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## SYSTEMATICS AND PHYLOGENY

# Molecular phylogenetics of *Phyllanthus sensu lato* (Phyllanthaceae): Towards coherent monophyletic taxa

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**Abstract** The genus *Phyllanthus* is paraphyletic as currently circumscribed, with the genera *Breynia*, *Glochidion* and *Synostemon* nested within it. A phylogeny based on nuclear (ITS, *PHYC*) and chloroplast (*matK*, *accD-psaI*, *trnS-trnG*) markers is presented, including 18/18 subgenera and 53/70 sections. Differences in habit, branching type, floral and fruit characters are discussed, and we find indications for shifts in pollination and dispersal strategies possibly underlying the convergent evolution of these characters in multiple clades. Several taxonomic issues were found in the subgeneric classification of *Phyllanthus* that will require new transfers and rank changes. *Phyllanthus* subg. *Anesonemoides*, subg. *Conami*, subg. *Embllica*, subg. *Gomphidium*, subg. *Kirganelia* and subg. *Phyllanthus* are polyphyletic, and several sections appear to be paraphyletic (e.g., *P.* sect. *Anisonema*, sect. *Embllicastrum*, sect. *Pseudoactephila*, sect. *Swartziani*, and sect. *Xylophylla*); *P.* subg. *Phyllanthodendron* is furthermore paraphyletic with the genus *Glochidion* nested within. To create a classification of tribe Phyllanthae that comprises exclusively monophyletic taxa, it is necessary to treat several clades at the same taxonomic rank as the genera *Breynia*, *Glochidion* and *Synostemon*. Since combining all genera would lead to one giant heterogeneous genus that is difficult to define, we recommend dividing *Phyllanthus* into several monophyletic genera, which have previously been recognized and often possess diagnostic (combinations of) morphological characters. This new classification is forthcoming.

**Keywords** molecular phylogenetics; paraphyly; Phyllanthaceae; *Phyllanthus*; sections; subgenera; systematics

**Supporting Information** may be found online in the Supporting Information section at the end of the article.

## ■ INTRODUCTION

The pantropical family Phyllanthaceae is the second-most species-rich segregate from Euphorbiaceae *sensu lato*, to be recognized since the publication of APG II (2003). It currently consists of about 2000 species, with more than 1200 placed in the largest tribe Phyllanthae Dumort (Govaerts & al., 2000; Hoffmann & al., 2006). Phyllanthae have been the focus of extensive discussion concerning the relationships and circumscriptions of genera (e.g., Hoffmann & al., 2006; Pruesapan & al., 2012; Van Welzen & al., 2014).

Previous phylogenetic studies that focused specifically on the Phyllanthaceae sought to elucidate the structure of the various tribes (mostly of subfamily Phyllanthoideae) (e.g., Kathriarachchi & al., 2005, 2006; Samuel & al., 2005; Vorontsova &

al., 2007), leading to revised classifications of the tribes Phyllanthae (Hoffmann, 2008; Ralimanana & Hoffmann, 2011, 2014; Ralimanana & al., 2013; Van Welzen & al., 2014), Poranthereae (Vorontsova & Hoffmann, 2008, 2009) and Wielandiaeae (Hoffmann & McPherson, 2007). However, tribe Phyllanthae remains problematic, mainly because the largest genus, *Phyllanthus* L., is paraphyletic (Kathriarachchi & al., 2006).

*Phyllanthus* contains more than 800 species and has a complex taxonomic history (Govaerts & al., 2000; Bouman & al., 2018a). The main characters used to distinguish *Phyllanthus* from other genera are the absence of corolla, pistillodes and staminodes; the presence of a disc or disc glands in the flowers and a specialized branching system called phyllanthoid branching (Webster, 1956) that is present in the majority of species. Species with phyllanthoid branching have deciduous floriferous

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branchlets subtended by reduced scale-like leaves (cataphylls) (Fig. 1F) and lack laminate leaves on the main stem (Webster, 1956). The genus is morphologically very diverse and shows a large range in habit, flower, seed and pollen morphology (Webster, 1956; Punt, 1967, 1972, 1980, 1986, 1987; Meeuwis & Punt, 1983; Lobreau-Callen & al., 1988; Stuppy, 1996; Webster & Carpenter, 2002, 2008; Kathriarachchi & al., 2006). Several morphological characters seem to have evolved or were lost more than once (Kathriarachchi & al., 2006; Falcón & al., 2020), however, rendering the taxonomy complex and identifications difficult. *Phyllanthus* was shown to be paraphyletic in recent studies, with the genera *Synostemon* F. Muell., *Breynia* J.R. Forst. & G. Forst. (including *Sauropus* Blume) and *Glochidion* J.R. Forst. & G. Forst. nested within it. First indications of paraphyly were found by Wurdack & al. (2004) and Samuel & al. (2005), but the sample sizes were inadequate for effecting taxonomic changes at the generic level (Kathriarachchi & al., 2006). During subsequent studies of tribe Phyllanthae with increased sampling, including the majority of subgenera and sections of *Phyllanthus*, it was confirmed that the genus was indeed paraphyletic (Kathriarachchi & al., 2006; Falcón & al., 2020).

Several solutions have been proposed by various authors for handling paraphyletic taxa. Some vouch for the acceptance of paraphyletic taxa (e.g., Brummitt, 2002, 2003; Hörandl, 2007), while most taxonomists favour recognizing exclusively monophyletic taxa, either by subsuming (e.g., Larridon & al., 2011; Khanum & al., 2016; Bruyns & al., 2017) or dividing (e.g., Ehrendorfer & Barfuss, 2014; Manning & al., 2014) previously established classifications. The first solution was proposed by Kathriarachchi & al. (2006), resulting in *Breynia*, *Glochidion* and *Synostemon* being subsumed into *Phyllanthus* to create a single giant genus of more than 1200 species (Hoffmann & al., 2006). New names for local floras were published by several authors who followed their decision (e.g., Chakrabarty & Balakrishnan, 2009; Wagner & Lorence, 2011; Kurosawa, 2016; Govaerts, 2018). However, others feel that this would only push the problems to the subgeneric level (Pruesapan & al., 2008; Van Welzen & al., 2014). They suggested that a more representative phylogeny would be needed to explore the option of creating new monophyletic and morphologically recognizable genera (e.g., Pruesapan & al., 2008). An analysis with increased sampling of the genera nested within *Phyllanthus* showed that *Glochidion* was monophyletic, but that *Breynia* should be combined with *Sauropus* and that the Australian genus *Synostemon* should be resurrected (Pruesapan & al., 2008, 2012; changes implemented in Chakrabarty & Balakrishnan, 2012, 2015; Van Welzen & al., 2014). As a consequence, the genus *Phyllanthus* remains paraphyletic, but with many morphologically defined subgenera and sections that are potential candidates for new or reinstated genera. Despite the body of work leading up to and including Van Welzen & al. (2014), there has been some reluctance to follow the revised classification of *Synostemon* and *Breynia* due to the issue of the non-monophyly of *Phyllanthus* (Kato & Kawakita, 2017; Govaerts, 2018).

Due to its diversity in habit, flower, pollen and seed morphology (Fig. 1), the genus *Phyllanthus* is currently divided

into 18 subgenera with 70 sections and 14 subsections (Bouman & al., 2018a). The first species within the genus were described by Linnaeus (1753), from Neotropical and Indian material. Soon after, many new genera were defined based on differences in flower morphology, specifically the number and fusion of the stamens in staminate flowers (e.g., Jussieu, 1824; Baillon, 1858). A major change was undertaken by Müller (1863, 1865, 1866), who combined over 10 genera into *Phyllanthus* s.l. with more than 40 sections. The genus *Glochidion* was considered to be closer to *Phyllanthus* than *Breynia* or *Sauropus* and was therefore combined with *Phyllanthus* (Müller, 1866), but was segregated again by Hooker (1887). Müller's (1866) classification was further modified by Webster (1979), who reinstated the genus *Margaritaria* L.f. in his revision of *Phyllanthus* from the West Indies. Webster (1956, 1957, 1958) utilized previously established sections and subgenera (Kurz, 1873; Croizat & Metcalf, 1942) to create a provisional hierarchical classification of subgenera and sections to show the relations between groups. This classification scheme was subsequently expanded by Webster himself (Webster, 1967b, 1970, 1978, 1986, 1995, 2001a, 2001b, 2002a, 2002b, 2003, 2004) and various authors in the treatment of *Phyllanthus* for other areas such as Africa (Brunel & Roux, 1977, 1985; Brunel, 1987), Malesia (Airy Shaw, 1971, 1975, 1980) and New Caledonia (McPherson & Schmid, 1991). The main characters for this classification were differences in flower, fruit and pollen morphology, and the presence or absence of phyllanthoid branching (Webster, 1956). The congruence of this morphology-based classification with molecular phylogenies was evaluated by Kathriarachchi & al. (2006) and Falcón & al. (2020). Several subgenera were found to be polyphyletic, although most of these issues were addressed in subsequent revisions (Webster, 2007; Ralimanana & Hoffmann, 2011, 2014; Ralimanana & al., 2013).

Previous classifications and results from phylogenetic studies and subsequent revisions were summarized by Bouman & al. (2018a) (and only a minority of species could not yet be classified due to incomplete data). Previous samplings in phylogenetic studies by Kathriarachchi & al. (2006) and Falcón & al. (2020) have only covered about 10% of the genus. To settle the debate as to whether it is possible to render the undiagnosable *Phyllanthus* into morphologically diagnosable, monophyletic taxa, a thoroughly sampled phylogenetic analysis of the genus is needed. Such a phylogeny should provide a sound examination of the classification presented by Bouman & al. (2018a). In the present study, we include a much higher sampling, with 220 of the 881 species, with a complete sampling at the subgeneric level (18/18) and with 53 of the currently 70 recognized sections. The subgeneric classification of the species of *Phyllanthus* included here follows Bouman & al. (2018a).

## ■ MATERIALS AND METHODS

**Taxon sampling.** — Increased sampling efforts were undertaken to include *Phyllanthus* species from the entire distribution range and the majority of taxonomically defined subgroups.

Additional sequences used in other studies were obtained from GenBank (Appendix 1). Most of the previously unsampled groups listed by Kathriarachchi & al. (2006: table 1) were included. Recently collected silica-gel dried leaf samples were obtained from various contributors from botanical gardens in Europe, Africa and Asia (see Acknowledgments); other DNA samples were obtained from herbarium material. A full list of

all samples is given in Appendix 1. Ingroup sampling included 32 species of *Breynia* (43 samples), 7 species of *Synostemon* (10 samples), 12 species of *Glochidion* (15 samples) and 221 species of *Phyllanthus* (312 samples). Several species of *Antidesma* L., *Bridelia* Willd., *Flueggea* Willd., *Heterosavia* (Urb.) Petra Hoffm., *Margaritaria*, *Notoleptopus* Voronts. & Petra Hoffm. and *Plagiocladus* Jean F. Brunel were used as outgroups



**Fig. 1.** Major characters of *Phyllanthus* and the related genera *Breynia* and *Glochidion*. **A**, Habit of the herbaceous *P. tenellus* (*P.* subg. *Tenellanthus*); **B**, Habit of *P. watsonii* (*P.* subg. *Eriococcus*); **C**, Habit and fruits of *P. emblica* (*P.* subg. *Emblica*); **D**, Non-phyllanthoid branching in *P. myrtellus*; note the leaves subtending lateral branches (*P.* subg. *Macraea*); **E**, Sub-phyllanthoid branching in a young plant of *P. glaucus*, lateral branches are deciduous (*P.* subg. *Kirganelia*); **F**, Phyllanthoid branching and phylloclades in *P. arbuscula* (*P.* subg. *Xylophylla*); **G**, Young capsules of *P. myrtellus* (*P.* subg. *Macraea*); **H**, Dehiscent capsule of *P. juglandifolius* (*P.* subg. *Xylophylla*); **I**, Berries on a specialized leafless branchlet of *P. microcarpus* (*P.* subg. *Kirganelia*); **J**, Capsules of *G. eriocarpum* with orange arillate seeds exposed in some (*Glochidion*); **K**, Staminate flowers of *P. pulcher* (*P.* subg. *Eriococcus*); **L**, Pistillate flowers of *P. pulcher* (*P.* subg. *Eriococcus*); **M**, Flowers of *P. mimosoides* (*P.* subg. *Xylophylla*); **N**, Flowers of *P. arbuscula* (*P.* subg. *Xylophylla*); **O**, Staminate flower of *P. cf. poilanei* (*P.* subg. *Phyllanthodendron*); **P**, Pistillate flower of *B. androgyna* (*Breynia*). — Photos: A, C–G, I–M & O by R.W. Bouman; B © R.-Y. Yu; H by J.S. Strijk; N © M.S. Nuraliev.

(selection based on previous phylogenies: Wurdack & al., 2004; Pruesapan & al., 2008).

**DNA extraction, amplification and sequencing.** — DNA was extracted from fresh material using the DNeasy Plant Mini kit (Qiagen, Hilden, Germany) following the manufacturer's protocol, with a modified protocol (Wurdack & al.,

2004) adopted for herbarium material. Modifications consisted of an extended lysis step from 10 min to 12–24 h with the addition of 20 mg/ml proteinase K and 6.5%  $\beta$ -mercaptoethanol. The final elution was extended to  $2 \times 30$  min with each elution step undertaken with only 40  $\mu$ l AE buffer. Collection and voucher data are presented in Appendix 1. Other samples

**Table 1.** Primer sequences for the amplification of the various markers with annealing temperatures and references.

Primer	Forward or reverse primer	Sequence (5' → 3')	Annealing temperature (°C)	Source
PHYC-F	Forward	CCAGCTACTGATATACCTCAAGCTTC	48	Samuel & al., 2005
PHYC-R	Reverse	CCAGCTTCCATAAGGCTATCAGTACT	48	Samuel & al., 2005
PHYC-178F	Forward	TGGGTAC(AGT)AT (GT)GCATCTCTTG	55	Designed here
PHYC-260F	Forward	AAAATTGTGGGGCTTGGTGG	55	Designed here
PHYC-439F	Forward	TGCT(CT)CT(CT)AGAGATGCACCT	55	Designed here
PHYC-260Rev	Reverse	CCACCAAGCCCCACAATTTT	55	Designed here
PHYC-344Rev	Reverse	CCTGAAC(AC)CCAAACACTTGC	55	Designed here
PHYC-490Rev	Reverse	CTCCRTCACACTTAACTA(AG)(AG)TCCA	55	Designed here
ITS5	Forward	GGAAGTAAAAGTCGTAACAAGG	52.5	White & al., 1990
ITS4	Reverse	TCCTCCGCTTATTGATATGC	52.5	White & al., 1990
ITS2	Reverse	GCTGCGTTCTTCATCGATGC	52.5	White & al., 1990
ITS3	Forward	GCATCGATGAAGAACGCAGC	52.5	White & al., 1990
accD	Forward	AAT(CT)GTACCACGTAATC(CT)TTTAAA	49	Shaw & al., 2007
psaI-75R	Reverse	AGAAGCCATTGCAATTGCCGAAA	49	Small & al., 1998
accd-121F	Forward	AGCAAAATAAAAT(AG)CGAAGAGTG	55	Designed here
accd-151F	Forward	ACGAAAGCCCTATCAACAAGAGA	50	Designed here
accd-226R	Reverse	CTCTTGTTGATAGGGCTTTCGT	50–55	Designed here
accd-462Rev	Reverse	TCTGCTCCCGAGAAATTCGT	48	Designed here
accd-595Rev	Reverse	GGAGTGTAGAACTAAGTAAATGGACT	50–55	Designed here
trnS-F	Forward	GCCGCTTTAGTCCACTCAGC	55	Hamilton, 1999
trnG-R	Reverse	GAACGAATCACACTTTTACCAC	55	Hamilton, 1999
trnSG-448F	Forward	CCATTTCCATGACCTAGCCCAA	55	Designed here
trnSG-535R	Reverse	TTCGAATCGAAGAAATCCTTTTATCT	55	Designed here
trnK-570F	Forward	TCCAAAATCAAAGAGCGATTGG	55	Samuel & al., 2005
matK80F	Forward	CTATACCCACTTATCTTTTCGGGAGT	55	Samuel & al., 2005
matK390F	Forward	CGATCTATTCAATCAATATTC	55	Samuel & al., 2005
matK800F	Forward	CATGCATTATGTTAGATATCAAGG	55	Samuel & al., 2005
matK1200F	Forward	GA(CT)TCTGATATTATCAACCGATTTG	55	Samuel & al., 2005
matK190R	Reverse	ATTCGAGTAATTAACGTTTTACAA	55	Samuel & al., 2005
matK530R	Reverse	GTTCCAATCCAATACTCGTGAAG	55	Samuel & al., 2005
matK950R	Reverse	AAAAT(AG)ACATTGACATAAATTGACAA(AG)G	55	Samuel & al., 2005
matK1300R	Reverse	CGAAGTATATA(CT)TT(CT)ATTCGATACA	55	Samuel & al., 2005
matK1710R	Reverse	GCTTGCAATTTTCATTGCACACG	55	Samuel & al., 2005

were extracted with the NucleoMag 96 Tissue kit (Macherey-Nagel, Düren, Germany) following the manufacturer's protocol using a KingFisher Flex magnetic particle processor (Thermo Scientific, Waltham, Massachusetts, U.S.A.), but with an extended lysis step of 12–24 h.

Two nuclear (high-copy spacer ITS, low-copy *PHYC*) and three chloroplast (*accD-psaI*, *trnS-trnG* intergenic spacers, *matK* with the *trnK* intron) DNA markers were selected for use in this study based on variability and to complement previously generated data (e.g., Kathirarachchi & al., 2006; Kawakita & Kato, 2009; Pruesapan & al., 2008, 2012). Primers are shown in Table 1. Polymerase chain reactions (PCR) were performed in volumes of 25  $\mu$ l consisting of: 15.25  $\mu$ l Milli-Q H<sub>2</sub>O, 2.5  $\mu$ l 50 $\times$  PCR Buffer, 1  $\mu$ l 50 mM of MgCl<sub>2</sub>, 1  $\mu$ l each of forward and reverse primers (10 mM), 2  $\mu$ l 2.5 mM dNTP, 1  $\mu$ l 10  $\mu$ g/ $\mu$ l bovine serum albumin (BSA), 0.25  $\mu$ l KlearTaq and 1–2  $\mu$ l of DNA. A standard PCR program was used for amplification, with an initial denaturation for 2 min at 94°C; 40 cycles of 1 min denaturation at 94°C, annealing for 30 s with the annealing temperature specific for each primer (see Table 1) and elongation for 1 min at 72°C; and a final elongation step of 10 min at 72°C. New internal primers were designed for the *PHYC*, *accD-psaI* and *trnS-trnG* markers in order to amplify the marker in smaller segments, which proved to be more effective when working with herbarium material. Primers were designed using sequences from several *Breynia*, *Glochidion*, *Phyllanthus*, and *Synostemon* species with the online application Primer3Plus (bioinformatics.nl/cgi-bin/primer3plus/primer3plus.cgi) with default settings (Fig. 2).

The length of PCR fragments was verified on a 1% agarose gel with electrophoresis. Successful PCR samples were subsequently analyzed on either an ABI3730xl automated sequencer (Applied Biosystems, Foster City, California, U.S.A.) by using ABI BigDye terminator chemistry, or a MegaBACE 1000 automated sequencer (Amersham Bioscience, now GE Healthcare Europe, Diegem, Belgium) using DYEnamic ET Dye Terminators chemistry following the manufacturers' protocols by another company (BaseClear, Leiden, the Netherlands). Primer combinations used during sequencing were dependent on DNA quality, and markers of herbarium specimens were often amplified in segments of 200–300 nucleotides.

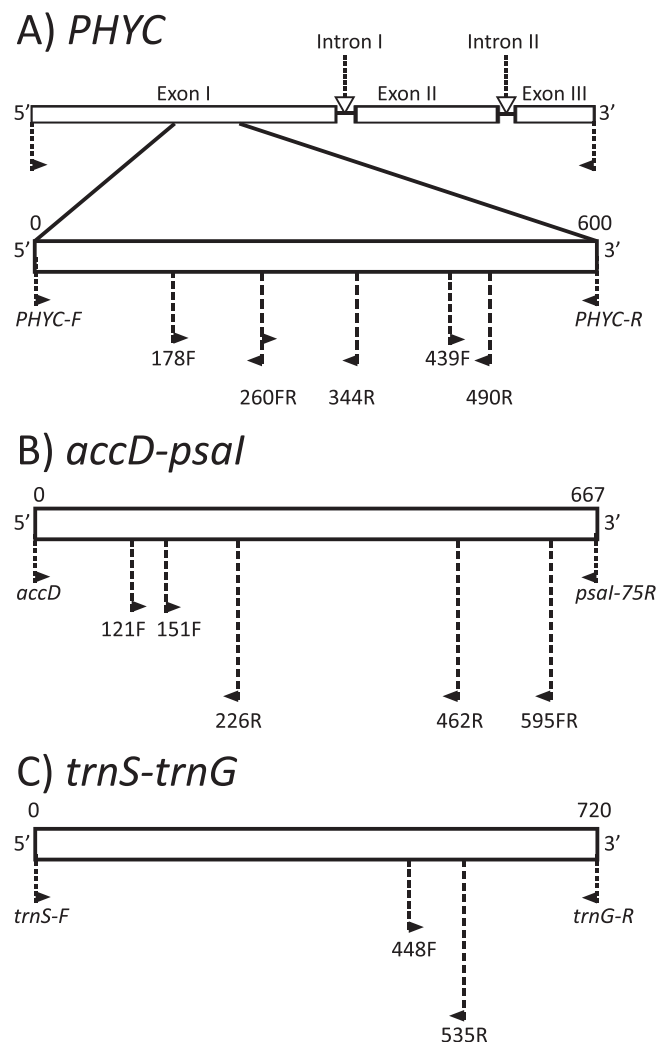
#### Sequence cleaning, alignment and resulting datasets. —

Forward and reverse sequences were combined, primers trimmed and cleaned of reading errors using the program Sequencher v.4.14 (GeneCodes Corp., <http://www.genecodes.com/>) and aligned using the program ClustalW v.2.1. (Larkin & al., 2007) on the CIPRES (Cyber Infrastructure for Phylogenetic REsearch) gateway (<https://phylo.org/>) using default settings. The subsequent alignment file was checked and manually corrected using a similarity criterion for obvious alignment errors in PAUP v.4.0a (Swofford, 2002). Some ambiguous alignment positions were encountered in the *trnS-trnG* spacer, which varied greatly in sequence length from positions 259 to 413 in the alignment, and these were excluded before analysis.

For analysis, ends of the data matrices (suppl. Appendices S1–S5) were truncated to match sequences generated here

and those retrieved from GenBank. The individual marker trees (suppl. Figs. S1–S7) were visually inspected for incongruence before combining the datasets. Several species were included from GenBank or with only partial sequences obtained from herbarium species; this resulted in some missing data for a number of taxa (see Appendix 1). To check for the effect of missing data on the relationships between major groups, two separate datasets were prepared. A full dataset, which contained all specimens from the individual marker analyses and a trimmed dataset that only included samples of which at minimum four of the five markers were sequenced. The full dataset contained 396 terminals, while the trimmed dataset contained 290 terminals.

**Phylogenetic analyses.** — Analyses of the individual markers, the combined and combined reduced datasets were run under Bayesian inference using MrBayes v.3.2.7 (Ronquist



**Fig. 2.** Schematic design for the marker *PHYC* (A), *accD-psaI* (B) and *trnS-trnG* (C) spacer with newly designed primers indicated by arrowheads. Number behind primer names indicates approximate nucleotide position within the marker including insertions in the matrix. *PHYC* figure adapted from Samuel & al. (2005).

& al., 2012) and maximum likelihood using RAxML v.8.2.12 (Stamatakis, 2014) via the CIPRES gateway. Missing sequences due to amplification problems or those that could not be obtained from GenBank, were recorded as missing data following Wiens (2003). MrModeltest v.2 (Nylander, 2004) was used on the dataset for each marker set to obtain the best-fitting model for Bayesian inference. All best models were the most-parameterized models, which include a Gamma distribution ( $\Gamma$ ) (coded as: nst = 6, rates = gamma for ITS, *accD-psaI* and *trnS-trnG*, rates = equal for *PHYC* and *matK*), and all individual analyses were run for 10 million generations on two parallel runs of four Markov chains (CIPRES default). An initial burn-in of 25% was used. Each marker was run as a separate partition in the concatenated matrix following previously determined rates. Effective sampling sizes (ESS) and convergence of the two runs were checked via the resulting “.p” files using Tracer v.1.7.1 (Rambaut & Drummond, 2018). The maximum likelihood tree was reconstructed under the GTRCAT model and CIPRES default settings to accelerate computation of our dataset. The analysis was run with a concatenated dataset partitioned by marker with 1000 bootstrap iterations.

## ■ RESULTS

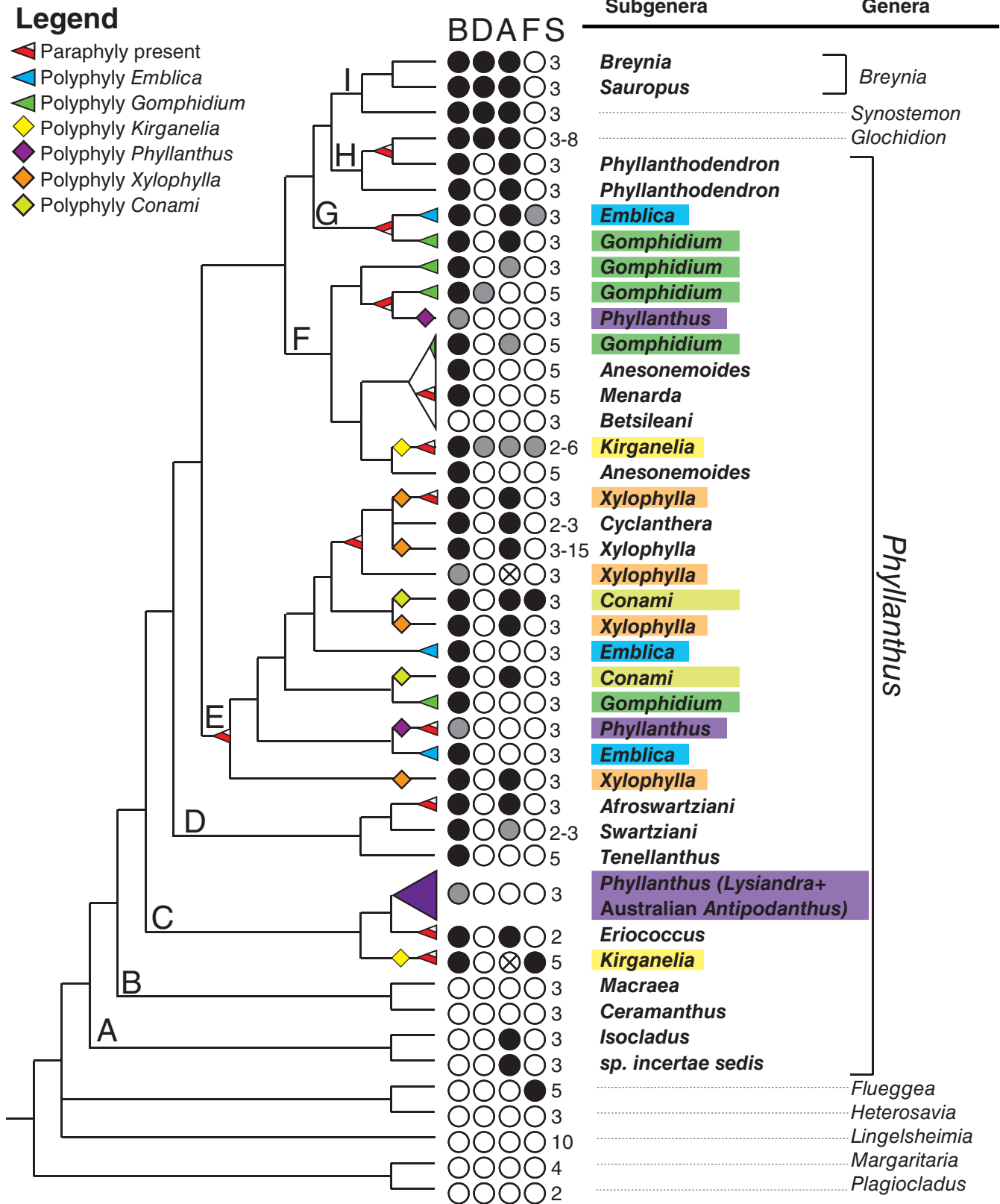
**Analysis of the individual and combined nuclear/combined chloroplast markers.** — Due to the use of herbarium material and data available from GenBank, the majority of taxa lacked comprehensive data for all markers. Table 2 shows the number of contigs for each marker and the number of informative sites. We generated 1349 new sequences during this study and included 300 sequences from GenBank. Non-coding regions such as the *accD-psaI* spacer had many more gaps than the coding region of *PHYC*. Results for individual markers recovered similar clades, but lacked adequate support to provide reliable and stable relationships between clades. Clade A (Figs. 3, 4; suppl. Figs. S1–S7) was recovered as sister to the remainder of the genus *Phyllanthus* with maximum support (suppl. Fig. S3; PP 1.0) in the ITS topology, but with lower support in the other markers. There is consistently high support for clade B (PP > 0.99), but resolution within the clade differs between markers. *Phyllanthus* subg. *Kirganelia* (A.Juss.) Kurz

(clade C1 in Fig. 4; PP 1.0) was consistently retrieved as sister to a clade comprising subg. *Eriococcus* (Hassk.) Croizat & Metcalf (clade C3) and sect. *Lysiandra* (F.Muell.) G.L.Webster + sect. *Antipodanthus* G.L.Webster (C2; discussed below) (PP > 0.66) (suppl. Figs. S3–S7, except in suppl. Fig. S4). The relationships between clades D, E and F (Fig. 4) were generally poorly supported, although clade D was confirmed as monophyletic in most datasets (PP > 0.89) except for the nuclear, ITS, *PHYC* and *accD-psaI* topologies. Support for the relationship between *P.* subg. *Phyllanthodendron* and *Glochidion* was obtained from all markers (clade H; PP 1.0). Similarly, the relationship between the genera *Breynia* and *Synostemon* was also recovered in all markers (clade I; PP > 0.97), except for *trnS-trnG*, where it was part of a larger polytomy with the genus *Glochidion*.

**Incongruence.** — During the Bayesian analyses of the individual markers, some incongruence was found, but mostly between chloroplast and nuclear markers. The most significant incongruence found was between the ITS dataset (suppl. Fig. S3) and the other four markers (suppl. Figs. S4–S7) and affected mainly *Phyllanthus* subg. *Gomphidium* (Baill.) G.L. Webster and subg. *Betsileani* (Jean F.Brunel) Ralim. & Petra Hoffm. *Phyllanthus* subg. *Betsileani* was recovered as sister to subg. *Gomphidium* sect. *Gomphidium* and sect. *Nymanina* (suppl. Fig. S3; PP 1.0), while in the concatenated dataset, these taxa were in the neighbouring clades F2 and F1, respectively (Fig. 4). In the analysis of *PHYC*, *accD-psaI*, *matK* and our concatenated datasets (except concatenated nuclear dataset), *P.* subg. *Betsileani* was always recovered as sister to other species of Madagascar from subg. *Menarda* and part of subg. *Anesonemoides* and subg. *Gomphidium*. Kathriarachchi & al. (2006) opted to exclude ITS sequences of *P.* subg. *Betsileani* in their concatenated analysis. Branch lengths were here observed to be quite short, indicative of a more recent split, with the ITS marker lacking accumulated additional mutations. We, therefore, decided to combine the datasets without excluding specific markers for certain species, resulting in a consensus tree of all markers that showed a similar relationship between *P.* subg. *Gomphidium*, subg. *Anesonemoides*, subg. *Betsileani* and subg. *Menarda* (Comm. ex A.Juss.) Ralim. & Petra Hoffm. (Clade F) to that found in the *PHYC* and chloroplast marker sets. The nuclear (suppl. Fig. S1) and chloroplast (suppl. Fig. S2) datasets differed

**Table 2.** Summary of individual marker datasets used in the analyses. Number of generated sequences shows between brackets the number of missing nucleotide sequences. Alignment length of *trnS-trnG* shows total length of the matrix with in brackets the length used in the analysis after exclusion of ambiguously aligned sections.

Marker	No. of sequences in dataset (missing)	Max. sequence length (bp)	Alignment length (bp)	No. of informative sites
ITS	352 (42)	304–650	732	451
<i>PHYC</i>	335 (49)	134–581	589	329
<i>matK</i>	369 (35)	732–1791	2170	1179
<i>accD-psaI</i>	321 (73)	197–546	1036	552
<i>trnS-trnG</i>	272 (122)	209–635	1233 (1078)	732



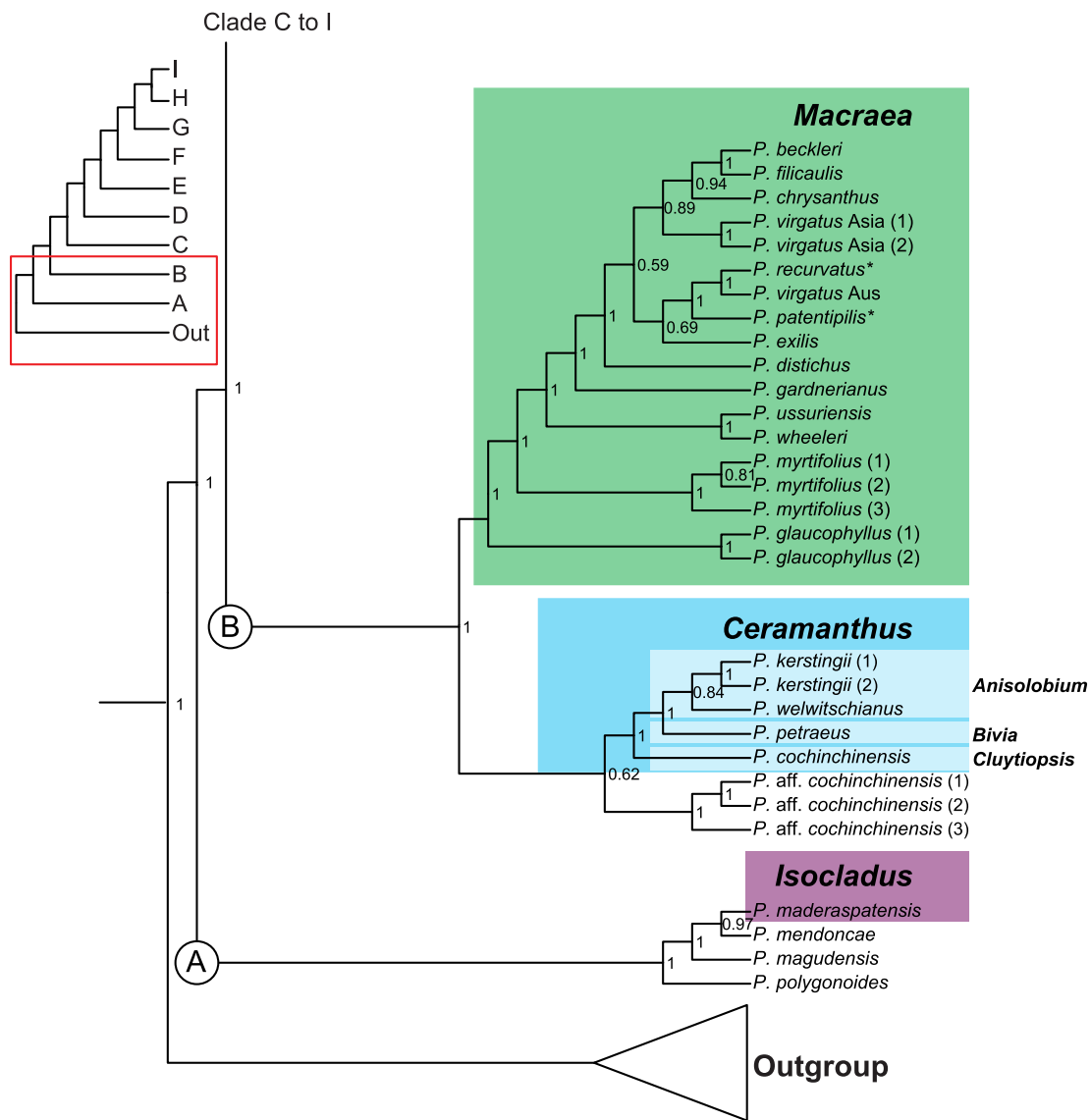
**Fig. 3.** Molecular phylogenetic relationships of tribe Phyllanthae, simplified from Fig. 4 showing genera and subgenera. Colouring of clades follows Fig. 4, and paraphyly is highlighted with a red-white triangle (◄). Several morphological characters and character states are shown: B, branching non-phyllanthoid (○), sub-phyllanthoid (◐) or phyllanthoid (●); D, disc present (○), absent (●) or when both variations occur in the clade (◐); A, androphore filaments free (○), fused (●) or when both are present (◐); F, fruit capsules (○), berries (●), or when both are present (◐); S, average stamens number.



in the relationship between clades D–F. In the nuclear phylogeny, clade F is sister to clades D, E & G–I (suppl. Fig. S1; PP 0.99), while the chloroplast phylogeny is similar to the concatenated dataset with clade D sister to clades E–I (suppl. Fig. S2; Fig. 4). Additional incongruence was found in the relationships between *P. subg. Tenellanthus*, subg. *Swartziani* and subg. *Afroswartziani* (Fig. 4, clade D; but see suppl. Figs. S1 & S2). In the chloroplast dataset, *P. subg. Swartziani* is recovered as sister to a clade comprising subg. *Tenellanthus* and subg. *Afroswartziani*. This is in contrast with the combined dataset (Fig. 4), in which *P. subg. Tenellanthus* is recovered as sister to the other subgenera.

**Concatenated datasets.** — Our total dataset of all markers combined resolved *Phyllanthus* in eight major clades

(Figs. 3, 4; suppl. Fig. S8), but the genus, like in all former analyses, was found to be paraphyletic. While the majority of relationships between groups remained largely unchanged (Figs. 3, 4), internal support of species relations within major groups differed between the analyses of the total and reduced datasets. Posterior probabilities of major nodes differed, and clade E was more resolved in the analysis of the reduced dataset (suppl. Fig. S8). The relationship between clades A–I did not differ when comparing the reduced dataset with the total dataset. In Fig. 4, the relationship between clades E1, E2 and E3 was not resolved. In the reduced dataset (suppl. Fig. S8), clade E2, including *P. subg. Conami* sect. *Nothoclema* G.L. Webster and subg. *Emblica* sect. *Microglochidion* (Müll. Arg.) Müll. Arg., was resolved as sister to clade E3 (PP 0.89).



**Fig. 4.** Bayesian majority-rule consensus tree of the full combined nuclear (ITS, *PHYC*) and chloroplast (*accD-psaI*, *matK*, *trnS-trnG*) datasets for *Phyllanthus* and related genera; posterior probabilities (PP) are displayed at the nodes; infrgeneric classification follows Bouman & al. (2018a); subgenera are given above colored clades, sections to the right. Outgroups and some ingroup genera are collapsed (see full tree in suppl. Fig. S10). Manuscript names of new undescribed species are indicated with an asterisk.

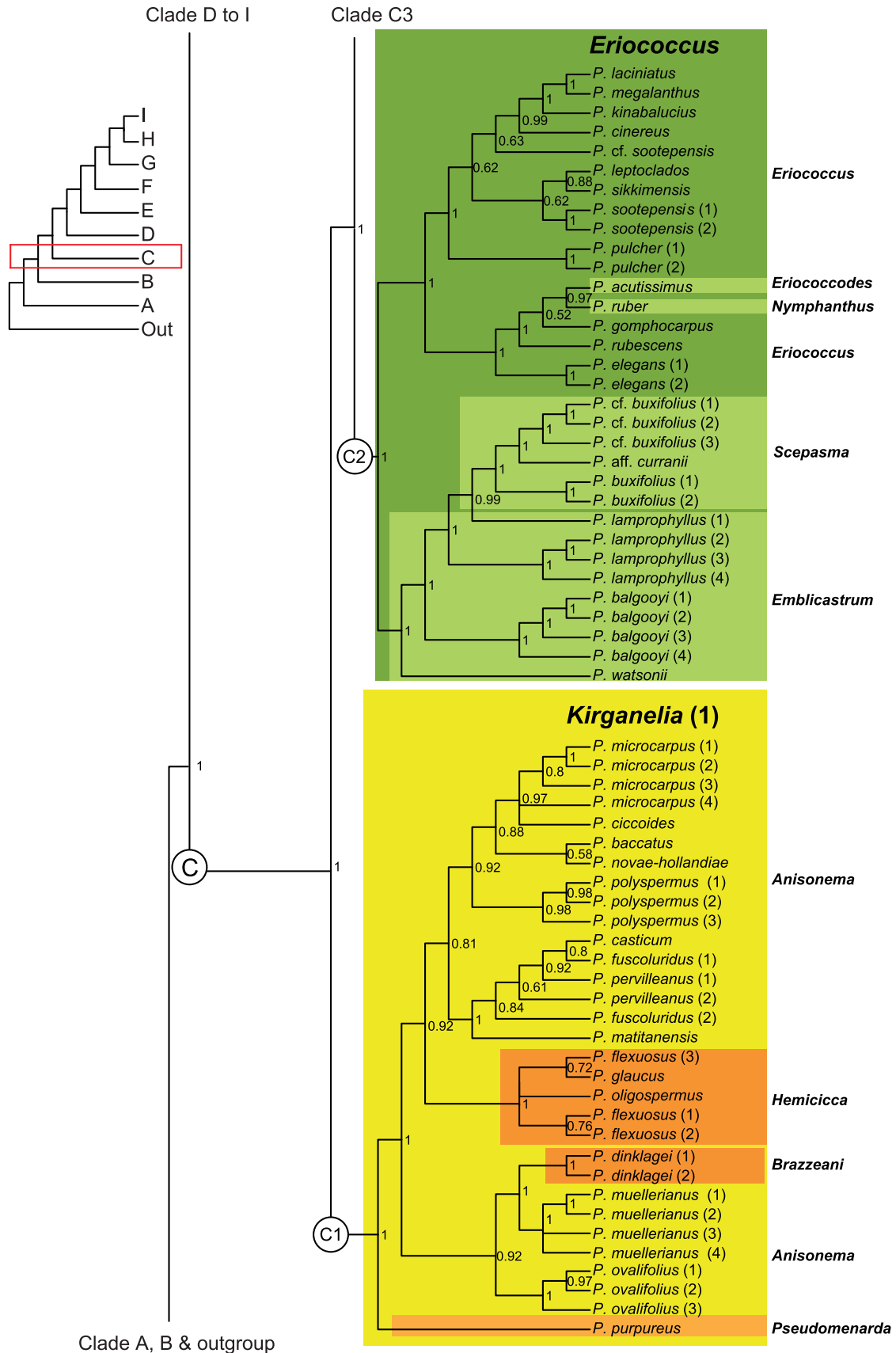


Fig. 4. Continued.

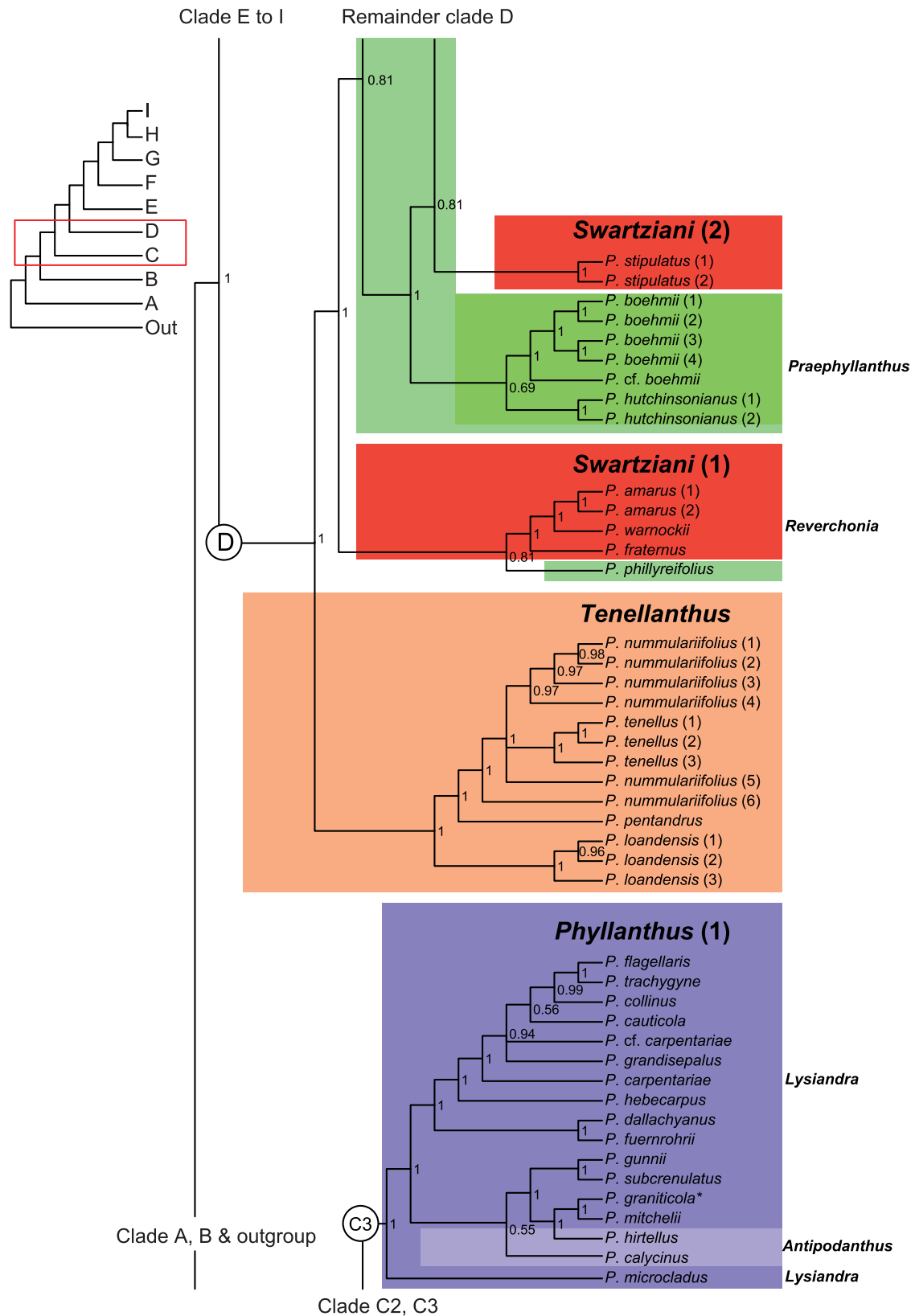


Fig. 4. Continued.

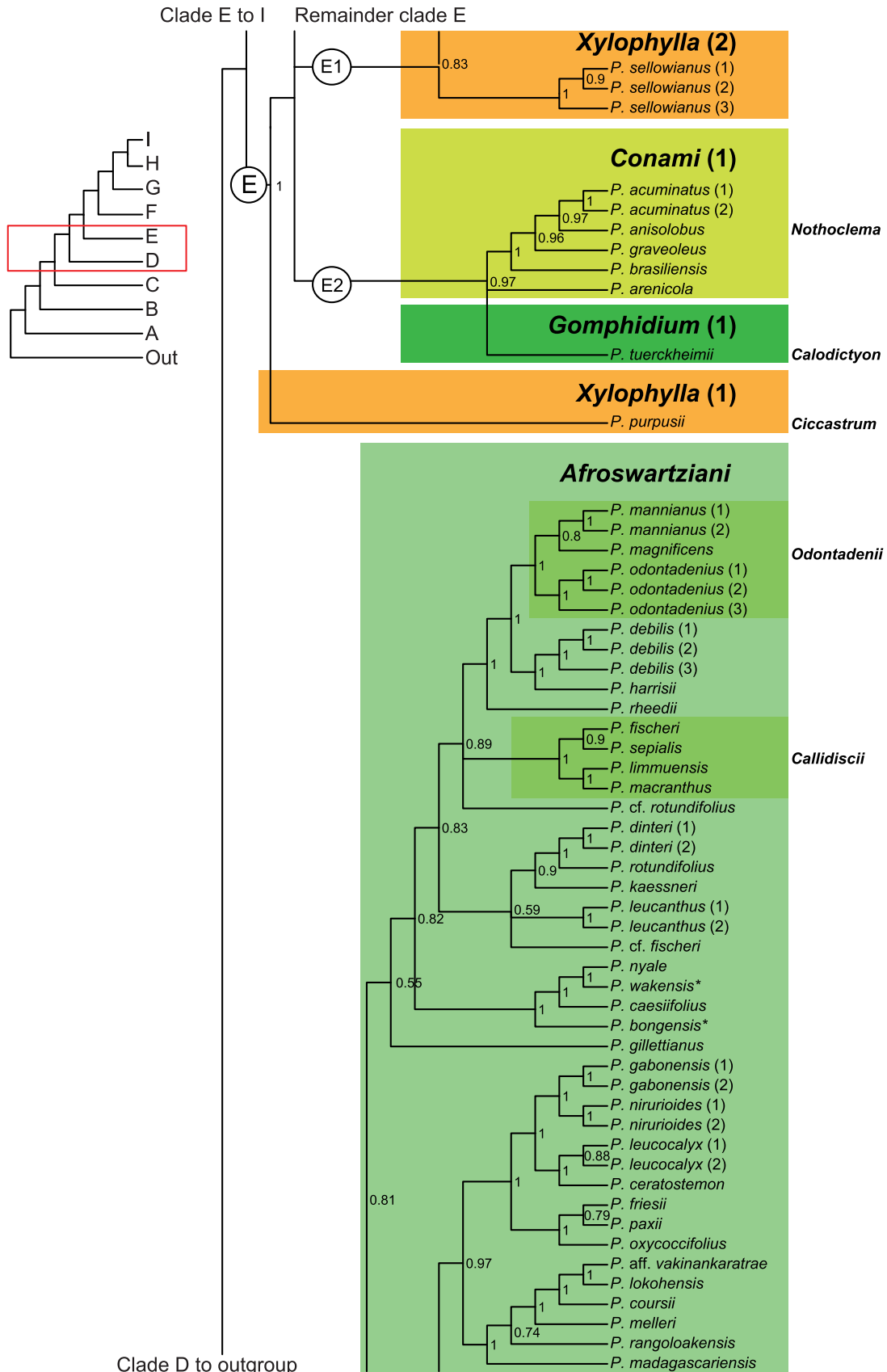


Fig. 4. Continued.

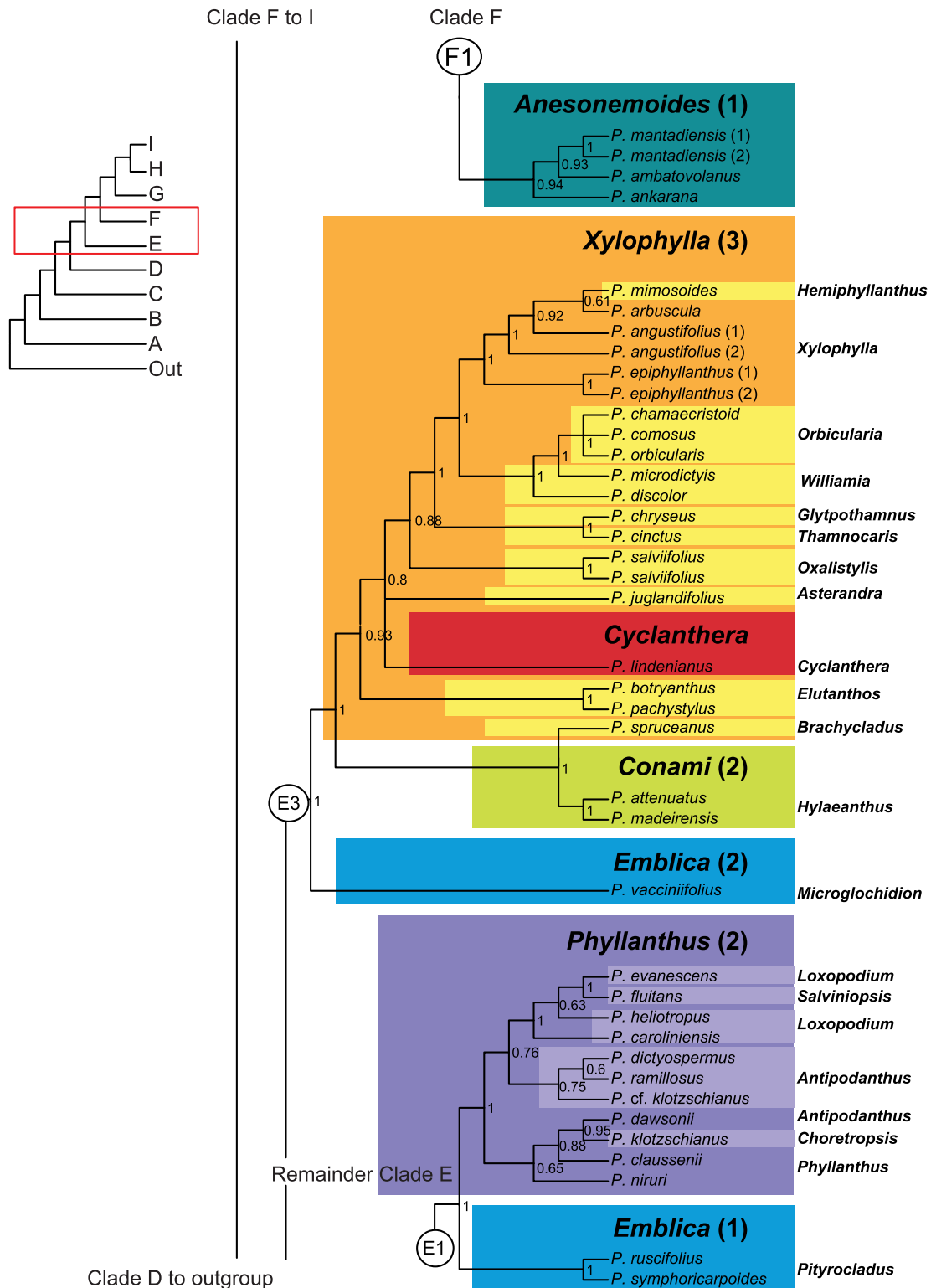


Fig. 4. Continued.

This might be an artifact of the number of markers available for taxa in clade E in the total dataset. The reduced dataset also achieves greater resolution of clade F, particularly in *P.* subg. *Gomphidium* and the relationship between its sections *Gomphidium* and *Nymanina*. *Phyllanthus* sect. *Nymanina*

is found to be paraphyletic (see suppl. Fig. S8) with sect. *Gomphidium* nested within (PP 1.0). Other clades did not show changes in the relationships between major groups in the reduced dataset, with only support levels differing between matrices.



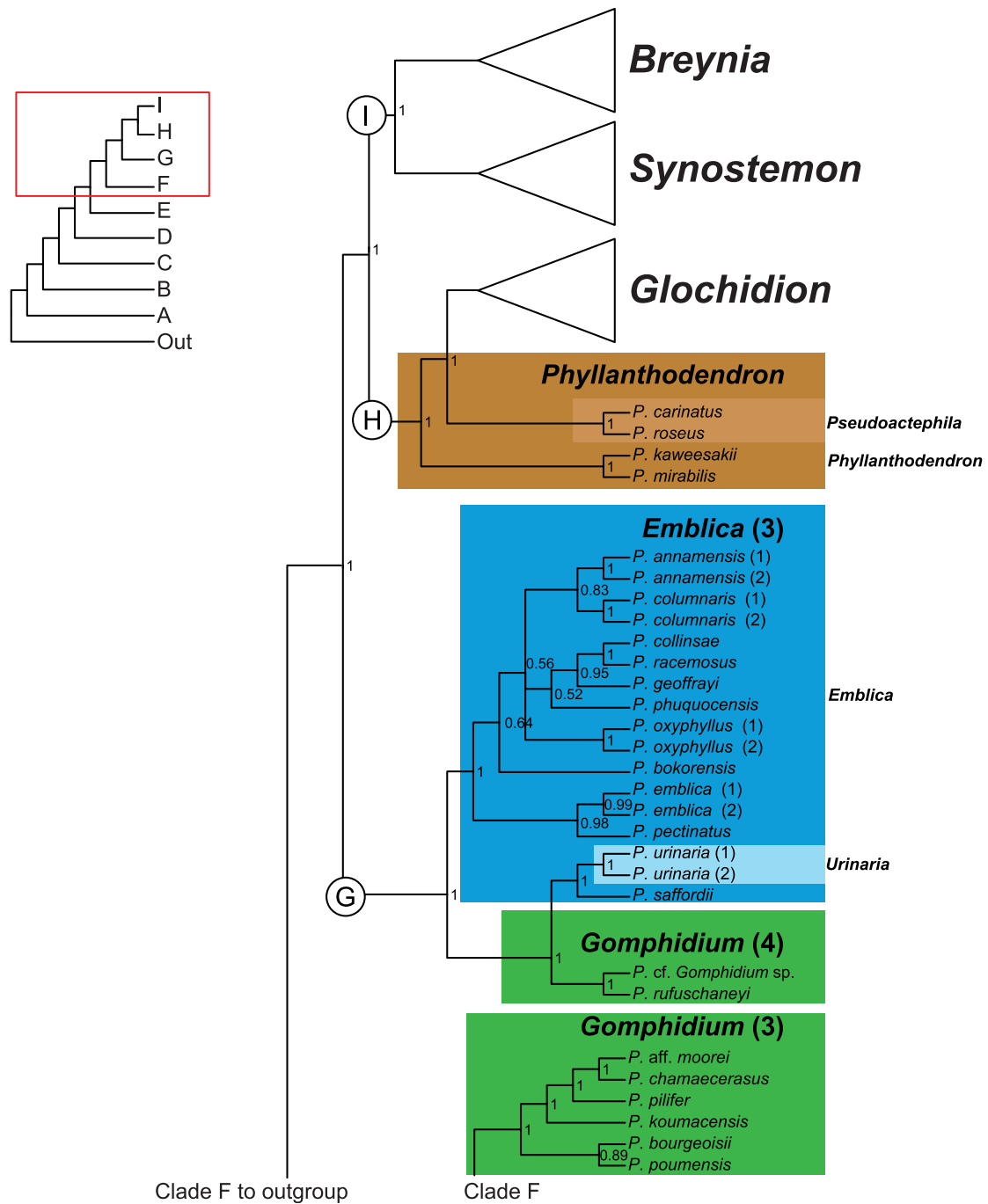


Fig. 4. Continued.

Comparing Bayesian inference (Fig. 4) with maximum likelihood (suppl. Fig. S9) of our total dataset did not result in significant differences. The same larger clades A–I were retrieved (though weakly supported for the relationship between clades D–G). Internal relationships between species differed slightly, often not significantly (BP < 50). Aside from differences in node support, clades A–D, did not differ between Bayesian inference and maximum likelihood. Clade E was similarly resolved between the two analysis methods, but was more

weakly supported in the ML analysis. The support for the relationship between clades E1–E3 was too low to be informative. Similar to the analysis of our reduced dataset (suppl. Fig. S8), part of *P.* subg. *Gomphidium* sect. *Nymanina* was found to be sister to all other species of sect. *Gomphidium*, but other relationships within this part of clade F2 were only resolved with low support. Aside from internal relationships between species (with weak support, BP < 50), clade G–I did not differ between Bayesian inference and maximum likelihood.

## ■ DISCUSSION

*Phyllanthus* is a paraphyletic conglomerate of multiple subgenera and (sub)sections, which together are presently classified as one genus. *Glochidion* and *Breynia* (including *Sauropus* and previously *Synostemon*) were treated separately on the basis of a loss of the nectar disc (*Glochidion*, part of *Synostemon*) or due to a functional change, with disc glands becoming scales that close the staminate flowers until the pollen is mature (part of *Breynia*, part of *Synostemon*) (Radcliffe-Smith, 2001; Van Welzen & al., 2014). For a sound discussion on any possible combination or separation, the flaws of the current system need to be discussed, as well as the morphological distinctness of the various groups and clades. Floral convergence or conservation of floral morphology appears to be a general pattern within the tribe Phyllanthae. In our phylogeny with denser taxon sampling presented here, several paraphyletic and polyphyletic subgenera and sections were discovered in various clades. These non-monophyletic groups were originally classified together on the basis of morphological ancestral commonality, but these patterns are the results of convergent evolution. Several morphological characters, such as branching type and changes in floral morphology, are indicative of various clades and are discussed below.

**Non-monophyletic taxa and the subgeneric classification of *Phyllanthus*.** — *Phyllanthus* consists of eight clades in our phylogeny, but our results indicate the existing subgeneric classification as summarized by Bouman & al. (2018a) still contains several problems. Several subgenera are polyphyletic, and the paraphyly of several sections is furthermore confirmed here (Fig. 3). Kathriarachchi & al. (2006) already encountered issues in several clades, but subsequent revisions (Hoffmann & al., 2006; Ralimanana & Hoffmann, 2011, 2014; Ralimanana & al., 2013) only addressed some (most with the species from Madagascar), while others remained unresolved.

The relationships previously recovered (Kathriarachchi & al., 2006; Falcón & al., 2020) between the genera *Margaritaria*, *Flueggea*, *Heterosavia* and *Plagiocladus* are confirmed here, but the relationship of *Lingelsheimia* as sister to *Flueggea* and the other genera is only weakly supported (suppl. Fig. S10; PP = 0.58, but see suppl. Fig. S9). Six species of *Margaritaria* were included. *Margaritaria rhomboidalis* (Baill.) G.L.Webster from Madagascar is sister to all other species of the genus. Interestingly, *M. nobilis* L.f. from the Americas seems to be closely related to the Australian species *M. dubium-traceyi* Airy Shaw & B.Hyland indicating some recent long-distance dispersal. Clade A consists of *Phyllanthus maderaspatensis* of subg. *Isocladus* together with one species from North America, *P. polygonoides* Nutt. ex Spreng., and two from Africa, *P. mendoncae* Jean F.Brunel and *P. magu-densis* Jean F.Brunel (currently a synonym of *P. maderaspatensis*). Ralimanana & Hoffmann (2011), based on recommendations by Kathriarachchi & al. (2006), removed all other species from *P. subg. Isocladus*, but as demonstrated here, this was premature. All species resolved here in clade A were previously classified in *P. subg. Isocladus* by different authors (Brunel, 1987;

Webster, 2001b). *Phyllanthus* subg. *Isocladus* is here found to be larger than the monospecific definition proposed by Ralimanana & Hoffmann (2011), but smaller than Webster's (1956) original conspectus (which includes former sections currently recognized as distinct subgenera).

Clade B contains 13 sampled species of *Phyllanthus* subg. *Macraea*, which are sister to four sampled species of subg. *Ceramanthus* (Fig. 4; PP 1.0). Three sections were included, of which *P. subg. Ceramanthus* sect. *Cluytopsis* Müll.Arg. was found to be sister to a clade comprising sect. *Anisobium* Müll. Arg. and sect. *Bivia* Jean F.Brunel & Jacq.Roux. Unfortunately, we were not able to sample the type of *P. subg. Ceramanthus*, *P. albidiscus* (Ridl.) Airy Shaw. However, similarities in habit, branching type, flower morphology, most notably the fused connectives, rather large anthers and pantoporate pollen with macro-reticulate exine (Punt, 1972; Wu & al., 2016), are synapomorphies for *P. subg. Ceramanthus*, confirming that these species belong to the same group. *Phyllanthus virgatus* G.Forst. is currently regarded as a widespread species occurring from India to the Pacific. This study includes samples from Asia and Australia, which were found to be non-monophyletic. Given the morphological variation exhibited across this complex, several other species have been proposed and some subsequently subsumed (e.g., Hunter & Bruhl, 1997; Verwijs & al., 2019). Denser sampling across French Polynesia and including the type region is needed to improve species delimitation. *Phyllanthus* subg. *Kirganelia* was found to be polyphyletic with species found in clades C and F (Figs. 3, 4). *Phyllanthus* sect. *Anisonema* (A.Juss.) Griseb. and sect. *Polyanthi* Jean F. Brunel were furthermore found to be paraphyletic, with sect. *Brazzeani* Jean F.Brunel & Jacq.Roux, sect. *Hemicicca* (Baill.) Müll.Arg. and sect. *Omphacodopsis* Jean F.Brunel nested within each, respectively (PP = 1.0 for both). In the phylogeny of Kathriarachchi & al. (2006), *P. acidus* (L.) Skeels was part of a clade separate from other species of *P. subg. Kirganelia*, but no subsequent transfers were made. The sole species of *P. subg. Kirganelia* sect. *Ciccopsis* G.L.Webster, *P. pseudocicca* Griseb., has only been collected once and has not been included in any phylogenetic study. Based on its Neotropical distribution, free stamens and inflorescence structure, it is likely related to species of clade F. *Phyllanthus* subg. *Kirganelia* (clade C) is sister to a clade that includes subg. *Eriococcus* and part of subg. *Phyllanthus*. All sections of *P. subg. Eriococcus* were sampled (clade C2) and sect. *Eriococcus* and sect. *Embliscastrum* were found to be paraphyletic (Fig. 4). *Phyllanthus* sect. *Scepasma* (Blume) Müll.Arg., sect. *Nymphanthus* (Lour.) Müll.Arg. and sect. *Eriococcodes* should be subsumed within sect. *Embliscastrum* and sect. *Eriococcus*, respectively. Clade C also consists of a clade of Australian species (clade C3), which are all currently placed in the polyphyletic *P. subg. Phyllanthus*. The majority of species belong to *P. sect. Lysiandra* (F.Muell.) G.L.Webster, originally published at subgeneric rank by Mueller (1859) with *P. subcrenulatus* F.Muell. as the type. Two species in this clade were placed by Webster (2001a,b) in *P. subg. Phyllanthus* sect. *Antipodanthus* G.L.Webster, together with several Neotropical species. However, the Neotropical



samples are nested within the strongly supported American clade E (PP 1.0). The Australian species of *P.* sect. *Antipodanthus* should be transferred to sect. *Lysiandra* (see Webster [2020], undated manuscript “Outline of Australian *Phyllanthus*”), and clades C1, C2 and C3 should be treated at the same taxonomic rank as they are each morphologically very different (see below).

In clade D, *Phyllanthus* subg. *Tenellanthus* is sister to a clade containing subg. *Swartziani* (G.L.Webster) Ralim. & Petra Hoffm. and subg. *Afroswartziani* (PP 1.0), although there is some incongruence between the nuclear and chloroplast datasets (suppl. Figs. S1, S2; see above). In our analysis, the sampling of *P.* subg. *Swartziani* was only expanded with two extra species (*P. fraternus* G.L.Webster, *P. phillyreifolius* Poir.). The position of *P. phillyreifolius* in subg. *Swartziani* as sister to the other species (Fig. 4, PP 0.98) is unexpected. This species from the Mascarenes was placed in *P.* subg. *Afroswartziani* by Bouman & al. (2018a), which was confirmed in the nuclear dataset (suppl. Fig. S1), but not in the chloroplast or total datasets (suppl. Fig. S2; Figs. 3, 4). In the nuclear dataset, *P. phillyreifolius* was resolved as sister to a clade comprising Madagascan species (suppl. Fig. S1, PP 1.0), which is geographically more congruent. The Neotropical species *P. stipulatus* (Raf.) G.L.Webster was resolved as part of subg. *Afroswartziani*. This indicates a dispersal separate from clade E to the Neotropics (also found by Falcón & al., 2020: see Small Neotropical Clade). Falcón & al. (2020) did not include more African taxa in their phylogenetic study, but suggested to include the Neotropical *P.* subsect. *Pentaphylli* within subg. *Afroswartziani* without discussing placement in any extant section. The sampling of *P.* subg. *Afroswartziani* was greatly expanded in this study, with additional samples from sect. *Callidisci* Jean F.Brunel, sect. *Odontadenii* Jean F.Brunel and sect. *Praephyllanthus* Jean F.Brunel. Aside from these sections, there are currently no other (sub-)sectional groupings within *P.* subg. *Afroswartziani*, but our results show that this subgenus comprises two major clades. To retain previously defined sections, new groups should be defined that can be morphologically distinguished. Brunel (1987) proposed several groups, but did not validate the names. A new study of these mostly African species could result in a viable sectional classification, but we raise serious doubt whether the sections should be retained in their current form.

Clade E consists of species from the Neotropics and West Indies, but some were originally classified in mostly Palaeotropical subgenera (e.g., *Phyllanthus* subg. *Emblica* and subg. *Gomphidium*). The phylogenetic study of Falcón & al. (2020) also focused on this clade, and they included more species of *Phyllanthus* from the West Indies, but not from South America. Three main groups are distinguished in clade E, but the relationship between them is only resolved in our analysis based on the reduced dataset (suppl. Fig. S8), designated as clades E1–E3. Clade E1 consists of low sprawling shrubs (*P.* subg. *Emblica* sect. *Pityrocladus*) and herbs (*P.* subg. *Phyllanthus*) and was found to be sister to a clade of *P.* subg. *Conami* sect. *Nothoclema* (E2) and a large part of subg. *Xylophylla* (E3) (Fig. 4, PP 1.0). *Phyllanthus* subg. *Phyllanthus*, as discussed above, is polyphyletic with other species resolved in clades C3

and F1. *Phyllanthus* subg. *Phyllanthus* in clade E contains the type, *P. niruri* L., and sect. *Antipodanthus*, sect. *Loxopodium* G.L.Webster (with sect. *Salviniopsis* Holm-Niels ex Jean F.Brunel nested within) and sect. *Choretropsis* Müll.Arg. *Phyllanthus* subg. *Conami* is retrieved in clades E2 and E3, each clade containing species of different sections (sect. *Nothoclema* and sect. *Hylaeanthus* G.L.Webster, respectively). The sister relationship of *P.* subg. *Conami* sect. *Hylaeanthus* and subg. *Xylophylla* sect. *Brachycladus* G.L.Webster is surprising: while they are similar in vegetative characters and staminate flowers (Webster, 2004), they differ in pollen, inflorescence structure and fruit type, possibly indicating a shift in pollinator and/or seed disperser. *Phyllanthus* subg. *Xylophylla* as defined by Webster (1958) is morphologically heterogeneous, including species with phylloclades (Fig. 1), non-phyllanthoid branching (sect. *Elutanthos*), and very variable floral characteristics. This might underlie the apparent polyphyly of the subgenus. The majority of species are found in clade E3, with *P. purpusii* Brandegee sister to all other species of clade E (PP 1.0). The placement of *P. sellowianus* (Klotzsch) Müll.Arg. received low support by Kathriarachchi & al. (2006) and Falcón & al. (2020) and was not confirmed here, instead being resolved as sister to other species of clade E1 (Fig. 4; PP 0.83). Clade E3, excluding *P. vacciniifolius* (Müll. Arg.) Müll.Arg., should be treated as subg. *Xylophylla*, but several issues need to be addressed. Falcón & al. (2020) did not suggest many changes to the sectional classification of *P.* subg. *Xylophylla* compared to Webster (1958). *Phyllanthus* subg. *Cyclanthera* was found both here and by Falcón & al. (2020) to be nested within clade E3 with a particularly long branch. Other parts of clade E (Fig. 4) do not differ much from clades I–IV of Falcón & al. (2020), but we do find that *P.* sect. *Williamia* (Baill.) Müll.Arg. is paraphyletic, while Falcón & al. (2020) found a weakly supported monophyletic group sister to sect. *Orbicularia* (Baill.) Griseb. Our results indicate that *P.* subg. *Xylophylla* is best to be circumscribed and restricted to clade E3 similar to Falcón & al. (2020), but that subg. *Cyclanthera* and subg. *Conami* sect. *Hylaeanthus* should be subsumed within it. *Phyllanthus* subg. *Xylophylla*, as defined by Webster (1958), has clypeate pollen as an apomorphy, but the apparent polyphyly and inclusion of other groups found here to be nested within it, indicates that this feature was lost independently several times. Webster (2002b) treated *P.* sect. *Microglochidion* (Müll.Arg.) Müll.Arg. and sect. *Pityrocladus* G.L.Webster within the Palaeotropical subg. *Emblica*, thereby creating a group with a disjunct distribution. The Neotropical sections are here found to be part of clades E3 and E1 and should be treated separately from other species of *P.* subg. *Emblica* (clade G). The Palaeotropical species of *P.* subg. *Emblica* (clade G) formed a monophyletic group, with the exception of *P. rufuschaneyi*, which was classified in subg. *Gomphidium* (Bouman & al., 2018b). This woody shrub was retrieved as sister to the herbaceous *P.* subg. *Emblica* sect. *Urinaria* (PP 1.0) and should be transferred. *Phyllanthus* sect. *Emblica* also consists of woody shrubs and trees, and it is likely that *P. urinaria* shows a shift to herbaceous habit from a woody ancestor. If *P. rufuschaneyi* is treated in sect. *Urinaria*, then the group

becomes even less distinguishable from sect. *Emblica* and both could be combined.

The species of *Phyllanthus* from Madagascar have received recent taxonomic revisions (Ralimanana & Hoffmann 2011, 2014; Ralimanana & al., 2013) that also updated several subgenera following the results of Kathriarachchi & al. (2006). Previous placements in *P.* subg. *Afroswartziani* are confirmed and they formed a single clade (PP 1.0) related to other African species. Other subgenera were here retrieved in clade F1, but not all are monophyletic. The relationship found here in clade F represents the highest contrast with the phylogeny presented by Kathriarachchi & al. (2006). Support for the relationships between clades H–O in their phylogeny (Kathriarachchi & al., 2006: fig. 3) was lower for major clades. The topological changes, found here with stronger support, probably result from the increased number of markers and samples used. Clade F1 here consists of several sections of *P.* subg. *Kirganelia* (discussed above) and subg. *Betsileani*, subg. *Menarda*, subg. *Anesonemoides* and part of subg. *Gomphidium*, all from Madagascar. *Phyllanthus* subg. *Menarda* is nested within a clade of Madagascan species in subg. *Gomphidium*, which is also mixed with the polyphyletic subg. *Anesonemoides*. This is a complicated group, and for the remaining species of *P.* subg. *Gomphidium* in Madagascar (Hoffmann & McPherson, 2003; Ralimanana & Hoffmann 2011), a different name should be selected with some scrutiny on how many groups should be retained. *Phyllanthus* subg. *Gomphidium* was presumed to have a pantropical distribution with one species from Guatemala (*P. tuerckheimii* G.L. Webster, here found to be related to subg. *Conami* sect. *Nothoclema*; clade E2, PP 0.97), some from Madagascar (clade F1), East Malesia and New Caledonia (clades F2 and G). The majority of species in *P.* subg. *Gomphidium* were retrieved in clade F2 (PP 1.0), which contains four sections divided into two major clades all from Australia, East Malesia and New Caledonia. *Phyllanthus* sect. *Leptonema* was found to be nested within sect. *Adenoglochidion* as sister to *P. vulcani* Guillaumin (Fig. 4; PP 0.67), while sect. *Nymanina* was resolved as paraphyletic in the reduced dataset (suppl. Fig. S8) with regard to sect. *Gomphidium*. The New Caledonian species were extensively treated by McPherson & Schmid (1991), who recognized some groups, but opted not to classify them in separate subsections. The high diversity of species (>100) in *P.* subg. *Gomphidium* in Asia and the Pacific has been linked to a possible co-diversification event with its mutualistic moth pollination (Kawakita & Kato, 2004). Three herbaceous desert species from Australia, doubtfully considered as part of *P.* subg. *Phyllanthus* sect. *Lysianandra* by Bouman & al. (2018a), were found to be closely related to species of subg. *Gomphidium* from New Caledonia (Fig. 4; PP 0.7), and they should be transferred. The Australian desert species appear to represent a specialized offshoot within *P.* subg. *Gomphidium*, possibly driven by aridification. We confirm previously found relationships between the genera *Breynia*, *Synostemon*, *Glochidion* and *Phyllanthus* subg. *Phyllanthodendron* from Pruesapan & al. (2012) (here as clades H and I). *Phyllanthus* subg. *Phyllanthodendron* is paraphyletic and consists of two clades, with species of sect. *Phyllanthodendron*

sister to a clade containing species of sect. *Pseudoactephila* Croizat and the genus *Glochidion* into which they should be transferred.

**Morphological character evolution.** — Several morphological characters have been shown to be useful when distinguishing the various infrageneric taxa within *Phyllanthus*. A recent study by Gama & al. (2016) suggested that the two perianth whorls in *P. urinaria*—and by extension in subg. *Emblica* and the genera *Breynia* and *Glochidion*—could be distinguished as petals and sepals. However, a perianth with two whorls is also found in *P.* subg. *Macraea*, subg. *Ceramanthus* (Brunel, 1987), subg. *Gomphidium* (McPherson & Schmid, 1991) and several others. They are often indistinguishable (except in *P.* subg. *Ceramanthus* and subg. *Gomphidium*) and are perhaps better referred to as tepals (see Ralimanana & Hoffmann, 2011), but are generally treated as sepals in taxonomic treatments (Webster, 1956; Chakrabarty & Balakrishnan, 2018; Verwijs & al., 2019). Structures identified as petals also occur adjacent to the sepal whorl in other genera within Phyllanthaceae such as the genera *Actephila* Blume, *Bridelia* Willd. and *Cleistanthus* Hook.f. ex Planch. As the floral ontogeny has only been studied in a limited number of species, we cannot draw any conclusion on whether this is a true synapomorphy, as suggested by Gama & al. (2016). Phyllanthoid branching occurs in the majority of *Phyllanthus* species but, as found by Kathriarachchi & al. (2006), with several independent reversals, including desert species with a more sprawling habit and the aquatic species *P. fluitans* Benth. ex Müll.Arg. The functional “advantage” of phyllanthoid branching has not been extensively studied, although from the few studies available, it does not seem to be related to chromosome number (see Webster & Ellis, 1962; Bancilhon, 1971). Individual plants often exhibit sub-phyllanthoid branching within the first few nodes (Fig. 1E) (Webster, 1956). Some species, such as those in *P.* subg. *Kirganelia* sect. *Pseudomenarda* Müll.Arg. (clade C1) and species in clade C3, retain sub-phyllanthoid branching in maturity (Brunel, 1987; Telford & al., unpub. data).

Loss of nectar secretion in *Breynia*, *Synostemon* and *Glochidion* was interpreted as a synapomorphy for these genera, distinguishing them from *Phyllanthus* (Radcliffe-Smith, 2001). The loss of the nectar disc in *Glochidion* is likely to have occurred independently as *Glochidion* is more closely related to the paraphyletic *P.* subg. *Phyllanthodendron* (Fig. 4). The loss of the disc has also been correlated within *Glochidion* to the presence of a pollination mutualism with moths (Kawakita & Kato, 2009), which might have led to a co-diversification of plant and pollinator. Moths were also found to pollinate flowers in *P.* subg. *Gomphidium* (clade F2) (Kawakita & Kato, 2004). A similar loss or reduction of the nectar disc is found in several species (Fig. 4) (McPherson & Schmid, 1991; Kawakita & Kato, 2004). The nectar disc has been lost independently at least four times (clades F1, F2, H and I). Whether this loss in *P. acidus* is related to a similar pollination system requires investigation (cf. Webster, 1958).

Fruit types within the genus *Phyllanthus* are sometimes characteristic of taxonomic groups. They are usually explosive

schizocarpic capsules that rarely exceed 1 cm in diameter (Fig. 1H). Berries have evolved several times independently and are found in the genus *Flueggea* and within *Phyllanthus* clades C1, E3 and F1. Some species in *Breynia* produce tardily dehiscent, berry-like fruits. Berries in *Phyllanthus* are often small and hypothesized to be associated with dispersal by birds (Luo & al., 2011). A marked transition in fruit morphology is found in *P.* subg. *Kirganelia* sect. *Polyanthi* and sect. *Omphacodopsis* (clade F1): species of sect. *Omphacodopsis* are characterized by inflated capsules with a very thin exocarp, whereas species in sect. *Polyanthi* have apple-like berries (Brunel, 1987), which indicates a remarkable shift in dispersal strategy. Similarly, the sister relationship between *P.* subg. *Conami* sect. *Hylaeanthus* and subg. *Xylophylla* sect. *Brachycladus* (clade E3) is accompanied by marked differences in fruit (capsules vs. berries) and pollen morphology (clypeate vs. porate) (Webster & Carpenter, 2002; Webster, 2004). The potential correlation between these morphological shifts and their ecology requires field study to understand these interesting systems of evolutionary biology.

Staminate flowers show more morphological variation between clades than pistillate flowers and are often more informative for distinguishing taxa. Pistillate flowers are usually composed of two whorls of tepals, an annular nectar disc and the 3-locular ovary with bifid stigmas (although exceptions characterize certain groups). The number of stamens is variable between the genera *Plagiocladus* to *Flueggea*, but within *Phyllanthus* and the genera nested within, the presence of mainly three stamens appears to be conserved (Fig. 3). *Phyllanthus* subg. *Kirganelia* (clade C) is characterized by staminate flowers with usually five stamens fused in two whorls (two outer free stamens and three inner with fused filaments). It is sister to *P.* subg. *Eriococcus* (clade C2), which has staminate flowers with four sepals arranged in a cross (Fig. 1J) and two fully connate stamens, and a clade C3, in which the species all have three stamens with more or less fused filaments and sometimes enlarged connectives (Telford, unpub. data). The number of pollination studies within *Phyllanthus* is expanding (e.g., Kato & al., 2003; Kawakita & Kato, 2004, 2009; Luo & al., 2011; Kato & Kawakita, 2017; Kawakita & al., 2019), but most have recovered variations within the mutualism with moths while the pollination system in many taxa is still unknown. In clade C, flowers of *P.* subg. *Kirganelia* (clade C1) are pollinated by mutualistic moths (Kawakita & Kato, 2009), but the pollination system is not known in clades C2 and C3. With recent findings of a New World dispersal and pollination by leafhopper moths (Kawakita & al., 2019), the question arises of how prolific this mutualism is and whether other pollination systems might depart from the standard mechanism. Unfortunately, the pollination system of other genera in tribe Phyllanthae including *Margaritaria* and *Heterosavia* remains unknown, although species in clade A are often parasitized (not actively pollinated) by *Epicephala* moths (Kato & Kawakita, 2017). Webster (1957, 1958) created many new sections for the West Indian species of *P.* subg. *Phyllanthus* and subg. *Xylophylla*, mainly because he encountered a large variation in habit

and flowers: shrubs with phylloclades and flowers with three stamens and six sepals in sect. *Xylophylla* (Fig. 1) to low shrubs with whorled stamens, sometimes more than 10, in sect. *Orbicularia* (Webster, 1958). The morphological reconstruction done by Falcón & al. (2020: figs. 4 & 5) shows shifts in the West Indian species in disc morphology, stamen number and branching type. With more information on the ecology of the various species, this group might be ideal to study island diversification and its causes.

Three main types of pollen are found in tribe Phyllanthae, viz. pantoporate, porate with usually three colpi, or clypeate (Webster & Carpenter, 2002, 2008). Colporate pollen is found in almost all clades except in clade B, in which species of *Phyllanthus* subg. *Macraea* are characterized by clypeate pollen, whilst those of subg. *Ceramanthus* have pantoporate pollen without distinct colpi (Punt, 1972; Webster & Carpenter, 2008). Clypeate pollen has evolved independently in clade E (in *P. purpusii*, which is sister to all other species of clade E), *P. selowianus* of clade E1 and the majority of species in clade E3 (see Webster, 1958; Webster & Carpenter, 2008). Webster & Carpenter (2002) offered several hypotheses on the origin of clypeate pollen in Neotropical *Phyllanthus* species, but these require further study. The absence of clypeate pollen in *P.* subg. *Cyclanthera* and subg. *Conami* sect. *Hylaeanthus* indicates two independent losses of this particular pollen type in clade E3. Pollen in *P.* subg. *Cyclanthera* is characterized by a central raised pilum, which is unique among angiosperms (Webster & Carpenter, 2002; Webster, 2002b). Species of *P.* subg. *Cyclanthera* are herbs, and the staminate flowers have a transformed disc-like androecium (Webster, 1957, 1958, 2002b), all in stark contrast to other species in clade E3, which are all woody.

New issues are identified in the infrageneric classification of *Phyllanthus*, calling for a re-assessment of the diagnostic characters previously used. Many previous classifications relied on the branching system or pollen morphology (Webster, 1956, 1957, 1958; Brunel, 1987), but the independent losses of character states have obfuscated relations between various groups.

## ■ CONCLUSION

Resolving the paraphyly of the genus *Phyllanthus* has been the topic of discussion in several phylogenetic studies of tribe Phyllanthae (Kathriarachchi & al., 2006; Priesapan & al., 2008, 2012; Van Welzen & al., 2014). Similar situations occur in other giant genera, like *Euphorbia* L. and *Syzygium* Gaertn., which were found to be paraphyletic and subsequently combined with the genera nested within (see Bruyns & al., 2006; Craven & Biffin, 2010; Ahmad & al., 2016). Seemingly, suggestions for combining taxa often provide less objections, especially if one group is already large, than doing the opposite, which would lead to recognizable units. *Breynia*, *Synostemon* and *Glochidion* are currently retained as distinct genera from *Phyllanthus* (Van Welzen & al., 2014), while the clades that

comprise *Phyllanthus* can be differentiated by looking at several characters. The morphological patterns and taxonomic problems highlighted here and by Kathriarachchi & al. (2006) support the recognition of individual clades as distinct taxa. In fact, many of the now recognized infrageneric taxa have to be redefined after our analysis as they are poly- or paraphyletic. Based on the recognizability of the monophyletic groups, redefining them as genera (which was once the case) is the best option, as, in spite of the many name changes, it provides a better reflection of the evolutionary history of *Phyllanthus* s.l. and will in the future improve identifications greatly. Instead of one giant genus, where identification is difficult and evolution is only depicted by the various subgenera, it is more sensible and worthwhile to recognize separate genera that highlight the morphological variation within the tribes. Additionally, patterns of floral convergence can be discussed in the light of separate lineages, highlighting the complex diversity of tribe Phyllanthae. Before Müller (1863, 1865, 1866) created a single large genus with many sections, several groups were treated as separate genera. The subgeneric classification proposed by Webster (1956, 1957, 1958), and expansions incorporating results from various morphological studies (notably Punt, 1967, 1972, 1980, 1986, 1987), laid the foundation for discussing species relationships within this large group. Building on the framework presented by Webster (1956) and accommodating recent phylogenetic data will result in a useful evolutionary classification for tribe Phyllanthae. A number of morphological characters, such as branching, habit, floral and fruit morphology help to distinguish the groups, and we illustrate many of these characters in Figs. 1 and 3. The current study clarifies the classification uncertainty around *Phyllanthus* s.l. and provides biologists and ecologists (e.g., Kato & Kawakita, 2017) with a sound and useful phylogenetic and taxonomic framework. The sampling of about 10% of *Phyllanthus* in Kathriarachchi & al. (2006) would have resulted in a larger number of genera needing to be recognized, but our current phylogeny shows good support at major nodes, and we therefore recommend dismantling *Phyllanthus* into nine genera for which names are already available. These will roughly be clades A–I (Figs. 3, 4), while retaining *Synostemon* as separate from *Breynia*, and treating *P.* subg. *Kirganelia* (clade C1), subg. *Eriococcus* (clade C2) and sect. *Lysiandra* (clade C3) as separate taxa. We will formalize these changes in a separate paper, which is in preparation.

## ■ AUTHOR CONTRIBUTIONS

PJAK, PCvW and RWB conceived the original idea for the study. RWB conducted the study, collected plant material in China, designed and performed the molecular labwork and wrote the first draft of the manuscript. JSS and RMKS helped with the organization of fieldwork in China. JJB and IRHT supplied collections of material from Australia. All authors have revised and approved the final manuscript. — RWB, <https://orcid.org/0000-0002-2949-3318>; PJAK, <https://orcid.org/0000-0001-6569-4726>; IRHT, <https://orcid.org/0000-0002-3570-0053>; JJB, <https://orcid.org/0000-0001-9112-4436>; JSS, <https://orcid.org/0000-0003-1109-7015>; RMKS, <https://orcid.org/0000-0002-8104-7761>; PCvW, <https://orcid.org/0000-0002-5072-431X>

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#### Appendix 1. GenBank accession numbers used in phylogenetic analyses.

Taxon name, origin, collector and collection number, herbarium code, accession numbers for ITS, *PHYC*, *accD-psaI*, *matK*, *trnS-trnG*. Newly generated sequences are in bold. Accessions from DNA banks of Kew and Missouri Botanical Garden are underscored. The majority of published sequences were taken from Kathriarachchi & al. (2006), Pruesapan & al. (2008, 2012) and Kawakita & Kato (2009).

*Actephila excelsa* (Dalzell) Müll.Arg., China, Yunnan, Xishuangbanna Tropical Botanical Garden, Bouman & Yong RWB057 (HITBC), –, **MN904188**, **MN915296**, **MN916079**, –, *Antidesma bunius* (L.) Spreng., Unknown, Ghent living collection xx0Gent19002015, no voucher, –, **MN904189**, –, **MN916080**, –, *Breynia amoebiflora* (Airy Shaw) Welzen & Pruesapan, Thailand, Chiang Mai, Maxwell 90-721 (L), –, –, EU643747, –, **B. amoebiflora** (Airy Shaw) Welzen & Pruesapan, Thailand, Kerr 19655 (P), GQ503379, GQ503437, GQ503498, –, GQ503562; **B. androgyna** (L.) Chakrab. & N.P.Balacr. (*Breynia androgyna* 1), Thailand, Chachoengsao, Van Welzen 2006-4 (L), EU623563, GQ503439, GQ503500, EU643748, GQ503564; **B. androgyna** (L.) Chakrab. & N.P.Balacr. (*Breynia androgyna* 3), Sri Lanka, Kathriarachchi & al. 40 (K), AY936747, GQ503459, GQ503517, –, GQ503588; **B. asteranthos** (Airy Shaw) Welzen & Pruesapan, Thailand, Nakhon Sawan, Esser 99-13 (L), EU623565, –, GQ503501, EU643751, –, **B. bicolor** (Craib) Chakrab. & N.P.Balacr., Thailand, Chiang Mai, Esser 99-21 (L), EU623567, –, GQ503503, EU643754, –, **B. brevipes** (Müll.Arg.) Chakrab. & N.P.Balacr., Thailand, Phetchaburi, Middleton & al. 974 (L), EU623568, –, –, EU643755, –, **B. discigera** Müll.Arg., Indonesia, N. Sumatra, Takeuchi & al. 18873 (L), EU623550, GQ503410, –, EU643736, –, **B. discocalyx** (Welzen) Welzen & Pruesapan, Thailand, Ranong, Beusekom & Phengkklai 566 (L), GQ503387, –, –, EU643757, GQ503569; **B. disticha** J.R.Forst. & G.Forst. (*Breynia disticha* 1), Netherlands, Utrecht botanical garden, Bouman & Verwijns RWB024 (L), **MN915814**, **MN904191**, **MN915298**, **MN916082**, **MN915581**; **B. disticha** J.R.Forst. & G.Forst. (*Breynia disticha* 2), Singapore, Singapore botanical garden, Yu 63 (L), **MN915815**, **MN904192**, **MN915299**, **MN916083**, **MN915582**; **B. fruticososa** (L.) Müll.Arg., China, Hong Kong, Bouman & al. RWB025 (L), **MN915816**, **MN904193**, **MN915300**, **MN916084**, **MN915583**; **B. garrettii** (Craib) Chakrab. & N.P.Balacr., China, Guizhou, Sino-American Ruzhou Botanical Expedition 1872 (L), EU623570, GQ503444, GQ503507, EU643760, GQ503572; **B. glauca** Craib, Thailand, Nong Khai, Pooma & al. 2702 (L), EU623551, GQ503411, –, EU643737, GQ503532; **B. hirsuta** (Beille) Welzen & Pruesapan, Thailand, Larsen & al. 33993 (P), GQ503391, GQ503445, –, EU643762, –, **B. kerrii** (Airy Shaw) Welzen & Pruesapan, Thailand, Tak, Van Beusekom & Phengkklai 1065 (P), EU623574, GQ503452, –, EU643764, GQ503579; **B. lanceolata** (Hook.f.) Welzen & Pruesapan, Thailand, Chanthaburi, Esser 2001-4 (L), EU623584, –, –, EU643774, –, **B. lithophila** Welzen & Pruesapan, Thailand, Phonsena & al. 5595 (L), –, GQ503464, GQ503522, –, GQ503595; **B. macrantha** (Hassk.) Chakrab. & N.P.Balacr., Australia, Queensland, Telford & Bruhl 13107 (L), GQ503396, –, –, –, **B. macrantha** (Hassk.) Chakrab. & N.P.Balacr., Thailand, Maxwell 95-1125 (L), –, –, –, MT551232, –, **B. cf. macrantha** (Hassk.) Chakrab. & N.P.Balacr., China, Yunnan, Xishuangbanna Tropical Botanical Garden, Bouman & Yong RWB050 (HITBC), **MN915813**, **MN904190**, **MN915297**, **MN916081**, **MN915580**; **B. micrasterias** *Breynia micrasterias* (Airy Shaw) Welzen & Pruesapan,

## Appendix 1. Continued.

Malaysia, Sarawak, *Erwin & Chai S 27479* (L), EU623578, GQ503455, –, EU643768, GQ503582; “*B. novoguineensis*” msc. name, sp. nov., Indonesia, Papua, *Baker & al. 37* (L), EU623549, GQ503409, GQ503472, –, GQ503530; *B. oblongifolia* (Müll.Arg.) Müll.Arg., Australia, *Forster 32745* (NE), GQ503355, GQ503414, GQ503475, –, GQ503534; *B. orbicularis* (Craib) Welzen & Pruesapan, Laos, Vientiane, *Soejarto & Southavong 10792* (L), EU623580, GQ503456, GQ503513, AY936645, GQ503584; *B. poomae* (Welzen & Chayam.) Welzen & Pruesapan, Thailand, Chiang Rai, *Phonsena & al. 5245* (L), EU623582, GQ503457, GQ503515, EU643771, GQ503586; *B. repens* Welzen & Pruesapan, Thailand, *Middleton & al. 2287* (L), GQ503385, –, –, GQ503566; *B. retusa* (Dennst.) Alston, Sri Lanka, *Kathirarachchi & al. 43* (K), –, –, AY936565, –, *B. retusa* (Dennst.) Alston, Laos, Vientiane, *Soejarto & Southavong 10783* (L), GQ503358, GQ503417, GQ503477, –, GQ503536; *B. rostrata* Merr., China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB055* (HITBC), MN915817, MN904194, MN915301, MN916086, MN915585; *B. similis* (Craib) Welzen & Pruesapan (*Breynia similis* 1), Chiang Mai, Thailand, *Larsen & al. 46639* (L), GQ503399, GQ503462, GQ503520, EU643778, GQ503592; *B. similis* (Craib) Welzen & Pruesapan (*Breynia similis* 2), China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB054* (HITBC), MN915818, MN904195, MN915302, MN916085, MN915584; *B. spatulifolia* (Beille) Welzen & Pruesapan, USA, Honolulu, *Wong s.n.* (L), EU623588, –, GQ503523, AY936647, GQ503596; *B. stipitata* Müll. Arg., UK, RBG Kew, living collection from Australia, Queensland, *Chase 14461* (K), –, –, AY552422, –, *B. stipitata* Müll.Arg., Australia, *Bruhl 2478* (NE), GQ503359, GQ503418, GQ503478, –, GQ503537; *B. thorelii* (Beille) Welzen & Pruesapan, Thailand, Chiang Mai, *Van Welzen 2006-1* (L), EU623590, GQ503468, GQ503526, EU643782, GQ503600; *B. thyrsiflora* (Welzen) Welzen & Pruesapan, Thailand, Kanchanaburi, *Kostermans 765* (L), EU623591, GQ503469, GQ503527, EU643783, GQ503601; *B. vestita* Warb., Indonesia, Papua, *Barker & Beaman 70* (L), EU623553, GQ503419, GQ503480, EU643738, GQ503540; *B. villosa* (Blanco) Welzen & Pruesapan, Thailand, *Phengkklai & al. 12122* (BKF), EU623593, –, –, EU643786, –, *B. vitis-idea* (Burm.f.) C.E.C.Fisch. (*Breynia vitis-idea* 1), Vietnam, *Tagane & al. V388* (L), MN915819, MN904184, MN915303, MN916087, –, *B. vitis-idea* (Burm.f.) C.E.C.Fisch. (*Breynia vitis-idea* 2), Vietnam, *Tagane & al. V404* (L), MN915820, MN904185, MN915304, MN916088, MN915586; *B. vitis-idea* (Burm.f.) C.E.C.Fisch. (*Breynia vitis-idea* 3), Philippines, *Madajucon 5676* (L), MN915821, MN904186, MN915305, MN916089, –, *B. vitis-idea* (Burm.f.) C.E.C.Fisch. (*Breynia vitis-idea* 4), Singapore, Singapore botanical garden, *Yu 157* (L), MN915822, MN904187, MN915306, MN916090, MN915587; *Bridelia tomentosa* Blume, China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB063* (HITBC), –, MN904196, MN915307, MN916359, –, *Flueggea virosa* (Roxb. ex Willd.) Royle (*Flueggea virosa* 1), China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yunhong RWB068* (HITBC), MN915824, MN904197, MN915308, MN916091, –, *Flueggea virosa* (Roxb. ex Willd.) Royle (*Flueggea virosa* 2), Australia, *Mitchell 2890* (BRI), MN915823, –, –, MN916104, –, *Flueggea virosa* (Roxb. ex Willd.) Royle (*Flueggea virosa* 3), Indonesia, *Chase 2104* (K), –, –, AY552426, –, *Flueggea virosa* (Roxb. ex Willd.) Royle (*Flueggea virosa* 4), Thailand, *Larsen & al. 45328* (L), –, GQ503420, GQ503481, –, –, *Flueggea virosa* (Roxb. ex Willd.) Royle (*Flueggea virosa* 4), Singapore, Singapore botanical garden, *Yu 64* (L), MN915825, MN904198, –, MN916092, MN915588; *Glochidion benthamianum* Domin, Australia, *Bruhl 1026* (NE), GQ503363, –, GQ503482, –, GQ503541; *G. ellipticum* Wight (*Glochidion ellipticum* 1), China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB058* (HITBC), MN915826, MN904199, MN915310, MN916093, MN915589; *G. ellipticum* Wight (*Glochidion ellipticum* 2), China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB061* (HITBC), MN915827, MN904200, MN915311, MN916094, MN915590; *G. ellipticum* Wight (*Glochidion ellipticum* 3), China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB062* (HITBC), MN915829, MN904202, MN915309, MN916096, MN915591; *G. eriocarpum* Champ. ex Benth., China, Hong Kong, *Bouman & al. RWB027* (L), MN915828, MN904201, –, MN916095, MN915592; *G. ferdinandii* (Müll.Arg.) Pax & K.Hoffm., Australia, *Bruhl 2457* (NE), GQ503366, GQ503421, GQ503484, –, GQ503543; *G. harveyanum* Domin, Australia, *Bruhl 2527* (NE), GQ503368, GQ503423, GQ503486, –, GQ503545; *G. lanceolarium* (Roxb.) Voigt, China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB064* (HITBC), MN915830, MN904203, MN915312, MN916097, MN915593; *G. lanceolatum* Hayata, New Caledonia, *Kawakita 116* (KYO), AY525687, FJ235327, –, FJ235235, –, *G. lobocarpum* (Benth.) F.M.Bailey, Australia, *Bruhl 1146* (NE), GQ503371, GQ503424, GQ503488, –, GQ503548; *G. philippicum* (Cav.) C.B.Rob., Australia, *Forster 29379* (NE), GQ503373, GQ503426, GQ503490, –, GQ503550; *G. puberum* *Glochidion puberum* (L.) Hutch., China, Guizhou, *Chase 11460* (K), AY936659, –, –, AY552428, –, *G. sphaerogynum* (Müll.Arg.) Kurz (*Glochidion sphaerogynum* 1), Thailand, *Van der Schuur 128* (L), MN915831, MN904204, MN915313, MN916280, MN915594; *G. sphaerogynum* (Müll.Arg.) Kurz (*Glochidion sphaerogynum* 2), Thailand, *Van Welzen 2003-21* (L), EU623555, GQ503427, –, EU643740, GQ503551; *G. wrightii* Benth., China, Hong Kong, *Bouman & Liu RWB032* (L), MN915832, MN904205, MN915314, MN916098, MN915595; *Heterosavia bahamensis* (Britton) Petra Hoffm., USA, Fairchild tropical garden (cultivated), *Wurdack D048* (US), AY936749, AY830381, –, AY830284, –, *Leptopus chinensis* (Bunge) Pojark., UK, Edinburgh Botanical garden (cultivated), *Brownless s.n.* (L), MN915833, MN904206, MN915315, MN916099, –, *Lingelsheimia* sp., Madagascar, *Rabenantoandro & al. 1115* (MO), AY936662, AY830375, –, AY830272, –, *Margaritaria anomala* (Baill.) Fosberg, Madagascar, *Ramison 413* (MO), MN915834, –, –, MN916100, –, *M. discoidea* (Baill.) G.L.Webster (*Margaritaria discoidea* 1), Kenya, *Nicholson 1* (L), –, MN904208, MN915317, MN916102, –, *M. discoidea* (Baill.) G.L.Webster (*Margaritaria discoidea* 2), Kenya, *Nicholson s.n.* (L), –, MN904207, MN915316, MN916101, –, *M. discoidea* (Baill.) G.L. Webster (*Margaritaria* sp. Uganda), Uganda, *Nicholson 3a* (L), MN915835, MN904211, MN915320, MN916107, MN915597; *M. dubiumtraceyi* Airy Shaw & B. Hyland, Australia, *Forster 29387* (BRI), –, –, MN935815, MN916103, –, *M. indica* (Dalzell) Airy Shaw, Singapore, Singapore botanical garden, *Orr 80532*, no voucher, –, MN904209, MN915318, MN916105, –, *M. nobilis* L.f., Puerto Rico, *Orr 875422*, no voucher, –, MN904210, MN915319, MN916106, MN915596; *M. rhomboidalis* (Baill.) G.L.Webster, Madagascar, *Rabenantoandro & al. 656* (K), AY936665, –, –, AY936571, –, *Notoleptopus decaisnei* (Benth.) Vorontsov & Petra Hoffm., Australia, *Evans 3222* (K), AM745836, –, –, AM745833, –, *N. decaisnei* (Benth.) Vorontsov & Petra Hoffm., Australia, *Fraser 267* (L), –, GQ503431, GQ503491, –, GQ503555; *Phyllanthus acidus* (L.) Skeels, Thailand, *Van Welzen 2003-14* (L), MN915836, GQ503432, GQ503492, MN916108, GQ503556; *P. acuminatus* Vahl (*Phyllanthus acuminatus* 1), Venezuela, *Breteler 4238* (WAG), MN915837, MN904212, MN915321, MN916109, MN915598; *P. acuminatus* Vahl (*Phyllanthus acuminatus* 2), Guatemala, *Wallnöfer 6031* (U), MN915838, MN904213, MN915322, MN916110, MN915599; *P. acutissimus* Miq., Thailand, *TRP-5004102* (BK), AB550090, –, –, –, *P. aeneus* Baill., New Caledonia, *Kawakita 272* (KYO), –, FJ235352, –, FJ235260, –, *P. amarus* Schumach. & Thonner (*Phyllanthus amarus* 1), Thailand, *Van Welzen 2006-5* (L), EU623557, GQ503433, GQ503493, EU643742, GQ503557; *P. amarus* Schumach. & Thonner (*Phyllanthus amarus* 2), Gabon, *Wieringa 8189* (WAG), MN915847, MN904217, MN915331, MN916114, –, *P. ambatovolanus* Leandri, Madagascar, *Randriamampionona & al. 51* (K), MN915848, MN904218, MN915332, MN916115, MN915605; *P. angustifolius* (Sw.) Sw., Germany, Bayreuth botanical garden living collection, *Lauerer 091479*, no voucher, MN915849, MN904219, MN915333, MN916116, MN915606; *P. anisobolus* Müll.Arg., Costa Rica, *Liesner 14363* (U), MN915850, MN904220, MN915334, MN916117, MN915607; *P. ankarana* Leandri, Madagascar, *Ralimanana & al. 663* (K), MN915851, MN904221, MN915335, MN916118, MN915608; *P. ankaratrae* (Leandri) Petra Hoffm. & McPherson, Madagascar, *Rakotonasolo & Zachary 802* (K), MN915852, MN904222, MN915336, MN916119, MN915609; *P. annamensis* Beille (*Phyllanthus annamensis* 1), Vietnam, *Yahara & al. V3843* (L), MN915853, MN904223, MN915337, MN916120, –, *P. annamensis* Beille (*Phyllanthus annamensis* 2), Vietnam, *Tagane & al. V3863* (L), MN915854, MN904224, MN915338, MN916121, –, *P. arbuscula* (Sw.) J.F.Gmel., Belgium, Meisse living collection, *Reynders 19074182* (L), MN915855, MN904226, MN915339, MN916123, MN915610; *P. arenicola* Casar., Brazil, *Maas & Carauta s.n.* (U), –, MN905071, MN915340, MN916124, MN915611; *P. attenuatus* Miq., Venezuela, *Breteler 4696* (WAG), MN915856, MN904304, MN915341, MN916125, MN915612; *P. baccatus* F.Muell. ex Benth., Australia, *Mitchell PRP1514* (NE), –, –, MN915342, MN916126, MN915613; *P. balgooyi* Petra Hoffm. & A.J.M.Baker (*Phyllanthus balgooyi* 1), Malaysia, Sabah, *Van der Ent*, no voucher, MN915857, MN904227, MN915343, MN916300, MN915614; *P. balgooyi* Petra Hoffm. & A.J.M.Baker (*Phyllanthus balgooyi* 2), Malaysia, Sabah, *Yu 192* (L), MN915858, MN904228, MN915344, MN916301, MN915615; *P. balgooyi* Petra Hoffm. & A.J.M.Baker (*Phyllanthus balgooyi* 3), Philippines, *Yu 259* (L), MN915859, MN904229, MN915345, MN916324, MN915616; *P. balgooyi* Petra Hoffm. & A.J.M.Baker (*Phyllanthus balgooyi* 4), Philippines, *Agoo 5700* (L), MN915860, MN904230, MN915346, MN916325, MN915617; *P. beckleri* Müll.Arg., Australia, *Hosking 2680* (NE), MN915861, MN904231, MN915347, MN916127, MN915618; *P. bernieranus* Baill. ex Müll.Arg., Madagascar, *Phillipson 5373* (K), MN915862, MN904232, MN915348, MN916128, MN915619; *P. betsileanus* Leandri, Madagascar, *Labat 2402* (K), MN915863, MN904233, MN915349, MN916360, MN915620; *P. boehmii* Pax var. *boehmii* (*Phyllanthus boehmii* 1), Tanzania, *Gereau 5007* (WAG), MN915864,



## Appendix 1. Continued.

MN904254, MN915350, MN916302, MN915621; *P. boehmii* Pax var. *boehmii* (*Phyllanthus boehmii* 2), Kenya, *Wieringa 8841* (WAG), MN915865, MN904234, MN915351, MN916129, MN915622; *P. boehmii* Pax var. *humilis* Radcl.-Sm. (*Phyllanthus boehmii* 3), Tanzania, *Bidgood 6838* (WAG), MN915866, MN904235, MN915352, MN916130, MN915623; *P. boehmii* Pax var. *humilis* Radcl.-Sm. (*Phyllanthus boehmii* 4), Zaire, *Lisowski 13765* (WAG), MN915867, MN904303, MN915353, MN916131, MN915624; *P. cf. boehmii* Pax, Ethiopia, *Friis 13159* (WAG), MN915883, MN904249, MN915371, MN916143, MN915635; *P. bokorensis* Tagane, Cambodia, *Toyama & al. 1740* (FU), –, –, MN915354, MN916132, –, “*P. bongensis*” msc. name, sp. nov., Ethiopia, *de Wilde 7858* (WAG), MN915868, MN904305, MN915355, MN916284, –, *P. botryanthus* Müll.Arg., Curacao, *de Wilde 31* (WAG), MN915869, MN904255, MN915356, MN916133, MN915625; *P. bourgeoisii* Baill., New Caledonia, *McMillan 5201* (WAG), MN915870, MN905064, MN915357, MN916134, –, *P. brasiliensis* (Aubl.) Poir., Peru, Loreto, Pongo de Cainarachi, *Ule 6408* (L), MN915871, MN904236, MN915358, MN916135, MN915626; *P. bupleuroides* Baill., New Caledonia, *McPherson 18692* (MO), MN915872, MN904237, MN915359, MN916136, –, *P. buxifolius* (Blume) Müll.Arg. (*Phyllanthus buxifolius* 1), Singapore, Singapore botanical garden, *Yu 163* (L), MN915873, MN904240, MN915360, MN916326, MN915627; *P. buxifolius* (Blume) Müll.Arg. (*Phyllanthus buxifolius* 2), Singapore, Singapore botanical garden, *Yu 167* (L), MN915874, MN904241, MN915361, MN916285, MN915628; *P. cf. buxifolius* (Blume) Müll.Arg. (*Phyllanthus cf. buxifolius* 1), Philippines, *Agoo 5659* (L), MN915884, MN904238, MN915372, MN916286, MN915636; *P. cf. buxifolius* (Blume) Müll.Arg. (*Phyllanthus cf. buxifolius* 2), Philippines, *Agoo 5683* (L), MN915885, MN905070, MN915373, MN916287, MN915637; *P. cf. buxifolius* (Blume) Müll.Arg. (*Phyllanthus cf. buxifolius* 3), Philippines, *Agoo 5738* (L), MN915886, MN904239, MN915374, MN916328, MN915638; *P. caesiifolius* Petra Hoffm. & Cheek, Cameroon, *Cheek 10376* (WAG), MN915875, MN904242, MN915362, MN916137, MN915629; *P. calycinus* Labill., Australia, *Chase MWC 2163* (K), AY936674, AY579869, –, AY552446, –, *P. carinatus* Beille, Cambodia, *Toyama & al. 3212* (FU), –, MN904243, MN915363, MN916138, –, *P. carolinensis* Walter, Suriname, *Groenendijk 55* (WAG), MN915876, –, MN915364, MN916139, MN915630; *P. carpentariae* Müll.Arg., Australia, *Clarkson & Neldner 8410* (L), MN915877, MN905063, MN915365, MN916140, MN915631; *P. cf. carpentariae* Müll.Arg., Australia, *Hyland 8033* (L), MN915888, MN904256, MN915376, MN916147, MN915639; *P. casticum* P.Willemet, Madagascar, *Wolhauser SW60172* (WAG), MN915878, MN904244, MN915366, MN916141, –, *P. castus* S.Moore (*Phyllanthus castus* 1), New Caledonia, *MacKee 16581* (L), MN915889, MN904246, MN915367, MN916327, MN915632; *P. castus* S.Moore (*Phyllanthus castus* 2), New Caledonia, *McPherson 19255* (MO), MN915880, MN904245, MN915368, MN916304, –, *P. caudatus* Müll.Arg., New Caledonia, *Kawakita 278* (KYO), –, FJ235351, –, FJ235259, –, *P. cautilola* J.T.Hunter & J.J.Bruhl, Australia, *Mitchell 837* (NE), MN915881, MN904247, MN915369, MN916303, MN915633; *P. ceratostemon* Brenan, Tanzania, *Bidgood 6776* (WAG), MN915882, MN904248, MN915370, MN916142, MN915634; *P. chacoensis* Morong, Paraguay, *Krapovickas & al. 45628* (K), AY936677, –, –, AY936582, –, *P. chamaecerasus* Baill., New Caledonia, *Munzinger & McPherson 573* (MO), AY936678, –, –, AY936583, –, *P. chamaecristoid* Urb., Cuba, *van Ee & al. 404* (K), AY936679, –, –, AY936584, –, *P. chrysanthus* Baill., New Caledonia, *Munzinger & McPherson 796* (MO), AY936680, –, –, AY936585, –, *P. chryseus* Howard, Cuba, *Van Ee & al. 387* (K), AY936681, MN904257, MN915379, AY936586, MN915644; *P. ciccoides* Müll.Arg., Australia, *Pajmans 2876* (DAV), MN915891, –, –, MN916150, –, *P. cinctus* Urb., Cuba, *Ekman 19166* (K), MN915892, MN904258, MN915380, MN916151, MN915645; *P. cinereus* Müll.Arg., Sri Lanka, *Kathirarachchi & al. 66* (K), AY936682, MN904259, MN915381, AY936587, –, *P. clambooides* (F.Muell.) Diels, Australia, *Forster 26376* (L), MN915893, MN904260, MN915382, MN916152, MN915646; *P. clausenii* Müll.Arg., Brazil, Minas Gerais, *Hatschbach 64117* (U), MN915894, MN904261, MN915383, MN916153, MN915647; *P. cochinchinensis* Spreng., China, Hong Kong, *Bouman & al. RWB026* (L), MN915895, MN904262, MN915384, MN916154, MN915648; *P. aff. cochinchinensis* Spreng. (*Phyllanthus aff. cochinchinensis* 1), China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB052* (HITBC), MN915840, MN904250, MN915324, MN916144, MN915601; *P. aff. cochinchinensis* Spreng. (*Phyllanthus aff. cochinchinensis* 2), China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB065* (HITBC), MN915841, MN904251, MN915325, MN916145, MN915602; *P. aff. cochinchinensis* Spreng. (*Phyllanthus aff. cochinchinensis* 3), China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB060* (HITBC), MN915842, MN904252, MN915326, MN916146, MN915603; *P. collinsae* Craib, Thailand, *Middleton 3302* (L), MN915896, MN904263, MN915385, MN916155, MN915649; *P. collinus* Domin, Australia, *Telford & Bruhl 13119* (L), –, MN904264, MN915386, MN916156, MN915650; *P. columnaris* Müll.Arg. (*Phyllanthus columnaris* 1), Myanmar, *Fujikawa & al. 095327* (L), –, MN904302, MN915387, MN916157, MN915651; *P. columnaris* Müll.Arg. (*Phyllanthus columnaris* 2), Myanmar, *Funakoshi & al. 085264* (L), MN915897, –, MN915388, MN916283, MN915652; *P. aff. columnaris* Müll.Arg. (*Phyllanthus aff. columnaris* 1), Thailand, *Middleton 1715* (L), MN915843, MN904215, MN915327, MN916112, MN915600; *P. aff. columnaris* Müll.Arg. (*Phyllanthus aff. columnaris* 2), Thailand, *Tagane & al. T570* (L), MN915844, MN904216, MN915328, MN916113, –, *P. comosus* Urb., Cuba, *Gutierrez & al. 81777* (WIS), AY936685, –, –, AY936590, –, *P. coursii* Leandri, Madagascar, *Razafindrahaja 184* (MO), MN915898, MN904266, MN915389, MN916329, –, *P. cryptophilus* (Comm. ex A.Juss.) Müll.Arg., Madagascar, *Dumetz 593* (WAG), MN915899, MN904265, MN915390, MN916358, MN915653; *P. aff. curranii* C.B.Rob., Philippines, *Yu 261* (L), MN915900, MN904267, MN915391, MN916158, MN915604; *P. cuscutiflorus* S.Moore, Singapore, Singapore botanical garden, *Yu 61* (L), MN915901, MN904268, MN915392, MN916299, MN915654; *P. dallachyanus* Benth., Australia, *Forster 32938* (NE), –, –, MN915393, MN916298, MN915655; *P. dawsonii* Steyerl., Brazil, *da Silva 2073* (DAV), MN915902, –, –, MN916159, –, *P. debilis* J.G.Klein ex Willd. (*Phyllanthus debilis* 1), China, Hong Kong University campus, *Bouman & Liu RWB037* (L), MN915903, MN904269, MN915394, MN916330, MN915656; *P. debilis* J.G.Klein ex Willd. (*Phyllanthus debilis* 2), China, Hong Kong University campus, *Bouman RWB071* (L), MN915904, MN904270, MN915395, MN916331, MN915657; *P. debilis* J.G.Klein ex Willd. (*Phyllanthus debilis* 3), Philippines, *Kamarudin & Apok s.n.* (L), MN915905, MN904271, MN915396, MN916332, MN915658; *P. delpyanus* Hutch. (*Phyllanthus delpyanus* 1), Republic of the Congo, *Kami & al. 1215* (WAG), MN915906, –, MN915397, MN916161, MN915659; *P. delpyanus* Hutch. (*Phyllanthus delpyanus* 2), Republic of the Congo, *M'Boungou 659* (WAG), –, MN904272, MN915398, MN916160, –, *P. dictyospermus* Müll.Arg., Brazil, *Santos 5712* (DAV), MN915907, –, –, MN916162, –, *P. dinklagei* Pax (*Phyllanthus dinklagei* 1), Gabon, *Bissiengou* (WAG), MN915908, MN904273, MN915399, MN916333, MN915660; *P. dinklagei* Pax (*Phyllanthus dinklagei* 2), Gabon, *Maas 9993* (WAG), MN915909, MN904274, MN915400, MN916334, MN915661; *P. dinteri* Pax (*Phyllanthus dinteri* 1), Namibia, Damaraland, *Wilhemstal, Dinter 213* (WAG), MN915910, –, MN915401, MN916335, MN915662; *P. dinteri* Pax (*Phyllanthus dinteri* 2), Namibia, *Oliver 6543* (WAG), MN915911, MN905069, MN915402, MN916336, MN915663; *P. discolor* Poepp. ex Spreng, Cuba, *Berzain & al. 71878* (K), AY936688, MN904275, MN915403, AY936593, MN915664; *P. distichus* Hook. & Arn., USA, Hawaii, *Harold st. John 17.985* (L) (L), MN915912, MN904276, MN915404, MN916163, MN915665; *P. dzumacensis* M.Schmid, New Caledonia, *Jaffre 2412* (L), MN915913, MN905065, MN915405, MN916164, MN915666; *P. elegans* Wall. ex Müll. Arg. (*Phyllanthus elegans* 1), Vietnam, *Yahara & al. V3499* (L), MN915914, –, MN915406, MN916165, –, *P. elegans* Wall. ex Müll. Arg. (*Phyllanthus elegans* 2), Vietnam, *Yahara & al. V5597* (L), MN915915, MN904277, MN915407, MN916166, –, *P. elsiae* Urb., Venezuela, *Davidse & Gonzalez 13359* (L), MN915916, MN904278, MN915408, MN916337, MN915667; *P. emblica* L. (*Phyllanthus emblica* 1), Myanmar, *Makino banical garden expedition(2015) 103008* (MBK), MN915917, MN904279, MN915409, MN916167, MN915668; *P. emblica* L. (*Phyllanthus emblica* 2), Thailand, Phu Kae botanical garden, *Van Welzen 2003-11* (L), GQ503378, GQ503434, GQ503494, EU643743, GQ503558; *P. engleri* Pax, Tanzania, *Mwanguungu 1138* (WAG), –, MN905066, MN915410, MN916168, MN915669; *P. epiphyllanthus* L. (*Phyllanthus epiP.* 1), Germany, Bayreuth botanical garden, living collection, *Lauerer 080405*, no voucher, MN915918, MN904225, MN915411, MN916122, MN915670; *P. epiphyllanthus* L. (*Phyllanthus epiP.* 2), Belgium, Meisse, living collection, *Reynders IPEN: XX-0-BR-19840633* (L), MN915919, MN904280, MN915412, MN916169, MN915671; *P. erwinii* J.T.Hunter & J.J.Bruhl, Australia, *Mitchell PRP1456* (NE), MN915920, MN904281, MN915413, MN916338, –, *P. evanescens* Brandegee, Nicaragua, *Stevens 32461* (MO), MN915921, MN904282, MN915414, MN916339, –, *P. exilis* S.Moore, Australia, *Hunter & al. 1528* (L), MN915922, MN904283, –, MN916362, MN915672; *P. favieri* M.Schmid, New Caledonia, *McPherson & Munzinger 18028* (MO), AY936690, –, –, AY936596, –, *P. filicaulis* Benth., Australia, *Telford 13516* (NE), MN915923, MN904284, MN915415, MN916170, MN915673; *P. finschii* K.Schum., Papua New Guinea, *Takeuchi & Ama 15603* (L), MN915924, MN904285, MN915416, MN916171, MN915674; *P. fischeri* Pax, Tanzania, *Gereau 1996* (WAG), MN915925, MN904286, MN915417, –, MN915675; *P. cf. fischeri* Pax, Ethiopia, *de Wilde 4391* (WAG), MN915887, MN905067, MN915375, MN916343, MN915725; *P. flagellaris* Benth., Australia, *Fryxell & Craven* (L), MN915926, MN904287, MN915418, MN916307, MN915676; *P. flexuosus* (Siebold & Zucc.) Müll.Arg. (*Phyllanthus flexuosus* 1), China, *Chow 132* (L), MN915927,

## Appendix 1. Continued.

MN904289, MN915419, MN916173, MN915677; *P. flexuosus* (Siebold & Zucc.) Müll.Arg. (*Phyllanthus flexuosus* 2), USA, Berkeley, Cultivated, *Mcnamara 162 Living collection Berkeley*, no voucher, MN915928, MN904290, MN915420, MN916174, MN915678; *P. flexuosus* (Siebold & Zucc.) Müll.Arg. (*Phyllanthus flexuosus* 3), Myanmar, *Aung & al. 092433* (MBK), MN915929, MN904288, MN915421, MN916172, MN915679; *P. fluitans* Benth. ex Müll.Arg., Germany, Cultivated Botanical garden Bonn, *Krämer xx-0-Dath-518* (L), MN915930, MN904292, MN915422, MN916176, MN915680; *P. fraternus* G.L.Webster, Pakistan, *Nooteboom 3010* (L), MN915931, –, MN915423, MN916306, MN915681; *P. friesii* Hutch., Zambia, *Harder & al. 2778* (WAG), MN915932, MN904293, MN915424, MN916177, MN915682; *P. fuernrohrii* F.Muell., Australia, *Coveny 13478* (NE), –, MN904294, –, MN916178, –, *P. fuscoluridus* Müll.Arg. var. *fuscoluridus* (*Phyllanthus fuscoluridus* 2), Madagascar, *Schatz 1737* (WAG), MN915934, MN904296, MN915426, MN916179, –, *P. fuscoluridus* Müll.Arg. var. *villosus* (Leandri) Ralim. & Petra Hoffm. (*Phyllanthus fuscoluridus* 1), Madagascar, *Dorr 3650* (WAG), MN915933, MN905068, MN915425, MN916180, –, *P. aff. fuscoluridus* Müll.Arg., Madagascar, *Ravelonarivo 3808* (MO), MN915845, MN904295, MN915329, MN916282, –, *P. gabonensis* Jean F.Brunel (*Phyllanthus gabonensis* 1), Gabon, *Maas 10095* (WAG), –, MN904299, MN915427, MN916181, MN915683; *P. gabonensis* Jean F.Brunel (*Phyllanthus gabonensis* 2), Gabon, *Wieringa 8492* (WAG), –, MN915935, MN904313, MN915428, MN916182; *P. gardnerianus* (Wight) Baill., Sri Lanka, *Kathirarachchi & al. 42* (K), AY936694, MN904314, MN915429, AY936598, MN915684; *P. geoffrayi* Beille, Thailand, *Larsen & al. 3259* (L), MN915936, MN904315, MN915430, MN935816, MN915685; *P. gillettianus* Jean F.Brunel, Namibia, *Germishuizen 9727* (WAG), MN915937, MN904316, MN915431, –, MN915686; *P. glaucophyllus* Sond. (*Phyllanthus glaucophyllus* 1), Guinea, *Van der Brugt 1156* (WAG), MN915938, MN904317, MN915432, MN916183, MN915687; *P. glaucophyllus* Sond. (*Phyllanthus glaucophyllus* 2), Guinea, *Haba 123* (WAG), MN915939, MN904318, MN915433, MN916340, MN915688; *P. glaucus* Wall. ex Müll.Arg. (*Phyllanthus glaucus* 2), China, Hong Kong, *Bouman & Liu RWB028* (L), MN915940, MN904291, MN915434, MN916175, MN915689; *P. [subg. Gomphidium] sp.* (*Phyllanthus* cf. *Gomphidium* sp.), Philippines, *Yu 250* (L), MN915889, MN904253, MN915377, MN916148, MN915640; *P. gomphocarpus* Hook.f., Malaysia, *Klackenberg & Lundin 579* (L), MN915941, MN905073, MN915435, MN916184, –, *P. grandisepalus* F.Muell. ex Müll.Arg., Australia, *Albrecht 13268* (NE), MN915942, MN904319, MN915436, MN916289, MN915690; “*P. graniticola*” msc. name, sp. nov., Australia, *Telford 13004* (NE), MN915943, MN904320, MN915437, MN916185, MN915691; *P. graveolens* Kunth, Ecuador, *Klitgaard & al. 399* (K), AY936696, MN904321, MN915438, AY936600, MN915692; *P. guillauminii* Däniker, New Caledonia, *Kawakita 273* (KYO), –, FJ235353, –, FJ235261, –, *P. gunnii* Hook.f., Australia, *Coveny 11474* (L), MN915944, MN904322, MN915439, MN916290, MN915693; *P. harrisi* Radcl.-Sm., Tanzania, Zanzibar, *Faulkner 3179* (WAG), MN915945, MN904323, MN915440, MN916341, MN915694; *P. hebecarpus* Benth., Australia, *Copeland NE66669* (NE), –, MN904324, –, MN916308, MN915695; *P. heliotropus* C.Wright ex Griseb., Cuba, *Maas & al. 7762* (U), MN915946, MN904325, MN915441, MN916186, MN915696; *P. hirtellus* F.Muell. ex Müll.Arg., Australia, *Pedersen 1328* (L), MN915947, MN904326, MN915442, MN916187, MN915697; *P. humbertii* (Leandri) Petra Hoffm. & McPherson, Madagascar, *Kawakita 235* (KYO), –, FJ235345, –, FJ235253, –, *P. hutchinsonianus* S.Moore (*Phyllanthus hutchinsonianus* 1), Zimbabwe, *Poilecot 7974* (K), AY936697, MN904327, MN915443, AY936601, MN915698; *P. hutchinsonianus* S.Moore (*Phyllanthus hutchinsonianus* 2), Zimbabwe, *Bamps 88* (WAG), MN915948, MN904306, MN915444, –, –, *P. hypospodius* F.Muell., Australia, *Bruhl & al. 1123* (L), –, GQ503435, GQ503495, EU643744, GQ503559; *P. juglandifolius* Willd., Netherlands, Hortus botanicus Amsterdam, cultivated, *Bouman RWB16* (L), MN915949, MN904328, MN915445, MN916188, MN915699; *P. kaessneri* Hutch., Tanzania, *Pocs 89182* (K), AY936700, –, –, AY936603, –, *P. kanalenis* Baill., New Caledonia, *McPherson & Van der Werff 17886* (K), AY936701, –, –, AY936604, –, *P. kaweesakii* Pornp., Chantar. & J.Parn., Thailand, *Pornpongrueng & Triyuttachai 1174* (KKU), KY091120, –, –, KY091108, –, *P. kerstingii* Jean F.Brunel (*Phyllanthus kerstingii* 1), Guinea, *Darbyshire 562* (WAG), MN915950, MN905074, MN915447, MN916189, MN915701; *P. kerstingii* Jean F.Brunel (*Phyllanthus kerstingii* 2), Guinea, *Malaisse 14792* (WAG), MN915951, –, MN915448, –, MN915702; *P. kidna* Challen & Petra Hoffm., Cameroon, *Cheek 11531* (K), FR715993, –, –, FR715992, –, *P. kinabalucius* Airy Shaw, Malaysia, Sabah, *Van der Ent (Kinabalu Parc living collection)*, no voucher, MN915952, MN904330, MN915449, MN916190, MN915703; *P. klotzschianus* Müll.Arg., Brazil, *Grappo & al. 780* (K), AY936702, –, –, AY936605, –, *P. cf. klotzschianus* Müll.Arg., Brazil, *Carneiro 10 10* (K), –, –, MN915450, –, MN915641; *P. koniambaensis* M.Schmid, New Caledonia, *Kawakita 277* (KYO), –, FJ235350, –, FJ235258, –, *P. koumaccensis* Guillaumin, New Caledonia, *McPherson 19163A* (MO), MN915953, MN904331, MN915451, MN916191, –, *P. laciniatus* C.B.Rob., Philippines, *Agoo 5660* (L), MN915954, MN904332, MN915452, MN916192, MN915705; *P. lacunarius* F.Muell., Australia, *Bates 62700* (NE), MN915955, MN904333, MN915453, MN916312, MN915706; *P. lacunellus* Airy Shaw, Australia, *Bates 62500* (NE), MN915956, MN904334, MN915454, MN916313, MN915707; *P. lamprophyllus* Müll.Arg. (*Phyllanthus lamprophyllus* 1), Philippines, *Agoo 5592* (L), MN915957, MN904335, MN915455, MN916193, MN915708; *P. lamprophyllus* Müll.Arg. (*Phyllanthus lamprophyllus* 2), Australia, *Telford & Bruhl 13049* (L), MN915958, MN904336, MN915456, MN916194, MN915709; *P. lamprophyllus* Müll.Arg. (*Phyllanthus lamprophyllus* 3), Australia, *Telford & Bruhl 13051* (L), MN915959, MN904337, MN915457, MN916195, MN915710; *P. lamprophyllus* Müll.Arg. (*Phyllanthus lamprophyllus* 4), Singapore, Singapore botanical garden, *Yu 161* (L), MN915960, MN904338, MN915458, MN916309, MN915711; *P. leptoclados* Benth., China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB051* (HITBC), MN915961, MN904339, MN915459, MN916196, MN915712; *P. leucanthus* Pax (*Phyllanthus leucanthus* 1), Eritrea, *de Wilde 4604* (WAG), MN915962, MN904300, MN915460, MN916149, MN915642; *P. leucanthus* Pax (*Phyllanthus leucanthus* 2), Ethiopia, *Friis 8619* (WAG), MN915963, MN904340, MN915461, MN916344, MN915713; *P. leucocalyx* Hutch. (*Phyllanthus leucocalyx* 1), Tanzania, *Bidgood 7161* (WAG), –, MN904341, MN915462, MN916197, –, *P. leucocalyx* Hutch. (*Phyllanthus leucocalyx* 2), Tanzania, *Bidgood 6969* (WAG), MN915964, MN904342, MN915463, MN916198, –, *P. lichenisilvae* (Leandri ex Humbert) Petra Hoffm. & McPherson, Madagascar, *Antilahimena 7638* (MO), –, MN904343, MN915464, MN916199, –, *P. ligustrifolius* S.Moore (*Phyllanthus ligustrifolius* 1), New Caledonia, *McPherson 19091* (MO), MN915965, MN904344, MN915465, MN916310, –, *P. ligustrifolius* S.Moore (*Phyllanthus ligustrifolius* 2), New Caledonia, *McPherson 5025* (L), MN915966, MN904309, MN915466, MN916311, MN915714; *P. limmuensis* Cufod., Ethiopia, *de Wilde 6524* (WAG), MN915967, MN904345, MN915467, MN916291, MN915715; *P. lindenianus* Baill., Dominican Republic, *Fuertes 345* (K), –, –, MN915468, MN916200, MN915716; *P. loandensis* Welw. ex Müll.Arg. (*Phyllanthus loandensis* 1), Malawi, *Pawek R597* (WAG), MN915968, MN904346, MN915469, MN916201, MN915717; *P. loandensis* Welw. ex Müll.Arg. (*Phyllanthus loandensis* 2), Malawi, *Pawek 12535* (WAG), MN915970, MN904297, MN915470, MN916202, MN915718; *P. loandensis* Welw. ex Müll.Arg. (*Phyllanthus loandensis* 3), Mozambique, *Nuvunga 526* (WAG), MN915969, MN905072, MN915471, MN916203, MN915719; *P. lokohensis* Leandri, Madagascar, *Antilahimena 8041* (MO), MN915971, MN904347, –, MN916316, –, *P. loranthoides* Baill., New Caledonia, *MacKee 31810* (K), AY936705, –, –, AY936607, –, *P. macranthus* Pax, Zimbabwe, *Biegel & al. 4847* (WAG), MN915972, MN905075, MN915472, MN916292, MN915720; *P. madagascariensis* Müll.Arg., Madagascar, *McPherson 18925* (MO), MN915973, MN904348, MN915473, MN916317, –, *P. madeirensis* Croizat, Brazil, *Vincentini 1206* (U), MN915974, MN905078, MN915474, MN916293, MN915721; *P. maderaspatensis* L., Madagascar, *Hunter & al. 1532* (K), AY936707, –, –, AY936609, –, *P. magnificens* Jean F.Brunel & J.P.Roux, Guinea, *van der Burgt 1196* (WAG), MN915975, MN904349, MN915475, MN916345, MN915722; *P. magudensis* Jean F.Brunel, Sudan, *Blokkhuis 50* (WAG), MN915976, MN904350, MN915476, MN916318, MN915723; *P. manganotii* M.Schmid, New Caledonia, *Kawakita 270* (KYO), –, FJ235349, –, FJ235257, –, *P. mannianus* Müll.Arg. (*Phyllanthus mannianus* 1), Cameroon, *Raynal 12256* (WAG), MN915977, MN904351, MN915477, MN916347, MN915724; *P. mannianus* Müll.Arg. (*Phyllanthus mannianus* 2), Cameroon, *Biye 129* (WAG), MN915978, MN904352, MN915478, –, MN915726; *P. mantadiensis* Ralim. & Petra Hoffm. (*Phyllanthus mantadiensis* 1), Madagascar, *Rasoazanany 110* (MO), MN915979, MN904353, MN915479, MN916204, –, *P. mantadiensis* Ralim. & Petra Hoffm. (*Phyllanthus mantadiensis* 2), Madagascar, *Rasoazanany 514* (MO), MN915980, MN904354, MN915480, MN916319, –, *P. marojejiensis* (Leandri) Petra Hoffm. & McPherson, Madagascar, *Kawakita 243* (KYO), –, FJ235346, –, FJ235254, –, *P. matitanensis* Leandri, Madagascar, *Ravelonarivo 4276* (MO), MN915981, MN904355, MN915481, MN916205, –, *P. megalanthus* C.B.Rob., Philippines, *Calaramo s.n.* (L), MN915982, MN904356, –, MN916206, MN915727; *P. melleri* Müll.Arg., Madagascar, *Lowry & al. 5814* (K), MN915983, MN904357, MN915482, MN916314, MN915728; *P. mendoncae* Jean F.Brunel, Ethiopia, *de Wilde 6464* (WAG), MN915984, –, –, –, *P. microcarpus* (Benth.) Müll.Arg. (*Phyllanthus microcarpus* 1), China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB056* (HITBC), MN915985, MN904358, MN915483, MN916207, MN915729;

## Appendix 1. Continued.

*P. microcarpus* (Benth.) Müll.Arg. (*Phyllanthus microcarpus* 2), Vietnam, Yang & al. V2332 (L), MN915986, MN904359, MN915484, MN916356, –; *P. microcarpus* (Benth.) Müll.Arg. (*Phyllanthus microcarpus* 3), Myanmar, Tanaka & al. MY112 (L), MN915987, MN904360, MN915485, MN916346, –; *P. microcarpus* (Benth.) Müll.Arg. (*Phyllanthus microcarpus* 4), Cambodia, Yahara & al. 4346 (L), –, MN904361, MN915486, MN916208, –; *P. microcladus* (Benth.) Müll.Arg., Australia, Telford 13038 (L), MN915988, MN904362, MN915487, MN916320, MN915730; *P. microdictyis* Urb., Cuba, Van Ee 399 (K), AY936709, MN904363, MN915488, AY936612, MN915731; *P. mimosoides* Sw., Belgium, Meisse living collection, Reynders 19074179 (L), MN915989, MN904364, MN915489, MN916209, MN915732; *P. mirabilis* Müll.Arg., Thailand, Sirichamorn YSM 2009-05 (L) (L), HM132100, HM132101, HM132099, –, HM132102; *P. Mitchellii* Benth., Australia, Bruhl 1919B (NE), MN915990, MN904365, MN915490, MN916210, MN915733; *P. aff. moorei* M.Schmid, New Caledonia, Munzinger 608 (MO), MN915839, MN904214, MN915323, MN916111, –, *P. muellerianus* (Kuntze) Exell (*Phyllanthus muellerianus* 1), Burkina Faso, Kew Seed bank collection 145024 (K), MN915991, MN904366, MN915491, MN916295, –, *P. muellerianus* (Kuntze) Exell (*Phyllanthus muellerianus* 2), Zambia, Bingham 6893 (WAG), MN915992, MN904368, MN915492, MN916212, MN915734; *P. muellerianus* (Kuntze) Exell (*Phyllanthus muellerianus* 3), Liberia, Jongkind 39824 (WAG), MN915993, MN904367, MN915493, MN916211, MN915735; *P. muellerianus* (Kuntze) Exell (*Phyllanthus muellerianus* 4), Gabon, Wieringa 7074 (WAG), MN915994, MN904369, MN915494, MN916213, –; *P. myrtifolius* (Wight) Müll.Arg. (*Phyllanthus myrtifolius* 1), China, Hong Kong University campus, Bouman & Liu RWB034 (L), MN915995, MN904370, MN915495, MN916214, MN915736; *P. myrtifolius* (Wight) Müll.Arg. (*Phyllanthus myrtifolius* 2), China, Yunnan, Xishuangbanna Tropical Botanical Garden, Bouman & Yong RWB053 (HITBC), MN915996, MN904371, MN915496, MN916215, MN915737; *P. myrtifolius* (Wight) Müll.Arg. (*Phyllanthus myrtifolius* 3), Singapore, Singapore botanical garden, Yu 58 (L), MN915997, MN904372, –, MN916216, MN915738; *P. niruri* L., Bolivia, De la Quintana 333 (MO), MN916000, MN904373, MN915499, MN916217, –, *P. nirurioides* Müll.Arg. (*Phyllanthus nirurioides* 1), Tanzania, Bidgood 8049 (WAG), MN915998, MN904374, MN915497, MN916305, MN915739; *P. nirurioides* Müll.Arg. (*Phyllanthus nirurioides* 2), Gabon, Wieringa 7502 (WAG) (WAG), MN915999, MN904375, MN915498, MN916218, MN915740; *P. novae-hollandiae* Müll.Arg., Australia, Telford 13024 (NE), MN916001, MN904376, MN915500, MN916219, MN915741; *P. nummulariifolius* Poir. (*Phyllanthus nummulariifolius* 1), Tanzania, Nicholson 3b (L), MN916002, MN904377, MN915501, MN916288, MN915742; *P. nummulariifolius* Poir. (*Phyllanthus nummulariifolius* 2), Gabon, Wieringa 8374 (WAG), MN916003, MN904380, MN915502, MN916361, MN915744; *P. nummulariifolius* Poir. (*Phyllanthus nummulariifolius* 3), Ghana, van Andel 5732 (WAG), MN916004, MN904381, MN915503, MN916223, MN915743; *P. nummulariifolius* Poir. (*Phyllanthus nummulariifolius* 4), Tanzania, Mwangoka 5900 (WAG), MN916005, MN904379, MN915504, MN916222, –, *P. nummulariifolius* Poir. (*Phyllanthus nummulariifolius* 5), Madagascar, Razafitsalama 235 (MO), MN916006, MN904378, MN915505, MN916220, –, *P. nummulariifolius* Poir. (*Phyllanthus nummulariifolius* 6), China, Blaxell 1118 (U), MN916007, MN904310, MN915506, MN916221, MN915745; *P. nyale* Petra Hoffm. & Cheek, Cameroon, Etuge 4453 (WAG), MN916008, MN904382, MN915507, MN916224, MN915746; *P. odontadenius* Müll.Arg. (*Phyllanthus odontadenius* 1), Cameroon, Darbyshire 207 (WAG), MN916009, MN904311, MN915508, MN916348, MN915747; *P. odontadenius* Müll.Arg. (*Phyllanthus odontadenius* 2), Netherlands, Utrecht botanical garden, cultivated, Bouman & Verwijs RWB025 (L), MN916010, MN904383, MN915509, MN916349, MN915748; *P. odontadenius* Müll.Arg. (*Phyllanthus odontadenius* 3), Gabon, Wieringa 7665 (WAG), MN916011, MN904384, MN915510, MN916350, MN915749; *P. oligospermus* Hayata, Taiwan, Kawakita 101 (KYO), –, FJ235360, –, FJ235268, –, *P. orbicularis* Kunth, Borneo, Eschevaria s.n. (L), MN916012, MN904298, MN915511, MN916225, MN915750; *P. oreichitius* Leandri, Madagascar, Antilahimena 4824 (MO), MN916013, MN904385, –, MN916226, –, *P. ovalifolius* Forssk. (*Phyllanthus ovalifolius* 1), Democratic Republic of the Congo, Luiswishi, Mallaisse T2688 (WAG), MN916014, MN904312, MN915512, MN916227, MN915751; *P. ovalifolius* Forssk. (*Phyllanthus ovalifolius* 2), Ethiopia, de Wilde 7622 (WAG), MN916015, –, MN915513, MN916228, MN915752; *P. ovalifolius* Forssk. (*Phyllanthus ovalifolius* 3), Ethiopia, Friis 13337 (WAG), MN916016, MN904301, MN915514, MN916229, MN915753; *P. oxycoffifolius* Hutch., Tanzania, Gereau 5219 (WAG), MN916017, MN904387, –, MN916231, MN915754; *P. oxyphyllus* Miq. (*Phyllanthus oxyphyllus* 1), Thailand, Middleton 3191 (L), MN916018, MN904388, MN915515, MN916232, MN915755; *P. oxyphyllus* Miq. (*Phyllanthus oxyphyllus* 2), Singapore, Singapore botanical garden, Yu 174 (L), MN916019, MN904389, –, MN916233, MN915756; *P. pachystylus* Urb., Cuba, Van Ee 402 (K), AY936720, MN904390, MN915516, AY936622, MN915757; *P. pancherianus* Baill., New Caledonia, McPherson & Munzinger 18264 (K), AY936721, MN904391, MN915517, AY936623, MN915758; “*P. patentipilis*” msc. name, sp. nov., Australia, Bruhl 1810 (NE), MN916020, MN904392, MN915518, MN916234, MN915759; *P. paxii* Hutch., Tanzania, Bidgood 2983 (WAG), MN916021, MN904393, MN915519, MN916235, MN915760; *P. pectinatus* Hook.f., Singapore, Singapore botanical garden, Yu 65 (L), MN916022, –, MN915520, MN916236, MN915761; *P. pentandrus* Schumach. & Thonner, Malawi, Kew Seed bank collection 519962 (K), MN916023, MN904394, MN915521, MN916237, –, *P. perrieri* (Leandri) Petra Hoffm. & McPherson, Madagascar, Rakotonasolo & al. 814 (K), MN916024, MN904395, MN915522, MN916238, MN915762; *P. pervilleanus* (Baill.) Müll.Arg., *Phyllanthus pervilleanus* (1), Comoro Islands, Mayotte, Hoffmann & al. 392 (K), AY936723, –, –, AY936625, –, *P. pervilleanus* (Baill.) Müll.Arg., *Phyllanthus pervilleanus* (2), Madagascar, Randrianasolo 526 (MO), MN916025, MN904396, MN915523, MN916351, –, *P. petraeus* A.Chev. & Beille, Liberia, Blyden 1037 (WAG), MN916026, MN904397, MN915524, MN916239, MN915763; *P. philippioides* Leandri, Madagascar, Ralimanana & al. 627 (K), MN916027, MN904398, MN915525, MN916240, MN915764; *P. phillyreifolius* Poir., Réunion, van Nek 2188 (WAG), MN916028, MN904399, MN915526, MN916241, MN915765; *P. phuquocensis* Beille, Cambodia, Tagane & al. 5532 (FU), MN916029, MN904400, MN915527, MN916242, –, *P. physocarpus* Müll.Arg., Gabon, McPherson 16148 (WAG), MN916030, MN904401, MN915528, MN916243, MN915766; *P. pilifer* M.Schmid, New Caledonia, McPherson 18525 (MO), MN916031, MN904402, MN915529, MN916244, –, *P. pinnatus* (Wight) G.L.Webster, Zimbabwe, Mav 1580 (K), MN916032, MN904403, MN915530, MN916245, MN915704; *P. polyanthus* Pax, Cameroon, Breteler 1938 (WAG), MN916033, –, MN915531, MN916246, MN915767; *P. polygonoides* Nutt. ex Spreng., USA, Texas, Kim & Miller 1078 (U), MN916034, MN904404, MN915532, MN916247, MN915768; *P. polyspermus* Schumach. & Thonner (*Phyllanthus polyspermus* 1), UK, RBG Kew, Living collection, origin South Africa, Kew seed bank HBL20160135 (Kew seed bank 174282) (K), MN916037, MN904406, MN915535, MN916249, –, *P. polyspermus* Schumach. & Thonner (*Phyllanthus polyspermus* 2), Mozambique, Saolomao 40 (WAG), MN916038, MN904407, MN915536, MN916250, MN915770; *P. polyspermus* Schumach. & Thonner (*Phyllanthus polyspermus* 3), Ethiopia, Friis 10341 (WAG), MN916036, MN904386, MN915534, MN916230, MN915771; *P. poumensis* Guillaumin, New Caledonia, Mackee 20748 (L), MN916039, MN904408, MN915537, MN916251, MN915772; *P. pulcher* Wall. ex Müll.Arg. (*Phyllanthus pulcher* 1), China, Yunnan, Xishuangbanna Tropical Botanical Garden, Bouman & Yong RWB066 (HITBC), MN916040, MN904409, MN915538, MN916252, MN915773; *P. pulcher* Wall. ex Müll.Arg. (*Phyllanthus pulcher* 2), Thailand, Esser 98-68 (L), MN916041, MN904410, MN915539, MN916253, MN915774; *P. purpureus* Müll.Arg., Namibia, Ward & al. 10442 (K), MN916042, MN904411, MN915540, MN916254, MN915775; *P. purpusii* Brandege, USA, Berkeley, cultivated, from Mexico, Breedlove 42730 Living collection Berkeley, no voucher, MN916043, MN904412, MN915541, MN916255, MN915776; *P. racemosus* L.f., Sri Lanka, Cooray 69090414 (L), MN916035, MN904405, MN915533, MN916248, MN915769; *P. ramillosus* Müll.Arg., Brazil, Arbo 6945 (DAV), MN916044, –, –, MN916256, –, *P. rangoloakensis* Leandri, Madagascar, Schatz & al. 3709 (K), MN916045, MN904413, MN915542, MN916257, MN915777; “*P. recurvatus*” msc. name, sp. nov., Australia, Wilson 612 (NE), MN916046, MN904414, MN915543, MN916258, MN915778; *P. rheedii* Wight, Sri Lanka, Kathirarachchi & al. 1 (K), AY936729, MN904415, MN915544, AY936630, MN915779; *P. roseus* (Craib & Hutch.) Beille, Laos, Kawakita 143 (KYO), KC913110, FJ235332, –, FJ235240, –, *P. rotundifolius* J.G.Klein ex Willd., Kenya, Wieringa 8849 (WAG), MN916047, MN904416, MN915545, MN916352, MN915780; *P. cf. rotundifolius* J.G.Klein ex Willd., Kenya, Nicholson 2 (L), –, MN904329, MN915446, MN916342, MN915700; *P. ruber* (Lour.) Spreng., China, Lee & al. s.n. (CUHK), AY765298, –, –, –, *P. rubescens* Beille, Vietnam, Yahara & al. V2902 (L), MN916048, MN904417, MN915546, MN916322, –, *P. rufuschaneyi* Welzen, R.W.Bouman & Ent, Malaysia, Sabah, Van der Ent (L), –, MN904418, MN915547, MN916259, MN915781; *P. ruscifolius* Müll.Arg., Colombia, Cuatrecasas 21631 (U), MN916049, MN905077, MN915548, –, MN915782; *P. saffordii* Merr., Guam, Fosberg 59609 (L), MN916050, MN904419, MN916260, –, *P. salvifolius* Kunth (*Phyllanthus salvifolius* 1), Ecuador, Balslev 1888 (U), MN916051, MN905076, MN915550, MN916261, –, *P. salvifolius* Kunth (*Phyllanthus salvifolius* 2), Ecuador, Jorgensen 61204 (U), MN916052, MN904420, MN915551, MN916262, MN915783; *P. sambiranensis* Leandri, Madagascar, Bürki & al. 3 (K), MN916053, MN904421, MN915552, MN916315, MN915784; *P. sauropodoides* Airy Shaw, Australia, Forster 29857 (L), EU623558, GQ503436, GQ503496,

## Appendix 1. Continued.

EU643745, GQ503560; *P. sellowianus* (Klotzsch) Müll.Arg. (*Phyllanthus sellowianus* 1), UK, RBG Kew, living collection, *Chase 14776* (K), **MN916054**, **MN904422**, **MN915553**, **MN916263**, **MN915785**; *P. sellowianus* (Klotzsch) Müll.Arg. (*Phyllanthus sellowianus* 2), UK, RBG Kew, living collection, *Chase 14777* (K), **MN916055**, **MN904423**, **MN915554**, **MN916264**, **MN915786**; *P. sellowianus* (Klotzsch) Müll.Arg. (*Phyllanthus sellowianus* 3), UK, RBG Kew, living collection, *Chase 14463* (K), **MN916056**, **MN904424**, **MN915555**, **MN916265**, **MN915787**; *P. sepialis* Müll.Arg., Kenya, *Luke 7112* (K), AY936732, –, –, AY936633, –, *P. serpentinus* S.Moore, New Caledonia, *Mackee 20770* (L), **MN916057**, –, **MN915556**, –, **MN915788**; *P. sikkimensis* Müll.Arg., Myanmar, *Fujikawa & al. 053175* (L), **MN916058**, **MN904425**, **MN915557**, **MN916296**, **MN915789**; *P. sootepensis* Craib (*Phyllanthus sootepensis* 1), Myanmar, *Makino botanical garden expedition(2015) 103251* (MBK), **MN916059**, **MN904426**, **MN915558**, **MN916297**, **MN915790**; *P. sootepensis* Craib (*Phyllanthus sootepensis* 2), Myanmar, *Makino botanical garden expedition(2015) 103753* (MBK), **MN916060**, **MN904427**, **MN915559**, **MN916266**, **MN915791**; *P. cf. sootepensis* Craib, China, Yunnan, Xishuangbanna Tropical Botanical Garden, *Bouman & Yong RWB059* (HITBC), **MN915890**, **MN904428**, **MN915378**, **MN916267**, **MN915643**; *P. spruceanus* Müll.Arg., Guyana, *Maas & Maas 474* (U), **MN916061**, **MN904429**, **MN915560**, **MN916353**, **MN915792**; *P. stipulatus* (Raf.) G.L.Webster (*Phyllanthus stipulatus* 1), Guyana, *Jansen-Jacobs 2813* (U), –, **MN904430**, **MN915561**, **MN916268**, **MN915793**; *P. stipulatus* (Raf.) G.L.Webster (*Phyllanthus stipulatus* 2), Suriname, *Gieteling 114* (WAG), **MN916062**, **MN904431**, **MN915562**, **MN916269**, **MN915794**; *P. subcrenulatus* F.Muell., Australia, *Streimann s.n.* (L), **MN916063**, **MN904432**, –, **MN916270**, **MN915795**; *P. symphoricarpoides* Kunth, Colombia, *Cuatrecasas 18421* (U), **MN916064**, **MN904307**, **MN915563**, **MN916321**, **MN915796**; *P. tenellus* Roxb. (*Phyllanthus tenellus* 1), Australia, *Bruhl 2633* (L), **MN916065**, **MN904433**, **MN915564**, **MN916354**, **MN915797**; *P. tenellus* Roxb. (*Phyllanthus tenellus* 2), Netherlands, cultivated Hortus botanicus Leiden, origin Costa Rica, *Bouman RWB019* (L), **MN916066**, **MN904434**, **MN915565**, **MN916355**, **MN915798**; *P. tenellus* Roxb. (*Phyllanthus tenellus* 3), Paramaribo cultuurtuin, *Groenendijk 15* (WAG), **MN916067**, **MN904308**, **MN915566**, **MN916357**, **MN915799**; *P. tenuirhachis* J.J.Sm., Indonesia, Java, Bogor botanical garden, *Yu & Tutie 165* (L), **MN916068**, **MN904435**, **MN915567**, **MN916271**, **MN915800**; *P. trachygyna* Benth., Australia, *Egan 2886* (NE), **MN916069**, **MN904436**, **MN915568**, **MN916294**, **MN915801**; *P. tuerckheimii* G.L.Webster, Guatemala, *Mendez 8022* (DAV), **MN916070**, –, –, **MN916272**, –, *P. unifoliatus* M.Schmid, New Caledonia, *Veillon 7986* (L), AY936734, –, –, AY936635, –, *P. urinaria* L. (*Phyllanthus urinaria* 1), Philippines, *Majaduacon 5750* (L), **MN916071**, **MN904437**, **MN915569**, **MN916273**, **MN915802**; *P. urinaria* L. (*Phyllanthus urinaria* 2), Netherlands, cultivated Hortus botanicus Leiden, origin Costa Rica, *Bouman RWB018* (L), **MN916072**, **MN904438**, **MN915570**, **MN916274**, **MN915803**; *P. ussuriensis* Rupr. & Maxim., Japan, *Kawakita 124* (KYO), –, FJ235366, –, FJ235274, –, *P. vacciniifolius* (Müll.Arg.) Müll.Arg., Venezuela, *Hokche & al. 854* (U), **MN916073**, **MN904439**, **MN915571**, **MN916275**, **MN915804**; *P. vakinankaratrae* Leandri, Madagascar, *Ralimanana & al. 435* (K), AY936737, –, –, AY936638, –, *P. aff. vakinankaratrae* Leandri, Madagascar, *Ravelonarivo 4264* (MO), **MN915846**, –, **MN915330**, **MN916281**, –, *P. virgatus* G.Forst. (*Phyllanthus virgatus*Asia 1), Hong Kong, *Bouman RWB069* (L), **MN916074**, **MN904440**, **MN915572**, **MN916276**, **MN915805**; *P. virgatus* G.Forst. (*Phyllanthus virgatus*Asia 2), Hong Kong, *Bouman RWB070* (L), **MN916075**, **MN904441**, **MN915573**, **MN916277**, **MN915806**; *P. virgatus* G.Forst. (*Phyllanthus virgatus*Aus), Australia, *Wrigley & Telford 46642* (K), AY936738, **MN904442**, **MN915574**, AY936639, **MN915807**; *P. vulcani* Guillaumin, New Caledonia, *Kawakita 274* (KYO), –, FJ235354, –, FJ235262, –, “*P. wakensis*” msc. name, sp. nov., Gabon, *Wieringa 5107* (WAG), –, **MN904443**, **MN915575**, –, **MN915808**; *P. warnockii* G.L.Webster, USA, Texas, *Worthington 18323* (L), AY936743, AY830380, –, AY830280, –, *P. watsonii* Airy Shaw, Malaysia, Peninsular part, *Yu 225* (L), **MN916076**, **MN904444**, **MN915576**, **MN916278**, **MN915809**; *P. webwitschianus* Müll.Arg., Tanzania, *Bidgoet & al. 1882* (K), AY936739, –, –, AY936640, –, *P. wheeleri* G.L.Webster, Sri Lanka, *Kathriarachchi & al. 33* (K), AY936740, **MN904445**, **MN915577**, AY936641, **MN915810**; *Plagiocladus diandrus* (Pax) Jean F.Brunel, Gabon, *Wieringa 2903* (WAG), –, –, –, AY936592, –, *P. diandrus* (Pax) Jean F.Brunel, Gabon, *de Wilde & de Wilde 11641* (WAG), AY936687, –, –, –, *Synostemon albiflorus* (F.Muell. ex Müll.Arg.) Airy Shaw (*Synostemon albiflorus* 1), Australia, *Forster 32329* (NE), **MN916077**, **MN904446**, **MN915578**, **MN916279**, **MN915811**; *S. albiflorus* (F.Muell. ex Müll.Arg.) Airy Shaw (*Synostemon albiflorus* 2), Australia, *Forster 34400* (NE), **MN916078**, **MN904447**, **MN915579**, **MN916323**, **MN915812**; *S. bacciformis* (L.) G.L.Webster, Australia, Northern Territory, *Cowie 13418* (L), GQ503382, –, GQ503502, –, –, *S. bacciformis* (L.) G.L.Webster, Thailand, Ubun Ratchatani, *Kerr 8350* (L), –, –, –, EU643753, –, *S. bacciformis* (L.) G.L.Webster, Thailand, Bangkok, *Pruesapan 2009-4* (L), –, GQ503440, –, –, –, *S. hirtellus* F.Muell., Australia, Queensland, *Bean 15558* (BRI), EU623573, GQ503447, GQ503508, EU643763, GQ503574; *S. kakadu* I.Telford & J.J.Bruhl, Australia, *Bruhl 1270* (NE), GQ503395, GQ503451, GQ503510, –, GQ503578; *S. sphenophyllus* Airy Shaw, Australia, Queensland, *Gray 08597* (BRI), GQ503402, GQ503465, –, EU643780, GQ503597; *S. spinosus* I.Telford & J.J.Bruhl, Australia, *Bean 20738* (NE), GQ503403, GQ503466, GQ503524, –, GQ503598; *S. trachyspermus* (F.Muell.) I.Telford & Pruesapan, Australia, *Bell 547* (NE), GQ503407, GQ503470, GQ503528, EU643784, GQ503602.