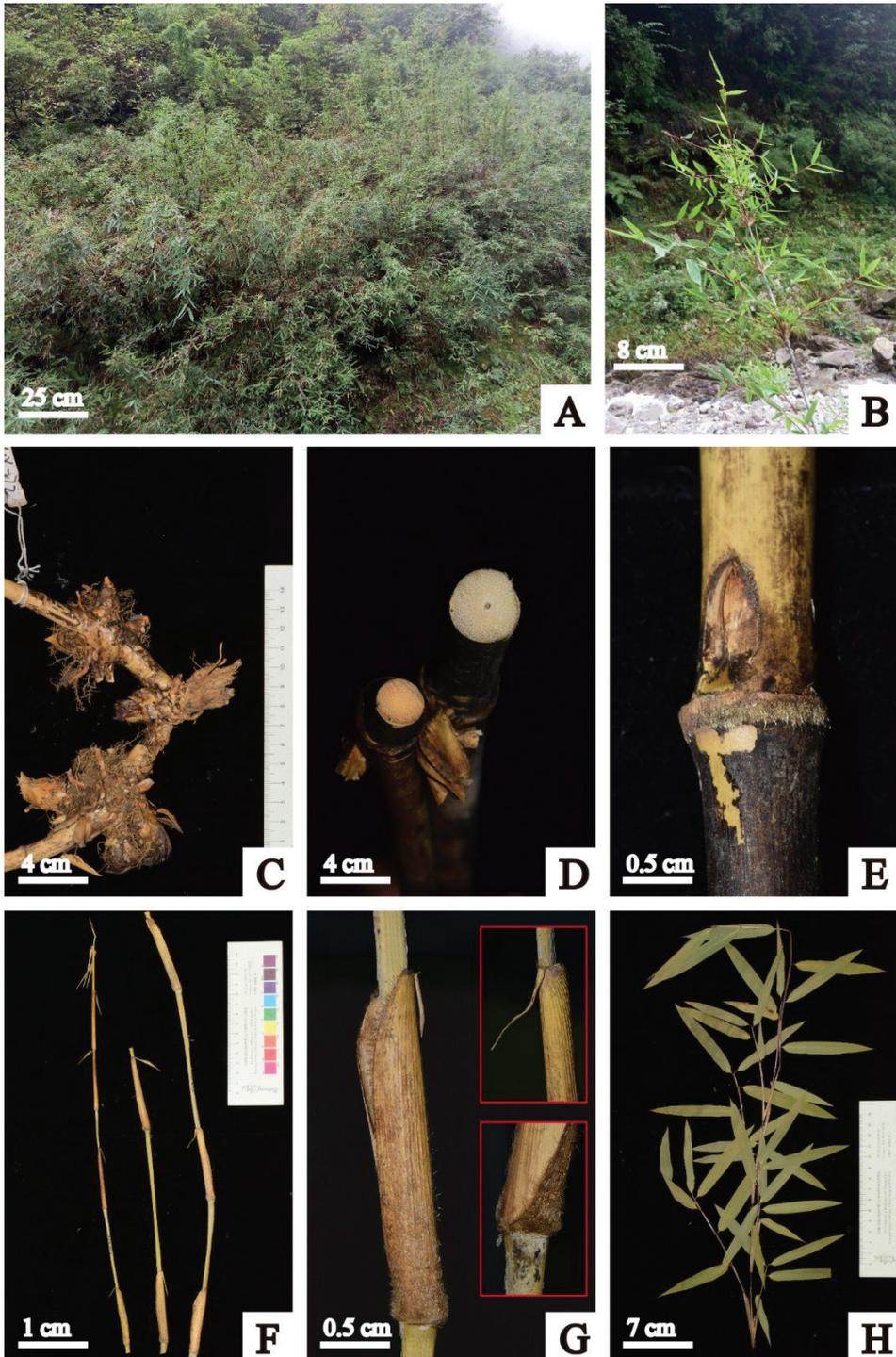
**Phenology.** New shoots July to August.

**Etymology.** The specific epithet refers to the beautiful color of leaf blade.

**Vernacular name.** Cù Lǜ Jiàn Zhú (Chinese pronunciation); 翠绿箭竹 (Chinese name).

**Distribution and habitat.** *Fargesia viridis* is only known from the type locality, the Dulongjiang Town. It occurs along the stream and grows as pure bamboo forest or under the evergreen broadleaved forest at an elevation of 2600–2800 m alt.

**Notes.** Morphological comparisons between *Fargesia viridis* and the related species were provided in Table 1. Other four species of this genus were found in the Dulongjiang Town, i.e., *F. declivis* Yi, *F. sagittatinea* Yi, *F. acuticontracta* Yi and *F. praecipua* Yi, with this new species being easily distinguished from the other species in this region by its shorter and thinner culms, solid internodes (except *F. acuticontracta*), and shorter culm sheath (only 1/3 as long as internode).



**Figure 1.** *Fargesia viridis* D.Z. Li & X.Y. Ye **A** habitat **B** individual **C** rhizome **D** culm showing solid and nearly solid internodes **E** culm bud and sheath scar with yellow setose **F** young culms with culm sheaths **G** culm sheath showing densely setose at base and oral characters **H** branchlet.



**Figure 2.** *Fargesia viridis* D.Z. Li & X.Y. Ye **A** branchlet **B** rhizome **C** node, showing branches and sheath scar with setose **D** young culm with culm sheaths **E, F** culm leaves showing sheath and densely setose at base **G** culm buds.

***Fargesia purpurea* D.Z. Li & X.Y. Ye, sp. nov.**

urn:lsid:ipni.org:names:77213335-1

Figs 3–5

**Diagnosis.** *Fargesia purpurea* D.Z. Li & X.Y. Ye resembles *F. pauciflora* (Keng) Yi and *F. brevipedis* Yi, but can be distinguished from the former by thinner and taller culms,

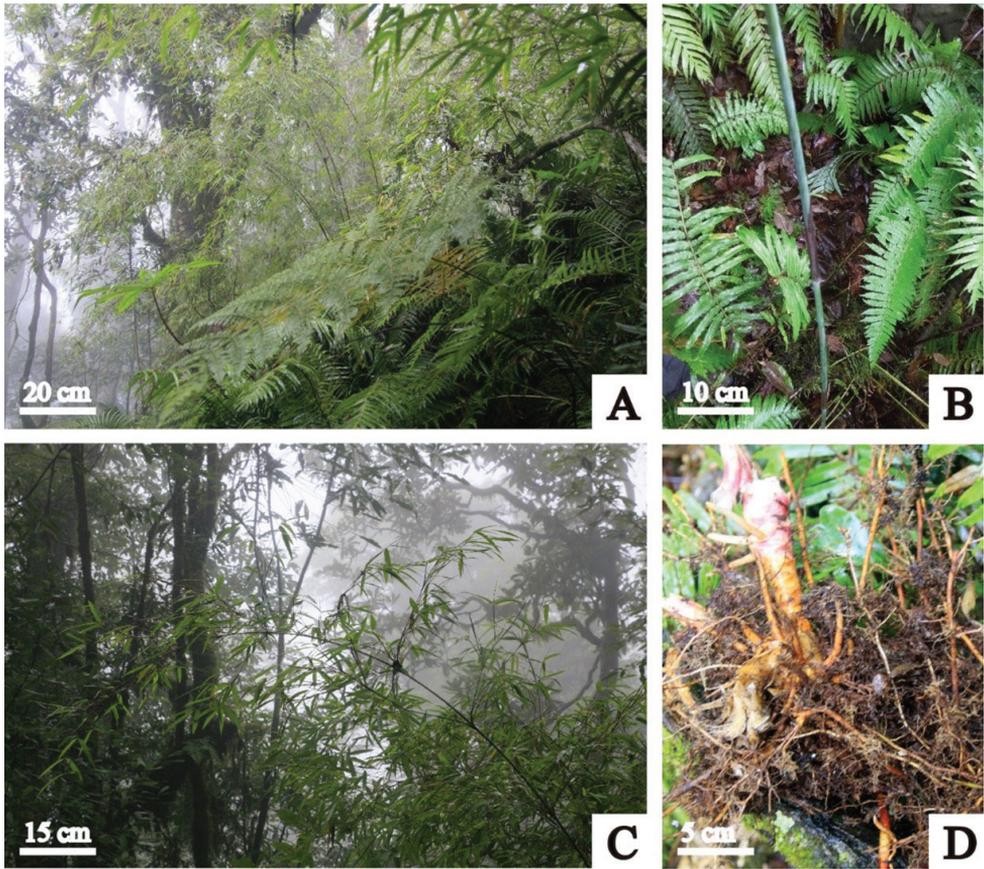
**Table 1.** Morphological comparison of *Fargesia viridis* and its related species.

| Characters                         | <i>Fargesia viridis</i>   | <i>Fargesia frigidis</i>   | <i>Fargesia zayuensis</i>   | <i>Fargesia similaris</i>  |
|------------------------------------|---|--|---|--|
| Culm height                        | 2–3 (4) m   | 1.5–3.5 m  | 6 m   | Shrubby  |
| Culm diameter                      | 0.6–1.2 cm  | 1–1.7 cm   | 0.8–1.5 cm  | 0.8–1.2 cm   |
| Internode                          | 16–22 (30) cm long, densely white powdery, glabrous, nearly solid   | 22–24 cm long, initially densely white waxy and white-gray setose below nodes, glabrescent, nearly solid   | 25–35 cm long, initially sparsely white powdery; hollow, wall 1.5–2 mm thick              | 9.5–18.2 cm long, white or black powdery below nodes, wall 2–3 mm thick, cavity filled with lamellate pith |
| Branch complement                  | 8–10  | 4–13   | 5–10  | 3–8(15)  |
| Sheath scar                        | Prominent, initially yellow setose, with persistent remains of sheath base  | Very prominent, woody  | Prominent   | Weakly prominent   |
| Culm sheath                        | Persistent or tardily deciduous, yellow setose and densely at base, readily deciduous, longitudinal ribs prominent, margins yellow ciliate, apex asymmetrical | Gradually deciduous to persistent, very sparsely appressed light yellow setulose, upper margins yellow–brown ciliate initially, longitudinal ribs conspicuous, apex asymmetrical | Gradually deciduous, abaxially slightly gray-brown setulose, margins brown ciliate or not | Glabrous, margins densely ciliate, apex slightly white powdery   |
| Culm sheath oral setae             | Absent or 1–2, 2 mm long  | Absent   | Readily deciduous   | Absent or 1–3  |
| Culm sheath ligule                 | Concave or truncate, ca. 1 mm   | Convex or truncate, 1–1.5 mm, glabrous   | Truncate, ca. 1 mm  | Truncate, ca. 1 mm   |
| Culm sheath blade                  | Erect or reflexed, triangular or linear-lanceolate  | Reflexed, readily deciduous, triangular to linear-lanceolate   | Readily deciduous, reflexed, rarely erect, linear-lanceolate                              | Erect, triangular-conical, glabrous  |
| Leaf number of the ultimate branch | 4–6   | 1–4  | 1–3   | 2–4  |
| Leaf sheath                        | 3–4 cm long, glabrous   | 1.5–2 cm long, glabrous  | 3–4 cm, glabrous  | Glabrous or with white pubescent margins   |
| Leaf oral setae                    | Absent  | Absent or sometimes few  | Absent  | 2–6, 2–4 mm long, yellow-brown or gray   |
| Leaf ligule                        | Truncate, ca. 1 mm  | Inclined- truncate, ca. 0.4 mm   | Truncate, glabrous  | Truncate, ca. 1 mm   |
| Petiole                            | 1–3 mm long   | 1 mm long  | 1 mm long   | Sparely gray-white pubescent   |
| Leaf blade                         | 4–9 × 0.7–1.4 cm, glabrous, secondary veins 2–3 pairs   | 2.3–5.2 × 0.45–0.7 cm, glabrous, secondary veins 2 or 3 pairs  | 5–8.5 × 0.4–0.6 cm, glabrous, secondary veins 2 pairs                                     | 1.3–6.5 × 0.4–0.6 cm, glabrous or abaxially white-gray pubescent, secondary veins 2- or 3 paired           |
| Habitat                            | Along the stream or under the evergreen broadleaved forest at the altitude of 2600–2800 m, northwest, Yunnan.   | On the shady slope of barren hills at 3100–3700 m, west Yunnan.  | Under the <i>Pinus</i> or broadleaved forest, 2500–3000 m, Zayu, Xizang (Tibet).          | Unknown, Yunnan  |

a ring of 4–5 mm tall brown setae below nodes, glabrous sheath scar, fewer branches and more leaf number, from the latter by a ring of 4–5 mm tall brown setae below nodes, less branch number, glabrous sheath scar, oral setae absent and narrower leaf blade.

**Type.** CHINA, Xizang (Tibet), Zayu County, Xiachayu Town, bamboo mountain of new village, 28°31'14"N, 96°57'59"E, 2705 m alt., 24 August 2015, X.Y.Ye & X.He YXY254-1 (holotype & isotype: KUN!).

**Description.** Rhizomes pachymorph, rhizome neck 5–10 cm long, 1.2–2 cm in diameter, solid. Culms (3)4–5(6) m tall, unicaespitose, 0.5–1.4 cm in diameter; inter-

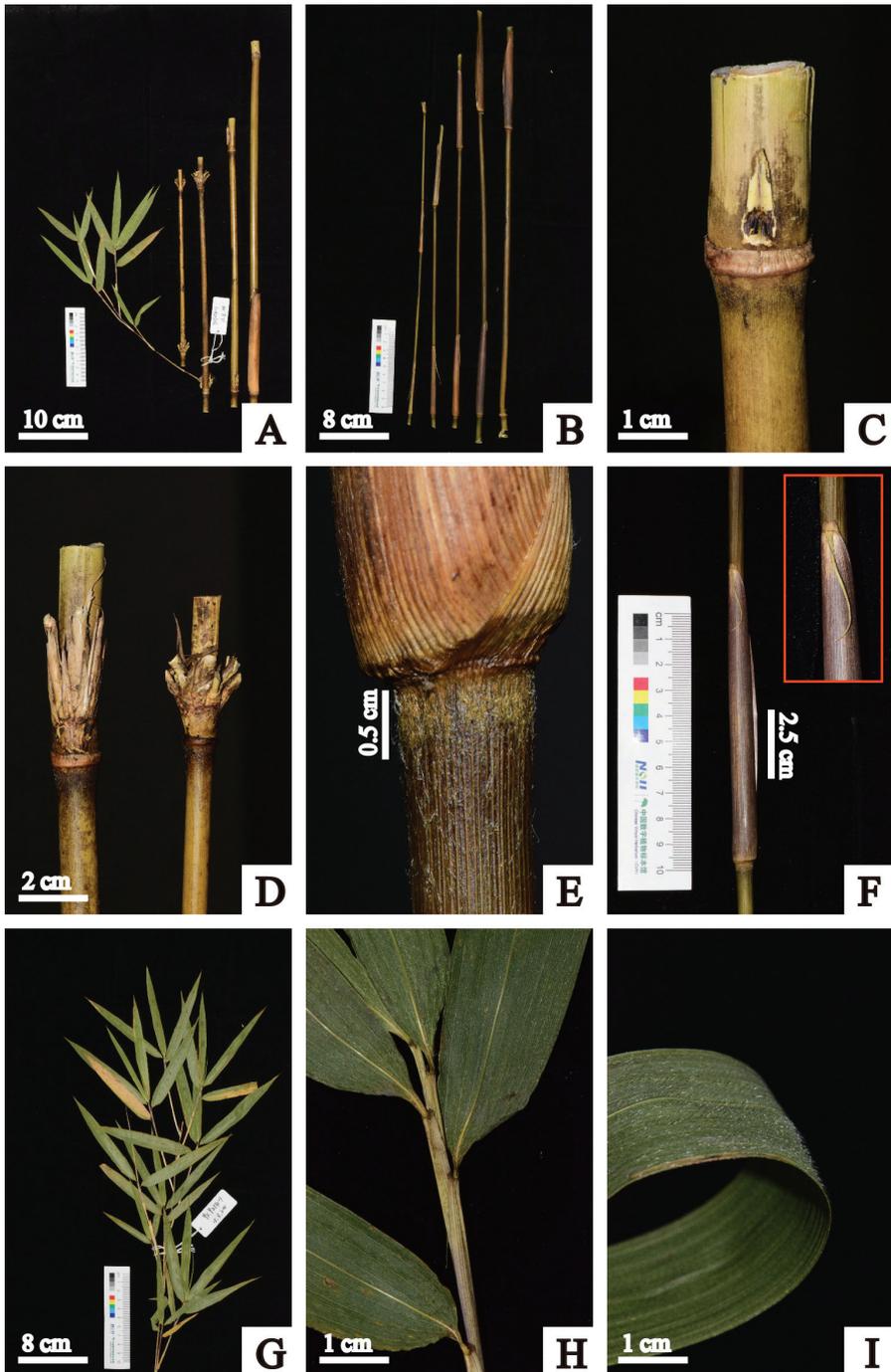


**Figure 3.** *Fargesia purpurea* D.Z. Li & X.Y. Ye **A** habitat **B** young and densely white powdery culm with purple culm sheath **C** individual **D** rhizome.

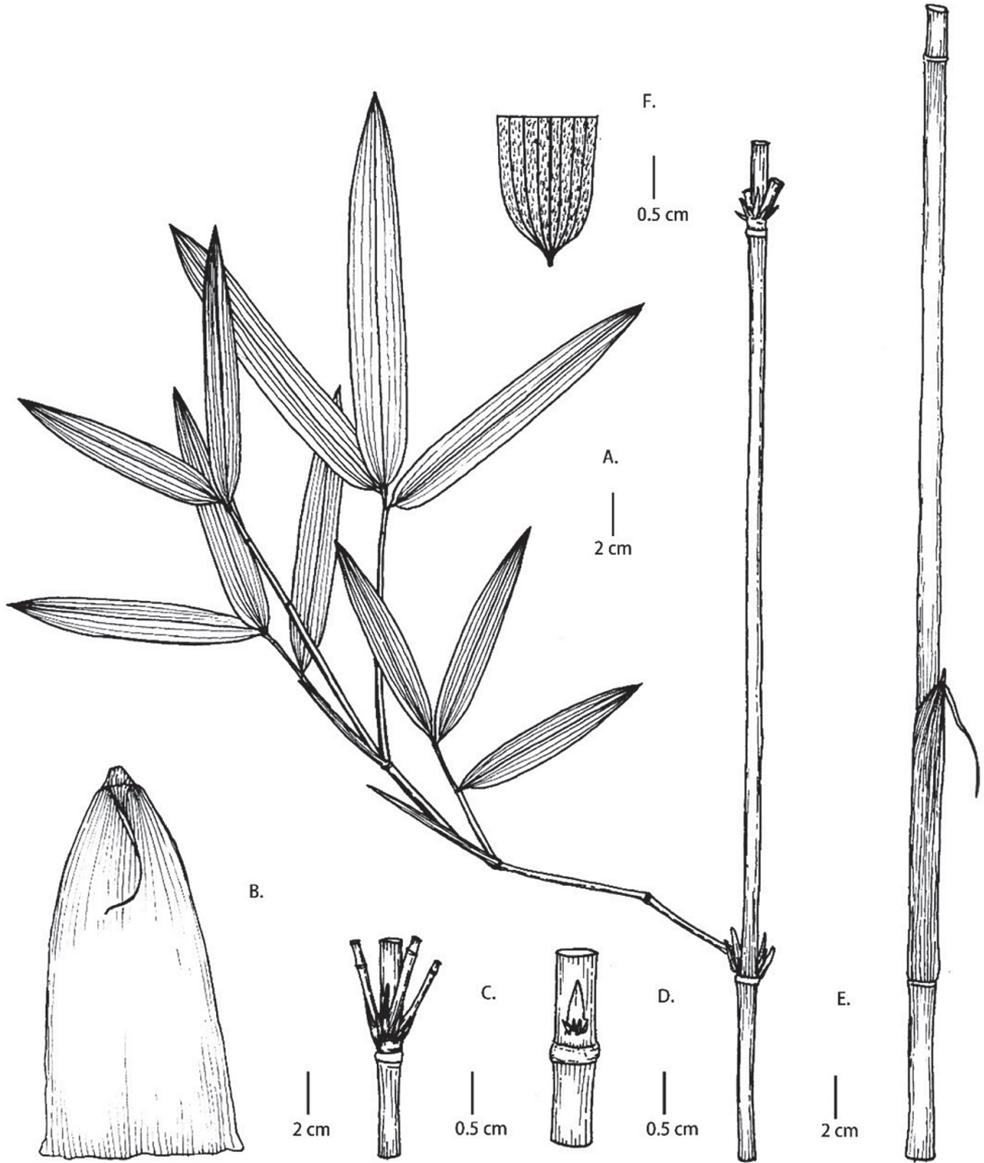
nodes terete, 30–46 cm long, white powdery and black when culms old, with a ring of 4–5 mm brown setae below nodes, longitudinal ribs prominent; wall 1–4 mm thick, cavity filled with lamellate pith; nodes with weakly prominent supra-nodal ridge; sheath scar prominent, with persistent remains of sheath base. Branches 3–7, open; buds triangular. Shoots purple, or with dark purple spots. Culm sheaths persistent, leathery, narrowly triangular, 1/3 as long as internodes, glabrous, longitudinal ribs prominent, upper margins ciliolate; auricles and oral setae absent; ligule truncate or inclined-truncate, 1–2 mm; blade reflexed, linear-lanceolate, glabrous, narrow than apex of culm sheath, readily deciduous. Foliage leaves 3–5 per ultimate branch; sheaths 2.5–4.5 cm long, glabrous, purple, margins ciliolate; auricles and oral setae absent; ligules truncate, ca. 1 mm; petiole 1–3 mm long; blades lanceolate, 5–12 × 0.5–1.4 cm, abaxially densely white pubescent, base cuneate, secondary veins 3–4 pairs, transverse veins conspicuous, margins serrate. Inflorescence unknown.

**Phenology.** New shoots July to August.

**Etymology.** The specific epithet refers to the color of culm sheath and leaf sheath.



**Figure 4.** *Fargesia purpurea* D.Z. Li & X.Y. Ye **A** internodes, showing branches and persistent culm sheath **B** young culms with culm sheaths **C** culm bud **D** branches **E** node, showing brown setae below node **F** culm sheath, showing details of blade and ligule **G** branchlet **H** leaf sheath **I** abaxial surface of leaf, showing densely pubescence.



**Figure 5.** *Fargesia purpurea* D.Z. Li & X.Y. Ye **A** internode with branchlet **B** culm sheath abaxial view, showing culm leaf blade **C** node with branches **D** culm bud **E** yong culm with culm sheath **F** abaxial surface of leaf, showing densely pubescence.

**Vernacular name.** Zǐ Qiào Jiàn Zhú (Chinese pronunciation); 紫鞘箭竹 (Chinese name).

**Distribution and habitat.** *Fargesia purpurea* is only known from the type locality, bamboo mountain of new village in Zayu county. It grows under the evergreen broad-leaved forest at an elevation of 2700–2800 m alt.

**Table 2.** Morphological comparison of *Fargesia purpurea* and its related species.

| Characters                         | <i>Fargesia purpurea</i>   | <i>Fargesia pauciflora</i>  | <i>Fargesia brevistipidis</i>   |
|------------------------------------|--|---|---|
| Culm height                        | (3)4–5(6) m  | 2–4 m   | 4–5 m   |
| Culm diameter                      | 0.5–1.4 cm   | 1–3 cm  | 1.2–2 cm  |
| Internode                          | 30–46 cm long, longitudinal ribs prominent, densely white powdery, with a ring of 4–5 mm brown setulose; wall 1–4 mm thick | 35–40 cm long, longitudinal ribs prominent, initially densely white powdery, glabrous; wall 2–3 mm thick            | 28–35 (40) cm long, initially white powdery, glabrous; wall 1.5–2(3) mm thick                                     |
| Branch complement                  | 3–7  | 6–10  | many  |
| Sheath scar                        | Prominent, glabrous, with persistent remains of sheath base  | Prominent, initially densely yellow-brown setose  | Prominent, initially yellow-brown setose  |
| Culm sheath                        | Persistent, glabrous, upper margins yellow-brown ciliate initially   | Persistent or gradually deciduous, glabrous or sparsely yellow-brown setose, margins brown ciliate                  | Persistent or gradually deciduous, glabrous or sparsely yellow-brown setose, white powdery, margins brown ciliate |
| Culm sheath ligule                 | Truncate or inclined-truncate, 1–2 mm  | Truncate or arcuate, 1–2.5 mm   | Truncate or arcuate, 1–1.5 mm   |
| Culm sheath blade                  | Reflexed, readily deciduous,   | Reflexed, linear-lanceolate, glabrous   | Reflexed, linear or linear-triangular,  |
| Leaf number of the ultimate branch | 3–5  | 2 or 3  | (3)5(6)   |
| Leaf sheath                        | Purple, glabrous   | Glabrous  | Purple or light green, glabrous   |
| Leaf oral setae                    | Absent   | Absent  | 4–8, 5–6 mm long  |
| Leaf ligule                        | Truncate, 1 mm tall  | Arcuate or truncate, glabrous   | 0.5 mm tall   |
| Petiole                            | 1–3 mm long  | Initially abaxially pubescent   | Initially pubescent   |
| Leaf blade                         | 5–12 × 0.5–1.4 cm, secondary veins 3–4 pairs, abaxially densely pubescent  | 9–14 × 0.7–1.2 cm, secondary veins 2–4 pairs, abaxially pubescent   | 6.5–11.5 × 0.5–0.85 cm, secondary veins 3–4 pairs, initially abaxially gray pubescent                             |
| Habitat                            | Under the evergreen broadleaved forest at the altitude of 2700–2800 m, Zayu, Xizang (Tibet).                               | Under the <i>Pinus</i> or broadleaved forest, or under shrubs, 2000–3200 m, southwest Sichuan and northeast Yunnan. | Under shrubs at the elevation of about 1250 m, central Sichuan.   |

**Additional specimens examined (paratype).** CHINA, Xizang (Tibet), Zayu County, Xiachayu Town, bamboo mountain of new village, 28°32'04"N, 96°59'07"E, 2724 m alt., 24 August 2015, X.Y.Ye & X.He YXY254-2 (KUN!).

**Notes.** Morphological comparisons between *Fargesia purpurea* and the related species were provided in Table 2. Two species of this genus were distributed in the Zayu county, namely, *F. zayuensis* Yi and *F. macclureana* (Bor) Stapleton, with this new species being easily distinguished from them in this region by its glabrous culm sheath and abaxially densely white pubescent leaf blade.

## Discussion

Both *Fargesia viridis* and *F. purpurea* have persistent culm sheaths and buds containing several obscure buds, making them belong to the section *Fargesia*. The shape of culm sheaths is different from these two species. *F. viridis* is characterized by narrowly rounded culm sheath, with apex nearly as wide as base, which is similar to the species of the series *Murielae*. *F. purpurea* is characterized by triangular culm sheaths, shorter than internodes, with apex narrower than base; these features are similar to those species of

the series *Yunnanenses*. Therefore, *F. viridis* and *F. purpurea* are assigned to the series *Murielae* and series *Yunnanenses*, respectively.

*Fargesia* is a polyphyletic genus and could be divided into three or four clades based on plastome sequences (Zhang et al. 2018; Zhou et al. 2019) and double-digested restriction enzyme-associated DNA sequencing (ddRAD-seq) data (Ye et al. 2019). *F. viridis* was classified as belonging to V-*Fargesia*4 clade based on the phylogenetic results of ddRAD-seq analyses (Ye et al. 2019), but no conclusion could be made for its position on the plastome phylogeny. Additionally, the phylogenetic relationship of *F. purpurea* in *Fargesia* has not been studied and that may be supplemented in the future.

*Fargesia viridis* (*F.* sp.2 in Fig. 2 of Ye et al. 2019) is closest to *F. frigidis* not only in morphology but also in phylogenetic relationships (Table 1, Ye et al. 2019), but the altitude distribution range of them are different. Moreover, *F. viridis* can be easily distinguished from *F. frigidis* by several morphologic characters, i.e. thinner culms, glabrous internodes, more leaves on ultimate branch. According to the identification keys, *F. viridis* is also similar to *F. zayuensis* and *F. similaris*; for example, they all have narrowly rounded culm sheath, with apex nearly as wide as the base, branch number usually above 5, auricles absent, glabrous leaf blade. However, a number of subtle features make *F. viridis* distinctive, such as internode nearly solid, densely white powdery culm, culm sheath persistent and densely yellow setose.

*Fargesia purpurea* resembles *F. pauciflora* and *F. brevistipedis* by its internode length, prominent sheath scar, culm sheath persistent, auricles and oral setae absent, and leaf blade abaxially pubescent, but differs in terms of the habitat, thinner culm, internode with a ring of 4–5 mm brown setulose, less branch number, glabrous culm sheath and sheath scar.

Mountains of Southwest China are the diversity center for *Fargesia* species; 80 out of 85 are distributed in this area and 73 of them are endemic. The two new species established here are also distributed in these mountains, indicating that the species diversity of *Fargesia* in this region may be beyond our knowledge. The species of *Fargesia* have an island-like distribution and allopatric speciation might have great impact on their diversity (Ye et al. 2019). However, the diversification of species could be caused by many reasons, such as heterogeneous environment, fluctuating climatic conditions, and adaptive evolution (Xing and Ree 2017; Ding et al. 2020). This genus with species distributed on a different elevation provides a case to disentangle the extrinsic and intrinsic factors that could promote species divergence. And research in this area may improve our ability to predict the evolutionary tendency and mitigate the threats posed by global warming to species distributed in the mountains of Southwest China.

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# Typification of *Juniperus pingii* W.C.Cheng (Cupressaceae)

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## Abstract

W.C.Cheng validly published the name *Juniperus pingii* W.C.Cheng in 1944 by providing a validating Latin diagnosis in de Ferré (1944), but he failed to cite any specimen. He repeated the publication of the name in 1947 with the same Latin diagnosis; he thus published an isonym “*J. pingii*” under Art. 6 Note 2. Cheng (1947) lectotypified the name *J. pingii* when he designated *W.C.Cheng 1015* as the “type” of the isonym. Farjon (2005) overlooked this early designation and his lectotypification of the name with the illustration from the 1944 protologue is not effective as the *W.C.Cheng 1015* specimen is extant.

## Keywords

China, conifer, Cupressaceae, *Juniperus pingii*, typification

## Introduction

Cheng (1939) did not validly publish the name “*Juniperus pingii*” because he did not provide a Latin diagnosis for the species. The name was validly published in an article by de Ferré (1944) in which a species diagnosis was provided including a simple figure and a short paragraph of Latin diagnosis in the footnote. Cheng

(1947) apparently was not aware of the valid publication of the species name in 1944 and, in 1947, repeated the publication of this species as a “sp. nov.” by providing a Latin diagnosis. We made a comparison between the two publications and found that the diagnosis of 1947 is completely identical to that of 1944. Obviously, the Latin diagnosis in both publications was provided by W.C.Cheng. De Ferré (1944) also ascribed the diagnosis to W.C.Cheng when she wrote “Voici sa diagnose latine telle qu’elle est contenue dans l’ouvrage inédit de W.C.Cheng” (Here is his Latin diagnosis as it is contained in the unpublished work of W.C.Cheng); de Ferré also wrote “*J. Pingii* Cheng sp. nov.”. As a result, the name is to be attributed to Cheng alone and correct citation of the species name is *Juniperus pingii* W.C.Cheng. The two publications are different with respect to type designation: no specimen was cited in the 1944 publication, but Cheng cited two collections in 1947 and designated *W.C.Cheng 1015* [China. Sichuan, Jiulong Xian (“Sikang, south of Chui-lung-hsien”), alt. 2800–3400 m] as the type. Cheng (1947) also cited *W.C.Cheng 939* from the same locality as a paratype. *Juniperus pingii* W.C.Cheng was validly published in 1944. “*Juniperus pingii* W.C.Cheng (1947)” is simply a later isonym (Art. 6 Note 2, Turland et al. 2018) of the original *J. pingii* and Cheng (1947) must be considered to have lectotypified *J. pingii* W.C.Cheng (de Ferré 1944). In *Flora Reipublicae Popularis Sinicae*, W.C.Cheng & W.T.Wang made a new combination [*Sabina pingii* (Cheng) W.C.Cheng & W.T.Wang, as “*Sabina pingii* (Cheng ex Ferré) W.C.Cheng & W.T.Wang”] based on *Juniperus pingii* Cheng [as “*Juniperus pingii* Cheng ex Ferré”] and indicated that the type was collected from Jiulong Xian of Sichuan of China (Wang et al. 1978), suggesting that W.C.Cheng accepted *W.C.Cheng 1015* from Jiulong Xian as the type of the name.

Both the figure provided in 1944 and the specimens cited in 1947 should be considered as original material studied by W.C.Cheng. Farjon (2005, 2010) overlooked the isonym of Cheng (1947) and, thus, had no idea of the lectotypification of the name. Farjon (2005) lectotypified the name with the illustration in de Ferré (1944), which should be accepted, provided the lectotype designated by W.C.Cheng (*W.C.Cheng 1015*) is lost. However, this is not the case. Cheng (1947) did not indicate the herbarium/institution for the lectotype in his designation. W.C.Cheng had worked in Nanjing until he moved to Beijing in 1962 and most of his specimens were moved to the Herbarium (PE) and were digitised and available online. We did not find *W.C.Cheng 1015* in either CVH (Chinese Virtual Herbarium, <http://www.cvh.ac.cn/>) or NSII (National Specimen Information Infrastructure, <http://www.nsii.org.cn/2017/query.php>). W.C.Cheng studied in France and worked with H.M. Gaussen on his Ph.D. thesis “*Les Forêts du Se-Tchouan et du Si-Kang Oriental*” (Ma 2011). We finally located the specimen *W.C.Cheng 1015* (TL0008814, Fig. 1) in Université Paul Sabatier Toulouse. This specimen is marked with “Type” and it was clearly studied by W.C.Cheng because it has a label with Cheng’s handwriting “*Juniperus pingii* Cheng sp. nov.”.

We checked the protologue in de Ferré (1944) and found that the illustration (“figure 21” in de Ferré 1944) contains a female cone and a separate seed, both from the lateral view. This figure is too simple to assist identification; it does not show any of



Figure 1. Lectotype of *Juniperus pingii* W.C.Cheng: W.C.Cheng 1015 (TL0008814).

the diagnostic characters as Cheng indicated “this species is closely related to *J. recurva* Buch.-Hamilt., from which it differs chiefly in the shorter leaves with distinctly keeled lower surface”. Nevertheless, the actual specimen W.C.Cheng 1015 possesses diagnostic

characters assisting the identification. As a result, there is no reason to supersede Cheng's lectotypification (*W.C.Cheng 1015*) with Farjon's designation (the illustration "figure 21" in de Ferré 1944).

## Typification

*Juniperus pingii* W.C.Cheng in Y. de Ferré, *Bull. Soc. Hist. Nat. Toulouse* 79: 76, f. 21 (1944)

≡ *Juniperus pingii* W.C.Cheng, *Trav. Lab. Forest. Toulouse* V, 1 (2): 93 (1939), *nom. inval.*; *Juniperus pingii* W.C.Cheng, *Res. Notes Forest. Inst. Natl. Centr. Univ. Nanking, Dendrol. Ser. 1: 2* (1947), *isonym*; *Sabina pingii* (W.C.Cheng) W.C.Cheng & W.T.Wang, *Fl. Reip. Pop. Sin.* 7: 355 (1978).

**Type.** China. Sichuan, Jiulong Xian ("Sikang, south of Chui-lung-hsien"), alt. 2800–3400 m, 24 May 1930, *W.C.Cheng 1015* (lectotype: TL0008814!).

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# Typifications in neotropical Sapotaceae

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## Abstract

Sapotaceae is historically known as having a tricky and challenging taxonomy due to tangled morphologic heterogeneity. Consequently, this resulted in a large number of described genera and binomials. After Pennington's *Flora Neotropica* work, several of those nomenclature issues were resolved. Nevertheless, many binomials remain unsolved and up for typification. Thus, following the International Code of Nomenclature for Algae, Fungi and Plants, we propose 74 new lectotype designations, four of these are second-step typifications.

## Keywords

Ericales, historical botany, lectotypification, nomenclature

## Introduction

Sapotaceae has 65–70 genera with around 1,250 species and is an important plant component from tropical regions in the world (Swenson et al. 2020). It is an economically interesting family by providing latex-derived products such as gutta-percha and chewing gum, valuable and durable timber and edible fruits (Pennington 1990, 1991).

In Linnaeus' first edition of *Species Plantarum* (Linnaeus 1753), the author began the taxonomic history of Sapotaceae by describing six species: *Achras zapota* L. (= *Manilkara zapota* (L.) P. Royen), *Chrysophyllum cainito* L., *Mimusops elengi*

L., *Mimusops kauki* L. (= *Manilkara kauki* (L.) Dubard), *Sideroxylon inerme* L. and *Sideroxylon spinosum* L. However, Jussieu's *Genera Plantarum* (Jussieu 1789) was the first work that recognised it as a homogenous group, then called "Sapotae". Since then, many morphological classification proposals have been reported, such as Baehni (1938, 1965), Lam (1939), Aubréville (1964) and Pennington (1990, 1991). Currently, based on phylogenetic and morphological analysis, Sapotaceae is divided into three monophyletic subfamilies: Sarcospermatoidae, Sapotoideae and Chrysophylloideae (Swenson and Anderberg 2005).

Historically, Sapotaceae taxonomy can be considered as tricky and truly challenging due to the morphologic heterogeneity of its many genera and species. This resulted in a large number of described genera and binomials associated with morphologically-related species that have tangled circumscriptions, such as *Pouteria* Aubl. and *Chrysophyllum* L. However, these numbers may often vary according to recent new discoveries (Alves-Araújo and Alves 2011, 2012a, b; Popovkin et al. 2016; Alves-Araújo and Mônico 2017; Sossai et al. 2017; Alves-Araújo 2018a), re-circumscriptions (Swenson et al. 2007; Mackinder et al. 2016) and phylogenetic studies (Terra-Araújo et al. 2015; Faria et al. 2017). *Pouteria* and *Chrysophyllum* are the largest genera in Sapotaceae with around 270 and 100 accepted names, respectively (The Plant List 2013). Furthermore, for tropical Americas, they have together more than 60 synonyms, most of them applied to *Pouteria* (around 45) (Pennington 1990, 1991).

Efforts, focusing on Sapotaceae internal relationships, were raised in the past two decades aiming to clarify genera and species boundaries (Swenson and Anderberg 2005; Swenson et al. 2008, 2013; Terra-Araújo et al. 2015; Faria et al. 2017). In addition, better understanding of taxonomic delimitation for many species, or even infra-species categories, are the goals for some available works (Terra-Araújo et al. 2012, 2016; Alves-Araújo et al. 2014; Alves-Araújo 2018b; Ferreira et al. 2019). Fortunately, those recent works had, as background, one of the most important contributions for the family in the world: Pennington's *Flora Neotropica* (Pennington 1990).

In his work, Pennington (1990) brings several aspects, from palynology (Harley 1990) to general taxonomy, approaching 11 genera and almost 1/3 of the world richness for Sapotaceae (approximately 400 species). Taxonomically, the author provides substantial historical information about those binomials and their *typi*, complementary analysed vouchers, geographic distribution maps and illustrations, keys and descriptions of many new species. He also included new synonyms and performed some typifications.

While performing Sapotaceae studies in Brazil and after consulting *Flora Neotropica*, despite Pennington's extraordinary efforts, we realised many binomials remain up for typification processes according to the International Code of Nomenclature (ICN) criteria (Turland et al. 2018). Thus, we aim to contribute for nomenclature stability through typification of the untypified names by choosing/indicating lectotypes when needed.

## Material and methods

This synopsis is based on the examination of binomials cited by Pennington (1990) in *Flora Neotropica: Sapotaceae*. To do so, information about protologues, herbarium specimens and historic and relevant literature with details of original elements were gathered together to perform the typifications. Main databases, such as IPNI (International Plant Names Index, <http://www.ipni.org>), Refflora (<http://refflora.jbrj.gov.br/>), SpeciesLink (<http://www.splink.org.br/index?lang=pt>), The Plant List (<http://www.theplantlist.org>) and Tropicos (<https://www.tropicos.org/home>) for the names herein treated and JSTOR Global Plants (<https://plants.jstor.org/>) for digitised plant specimens, have been consulted in order to analyse vouchers housed in the herbaria A, B, BM, BR, C, CORD, E, F, G, GH, GOET, HAL, HBG, IAN, K, L, LD, LE, LL, M, MA, MEL, MG, MICH, MIN, MO, MPU, NY, OXF, P, RB, S, SI, TCD, U, UC, UPS, US, W and YU (acronyms following Thiers, continuously updated).

All the newly-proposed types were carefully checked and are in accordance with the Articles 9.11, 9.12, 9.13 and 9.22 of the ICN adopted in Shenzhen (Turland et al. 2018). We also provide the homotypic synonyms and newly-tracked samples for accepted names with all available herbaria barcodes or collection numbers.

Pertinent details of some type designation were suppressed due to the amount of type designations. Nevertheless, we established that, to be eligible, the vouchers should be well-preserved and exhibit reproductive and/or diagnostic characteristics. There are three different situations (hereafter coded by numbers) that led us to typify: (1) Holotype not designated in the protologue; (2) If designated, there is more than one sample in the same herbarium or syntypes; and (3) Holotype destroyed or missing.

The lectotype designations take into account, depending on the context, the author's original institution, the collector's original institution and information from the labels. All lectotypes are formatted as follows: currently accepted name in each entry is shown alphabetically in bold italic typeface with full bibliographic reference, basionym (when present), any homotypic name, designation of lectotype and code for situation in bold typeface (1, 2 or 3) and any exceptional supporting notes. For those cases in which lectotypes were chosen for synonyms, they are presented below the currently accepted binomial with the same previously cited format, except by being preceded by "=" and only having italic typeface.

Type collections, including those cited by Pennington (1990), where we have not tracked or seen material are indicated by "n.v.". Additional information from herbarium labels are presented between square brackets "[...]".

## Typifications and new combinations

We here provide a list of the species names in seven genera, 74 new lectotype designations [10 for code (1), 42 for code (2) and 22 for code (3)], four of these being second-step typifications.

***Chrysophyllum argenteum* Jacq. subsp. *argenteum*, Enum. syst. pl. 15. 1760. Type: (lectotype, designated by Pennington [1990: 543]: Jacquin, Select. stirp. amer. hist. t. 38, f. 1. 1763).**

- = *Sideroxylon guadalupense* Spreng., Syst. veg. 1: 666. 1824. Type: Guadeloupe, C. Bertero s.n. (lectotype, designated by Pennington [1990: 544]: MO [n.v.]; isolectotypes: P [barcodes P00644517, P00644518, P00649285]!).
- = *Chrysophyllum immersum* Urb., Repert. Spec. Nov. Regni Veg. 15: 414. 1919. Type: TOBAGO. Easterfield, (yfr), *W. Broadway 4411* (lectotype, designated here: P [barcode P00649287]!); isolectotypes: BM [barcode BM000952601]!, F [barcode V0071916F]!, G [barcode G00434800]!, L [barcodes L 0064667, L 0064668]!, NY [barcode 00273428]!, P [barcode P00649288]!, U [barcode U 1596320]!, US [barcode 00323626]!). (3)

***Chrysophyllum argenteum* subsp. *auratum* (Miq.) T.D.Penn., Fl. Neotrop. Monogr. 52: 545–547, f. 126F–J. 1990.**

- ≡ *Chrysophyllum auratum* Miq. in Martius Fl. Bras. 7: 97–98. 1863. Type: GUYANA. Nr. Roraima, 1842–1843, (fl), *Rob. Schomburgk [ser. 2] 864* (lectotype, designated here: K [barcode K000633985]!; isolectotypes: BM [barcode BM000952599]!, F [barcodes V0071922F, V0071923F – fragm., V0071924F, V0071925F – fragm.]!, GH [barcode GH00075567]!, P [barcodes P00649294, P00649295, P00649296]!, US [barcode 00323621]!). (2)
- = *Chrysophyllum auratum* var. *majus* Miq. in Martius, Fl. Bras. 7: 98. 1863. Type: GUYANA. Nr. Roraima, [1842–1843], (fl), *Rob. Schomburgk [ser. 2] 813* (lectotype, designated here: BM [barcode BM0952598]!; isolectotypes: G [barcode G00434798 – mounted on three herbarium sheets]!, P [barcodes P00649291, P00649292, P00649293]!, U [barcode U 0006569]!). (2)

**Note 1.** Miquel (1863) mentioned the type collection of *Chrysophyllum auratum* Miq. as being composed of two different collections: Schomburgk #864 and #1389. Some of the original materials bring both collector numbers on their labels. According to van Dam (2002), Robert Schomburgk's collection may have two numbers on the labels where the first one corresponds to his own collection and the second is related to his brother's collection, Richard Schomburgk. Based on those samples, *Chrysophyllum auratum* was re-circumscribed as subspecies of *Chrysophyllum argenteum* Jacquin by Pennington (1990) under epithet *C. argenteum* subsp. *auratum* (Miq.) T.D.Penn.

**Note 2.** Miquel (1863) mentioned the type collection of *Chrysophyllum auratum* var. *majus* under Schomburgk #813 and #1507. As explained above, only #813 corresponds to Robert Schomburgk's collection (van Dam 2002). Labels from those samples housed at BM, G, P (3 sheets) and U herbaria have solely the

annotation #813, but those ones from K show #1507 (K000633986) or both #813 and #1507 (K000633987). We assumed only the vouchers under #813 and selected the sample at BM (BM0952598) as lectotype by its having well-preserved branches and flowers.

***Chrysophyllum argenteum* subsp. *ferrugineum* (Ruiz & Pav.) T.D.Penn., Fl. Neotrop. Monogr. 52: 547–548. 1990.**

≡ *Nycterisition ferrugineum* Ruiz & Pav., Fl. peruv. 2: 47, pl. 187. 1799. Type: PERU. [Cuchero, Chichao & Puente de Pillao], [1787] (fl), *H. Ruiz & J. Pavón s.n.* (lectotype, designated here: MA [barcode MA814291]!; isolectotypes: BC [barcode BC873102 – mounted on three herbarium sheets]!, BR [barcode 0000005417438]!, F [barcodes V0042273F, V0042274F]!, G (barcode G00434794 – mounted on three herbarium sheets]!, HAL [barcode 0116317]!, M [barcode M0174554 – fragm.]!, MA [barcodes MA814287, MA814293, MA817957, MA817959]!, P [barcodes P00649297, P00649298 – mounted on three herbarium sheets, P00649299]!, TUB [n.v.]). (2)

***Chrysophyllum inornatum* Mart., Flora 21, Beibl. 2: 96. 1838 (reprinted as Herb. Fl. Bras. 176).**

*Chrysophyllum inornatum* Mart., Flora 21, Beibl. 2: 96. 1838 (reprinted as Herb. Fl. Bras. 176). Type: BRAZIL. [Rio de Janeiro, São Paulo or Minas Gerais], [1820] (fl.), *F. Sellow s.n.* [4530] (lectotype, designated here: G [barcode G00434783]!; isolectotypes: K [barcode K000653001]!, M [barcode M0174545]!, P [barcode P00649335]!, U [barcode U 0006575]!, UC [barcode UC158699, UC493209]!, US [barcode 00037051]!). B†, F neg. 4247 (2).

**Note.** The label of the specimen at M [M0174545] brings the collection date as 1820. According to Moraes (2008), the set of specimens were most probably collected in Sellow's third journey in the Rio de Janeiro, São Paulo or Minas Gerais States.

***Chrysophyllum marginatum* (Hook. & Arn.) Radlk. subsp. *marginatum*, Act. Congr. Bot. Anvers 1885: 170. 1887.**

≡ *Myrsine marginata* Hook. & Arn., J. Bot. 1: 283. 1834. Type: Brazil. Rio Grande do Sul: Porto Alegre, (fl), *J. Tweedie s.n.* (lectotype, designated by Pennington [1990: 561]: K [barcode K000633995]!).

= *Chrysophyllum maytenoides* [*maytenodes*] var. *tenue* Kuntze, Revis. gen. pl. 3(2): 194. 1898. Type: “South Paraguay”, Sep 1892 (yfr), *C. Kuntze s.n.* (lectotype [first-step designated by Pennington [1990: 561], as “isotype”], second-step designated here: NY [barcode 00273433]!; isolectotype: NY [barcode 00273432]!). (2)

***Chrysophyllum oliviforme* L. subsp. *oliviforme*, Syst. Nat. (ed. 10) 2: 937. 1759. Type: (lectotype, designated by Vink [1958: 28]): Plumier, ed. Burmann, Gen. 57, tab. 69. 1756).**

- = *Chrysophyllum oliviforme* var. *pallescens* Urb. in Pierre & Urban, Symb. Antill. 5: 157. 1904. Type: HAITI. (fl.), *L. Picarda* 542 (lectotype, designated here: GH [barcode GH00075585]!; isolectotype: NY [barcode 00099909 – fragm.]!). (3)
- = *Chrysophyllum oliviforme* var. *platyphyllum* Urb. in Pierre & Urban, Symb. Antill. 5: 157. 1904. Type: HAITI. R. Artibonite, (fl.), *L. Picarda* 1642 (lectotype, designated here: NY [barcode 00099910]!; isolectotype: GH [barcode GH00075586]!). (3)
- = *Chrysophyllum brachycalyx* Urb., Symb. Antill. 7: 327. 1912. Type: JAMAICA. St. Elizabeth, Nr. Lacovia and Black River, (fl.), *W. Harris* 9955 (lectotype, designated here: BM [barcode BM000952606]!; isolectotypes: F [barcode V0071915F]!, NY [barcode 00099906]!). (3)
- = *Chrysophyllum gonavense* Urb., Ark. Bot. 22A (17): 74. 1929. Type: HAITI. Gonave Is., betw. Les Abricots and Les Etroits, (yfl.), *E. Ekman* H8769 (lectotype, designated here: S [barcode S05-2188]!; isolectotype: S [barcode S05-2189 – mounted on two herbarium sheets]!). (3)
- = *Chrysophyllum miragoaneum* [*miragoanum*] Urb., Ark. Bot. 22A (17): 75. 1929. Type: HAITI. Massif de la Hotte, Gros Mome Rochelois, nr. Miragoane, (fl.), *E. Ekman* H8648 (lectotype, designated here: S [barcode S05-2204]!; isolectotypes: F [barcode V0071917F]!, G [barcode G00434772]!, GH [barcode GH00075584]!, K [barcode K000633983]!, NY [barcode 00099907]!, S [barcode S05-2206]!, US [barcodes 00782536, 00113123]!). (3)

***Chrysophyllum oliviforme* subsp. *angustifolium* (Lam.) T.D.Penn., Fl. Neotrop. Monogr. 52: 541–543. 1990.**

- ≡ *Chrysophyllum angustifolium* Lam., Tabl. encycl. 2: 44. 1794. Type: HAITI. (fl.), *J. Martin* 163 (holotype: P-LA [barcode P00649370]!).
- = *Chrysophyllum picardae* Urb. in Pierre & Urban, Symb. Antill. 5: 158. 1904. Type: HAITI. Nr. Port-au-Prince, (fr.), *L. Picarda* 1198 (lectotype, designated by Pennington [1990: 541]: P [barcode P00649369]!).
- = *Chrysophyllum brachystylum* Urb., Symb. Antill. 7: 327. 1912. Type: DOMINICAN REPUBLIC. Barahona, (fl.), *M. Fuertes* 629 (lectotype, designated here: BM [barcode BM000952603]!; isolectotypes: BR [barcode 005416813]!, K [barcode K000633982]!). (3)
- = *Chrysophyllum montanum* Urb., Repert. Regni Veg. 13: 469. 1915. Type: DOMINICAN REPUBLIC. Barahona, Nr. Rincón, (fl.), *M. Fuertes* 1296 (lectotype, designated here: BM [barcode BM000952604]!; isolectotypes: A [barcode A00075552]!, F [barcode V0071918F]!, G [barcode G00434773 – mounted on two herbarium sheets]!, GH [barcode GH00075551]!, HBG [barcode HBG510658]!, MICH [barcode MICH1104635]!, NY [barcode 00099908]!, P [barcode P00649372]!, S [barcode S05-10744]!, U [barcode U0006577]!). (3)

= *Chrysophyllum heterochroum* Urb., Ark. Bot. 22A (17): 74. 1929. Type: HAITI. Massif de la Selle, Gros Morne des Commissaires, nr. Anses-à-Pitre, (fl.), *E. Ekman* H6748 (lectotype, designated here: S [barcode S05-2190]!; isolectotypes: S [barcode S05-2191]!, US [barcodes 00067586, 00782544]!). (3)

***Chrysophyllum revolutum* Mart. & Eichler in Miq., Fl. Bras. 7: 104. 1863.**

*Chrysophyllum revolutum* Mart. & Eichler in Miq., Fl. Bras. 7: 104. 1863. Type: PERU. San Martin, Nr. Tarapoto, 1855–1856 (fl, fr), *R. Spruce* 4260 (lectotype, designated here: K [barcode K000653005]!; isolectotypes: BM [barcodes BM000952585, BM000795552 – fragm.]!, BR [barcode 005417445]!, E [barcode E00259471]!, F [barcodes V0042261F, V0042262F – fragm.]!, G [barcodes G00439209, G00439210]!, GH [barcode GH00075583]!, GOET [barcode GOET010914]!, K [barcodes K000653003, K000653004]!, MPU [barcode MPU019050]!, NY [barcode 00273445]!, OXF [n.v.], P [barcode P00649388]!, W [barcode 1889-0105047]!). (2)

**Note.** All type collection is labelled with Spruce #4260; however, Martius & Eichler in Miquel (1863) indicated them under Spruce #2460. This, most likely, could be a misunderstanding, based on a typing or writing error. Moreover, after searching for more vouchers, we found a different sample at TDC herbarium under Spruce #2460 that corresponds to *Peperomia macrostachya* C.DC. (Piperaceae) (TCD0007412), reinforcing our assumption.

***Chrysophyllum sparsiflorum* Klotzsch ex Miq. in Martius, Fl. Bras. 7: 90. 1863.**

*Chrysophyllum sparsiflorum* Klotzsch ex Miq. in Martius, Fl. Bras. 7: 90. 1863. Type: GUYANA. Nr. Pirara, Jul-Aug 1843 (fl), *Rob. Schomburgk* [ser. 2] 420 (lectotype, designated here: K [barcode K000653012]!; isolectotypes: F – fragm. [n.v.], K [barcode K000653011]!, P [barcode P00649397]!). (2)

= *Chrysophyllum sparsiflorum* var. *fagifolium* Miq. in Martius, Fl. Bras. 7: 90. 1863. Type: BRAZIL. Para: Nr. Santarem, *R. Spruce* 632 (lectotype, designated here: M [barcode M0174521]!; isolectotype: U [barcode U 0006582]!). (2)

**Note.** Miquel (1863) mistakenly cited the samples collected by Richard Schomburgk # 680 as type collection of *Chrysophyllum sparsiflorum*. However, this set was collected, in fact, by Robert Schomburgk in his second collection series under #420 (van Dam 2002).

***Ecclinusa ramiflora* Mart., Flora 22, Beibl. 1: 2. 1839. Type: BRAZIL. Bahia: Ilhéus, *C. Martius* s.n. (holotype: M [barcode M0174559]!; isotypes: P [barcode P00649415]!).**

= *Ecclinusa abbreviata* Ducke, Bull. Mus. Hist. Nat. (Paris), sér. 2, 4: 743. 1932. Type: BRAZIL. Amazonas: Manaus, (fl.), *A. Ducke* s.n. (RB n° 22249) (lectotype, designated

here: S [barcode S05-2174]!; isolectotypes: G [barcode G00439194]!, K [barcodes K000640467, K000640468]!, P [barcode P00649414]!, RB [barcode RB00772244]!, U [barcode U 0006591]!, US [barcodes 00037025, 00037026]!). (2)

***Ecclinusa ulei* (K.Krause) Gilly ex Cronquist, Bull. Torrey Bot. Club 73: 311. 1946.**

≡ *Chrysophyllum ulei* K.Krause Notizbl. Königl. Bot. Gart. Berlin 6: 171. 1914. Type: GUYANA. Roraima region, (fl.), *E. Ule* 8729 (lectotype, designated here: K [barcode K000640466]!; isolectotype: MG [n.v.]). B†, F neg. 4258. (3)

***Ecclinusa lanceolata* (Mart. & Eichler ex Miq.) Pierre, Not. bot.: 57. 1891.**

≡ *Passaveria lanceolata* Mart. & Eichler ex Miq. in Martius, Fl. Bras. 7: 86. 1863. Type: BRAZIL. Amazonas: Rio Vaupes, Panure, 1852 (fl.), *R. Spruce* 2639 (lectotype, designated here: K [barcode K000640463]!; isolectotypes: BR [barcode BR005417827]!, F [barcode V0072122F]!, K [barcodes K000640464, K000640465]!, P [barcodes P00649410, P00649411]!, TCD [barcode TCD0017840]!, W [barcode W-Rchb. n° 1889-0010203]!). (2)

***Ecclinusa lancifolia* (Mart. & Eichler ex Miq.) Eyma, Recueil Trav. Bot. Neerl. 33: 202. 1936.**

≡ *Passaveria lancifolia* Mart. & Eichler ex Miq. in Martius, Fl. Bras. 7: 86. 1863. Type: BRAZIL. Amazonas: R. Negro, Barcelos & San Isabel, above Barrarua, (fl.), *R. Spruce* 1949 (lectotype, designated here: K [barcode K000640459]!; isolectotypes: BM [barcodes BM000952580, BM000952581, BM000952582]!, BR [barcode BR005417490]!, E [barcode E00259470]!, F [barcodes V0072123F, V0072124F]!, G [barcodes G00439195, G00439196]!, GH [barcode GH00075605]!, GOET [barcode GOET010916]!, K [barcode K000640460]!, NY [barcode 00273607]!, P [barcodes P00649412, P00649413]!, W [barcode 1889-0092142]!). (2)

***Manilkara jaimiqui* subsp. *emarginata* (L.) Cronquist, Bull. Torrey Bot. Club 73: 467. 1946.**

≡ *Sloanea emarginata* L., Sp. pl. 512. 1753. Type: BAHAMA ARCHIPELAGO, (fl), Herb Sloane vol. 232: 15 (Catesby 11: 87) (lectotype, designated by Dandy [1958: 112]: BM [barcode BM000952455]!; isolectotype: BM [barcode BM000952456]!).  
 = *Mimusops floridana* Engl., Bot. Jahrb. Syst. 12: 524. 1890. Type: USA. Florida: Boca Chica Key, *A. Curtiss* 1766 (lectotype, designated here: BM [barcode BM001024778]!; isolectotypes: F [n.v.], G [barcode G00439225]!, M [barcode M0174507]!, MEL [barcode MEL 2466140A]!, NY [n.v.], P [barcode P00645516]!, US [barcodes 02706398, 02706420]!). (3)

***Manilkara jaimiqui* subsp. *wrightiana* (Pierre) Cronquist, Bull. Torrey Bot. Club 73: 467. 1946.**

- ≡ *Mimusops wrightiana* Pierre in Pierre & Urban, Symb. Antill. 5: 171. 1904. Type: CUBA. (fl), *C. Wright 2917* (lectotype, designated by Pennington [1990: 92]: P [barcode P00645520]!; isolectotypes: G [barcode G00439221]!, GOET [barcode GOET010922]!, MO [barcodes MO-345857, MO-345858]!).
- = *Mimusops camagueyensis* Urb., Repert. Spec. Nov. Regni Veg. 24: 8. 1927. Type: CUBA. Camagüey, nr. Pastelillo, (fl), *E. Ekman 19071* (lectotype, designated here: S [barcode S13-8677]!; isolectotypes: BM [barcode BM000952453]!, F [barcode V0072101F]!, G [barcode G00439222]!, NY [barcode 00099938]!, S [barcode S-R-7872]!, US [barcode 00113368]!). (2)

***Micropholis crassipedicellata* (Mart. & Eichler) Pierre, Not. bot. 40. 1891.**

- ≡ *Pouteria crassipedicellata* (Mart. & Eichler) Baehni, Candollea. 9: 215. 1942. ≡ *Sideroxylon crassipedicellatum* Mart. & Eichler ex Miq. in Martius, Fl. Bras. 7: 57. 1863. Type: BRAZIL. Rio de Janeiro: Nr. Canta Gallo, (yfr), *T. Peckolt 356 [336]* (lectotype [first-step designated by Pennington [1990: 201], as “holotype”], second-step designated here: BR [barcode 005416455]!; isolectotypes: BR [barcode 005416783]!, P [barcode P00648170]!). (2)

**Note.** Vouchers at BR herbarium have Peckolt #356 as collector number, but one sample, found at P herbarium (P00648170), brings a different number (Peckolt #336) on the type of *Sideroxylon crassipedicellatum*. In addition, both collections at BR and P were collected in the same place and there is no indication of any collector number in the protologue. Main collections of Peckolt are housed at BR and Pierre probably mistakenly transcribed the annotation on P specimen as #336.

***Micropholis egensis* (A.DC.) Pierre in Urban, Symb. Antill. 5 (1): 127. 1904.**

- ≡ *Sideroxylon egense* A.DC., Prodr. 8: 182. 1844. Type: BRAZIL. Amazonas: Ega, (fl.), *E. Poeppig 2516* (holotype: G-DC [barcode G00139887]!; isotypes: G [barcodes G00439282, G00439283, G00439284]!, GOET [barcode GOET010927]!, NY [barcodes 00296955, 00842175]!, P [barcodes P00648172, P00648173, P00648174]!, US [barcode 00113310]!, W [barcodes 0067184, 0067185]!). B†, F neg. 4227.
- = *Micropholis martiana* Pierre in Urban, Symb. Antill. 5 (1): 126. 1904. Type: BRASIL. Amazonas, R. Japura, *C. Martius s.n.* (lectotype, designated here: U [barcode U 0006600 – fragm.]!). (1)
- = *Sideroxylon ulei* Krause, Verh. Bot. Vereins Prov. Brandenburg 50: 95. 1909. Type: BRAZIL. Amazonas: R. Jurua, Marary, (fl.), *E. Ule 5162a* (lectotype, designated here: K [barcode K000641477]!; isolectotypes: CORD [barcode CORD00003654]!, G [barcodes G00439281, G00439284]!, GOET [barcode GOET010928]!, IAN

[n.v.], RB [barcodes RB00544087, RB00560370]!, W [barcodes 1905-0003203, 1998-0005151]!. B†, F neg. 4229. (3)

***Micropholis guyanensis* (A.DC.) Pierre subsp. *guyanensis*, Not. bot. 2: 40. 1891.**

- ≡ *Sideroxylon guyanense* A.DC., Prodr. 8: 182. 1844. Type: FRENCH GUIANA. [Cayenne], (fl), *C. Martin s.n.* (holotype: P [barcode P00649234]!; isotypes: G [barcode G00139910]!, P [barcodes P00649235, P00649236]!, US [barcode 00323783]!).
- = *Sideroxylon cyrtobotryum* Mart. ex Miq. in Mart., Fl. Bras. 7: 57. 1863. Type: BRAZIL. Amazonas: nr. mouth of Rio Negro, (fl), *R. Spruce 1530* (lectotype, designated here: K [barcode K000641472]!; isolectotypes: BM [barcodes BM000952609, BM000952610]!, BR [barcode 005416172]!, E [barcode E00205609]!, F [barcodes V0072233F, V0072234F]!, G [barcodes G00439268, G00439269]!, GH [barcode GH00075912]!, GOET [barcode GOET010929]!, K [barcodes K000641471, K000641472]!, NY [barcode 00296953]!, P [barcodes P00649225, P00649226]!, RB [barcodes RB00544083, RB00560365]!, W [barcode 1889-0118439]!). (2)
- = *Chrysophyllum melinonii* Engl., Bot. Jahrb. Syst. 12: 521. 1890. Type: FRENCH GUIANA. (fl), *M. Melinon s.n.* (lectotype, designated here: P [barcode P00649231]!; isolectotypes: F [barcode V0071938F]!, LE [barcode LE00016012]!, MPU [barcodes MPU019047, MPU019048]!, P [barcodes P00649229, P00649230, P00649232]!). B†, F neg. 4250. (2)

***Micropholis humboldtiana* (Roem. & Schult.) T.D.Penn., Fl. Neotrop. Monogr. 52: 212–214. 1990.**

- ≡ *Chrysophyllum humboldtianum* Roem. & Schult., Syst. veg. 4: 813. 1819. Type: AMERICA MERID., *F. Humboldt & A. Bonpland 1116* (lectotype, designated here: B [barcode BW04593010]!). (2)
- = *Sideroxylon spruceanum* Mart. & Miq. in Martius, Fl. Bras. 7: 53. 1863. Type: BRAZIL. Amazonas: R. Negro below Barcellos, (fl.), *R. Spruce 1917* (lectotype, designated here: P [barcode 00649242]!; isolectotypes: BM [barcode BM00603423]!, BR [barcode 005416196]!, E [barcode E00208056]!, F [barcode V0072250F]!, G [barcodes G00439264, G00439265]!, GH [barcode GH00075917]!, K [barcodes K00641495, K00641496]!, NY [barcode 00296963]!, P [barcode P00649243]!, RB [barcodes RB00560371, RB00544086]!). (2)

**Note.** The new combination of *Chrysophyllum humboldtianum* as *Micropholis humboldtiana* was performed by Pennington (1990) citing the specimen “Humboldt & Bonpland s.n. (holotype, B-W (herb. n° 4593) n.v.)” with no other additional information. Nevertheless, that specimen mentioned by the author from Willdenow’s collection at B herbarium is actually a folder under #4593 which is composed of three vouchers with collector numbers #1116 (BW04593010), #1117 (BW04593030) and another with no number annotation (BW04593020). After analysing these specimens, we concluded that #1116 might be the corresponding material of *C. humboldtianum*

and also that #1117 and the unnumbered specimen are uncertain. Based on that, we selected the voucher Humboldt & Bonpland #1116 (BW04593010) as lectotype.

***Micropholis macrophylla* (Krause) T.D.Penn., Fl. Neotrop. Monogr. 52: 225. 1990.**

≡ *Lucuma macrophylla* Krause, Verh. Bot. Vereins Prov. Brandenburg 50: 94. 1909. Type: PERU. Loreto: Cerro de Escalero, (fl.), *E. Ule* 6793 (lectotype, designated here: K [barcode K000641504]!; isolectotypes: CORD [barcode CORD003652]!, F [barcode V0042269F]!, G [barcode G00237369]!, HBG [barcode HBG510672]!, L [barcode L 0006427]!), MG [n.v.]. B†, F neg. 4191. (3)

***Micropholis polita* (Griseb.) Pierre, Not. bot. 41. 1891.**

≡ *Sapota polita* Griseb., Pl. Wright. 2: 517. 1862. Type: CUBA. Orienta, near Monte Verde, (fl.), *C. Wright* 1323 (lectotype, designated here: GH [barcode GH00075860]!; isolectotypes: BR [barcode 0000005416851]!, G [barcode G00439261]!, GOET [barcode GOET010932]!, K [barcode K000641468]!, MO [barcode MO-345852]!, P [barcode P00649250]!, YU [barcode YU001710]!). (2)

***Micropholis retusa* (Spruce ex Miq.) Eyma, Recueil Trav. Bot. Néerl. 33: 198. 1936.**

≡ *Lucuma retusa* Spruce ex Miq. in Martius, Fl. Bras. 7: 70. 1863. Type: BRAZIL. Amazonas: Rio Uaupes, near Panure, (fl.), *R. Spruce* 2735 (lectotype, designated here: K [barcode K000641475]!; isolectotypes: BM [barcode BM000952608]!, BR [barcode 05416509]!, E [barcode E00208025]!, F [barcodes V781839F, V875622F]!, G [barcodes G00237367, G00237368]!, GH [barcode GH00075649]!, GOET [barcode GOET010933]!, K [barcode K000641476]!, MO [barcode MO-345915]!, NY [barcode 00273519]!, P [barcodes P00649253, P00649254]!, RB [barcodes RB00544028, RB00560355]!). (2)

***Micropholis rugosa* (Sw.) Pierre, Not. bot. 41. 1891.**

≡ *Chrysophyllum rugosum* Sw., Prodr. 49. 1788. Type: JAMAICA. (yfl.), *O. Swartz s.n.* (holotype: S [barcode S-R-1110]!; isotypes: BM [barcode BM000952614]!, LD [barcode 1260585]!, LINN [barcode HS381-6]!, M [barcode M0174588]!, SBT [barcode SBT12784]!).

= *Chrysophyllum pomiforme* Bertero ex Spreng., Syst. Veg. 1: 667. 1824. Type: JAMAICA. *C. Bertero s.n.* (lectotype, designated here: MO [barcode MO-345851]!; isolectotypes: G-DC [barcode G00139917]!, P [barcode P00649256]!). (2)

***Micropholis trunciflora* Ducke, Bol. Tecn. Inst. Agron. 19: 19. 1950.**

*Micropholis trunciflora* Ducke, Bol. Tecn. Inst. Agron. 19: 19. 1950. Type: BRAZIL. Amazonas: Manaus, Estrada do Aleixo, (fl.), *A. Ducke* 2216 (holotype: RB [bar-

code 00544036!]; isotypes: IAN [n.v. – probably the sample was transferred to RB], MG [n.v.], NY [barcode 01200481!].

- = *Pouteria klugii* Baehni, *Candollea* 14: 76. 1952. Type: PERU. Loreto: Nr. Iquitos, Mishuyacu, (fl), *G. Klug 130* (lectotype, designated here: NY [barcode 00273643!]; isolectotypes: F [barcode V0042279F!], G [barcode G00439256!], US [barcode 00067581!]). (2)

***Micropholis venulosa* (Mart. & Eichler) Pierre, *Not. bot.* 40. 1891.**

- ≡ *Sideroxylon venulosum* Mart. & Eichler, *Fl. Bras.* 7: 52. 1863. Type: VENEZUELAN-COLOMBIAN frontier. Rio Guainia, near mouth of Rio Casiquiare, (fl., fr.), *R. Spruce 3506* (lectotype, designated here: K [barcode K000641480!]; isolectotypes: BM [barcode BM000952612!], BR [barcodes 005416202, 005416837!], C [n.v.], F [barcodes V0072252F – fragm., V0072253F – fragm.], G [barcode G00439249!], M [n.v.], MO [barcode MO-345897!], MPU [barcode MPU013055!], NY [barcode 00296964!], OXF [n.v.], P [barcodes P00649272, P00649273!], RB [barcodes RB00560369, RB00544088!], W [barcode 1889-0118452!]). B†, F neg. 4198. (3)

**Note.** Type collection is labelled with Spruce #3506; however, most samples also bring #1476. The latter is solely herein included due to its relation on the vouchers' labels and there is no reference to it on the protologue whatsoever.

***Pouteria campechiana* (Kunth in Humb., Bonpl. & Kunth) Baehni, *Candollea* 9: 398. 1942.**

- ≡ *Lucuma campechiana* Kunth in Humb., Bonpl. & Kunth, *Nov. Gen. Sp.* 3: 240. 1819. Type: MEXICO. Nr. Campeche, (fl), *F. Humboldt & A. Bonpland s.n.* (holotype: P [barcode P00670927!]; isotype: MO [barcode MO-1185613!]). B†, F neg. 4186.
- = *Lucuma palmeri* Fernald, *Proc. Amer. Acad. Arts* 33: 87. 1897. Type: MEXICO. Guerrero: Acapulco, Oct 1894 – Mar 1895, (fl), *E. Palmer 386* (lectotype, designated here: US [barcode 00113263!]; isolectotypes: F [barcodes V0072005F, V0072006F, V0072007F – mounted on two herbarium sheets!], K [barcode K000641066!], MO [mounted on two herbarium sheets, barcodes MO-157709, MO-157710!], NY [barcode 00273490!], U [barcode U 00066634!], UC [barcode UC125678!]). (1)

***Pouteria cayennensis* (A.DC.) Eyma, *Recueil Trav. Bot. Neerl.* 33: 174. 1936.**

- ≡ *Richardella cayennensis* (A.DC.) Aubrév., *Adansonia* 11: 300. 1971. ≡ *Chrysophyllum cayennense* A.DC. in A. P. de Candolle, *Prodr.* 8: 160. 1844. Type: FRENCH GUIANA. [Cayenne], (fl), *J. Martin s.n.* (lectotype [first-step designated by Pennington [1990: 366], as “holotype”], second-step designated here: P [barcode P00640549!]; isolectotypes: G-DC [barcode G00139668!], P [barcodes P00640548, P00640550!], US [barcode 00037030!]). (2)

- = *Chrysophyllum sessiliflorum* Poir., *Encycl. suppl.* 2: 16. 1811. Type: FRENCH GUIANA. [Cayenne], (f1), *J. Martin s.n.* (holotype: P [barcode P00640551]!).
- = *Lucuma pulverulenta* Mart. & Eichler in Martius, *Fl. Bras.* 7: 70. 1863. Type: FRENCH GUIANA. [Cayenne], (f1), *J. Martin s.n.* (lectotype designated here: P [barcode P00640545]!; isolectotypes: BM [barcode BM00952534]!, F [barcodes V0072057F, V0072058F – fragm.]!, NY [barcode 00273518]!, P [barcode P00640544]!). B†, F neg. 4196. (2)

**Note.** When considered conspecific, under the genus *Pouteria*, *Chrysophyllum sessiliflorum* Poir. would have priority over *C. cayennense* A.DC. However, as the combination *Pouteria sessiliflora* (Sw.) Poir. was already occupied, the next earliest epithet is to be used, as done by Eyma (1936), who published the new combination *Pouteria cayennensis* (A.DC.) Eyma. In the protologue of *Chrysophyllum cayennense*, De Candolle (1844) provided the information “In Guyana prope Cayennam” and “v. s. comm. a Mus. par.”, but he did not make any reference to the collector’s name or number. When transferring *C. cayennense* to *Pouteria cayennensis*, Eyma (1936) assumed Martin’s collection s.n. at P herbarium as type. However, Baehni (1942) cited the type material was housed in the B herbarium as it follows “Guyane française; Cayenne (Martin s.n. !! = type in hb. B.)”. Nevertheless, after consulting both herbaria (B and P), we found three specimens at P and none at B. A little while after De Candolle’s publication, Martius & Eichler in Miquel (1863) described *Lucuma pulverulenta*, based on Martin’s material, probably from the herbarium B. Pennington (1990) cited “holotype, P” for *Chrysophyllum cayennense*, thereby inadvertently lectotypifying the name with a sheet at P. However, there are three different vouchers and we choose P (P00640549) as lectotype.

***Pouteria cinnamomea* Baehni, *Candollea*. 9: 252. 1942.**

- ≡ *Labatia discolor* Diels in Engl. Bot. Jahrb. Syst. 37: 601. 1906. Type: PERU. Cuzco: Prov. Convención, Idma, nr. Santa Anna, Jul 1905 (fl), *A. Weberbauer 5034* (lectotype, designated here: G [barcode G00439397]!; isolectotypes: F [barcodes V0042264F – fragm., V0042265F – fragm., V0042266F – fragm.]!). B†, F neg. 4232. (3)

***Pouteria dictyoneura* subsp. *fuertesii* (Urb.) Cronquist, *Lloydia* 9(4): 267. 1946.**

- ≡ *Paralabatia fuertesii* Urb., *Symb. Antill.* 7: 323. 1912. Type: DOMINICAN REPUBLIC. Nr. Barahona, May 1910 (fl), *M. Fuertes 19* (lectotype, designated here: S [barcode S05-2296]!; isolectotypes: BM [n.v.], BR [barcode 005415403]!, F [barcode V0072119F]!, GH [barcode GH00075779]!, GOET [barcodes GOET010939, GOET010940]!, HBG [barcode HBG510713]!, K [barcode K000641075]!, L [barcodes L 0006323, L 0006324]!, M [barcode M0174271]!, MO [barcode MO-2049469]!, SI [barcode SI003223]!, US [barcode 00113280]!). (2)

***Pouteria elegans* (A.DC.) Baehni, Candollea 9: 197. 1942.**

- ≡ *Sideroxylon elegans* A.DC. in A. P. de Candolle, Prodr. 8: 183. 1844. Type: BRAZIL. Amazonas: Ega, Sep 1831 (fl), *E. Poeppig 2492* (holotype: G-DC [barcode G00139949]!; isotypes: F [barcodes V0072241F, V0072242F – fragm.]!, GOET [barcode GOET010941]!, HAL [barcode 0139344]!, NY [barcode 00296956]!, OXF [n.v.], P [barcodes P00640583, P00640584]!, US [barcode 00113311]!, W [barcodes 0066769, 1889-0129955]!). B†, F neg. 4218.
- = *Pouteria arbuscula* Baehni, Candollea 14: 75. 1952. Type: BRAZIL. Amazonas: Basin of R. Negro San Gabriel, Sep 1928 (fl), *G. Tate 141* (lectotype, designated here: US [barcode 00113273]!; isolectotypes: G [barcode G00439480]!, NY [barcode 01211558]!). (3)

***Pouteria gardneriana* (A.DC.) Radlk., Sitzungsber. Math.-Phys. Cl. Konigl. Bayer. Akad. Wiss. München 12: 333. 1882.**

- ≡ *Lucuma gardneriana* A.DC. in A. P. de Candolle, Prodr. 8: 168. 1844. Type: BRAZIL. Piauí: Betw. Angrias & Sao Gonsalvo, Feb 1839 (fl), *G. Gardner 2228* (holotype: G [barcode G00439465]!; isotypes: BM [barcodes BM00952559, BM00952560]!, G-DC [barcode G00439466]!, GH [barcode GH00075638]!, K [barcodes K000641158, K000641159]!, NY [barcode 00273500]!, OXF [n.v.], P [barcodes P00647918, P00647919]!, W [barcode 1889-0092115]!). B†, F neg. 4202.
- = *Labatia ciliolata* Engl., Bot. Jahrb. Syst. 12: 515. 1890. Type: BRAZIL. Santa Catarina: Blumenau, Oct 1886 (fl), *J. Schenck 907* (lectotype [first-step designated by Pennington [1990: 451], as “isotype”], second-step designated here: P [barcode P00647921]!; isolectotype: P [barcode P00647920]!). B†, F neg. 4231. (3)
- = *Lucuma lanceolata* Raunk., Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn: 8. 1889. Type: BRAZIL. ? Rio de Janeiro, *A. Glaziou 14057a* (lectotype, designated here: P [barcode P00647922]!; isolectotypes: BR [barcode 005334988]!, C [barcodes C10018773, C10018774]!, G [barcode G00439463]!, K [barcode K000641156]!, MO [barcode MO-1994445]!, NY [barcode 00375397]!, P [barcodes P00647923, P00647924]!, US [barcode 00323781]!). (1)

***Pouteria glomerata* subsp. *stylosa* (Pierre) T.D.Penn., Fl. Neotrop. Monogr. 52: 420–422. 1990.**

- ≡ *Guaebeba stylosa* Pierre, Not. bot. 2: 42. 1891. Type: PANAMA. Obispo Falls nr. P.R.R. (fl), *S. Hayes 67* (holotype: BR [barcode 0000005415083]!; isotypes: BM [barcode BM000645679]!, E [barcodes E00259468, E00259469]!, G [barcode G00439455]!, K [n.v.], M [barcode M0174351 – fragm.]!, P [barcodes P00647929, P00647930]!, W [n.v.]).
- = *Pouteria cuprea* Huber, Bull. Soc. Bot. Geneve, sér.2, 6: 198. 1914. Type: BRAZIL. Pará: R. January, Prainha, May 1903 (fl), *A. Ducke s.n.* (MG n° 3568) (lecto-

type, designated here: RB [barcode RB00544050]!; isolectotype: BM [barcode BM000952563]!. (1)

***Pouteria gomphiifolia* (Mart.) Radlk., Sitzungsber. Math.-Phys. Cl. Konigl. Bayer. Akad. Wiss. Miinchen 12: 33. 1882.**

≡ *Lucuma gomphiifolia* [*“gomphiaefolia”*] Mart. ex Miq. in Martius, Fl. Bras. 7: 78, tab. 37, fig. 1. 1863. Type: BRAZIL. Amazonas: Mouth of R. Negro, N bank of Amazon, Aug 1851 (fl), *R. Spruce 1640* (lectotype, designated here: K [barcode K000641421]!; isolectotypes: BM [barcodes BM000952557, BM000952558]!, BR [barcode 0005415410]!, E [barcode E00259465]!, F [barcodes V0072033F – fragm., V0072034F – fragm.]!, G [barcode G00439453]!, GH [barcode GH00075608]!, GOET [barcode GOET010945]!, K [barcode K000641419]!, NY [barcodes 01211847, 00273502]!, OXF [n.v.], P [barcodes P00647931, P00647932]!, RB [barcode RB00378876]!, W [barcodes 1889-0092125, 1889-0118421]!). (2)

**Note.** Pennington (1990) cited Spruce #1670 [1640] as type material of *Lucuma gomphiifolia* as a reflex of the available information on the herbaria database. That is a mistake once Martius ex Miquel (1863) clearly informed Spruce #1640 as type collection of *Lucuma gomphiifolia*. In addition, Spruce #1670 corresponds to the lectotype of *Passiflora costata* Mast. (Passifloraceae) (Masters, 1872). Furthermore, other samples under Spruce #3117 (1670), or even only Spruce #3117, refer to the type collection of *Lucuma gomphiifolia* var. *blepharanta* Mart. (= *Pouteria gomphiifolia* (Mart.) Radlk.).

***Pouteria longifolia* (Mart. & Eichler) T.D.Penn.**

≡ *Chrysophyllum longifolium* Mart. & Eichler in Martius, Fl. Bras. 7: 97. 1863. Type: PERU. San Martín: Tarapoto, Oct 1865 (yfr), *R. Spruce 4234* (lectotype, designated here: K [barcode K000641453]!; isolectotypes: BM [barcode BM000952527]!, BR [barcode 005415120]!, K [barcode K000641452]!, P [barcode P00647954]!). (2)

***Pouteria lucens* (Mart. & Miq.) Radlk., Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 12: 333. 1882.**

≡ *Lucuma lucens* Mart. & Miq. in Mart., Fl. Bras. 7: 78. 1863. Type: BRAZIL. Amazonas: R. Vaupés, nr. Panure, *R. Spruce 2504* (lectotype, designated here: K [barcode K000641422]!; isolectotypes: A [n.v.], BM [barcode BM000952555]!, BR [barcode 005415168]!, E [barcode E00259464]!, F [barcode V0072043F – fragm.]!, G [barcodes G00439542, G00439543, G00439544, G00439545]!, GH [barcode GH00075643]!, GOET [barcode GOET010946]!, K [barcode K000641422]!, OXF [n.v.], MO [barcode MO-391907]!, NY [barcode 00273509]!, P [barcodes P00647955, P00647956]!, RB [barcodes RB00560332, RB00544020]!, W [barcodes 1889-0118424, 1889-0092126]!). (1)

***Pouteria lucuma* (Ruiz & Pav.) Kuntze, Revis. gen. pl. 3(2): 195. 1898.**

≡ *Achras lucuma* Ruiz & Pavón, Fl. peruv. 3: 17, t. 239. 1802. Type: PERU. Without exact locality, (fl), *J. Pavón s.n.* (lectotype, designated here: G [barcode G00439536]!; isolectotypes: G [barcodes G0043953, G00439537, G00439538, G00439540]!, MA [barcode MA-CARPO-100101]!). (1)

***Pouteria mattogrossensis* (Pilg.) Baehni, Candollea 9: 238. 1942.**

≡ *Labatia mattogrossensis* Pilg., Bot. Jahrb. Syst. 30: 181. 1902. Type: BRAZIL. Mato Grosso: Upper Kulisehu, Jul 1899 (fl), *R. Pilger 736* (lectotype, designated here: B [barcode B100248112]!; isolectotypes: F [barcode V0071982F – fragm.]!, NY [n.v.], US [n.v.]). B†, F neg. 4233. (3)

***Pouteria moaensis* Alain, Mem. Soc. Cub. Hist. Nat. “Felipe Poey” 22: 113. 1955.**

*Pouteria moaensis* Alain, Mem. Soc. Cub. Hist. Nat. “Felipe Poey” 22: 113. 1955. Type: CUBA. Oriente, Moa, E of airstrip, Jun 1945 (fl), *B. Clemente 4389* (lectotype, designated here: NY [barcode 00099949]!; isolectotypes: A [n.v.], GH [barcode GH00075815]!, US [barcode 00037035]!). (1)

***Pouteria obscura* (Huber) Baehni, Candollea 9: 361. 1942.**

≡ *Lucuma obscura* Huber, Bull. Soc. Bot. Genève, sér. 2, 6: 196, fig 9. 1914. Type: BRAZIL. Pará: Lower Trombetas, NE of Cuminá-mirim, Dec 1906 (fl), *A. Ducke s.n.* (MG n° 7974) (lectotype, designated here: RB [barcode RB00544021]!; isolectotype: BM [barcode BM000952547]!). (1)

***Pouteria psammophila* (Mart.) Radlk., Sitzungsber. Math.-Phys. Cl. Konigl. Bayer. Akad. Wiss. Minchen 12: 333. 1882.**

≡ *Labatia psammophila* Mart., Flora 21 (2), Beibl. 2 (4): 93. 1838 (reprinted as Herb. Fl. Bras. 173). Type: BRAZIL. Rio de Janeiro: Cabo Frio, (fl), *M. Wied-Neuwied s.n.* (holotype: BR [barcode 0006590642]!; isotypes: MEL [barcodes MEL 2353766A, MEL 2353767A]!, U [barcode U 0006685]!).

= *Pouteria crassinervia* Engl., Bot. Jahrb. Syst. 12: 514. 1890. Type: BRAZIL. Rio de Janeiro: Cabo Frio, *J. Schenck 3920* (lectotype, designated here: P [barcode P00648028]!; isolectotype: F [barcode V0072157F – fragm.]!). B†, F neg. 4200. (3)

***Pouteria ramiflora* (Mart.) Radlk., Sitzungsber. Math.-Phys. Cl. Konigl. Bayer. Akad. Wiss. Miinchen 12: 333. 1882.**

≡ *Labatia ramiflora* Mart., Flora 21 (2), Beibl. 2 (4): 93. 1838. (reprinted as Herb. Fl. Bras. 173). Type: BRAZIL. Minas Gerais: “inter vicum Contendas et praedi-

- um Tamanduain, deserto Prov. Minarum,” Aug 1818 (fl), *C. Martius s.n.* (holotype: M [barcode M0174362]!; isotypes: M [barcodes M0174363, M0174366, M0174367]!).
- = *Lucuma lateriflora* Benth. ex Miq. in Martius, Fl. Bras.7: 83. 1863. Type: BRAZIL. Para: Nr. Santarem, Jul 1850 (yfl), *R. Spruce 728* (lectotype, designated here: E [barcode E00259460]!; isolectotypes: E [barcode E00259461]!, GH [barcode GH00075642]!, GOET [barcode GOET010951]!, M [barcode M0174359]!, NY [barcode 00273508]!, S [barcode S05-4709]!), U [barcode U 0006690]!. (2)
- = *Lucuma parviflora* Benth. ex Miq. in Martius, Fl. Bras. 7: 81, tab. 34. 1863. Type: BRAZIL. Pará: Nr. Santarém, Jul 1850 (fl), *R. Spruce 729* (lectotype, designated here: E [barcode E00259462]!; isolectotypes: E [barcode E00259463]!, K [barcode K000641105]!, M [barcode M0174358]!, NY [barcode 00273514]!, P [barcode P00648035]!, U [barcode U 0006691]!). (2)
- = *Pouteria ramiflora* var. *grandifolia* Kuntze, Revis. gen. pl. 3(2): 195. 1898. Type: BRAZIL. Mato Grosso, Jul 1892 (fl), *C. Kuntze s.n.* (lectotype, designated here: NY [barcode 00860139]!; isolectotypes: F [barcode V0072186F, V0072187F – fragm.]!, G [barcode G00439502]!, MO [n.v.]). (1)
- = *Pouteria ramiflora* var. *oblongifolia* Kuntze, Revis. gen. pl. 3(2): 195. 1898. Type: BOLIVIA. Velasco, Jul 1892 (fl), *C. Kuntze s.n.* [55] (lectotype, designated by Pennington [1990: 279], as “isotype”: F [barcode V0072188F]!).

**Note 1.** Pennington (1990) and available information on the herbaria database cited Spruce #926 (728) and Spruce #926 (729) as type materials of *Lucuma lateriflora* and *Lucuma parviflora* Bentham ex Miq., respectively. However, Bentham in Miquel (1863) clearly cited in the protologue only Spruce #728 and #729 for them. In addition, specimens Spruce #926 correspond to *Sematophyllum inundatum* Mitt. (= *Trichosteleum inundatum* (Mitt.) A. Jaeger) (Sematophyllaceae – Bryophyta).

**Note 2.** There is no type citation in the protologue of *Pouteria ramiflora* var. *grandifolia* and, according to Zanoni (1980), Kuntze’s main set of plant collection is currently housed at NY. Thus, we selected the voucher NY [barcode 00860139], which is well-preserved and exhibits flowers and floral buds, as lectotype.

***Pouteria rigida* (Mart. & Eichler) Radlk. subsp. *rigida*, Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 12: 333. 1882.**

- ≡ *Lucuma rigida* Mart. & Eichler in Martius, Fl. Bras. 7: 73. 1863. Type: GUYANA. Nr. Roraima, 1842, *Rich. Schomburgk 976* (lectotype, designated by Pennington [1990: 357], as “isotype”: K [n.v.]; isolectotype: F [barcode V0360316F – fragm.]!).

**Note.** There are three different type collections spread in the herbaria under Schomburgk #976. They correspond to *Licania laxiflora* Fritsch (Chrysobalanaceae) (BM (BM000602323, BM000560075), K (n.v.), P (P00746021, P00746022), W (n.v.)) from Robert Schomburgk’s collection [ser. 2] 976, to *Oreodaphne gracilis* Meisn. (= *Ocotea gracilis* (Meisn.) Mez) (Lauraceae) (B (B100185322), BM (BM000993951))

from Robert Schomburgk's collection [ser. 1] 976 and, lastly, to *Lucuma rigida* Mart. & Eichler (K (n.v.), F (V0360316F)) from Richard Schomburgk's collection 976 (van Dam 2002). They were cited by their respective protologues and by having information on van Dam (2002). They can be easily distinguished and there is no misunderstanding whatsoever. Concerning *Lucuma rigida*, once Pennington (1990) indicated the sample at K as isotype, he inadvertently lectotypified the name. However, we did not track the voucher at K herbarium and its confirmation is needed.

***Pouteria rostrata* (Huber) Baehni, *Candollea* 9: 270. 1942.**

≡ *Lucuma rostrata* Huber, Bull. Soc. Bot. Genève, Ser. 2, 6: 195. 1914–1915. Type: BRAZIL. Para: Lower Trombetas, R Cumina-mirim, Dec 1906 (fl), *A. Ducke s.n.* (MG n° 7968) (lectotype, designated by Pennington [1990: 310], as “isotype”: BM [barcode BM000624871]!; isolectotypes: F [barcode V0072061F – fragm.]!, G [barcode G00439569]!, MG [n.v.], RB [barcode RB00544029]!, US [barcode 00113267]!).

**Note.** The protologue of *Lucuma rostrata* brings specimens under *A. Ducke* #7968 as type collection. Baehni (1942), based on those specimens, published the new combination, *Pouteria rostrata*, but he mentioned Huber #7968 in the publication as type material. This misunderstanding concerns just the names of collectors because, in both protologue and specimens, the collector is Ducke.

***Pouteria salicifolia* (Spreng.) Radlk., *Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München* 12: 333. 1882.**

≡ *Roussea salicifolia* Spreng., Syst. veg. 1: 419. 1824. Type: URUGUAY. Montevideo [BRAZIL. without precise locality, without date], [1821–1829], *F. Sellow s.n.* (lectotype, designated here: P [barcode P00648052]!; isolectotypes: L [barcodes L 0820131, L 0820132]!, K [barcodes K000641414, K000641415, K000717694]!, P [barcodes P00648051, P00648053]!). (2)

= *Lucuma sellowii* A.DC. in A.P. de Candolle, Prodr. 8: 167. 1844. Type: BRAZIL [Southern]. Rio Negro [propé Bagé, in Brasil austr.], [1829], *F. Sellow 1727* (lectotype, designated here: BR [barcode 000005580651]!; isolectotypes: F [barcode V0072062F]!, G [n.v.], P [barcode P00648050]!, US [barcode 00067597]!, W [n.v.]). (3)

**Note.** Sprengel (1824) cited “*R. foliis lineari-lanceolatis elongatis integerrimis glabris. Monte Video. Sello.*”. However, no specimen was found at any of the herbaria consulted by us. In addition, Pennington (1990) considered this type collection as dubious material “*Roussea salicifolia* Spreng., Syst. veg. 1: 419. 1825. Type: Uruguay, Montevideo, Sello s.n. (? isotype P)”. Under these circumstances, we interpret that Pennington referred to it as untraced voucher. As the type collection with the label cited by Sprengel (1824) was not found, which probably contained locality information, we inferred that those samples kept at L (two sheets), K (three sheets) and P (three sheets) herbaria correspond to the original material. Thus, we selected the specimen at P (P00648052) as lectotype.

***Pouteria surumuensis* Baehni, Candollea 9: 362. 1942.**

≡ *Lucuma sericea* K.Krause, Notizbl. Königl. Bot. Gart. Berlin 6: 169. 1914. nom. illegit. Not *Lucuma sericea* Benth. & Hook. (1876, Australia). Type: BRAZIL. Roraima: Rio Branco, Serra do Mel, Surumu, Aug 1909, (fl), *E. Ule* 8258 (lectotype, designated here: RB [barcode RB00544030]!; isolectotypes: F [barcode V0072198F]!, G [barcode G00439558]!, K [barcode K000641140]!, L [barcode L 0820130]!, U [barcode U 0006700]!). B†, F neg. 4197. (3)

***Pradosia schomburgkiana* (A.DC.) Cronquist subsp. *schomburgkiana*, Bull. Torrey Bot. Club 73: 311. 1946.**

≡ *Chrysophyllum schomburgkianum* A.DC. in A. P. de Candolle, Prodr. 8: 157. 1844. Type: GUIANA. (fl.), *Rob. Schomburgk [ser. 1] 505* (holotype: G-DC [barcode G00139569]!; isotypes: BM [barcode BM000952571]!, BR [barcode 005415137]!, E [barcode E00259450]!, F [barcodes V0071946F, V0071947F]!, G [barcodes G00439595, G00439596]!, K [barcodes K000640445, K000640446]!, L [barcode L 0820129]!, NY [barcode 00902225]!, OXF [n.v.], P [barcode P00649452]!, U [barcode U 0006718]!, US [barcode 00113129]!, W [n.v.]).

= *Chrysophyllum inophyllum* Mart. ex Miq. in Martius, Fl. Bras. 7: 105. 1863. Type: BRAZIL. Amazonas: Barra, (fl.), *R. Spruce 1393* (lectotype, designated here: M [barcode M0174519]!; isolectotypes: BM [barcode BM00952568]!, G [barcodes G00439592, G00439593]!, GH [barcodes GH00075576, GH00075577]!, GOET [barcodes GOET010957, GOET010958]!, K [barcodes K000640442, K000640443, K000640444]!, NY [barcode 00273429]!, P [barcodes P00649453, P00649454, P00649455, P00649456]!, RB [barcodes RB00544000, RB00642331, RB00642342]!). (1)

***Sideroxylon americanum* (Mill.) T.D.Penn., Fl. Neotrop. Monogr. 52: 118. 1990.**

≡ *Maurocenia americana* Mill., Gard. Dict. (ed. 8) 4: 1768. Type: JAMAICA. Palisadoes, *W. Houston s.n.* (holotype: BM [barcode BM000952515]!).

= *Bumelia oblongata* Urb., Symb. Antill. 6: 31. 1909. Type: JAMAICA. St. Ann., between Salem & Llandoverly, (fr), *W. Harris 10380* (lectotype, designated here: NY [barcode 00099912]!; isolectotypes: BM [barcode BM000952516]!, F [n.v.], K [barcode K000641550]!, US [barcode 01113661]!). (2)

= *Bumelia excisa* Urb., Repert. Spec. Nov. Regni Veg. 13: 471. 1915. Type: JAMAICA. Pedro Bluff, (fr), *W. Harris 9729* (lectotype, designated here: NY [barcode 00099924]!; isolectotypes: F [n.v.], K [barcode K000641549]!, US [barcode 01113660]!). (2)

= *Bumelia navassana* Urb. & Ekman, Ark. Bot. 21A(17): 71. 1929. Type: HAITI. [Between Haiti and Jamaica]. Navassana Island, (fl, fr), *E. Ekman H10811* (lectotype, designated here: S [barcode S09-43780]!; isolectotypes: A [barcode A00075540]!, C [barcode C10018764]!, F [barcode V0071900F]!, G [barcode G00439653]!, GH [barcode GH00075539]!, K [barcode K000641548]!, LL [barcode LL00372382]!,

MO [barcodes MO-2000302, MO-859995]!, NY [barcode 00099931]!, P [barcode P00689866]!, S [barcode S-R-9010]!, U [barcode U 0006727]!, US [barcodes 00113097, 00782598]!). (2)

***Sideroxylon angustum* T.D.Penn., Fl. Neotrop. Monogr. 52: 147. 1990.**

≡ *Bumelia revoluta* Urb., Symb. Antill. 9: 417. 1925. Type: CUBA. Sierra de Nipe, nr. Woodfred, (fl), *E. Ekman 15261* (lectotype, designated by Pennington [1990: 147], as “isotype”); NY [barcode 00099917]!; isolectotypes: S [barcode S-R-7864]!, UPS [barcode V-557127]!).

***Sideroxylon anomalum* (Urb.) T.D.Penn., Fl. Neotrop. Monogr. 52: 123. 1990.**

≡ *Dipholis anomala* Urb., Symb. Antill. 7: 325. 1912.  
 ≡ *Bumelia integra* Cronquist, J. Arnold Arbor. 26: 469. 1945. nom. superf. Type: DOMINICAN REPUBLIC. Barahona: El Hoyo, (fl), *M. Fuertes 1039* (lectotype, designated here: BM [barcode BM000952514]!; isolectotypes: A [barcode A0075533]!, E [barcode E00205607]!, F [barcodes V0071958F, V0071959F]!, GH [n.v.], HBG [barcode HBG510665]!, K [barcode K000641555]!, L [barcode L 0544796]!, MIN [barcode MIN1000838]!, NY [barcode 00099903]!, P [barcode P00644476]!, S [barcode S05-2116]!, U [barcode U 0006728]!, US [barcodes 00782607, 00113353]!, W [n.v.]). (2)

***Sideroxylon dominicanum* (Whetstone & T.A.Atk.) T.D.Penn., Fl. Neotrop. Monogr. 52: 148–149. 1990.**

≡ *Bumelia dominicana* Whetstone & T.A.Atk., Sida 11(4): 396. 1986.  
 ≡ *Bumelia ferruginea* (Ekman & O.C.Schmidt) Stearn, J. Arnold Arbor. 49: 287. 1968. nom. illeg.  
 ≡ *Dipholis ferruginea* Ekman & O.C.Schmidt, Repert. Spec. Nov. Regni Veg. 32: 94. 1933. Type: DOMINICAN REPUBLIC. Province Samana: Los Haitises, Boca del Infierno, (fl), *E. Ekman H15406* (lectotype, designated here: S [barcode S05-2124]!; isolectotypes: A [barcode A0075597]!, F [barcode V0071960F]!, G [barcode G00439639]!, GH [barcode GH00075596]!, K [barcode K000641570]!, NY [barcode 00099905]!, US [barcode 00113355]!). (2)

***Sideroxylon horridum* (Griseb.) T.D.Penn., Fl. Neotrop. Monogr. 52: 127. 1990.**

≡ *Bumelia horrida* Griseb., Cat. pl. Cub. 165. 1866. Type: CUBA. (fl), *C. Wright 2922* (holotype: GOET [barcode GOET010964]!; isotypes: BM [barcode BM000952512]!, G [barcodes G00439633, G00439634]!, GH [barcode GH00075532]!, K [barcode K000641559]!, MO [n.v.], NY [barcodes 1443596, 1443559]! P [barcodes P00644521, P00644522, P00644523, P00644524, P00644525]!, US [barcode 00113096]!, W [n.v.], YU [barcode YU001714]!).

= *Bumelia glomerata* Griseb., Pl. Wright 2: 518. 1862. Type: CUBA. (fl), *C. Wright 347* (lectotype, designated here: GH [barcode GH00075530]!; isolectotypes: BR [barcode 005334957]!, G [barcodes G00439631, G00439632]!, K [barcode K000641557]!, NY [barcode 00099925]!, P [barcode P00644528]!). (2)

***Sideroxylon jubilla* (Ekman ex Urb.) T.D.Penn., Fl. Neotrop. Monogr. 52: 137. 1990.**

≡ *Dipholis jubilla* Ekman ex Urb., Symbol. Antill. 9: 415. 1925.

≡ *Bumelia jubilla* (Ekman ex Urban) Stearn, J. Arnold Arbor. 49: 287. 1968. Type: CUBA. Oriente: Alto de Iberia, Nov 1916 (fl), *E. Ekman 8324* (lectotype, designated here: S [barcode S-R-7869]!; isolectotypes: A [barcode A00075598]!, BM [barcode BM00952506]!, F [barcode V0071961F]!, G [barcode G00439628]!, NY [barcode 00099896]!, UPS [barcode V-557261]!). (2)

***Sideroxylon montanum* (Sw.) T.D.Penn., Fl. Neotrop. Monogr. 52: 137. 1990.**

≡ *Bumelia montana* Sw., Prodr. 49. 1788. Type: JAMAICA. (fl), *O. Swartz s.n.* (holotype: S [barcode S-R-780]!; isotypes: G [barcode G00439623]!, M [barcode M0174567]!, P [barcode P00644531]!).

= *Dipholis pallens* Pierre & Urb., Symbol. Antill. 5: 136. 1904. Type: JAMAICA. Blue Mountains, Iron Face, Chester Vale, (fl), *W. Harris 5340* (lectotype, designated here: P [barcode P00644530]!; isolectotypes: BM [barcode BM000952505]!, NY [barcode 00099899]!). (2)

***Sideroxylon obovatum* Lam., Tabl. Encycl. 2: 42. 1974. Type: AMERICA MERID.?, collector s.n. (holotype: P-LA [n.v.]).**

= *Bumelia heterophylla* Urb., Symb. Antill. 7: 326. 1912. Type: DOMINICAN REPUBLIC. nr. Constanza, (fl), *H. von Türckheim 3473* (lectotype, designated here: BR [barcode 0000005416462]!). (3)

= *Bumelia lineolata* Urb. & Ekman, Ark. Bot. 21A(5): 56. 1927. Type: HAITI. Masif de la Selle, nr. Ansesa-Pitre, (fl), *E. Ekman 6968* (lectotype, designated here: S [barcode S05-2164]!; isolectotypes: K [barcode K000641541]!, NY [barcode 00099928]!, S [barcode S05-2165]!). (2)

***Sideroxylon obtusifolium* subsp. *buxifolium* (Roem. & Schult.) T.D.Penn., Fl. Neotrop. Monogr. 52: 116. 1990.**

≡ *Bumelia buxifolia* Roem. & Schult., Syst. veg. 4: 802. 1819. Type: VENEZUELA. Sucre: Cumana, (fl), *F. Humboldt & A. Bonpland s.n. [561]* (holotype: B-W [barcode BW04603010]!; isotypes: BM [n.v.], P [barcode P00670923]!).

= *Bumelia nicaraguensis* Loes., Bot. Jahrb. Syst. 60: 367. 1926. Type: NICARAGUA. Matagalpa: between Esquipulos y San Dionisio, (fl, fr), *E. Rothschild 463* (lectotype, designated by Pennington [1990: 116], as “isotype”: F [n.v.]). B†, F neg. 4275.

***Sideroxylon peninsulare* (Brandege) T.D.Penn., Fl. Neotrop. Monogr. 52: 105. 1990.**

≡ *Bumelia peninsularis* Brandege, Zoë 5: 107. 1900. Type: MEXICO. Baja California: Sierra de la Laguna, (fl), *T. Brandege s.n.* (lectotype, designated here: GH [barcode GH00075506]!; isolectotypes: US [barcodes 02703605, 00344806]!). (2)

***Sideroxylon picardae* (Urb.) T.D.Penn., Fl. Neotrop. Monogr. 52: 126. 1990.**

≡ *Bumelia picardae* Urb., Symb. Antill. 5: 148. 1904. Type: HAITI. Plain, (fl), June 1894, *L. Picarda 1242* (lectotype, designated here: P [barcode P00644571]!; isolectotypes: GH [barcode GH00075542]!, NY [barcode 00099913]!). (2)

***Sideroxylon repens* (Urb. & Ekman) T.D.Penn., Fl. Neotrop. Monogr. 52: 131. 1990.**

≡ *Dipholis repens* Urb. & Ekman, Ark. Bot. 22A(17): 70. 1929. Type: DOMINICAN REPUBLIC. Prov. Barahona: Cordillera de Bahoruco, (fl), *E. Ekman H6790* (lectotype, designated here: S [barcode S05-2136]!; isolectotypes: A [n.v.], G [barcode G00439664]!, GH [barcode GH00075599]!, K [barcode K000641566]!, NY [barcode 00099900]!, S [barcode S05-2139]!, US [barcodes 00113356, 00782524]!). (2)

***Sideroxylon rotundifolium* (Sw.) T.D.Penn., Fl. Neotrop. Monogr. 52: 120. 1990.**

≡ *Bumelia rotundifolia* Sw., Prodr. 50. 1788. Type: JAMAICA. (fl), *O. Swartz s.n.* (holotype: S [barcode S-R-784]!; isotype: M [barcode M0174381]!).  
= *Bumelia purdiaei* Urb., Symb. Antill. 5: 143. 1904. Type: JAMAICA. St. Catherine: banks of River Cobre, (fl), *W. Purdie s.n.* (lectotype, designated here: K [barcode K000641551]!; isolectotypes: K [barcode K000641552]!, NY [barcode 00099914]!). (2)

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# Lectotypification of five names in the genus *Stellaria* (Caryophyllaceae) in China

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## Abstract

Lectotypification for *Stellaria depressa* Em. Schmid, *S. yunnanensis* Franch., *S. ebracteata* Kom., *S. filicaulis* Makino, and *S. pusilla* Em. Schmid are designated here.

## Keywords

Caryophyllaceae, lectotype, *Stellaria*

## Introduction

The genus *Stellaria* L. was described by Linnaeus and comprises c. 190 species around the world (Chen and Rabeler 2001; Xu and Ma 2018; Wang et al. 2020; Xu et al. 2020). In China, 69 species were reported, with five new species described recently, of which 33 were endemic (Wu and Ke 1996; Chen and Rabeler 2001; Gan and Li 2014; Xu and Ma 2018; Song et al. 2020; Wang et al. 2020; Yang et al. 2020). During the study on the genus *Stellaria* in China, we found *S. depressa* Em. Schmid, *S. yunnanensis* Franch., *S. ebracteata* Kom., *S. filicaulis* Makino and *S. pusilla* Em. Schmid needed to be lectotypified according to Art. 9.3 and Art. 9.11 of the Shenzhen code (Turland et al. 2018). Hence, these species are lectotypified here after literature survey and specimen examination.

## Materials and methods

Specimens of *Stellaria depressa*, *S. yunnanensis*, *S. ebracteata*, *S. filicaulis* and *S. pusilla* matching the criteria of original material were searched at K, LE, MAK, P, TNS and Z. The lectotype designations in this paper follow the rules of the Shenzhen Code (Turland et al. 2018). All specimens were examined and studied by authors.

## Typification

### *Stellaria depressa* Em. Schmid, *Repert. Spec. Nov. Regni Veg.* 31: 41 (1932)

**Lectotype** (designated here):—China, Tschu-sang-po, am Lanak-La, August 13, 1927, *Bosshard s.n.* (Z000002693 digital image!, Figure 1; Isolectotypes: China, Aksai-Chin, *Bosshard s.n.*, Z barcode Z000002691 digital image!, China, Ladakh, Zingrul, *Bosshard s.n.*, Z barcode Z000002692 digital image!).

**Note.** When Schmid first described *S. depressa*, he cited three specimens “*Bosshard s.n.*, 16. VII. 1927; *Bosshard s.n.*, 13. VIII. 1927; *Bosshard s.n.*, 5. IX. 1927” collected by Bosshard from Ladakh and Tibet, but he didn’t designate any one of them as holotype in the protologue. According to Stafleu and Cowan (1993), Bosshard’s specimens were deposited in W and Z. We traced three specimens of *S. depressa* collected by Bosshard deposited in Z (Z000002693 digital image!, Z000002691 digital image!, Z000002692 digital image!). Although they were collected by Bosshard at different time, it seems that they were treated as types since they all have the label “Typus”. However, according to Arts. 9.1, 9.6, and 40 Note 1 of the ICN (Turland et al. 2018), none of them can be treated as holotype, but all should be considered as syntypes. Given a label on the specimen sheet with the description matching the protologue of *S. depressa*, its good preservation, and the perfect presence of flower and inflorescence, Z000002693 is designated here as the lectotype according to Art. 9.3 and 9.4 of the ICN (Turland et al. 2018).

### *Stellaria yunnanensis* Franch., *Bull. Soc. Bot. France.* 33: 433 (1886)

**Lectotype** (designated here):—China, Yunnan, Les collines incultes au dessus de Ta pin tze, September 1, 1882, *Delavay 4* (P01902917 digital image!, Figure 2; Isolectotypes: China, Les collines incultes au dessus de Ta pin tze, *Delavay 4*, P barcodes P01902916 and P01902918–P01902919 digital images!, China, Les pâturages au pied du Tsang chan, au dessus de Ta-li, *Delavay 1*, P barcodes P01902913–P01902915 digital images!, China, Da-pin-tze, *Delavay s.n.*, K barcode K000723671 digital image!).

**Note.** Franch described *S. yunnanensis* based on two specimens “*Delav. Caryoph. n.* 1, 4. jul. 1882; *Delav. Caryoph. n.* 4, 1. sept. 1882” collected by Delavay from Yunnan, China, without designating any one of them as holotype in the protologue. According

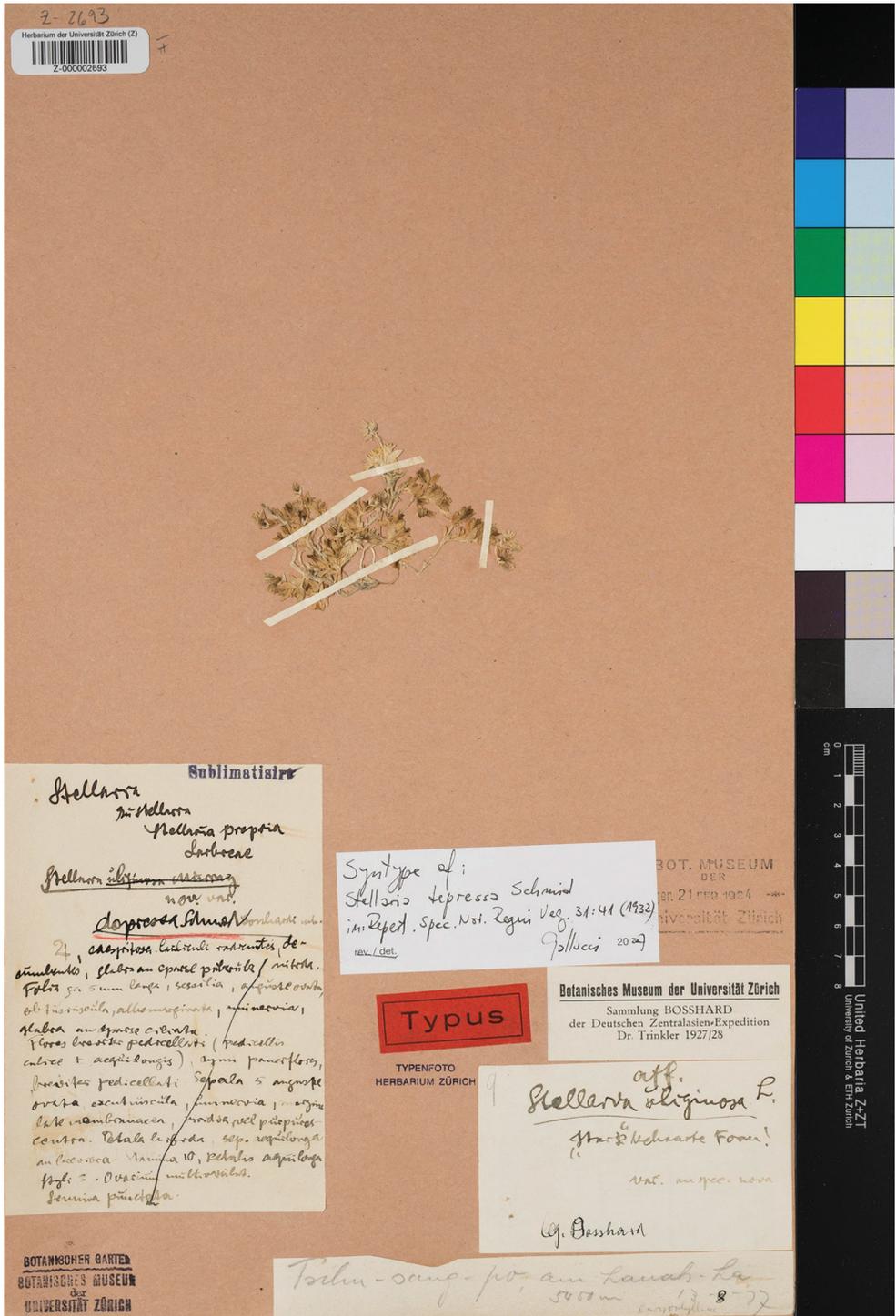


Figure 1. Lectotype of *S. depressa* Em. Schmid (Walter Bosshard, *Bosshard s.n.*, Z000002693).



Figure 2. Lectotype of *S. yunnanensis* Franch. (J.M. Delavay, *Delavay 4*, P01902917).

to Stafleu and Cowan (1976), Delavay's specimens were deposited in K, P and PC. Eight original materials were found in P (P01902913–P01902919 digital images!) and K (K000723671 digital image!), which all have Delavay's annotation and are well preserved. The specimens of P all bear the information "Syntype *Stellaria yunnanensis* Franch.". P01902917 well presents inflorescence and lower part of the plant and is in line with the protologue. So P01902917 is designated here as the lectotype according to Art. 9.3 and 9.4 of the ICN (Turland et al. 2018).

***Stellaria ebracteata* Kom., Trudy Imp. S.-Peterburgsk. Bot. Sada. 18: 441 (1901)**

**Lectotype** (designated here):—North Korea, Ad trajectum Abuzsa-kogar divortium aquarum inter flumina Tumin et Jalu, June 19, 1897, *Komarov s.n.* (LE01001957 digital image!, Figure 3; Isolectotype: North Korea, Trajectum Czaur-ien in valle fluvii Cham-muri, *Komarov s.n.*, LE barcode LE01001956 digital image!).

**Note.** Komarov described *S. ebracteata* and cited several specimens "*Komarov s.n.*, 18–27/VI 1894; *Komarov s.n.*, 24/VI 1897; *Komarov s.n.*, 12/VI 1897; *Komarov s.n.*, 19/VI 1897" collected by himself, but never designated any one of them as holotype in the protologue. According to Stafleu and Cowan (1979), Komarov's type specimens were deposited in LE. Two specimens traced in LE (LE01001957 digital image! and LE01001956 digital image!), match "*Komarov s.n.*, 12/VI 1897, *Komarov s.n.*, 19/VI 1897" in the protologue, and should be considered as syntypes following Arts. 9.6 and 40 Note 1 of the ICN (Turland et al. 2018). Unfortunately, due to the possible loss or destruction of specimens, the specimens "*Komarov s.n.*, 18–27/VI 1894" couldn't be found. Two specimens traced in LE have Komarov's script "*Stellaria ebracteata* Kom.", the description of collecting location, and the label "SYNTYPUS". Since LE01001957 is morphologically complete with the well presence of flower, inflorescence, and root, LE01001957 is designated here as the lectotype following Art. 9.3 and 9.4 of the ICN (Turland et al. 2018).

***Stellaria filicaulis* Makino, Bot. Mag. (Tokyo). 15: 113 (1901)**

**Lectotype** (designated here):—Japan, Tokyo, Koiwa-mura, June 16, 1895, *Watanabe s.n.* (TNS62378 digital image!, Figure 4; Isolectotypes: Japan, Musashi Prov., Koiwa-mura, Yoda, *Makino s.n.*, MAK barcode MAK009391 digital images!, Japan, Hitachi Prov., Itako, *Suzuki s.n.*, MAK barcode MAK009392 digital images!, Japan, Musashi Prov., Koiwa-mura, Yoda, *Watanabe s.n.*, MAK barcode MAK010156 digital image!).

**Note.** Makino first described *S. filicaulis* without designating a specimen as holotype but mentioned four specimens "*Watanabe s.n.*, June 16, 1895; *Makino s.n.*, June 23, 1895; *Watanabe s.n.*, June 16, 1895; *Suzuki s.n.*, May 19, 1901" in the protologue.



Figure 3. Lectotype of *S. ebracteata* Kom. (V. L. Komarov, Komarov s.n., LE01001957).

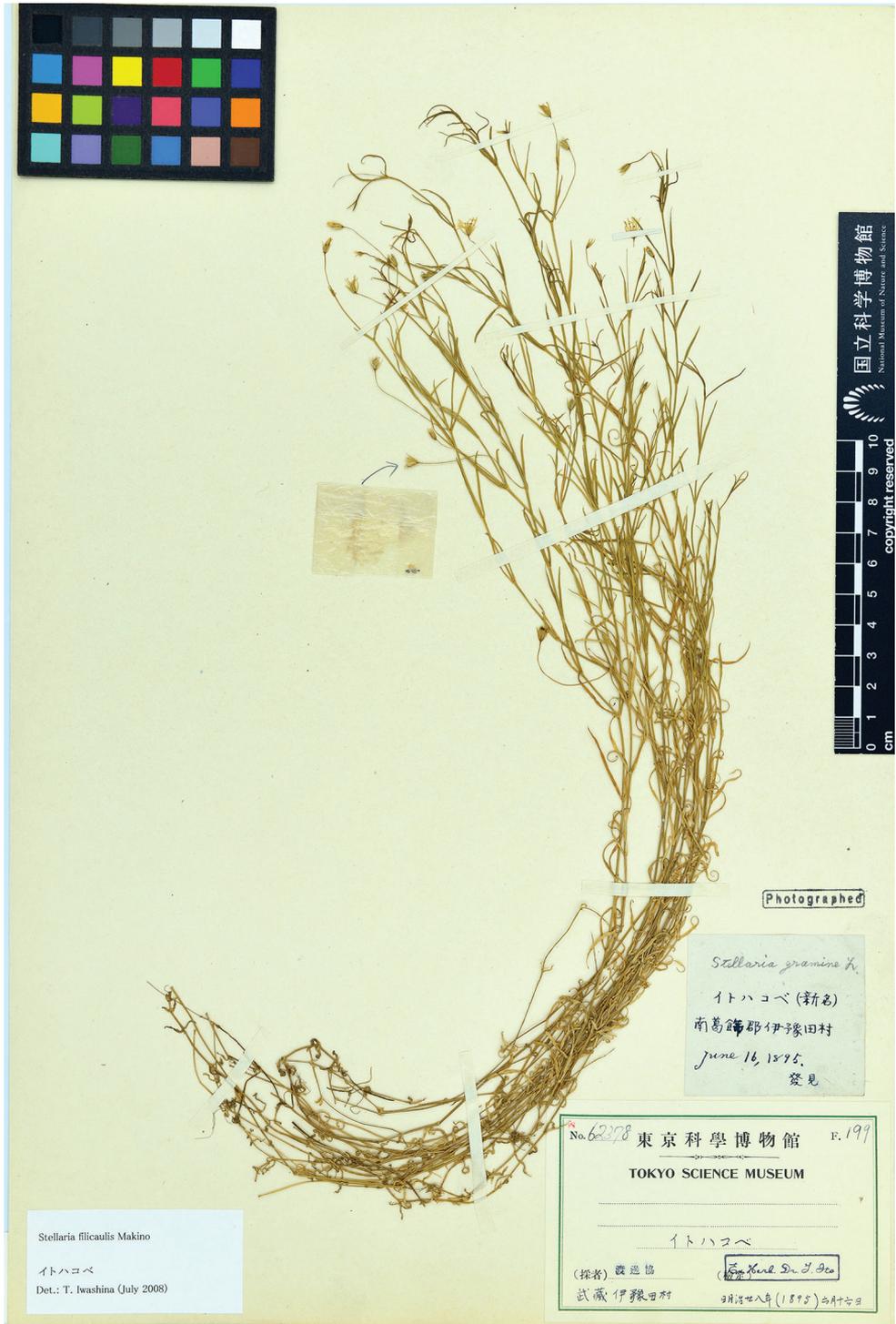


Figure 4. Lectotype of *S. filicaulis* Makino (Kano Watanabe, *Watanabe s.n.*, TNS62378).

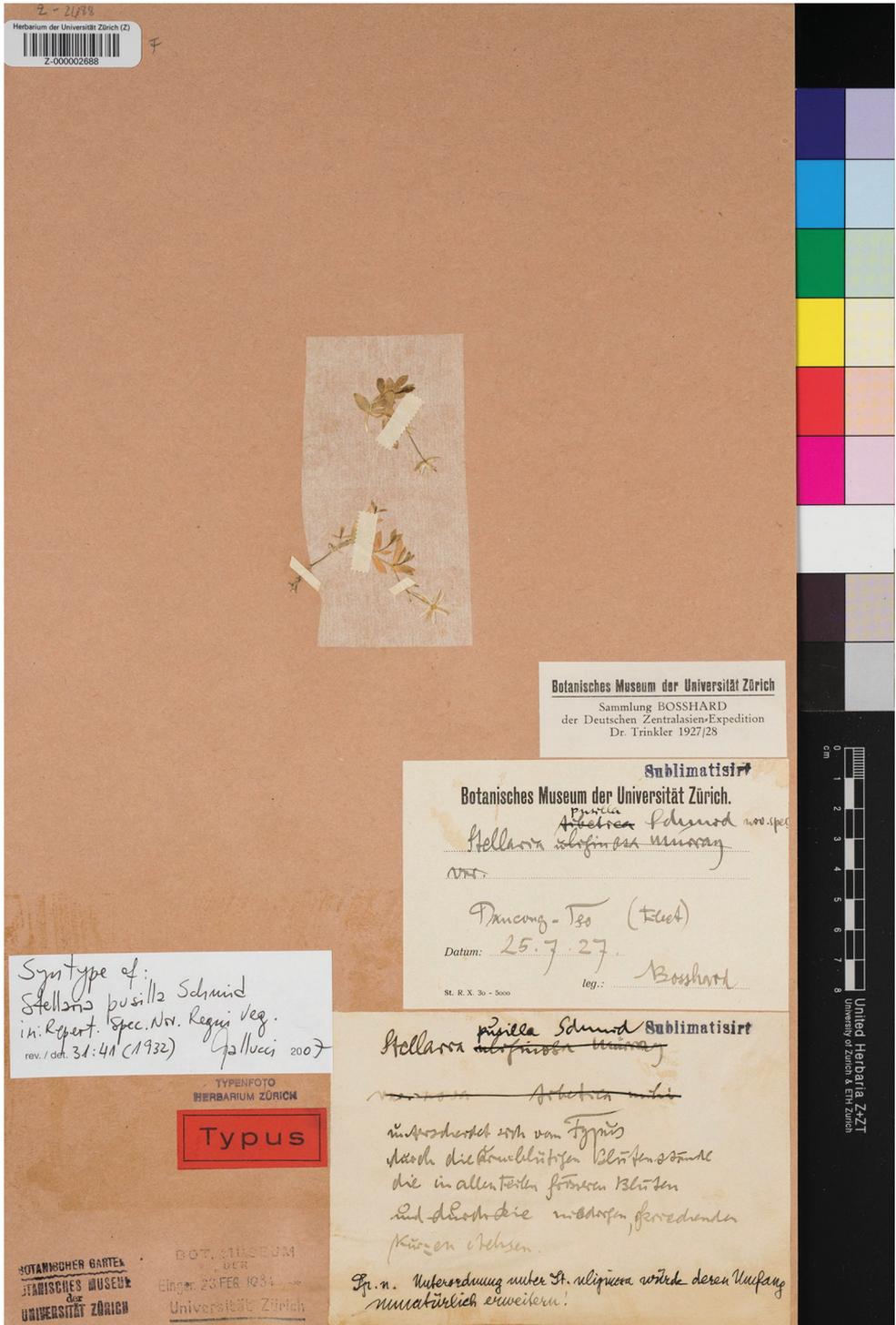


Figure 5. Lectotype of *S. pusilla* Em. Schmid (Walter Bosshard, *Bosshard s. n.*, Z000002688).

Yet following Arts. 9.6 and 40 Note 1 of the ICN (Turland et al. 2018), these specimens should be treated as syntypes. According to Stafleu and Cowan (1981 and 1988), the original specimens were traced in GH, TI and MAK, but no specimens could be found in GH and TI mentioned in the protologue. Tropicos (Tropicos 2020) cited “Type-Protologue: *K. Watanabe s.n.* in TI”, but related specimens were not found in TI. Fortunately, original specimens in TNS (TNS62378 digital image!) and MAK (MAK009391–MAK009392 digital images!, MAK010156 digital image!) were traced, with a description of the collecting location and date agreeing with the protologue. They could be confirmed as original specimens. Moreover, Makino might have described *S. filicaulis* based on one of these specimens because it has a label containing a message which means a new name. Hence, TNS62378 is designated here as the lectotype for its good preservation, the numerous flowers and fruits, and also greatly agreeing with the protologue according to Art. 9.3 and 9.4 of the ICN (Turland et al. 2018).

### ***Stellaria pusilla* EM. Schmid, Repert. Spec. Nov. Regni Veg. 31: 41 (1932)**

**Lectotype** (designated here):—China, Tibet, Panggong Tso, July 25, 1927, *Bosshard s.n.* (Z000002688 digital image!, Figure 5; Isolectotype: China, Tibet, Panggong Tso, *Bosshard s.n.*, Z barcode Z000002689 and Z000002690 digital image!).

**Note.** *S. pusilla* was described by Schmid based on three specimens “*Bosshard s.n.*, 25. VII. 1927; *Bosshard s.n.*, 29. VII. 1927; *Bosshard s.n.*, 13. VIII. 1927” collected by Bosshard from China, but he didn’t designate one of them as holotype in the protologue. Plants of Central Asia (Grubov and Kozhevnikov 2007) cited “Panggon Toso July 25, 1927 (typus)”. Yet following Art. 9.6 and Art. 40 Note 1 of the ICN (Turland et al. 2018), none of them can be treated as holotype, but all should be considered as syntypes. Bosshard selected type specimens that were deposited at W and Z (Stafleu and Cowan 1993). Three original specimens were traced deposited in Z (Z000002688 digital image!, Z000002689 digital image!, and Z000002690 digital image!). All of them agreed with the collection location and date in the protologue and had a label “Typus” and another label “Syntype of *Stellaria pusilla* EM. Schmid” written by Sallucn at the same time. Given its label “*Stellaria pusilla* Schmid nov. spes” and its good preservation, the presence of flower and lower part of the plant, Z000002688 is designated here as the lectotype following Art. 9.3 and 9.4 of the ICN (Turland et al. 2018).

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# Merger of *Betula tatewakiana* (Betulaceae) from northern Japan with northeast Asian *B. ovalifolia* based on ploidy level

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## Abstract

It has been controversial whether *Betula tatewakiana*, a dwarf birch distributed in Hokkaido of northern Japan, is an endemic species or a synonym of *B. ovalifolia* broadly distributed in northeast Asia. The endemic hypothesis is based on the idea that *B. tatewakiana* is diploid while *B. ovalifolia* is tetraploid and that they are separated based on the ploidy level; however, no chromosome data have actually been published before. Resolving the taxonomic problem is crucial also in judging the conservation priority of *B. tatewakiana* in a global perspective. Our chromosome observation revealed that *B. tatewakiana* is tetraploid as well as *B. ovalifolia*. We also conducted morphological observations and clarified that *B. tatewakiana* is morphologically identical to *B. ovalifolia* in white hairs and dense resinous glands respectively on adaxial and abaxial leaf surfaces, in which they differ from closely related species in the same section *Fruticosae*. We conclude that the hypothesis that *B. tatewakiana* is a Hokkaido endemic based on the ploidy level is not supported and that *B. tatewakiana* should be merged with *B. ovalifolia*.

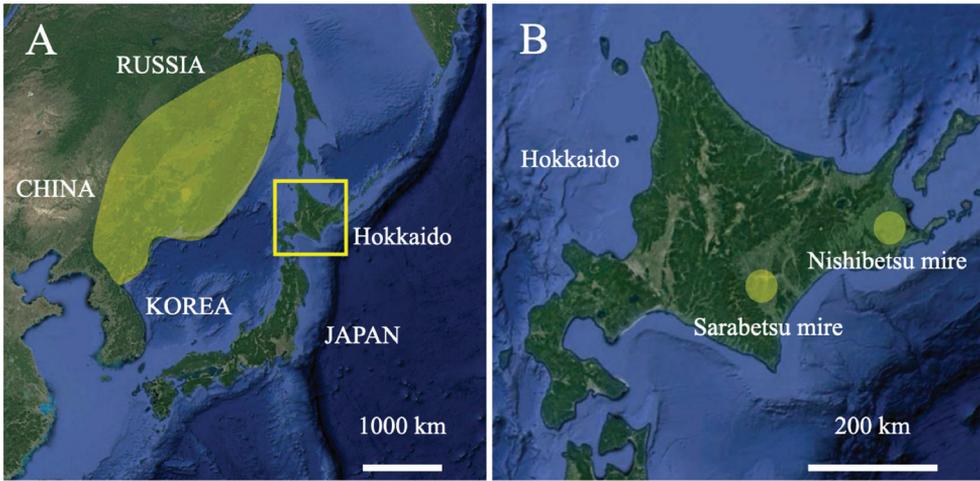
**Keywords**

*Betula*, chromosome number, conservation, dwarf birch, endangered species, Hokkaido, Japan, ploidy, Russian Far East, wetland

**Introduction**

*Betula ovalifolia* Rupr. is a dwarf birch found in wetlands (Gray 1996; Li and Skvortsov 1999). It grows only up to ca. 2 m tall (Li and Skvortsov 1999) and reproduces not only by seeds but also asexually by branching near ground level (Tabata 1966). This species is widely distributed in northeast Asia, i.e., Russian Far East (southern Khabarovsk Krai, Primorsky Krai, Amur Oblast, Jewish Autonomous Oblast), northeast China (Heilongjiang, Changbai Shan, Nei Mongol), North Korea, and northern Japan (Hokkaido) (Fig. 1; Gray 1996; Li and Skvortsov 1999). However, the taxonomic treatment of *B. ovalifolia* from Japan, and thereby its occurrence in Japan, has been controversial. In the first report from Japan, it was treated as an endemic species of Hokkaido and named *B. tatewakiana* M. Ohki & S. Watan. (Watanabe and Ohki 1959). Afterward, it had been treated as a variety of *B. humilis* Schrank (Murata 1978). Soon after that, Hara (1979) claimed that this species is identical to *B. ovalifolia*, but no data were presented. Since then, although this opinion is widely accepted in pictorial books and floras in Japan (Murata 1979; Ito 1981; Ohba 2006; Takahashi 2015), the idea to support *B. tatewakiana* was claimed again (Watanabe 1995) and the taxonomic problem still remains (Takahashi 2013; Takahashi et al. 2013; Nemoto 2016). Here, we tentatively use the name *B. tatewakiana* and will later discuss its taxonomy and proper name based on our results.

The taxonomic problem of *B. tatewakiana* and *B. ovalifolia* stems from the confusion in their ploidy level. Watanabe (1995) claimed that *B. tatewakiana* is diploid while *B. ovalifolia* is tetraploid and he recognized *B. tatewakiana* as the Japanese endemic restricted to Hokkaido. This idea, however, was originally reported in a conference abstract without images of the chromosomes (Watanabe and Somego 1991) and has never been published, but repeatedly mentioned in the following studies (Nemoto 2016). On the other hand, Nagamitsu et al. (2004) did not separate the two species and treated *B. ovalifolia* from Hokkaido as a tetraploid species based on Probatova and Sokolovskaya (1995, in Russian), who actually did not report the chromosome number of *B. ovalifolia* but of a hybrid between *B. ovalifolia* and *B. exilis*. A flow cytometric study of the genome size evolution in the genus *Betula* suggested that *B. ovalifolia* from the Asian continent is tetraploid (Wang et al. 2016). Ashburner and McAllister (2016) treated *B. tatewakiana* and *B. ovalifolia* as synonyms of *B. fruticosa* Pall. and reported the chromosome number  $2n = 56$  for *B. fruticosa*. According to the author (McAllister, personal communication), the chromosome observations were made with plants grown from seeds collected in Sarabetsu mire and Olga in Russian Far East. However, the materials were not mentioned in Ashburner and McAllister (2016) and one cannot be certain that the chromosome number applies to *B. tatewakiana* and *B. ovalifolia*.



**Figure 1.** Species distribution ranges of *Betula ovalifolia* (A) and *B. tatewakiana* (B). Map data 2020 (C) Google.

Thus, no published information exists about the ploidy level of *B. tatewakiana* and *B. ovalifolia* based on chromosome observations.

In this study, to resolve the taxonomic problem of *B. tatewakiana*, we focused on the confusion about the ploidy level, because this is the cause of the taxonomic controversy. We conducted chromosome observation and determined the ploidy level. We also conducted morphological observations of *B. tatewakiana*. Regarding *B. ovalifolia*, there are two closely related species in the same section *Fruticosae*, i.e., *B. humilis* Schrank and *B. fruticosa* Pall. *Betula ovalifolia* is distinguished from the two species by white hairs on the adaxial leaf surface (vs. glabrous in *B. humilis* and *B. fruticosa*) and by densely resinous glands on the abaxial leaf surface (vs. lack of glands in *B. humilis*) (Kuzeneva 1985, Li and Skvortsov 1999). In previous studies, which did not accept *B. tatewakiana*, these traits have not been well compared between *B. tatewakiana* and *B. ovalifolia*. Resolving the taxonomic problem and assessing the endemic status of *B. tatewakiana* would also help planning its conservation. *Betula tatewakiana* is found only in two localities in Japan, i.e., Sarabetsu and Nishibetsu mires in eastern Hokkaido (Fig. 1B). As a result of the exploitation of the mires, remaining habitats are only 3 and 16 ha in Sarabetsu and Nishibetsu mires, respectively (Takahashi 2013). Open ditches excavated inside and outside the mires are increasingly drying the habitats of *B. tatewakiana* and thereby it is red-listed at national and prefectural levels (Hokkaido 2001; Ministry of the Environment, Government of Japan 2020). Whether it is endemic or not is related to its conservation priority in a global perspective; on the other hand, if it is the same species as *B. ovalifolia* broadly distributed in northeast Asia, effective conservation should be planned considering genetic connectivity with conspecific populations abroad. This study is expected to provide basic information essential for the conservation of the species.

## Materials and methods

### Determination of ploidy level

We collected seeds of *B. tatewakiana* from six and five individuals from Sarabetsu and Nishibetsu mires in Hokkaido, Japan; seeds of *B. ovalifolia* were collected from one individual in Sikhote–Alin Nature Reserve in Primorsky Krai, Russian Far East (Table 1). Collected seeds were dried with silica gel and stored at 4 °C. Seeds were sowed on vermiculite and germinated at 25 °C day / 8 °C night condition for two weeks. After germination, root tips were collected and pretreated with 0.002 M 8-hydroxyquinoline solution for 24 hours at 4 °C in dark condition. Next, the root tips were fixed in Farmer’s solution (glacial acetic acid: 99% ethanol = 1: 3) at 4 °C in dark condition. After fixation, the root tips were macerated in 1 N HCl for 18 minutes and stained with 1% aceto-orcein for 5 minutes and squashed on a slide. Metaphase chromosomes were observed using an optical microscope Zeiss Axio Imager A1 (Carl Zeiss, Jena, Germany), and pictured by Anyty 3R-DKMC01 (3R solution corp., Fukuda, Japan).

### Morphological observations

To elucidate whether *B. tatewakiana* is morphologically identical to *B. ovalifolia* or not, we observed the key traits in the section *Fruticosae*: white hairs and dense resinous glands respectively on the adaxial and abaxial leaf surfaces. For *B. tatewakiana*, specimens examined were the holotype of *B. tatewakiana* (H. Suzuki and M. Ohki, s.n. with handwriting “Type” and collected on 18 August 1958 as cited in the protologue) in the herbarium of Hokkaido University Museum (SAPS) and our collections of 51 and 45 plants from Sarabetsu and Nishibetsu mires, that were deposited in the herbarium of Hokkaido University Botanic Garden (SAPT) (Appendix 1). For *B. ovalifolia*, our collections of 38 specimens from Primorsky Krai in the Russian Far East were used (SAPT, Appendix 1).

## Results

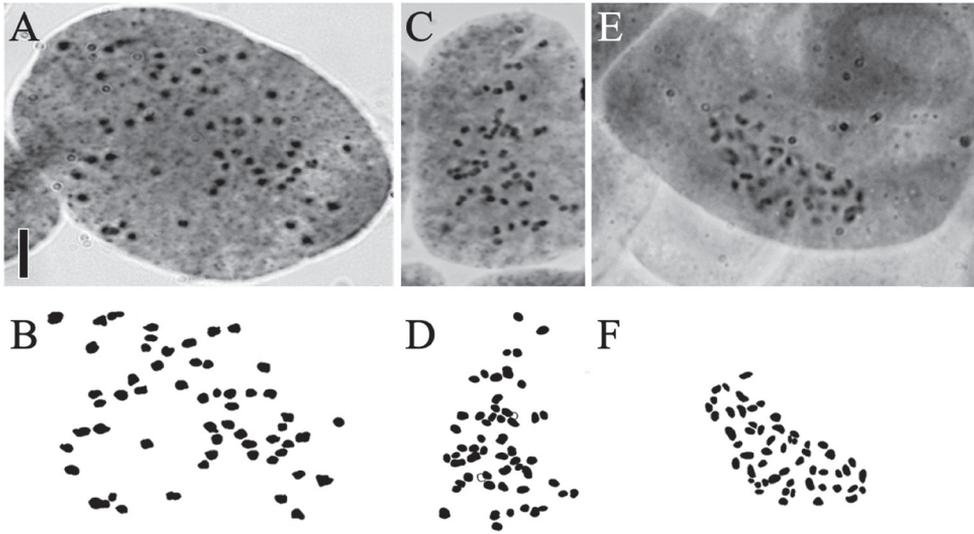
### Ploidy level

Somatic chromosomes at metaphase were approximately 1.0 µm long in both *B. tatewakiana* (Fig. 2A–D) and *B. ovalifolia* (Fig. 2E, F). The centromere positions could not be determined because of the small sizes of the chromosomes. The result of chromosome counts is summarized in Table 1. In *B. tatewakiana* from Sarabetsu mire, 3 individuals had 56 chromosomes (HUBG 14746 A, E, H) and 3 individuals had ca. 56 chromosomes (HUBG 14746 B, D, F). In *B. tatewakiana* from Nishibetsu mire, 4 individuals had 56 chromosomes (Yuki Shiotani 1, 26, 29, 30) and 1 individual had ca.

**Table 1.** Chromosome counts of *Betula tatewakiana* and *B. ovalifolia*.

| Taxon                 | Sampling site  | Chromosome counts  | Voucher no.   |
|-----------------------|--|--|---|
| <i>B. tatewakiana</i> | 42°37.33'N, 143°15.72'E, alt. 166 m, Sarabetsu mire,<br>Sarabetsu village, Hokkaido, Japan | 56<br>ca. 56   | HUBG* 14746 A, E, H<br>HUBG 14746 B, D, F                     |
|                       | 43°23.36'N, 145°03.66'E, alt. 32 m, Nishibetsu mire,<br>Betsukai town, Hokkaido, Japan     | 56<br>ca. 56   | Yuki Shiotani 1, 26, 29, 30 (SAPT)<br>Yuki Shiotani 27 (SAPT) |
|                       | <i>B. ovalifolia</i>   | 44°57.31'N, 136°33.01'E, alt. 25 m, Sikhote–Alin<br>Nature Reserve, Terney, Primorsky Krai, Russia | 56  |

\*HUBG: living collections of Hokkaido University Botanic Garden.

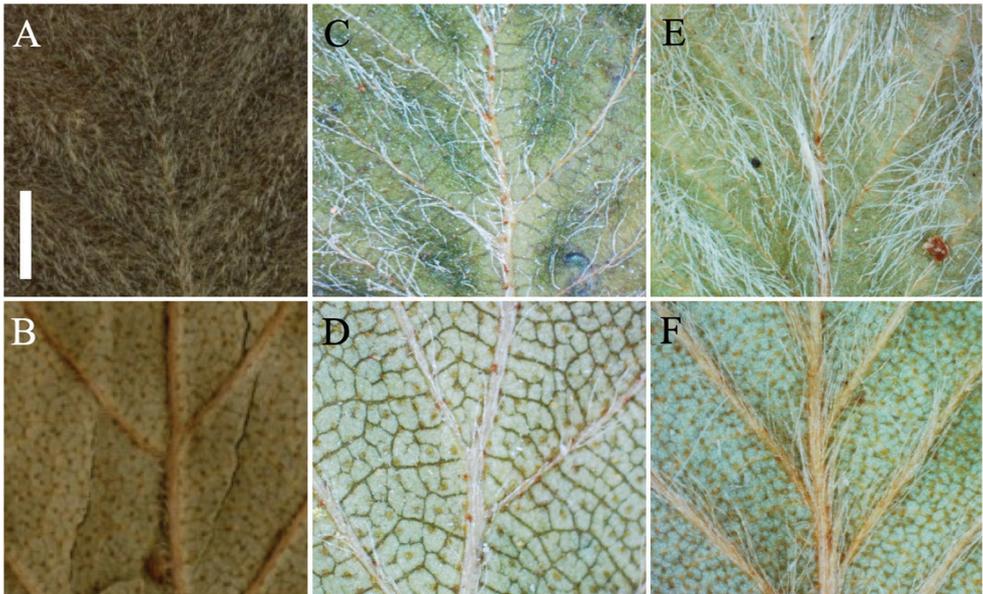


**Figure 2.** Somatic chromosomes at metaphase of *B. tatewakiana* and *B. ovalifolia*. Photomicrographs of *B. tatewakiana* from Sarabetsu mire (**A**,  $2n = 56$ : HUBG 14746 A) and Nishibetsu mire (**C**,  $2n = 56$ : Yuki Shiotani 29), and *B. ovalifolia* from Primorsky Krai (**E**,  $2n = 56$ : Koh Nakamura 14198) are shown. **B**, **D**, **F** are drawings of **A**, **C**, **E**, respectively. Scale bar: 5  $\mu$ m.

56 chromosomes (Yuki Shiotani 27). In *B. ovalifolia* from Primorsky Krai, 1 individual had 56 chromosomes (Koh Nakamura 14198).

### Morphological traits

The holotype of *B. tatewakiana* has white hairs and dense resinous glands respectively on the adaxial and abaxial leaf surface (Fig. 3A, B). Our collections of *B. tatewakiana* also have white hairs and dense resinous glands on the adaxial and abaxial leaf surface, respectively (Fig. 3C, D) and no morphological difference was recognized between the samples from Sarabetsu and Nishibetsu mires. In *B. ovalifolia*, our collections from Primorsky Krai have white hairs and dense resinous glands respectively on adaxial and abaxial leaf surface as well as *B. tatewakiana* (Fig. 3E, F).



**Figure 3.** Leaf traits of *B. tatewakiana* and *B. ovalifolia*. White hairs on adaxial leaf surface (**A, C, E**) and densely resinous glands on abaxial leaf surface (**B, D, F**) are shown for the holotype of *B. tatewakiana* (H. Suzuki and M. Ohki, s.n., **A, B**), *B. tatewakiana* of our collection (Yuki Shiotani 38, **C, D**), and *B. ovalifolia* in Russia (Koh Nakamura 14188, **E, F**). Scale bar: 1 mm.

## Discussion

### Merger of *B. tatewakiana* with *B. ovalifolia*

In our chromosome observation, the samples of *B. tatewakiana* from Sarabetsu and Nishibetsu mires had  $2n = 56$  (seven samples) and ca. 56 (four samples) chromosomes (Table 1). The chromosomes were too small (approximately  $1.0 \mu\text{m}$  long) to observe clearly and the chromosome count variation may need further verification; however, it is safe to say that *B. tatewakiana* is tetraploid because the basic chromosome number is 14 in the genus *Betula* (Eriksson and Jonsson 1986) and the diploid count should be  $2n = 28$ . Watanabe and Somego (1991) reported that *B. tatewakiana* is diploid, although no images of the chromosomes were presented. Thus, the possibility that there are both diploid and tetraploid in *B. tatewakiana* is not totally denied. However, his report was a gametophytic count and according to the author Watanabe the chromosome image was unclear (personal communication). For this reason, *B. tatewakiana* is highly likely to be tetraploid. Our chromosome count of *B. ovalifolia* was  $2n = 56$ . This is consistent with the flow cytometric study that suggested that *B. ovalifolia* from the Asian continent is tetraploid (Wang et al. 2016). Therefore, the idea to separate *B. tatewakiana* from *B. ovalifolia* based on the ploidy level (Watanabe and Somego 1991; Watanabe 1995) is not supported because both species are tetraploid. Hence, *B. tatewakiana* should be merged with *B. ovalifolia*. The observation of the morphological

traits also supports the merger of *B. tatewakiana* with *B. ovalifolia*. The two species are morphologically identical in white hairs and dense resinous glands respectively on the adaxial and abaxial leaf surfaces, based on which they are different from closely related dwarf birch species in the same section *Fruticosae*.

## Taxonomic treatment

***Betula ovalifolia* Rupr., Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Petersbourg 15: 378 (1857)**

≡ *B. tatewakiana* M. Ohki & S. Watan., J. Jap. Bot. 34: 329 (1959). Type: JAPAN, Hokkaido, Sarabetsu village: 18 August 1958, H. Suzuki and M. Ohki, s.n. (holotype, SAPS!)

**Type.** RUSSIA. Khabarovsk region: Mandshuria, 25 July 1855, R. Maack, s.n. (holotype, LE 01016954!)

## Implications for conservation

*Betula tatewakiana* is recognized as a synonym of *B. ovalifolia* as discussed above, and thereby it is not a Japanese endemic species. Hereafter, the Hokkaido populations are called *B. ovalifolia*. Because *B. ovalifolia* is broadly distributed in northeast Asia, i.e., Russian Far East, northeast China, North Korea, and northern Japan, the conservation priority of the species may not be high in a global perspective. On the other hand, the Hokkaido populations represent the only island populations disjunct from continental populations. The species had likely moved southward during glacial periods and retreated northward in warmer periods, and the Hokkaido populations are considered to be relict populations (Takahashi 2013). The Hokkaido populations can be reproductively isolated from the continental populations and can have a unique gene pool that deserves conservation. Also, in Japan, *B. ovalifolia* is distributed only in Sarabetsu and Nishibetsu mires and deserves conservation as national resource. On the other hand, if there exists gene flow among Hokkaido and continental populations, effective conservation should be planned considering genetic connectivity with populations abroad. Population genetics of *B. ovalifolia* in northeast Asia for conservation is the topic of our future investigation.

## Acknowledgements

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## Appendix I

Specimens for morphological observation:

### *Betula tatewakiana*

JAPAN, Hokkaido: Sarabetsu village, 18 August 1958, (H. Suzuki and M. Ohki, s.n., holotype, SAPS); Sarabetsu mire, 42°37.33'N, 143°15.72'E, alt. 166 m, 5 June 2017, Yuki Shiotani 65–115 (51 specimens, SAPT); Nishibetsu mire, 43°23.36'N, 145°03.66'E, alt. 32 m, 7 June 2017, Yuki Shiotani 1–26, 31–49 (45 specimens, SAPT)

### *B. ovalifolia*

RUSSIA, Primorsky Krai: Terney, 44°57.31'N, 136°33.01'E, alt. 25 m, 22 July 2016, Koh Nakamura 14169–14195, 14197, 14198 (29 specimens, SAPT); Terney, 44°56.85'N, 136°33.00'E, alt. 9 m, 23 July 2016, Koh Nakamura 14289–14297 (9 specimens, SAPT)

