



A detailed investigation of the *Pterocarpus* clade (Leguminosae: Dalbergieae): *Etaballia* with radially symmetrical flowers is nested within the papilionoid-flowered *Pterocarpus*

Bente B. Klitgård^{a,*}, Félix Forest^b, Thomas J. Booth^b, C. Haris Saslis-Lagoudakis^{b,c}

^a Herbarium, Library, Art and Archives, Royal Botanic Gardens, Kew, Richmond, TW93AE, United Kingdom

^b Jodrell Laboratory, Royal Botanic Gardens, Kew, Richmond, TW93DS, United Kingdom

^c Macroevolution and Macroecology Group, Research School of Biology, Australian National University, Canberra, 0200, Australia

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ABSTRACT

The pantropical genus *Pterocarpus* (Leguminosae: Dalbergieae) with papilionoid flowers, and allied genera in the *Pterocarpus* clade were sampled for the five molecular markers ITS2, *trnL-F*, *ndhF-rpL32*, *matK*, and *rbcl*, as part of our ongoing systematic studies in the clade. For wider analyses of the *Pterocarpus* clade the remaining 14 members of this clade were also sampled for *matK*. Phylogenetic analyses were performed under the maximum likelihood criterion (ML) and Bayesian criteria. In the five-marker analysis of the core *Pterocarpus* clade (including 106 accessions) two robustly supported clades were resolved. The first clade includes *Centrolobium*, *Etaballia*, *Inocarpus*, *Maraniona*, *Paramachaerium*, *Pterocarpus*, *Ramorinoa*, and *Tipuana*. The second includes all species of *Pterocarpus* (except *P. acapulcensis*), *Etaballia* with radially symmetric flowers, and *Paramachaerium*. *Paramachaerium* is placed as sister to the several *Pterocarpus* species from South America, while *Etaballia* is resolved within the clade containing the African and Asian species of *Pterocarpus*. The wider sampled *matK* data set includes 199 accessions. *Discolobium* and *Riedeliella* are recovered as sister to the remaining *Pterocarpus* clade. *Platymiscium* is strongly supported as sister to the rest of the members of the clade, and *Pterocarpus acapulcensis* is also here resolved in a separate lineage from the remaining *Pterocarpus* accessions. We used the phylogenies to investigate patterns of floral evolvability in the *Pterocarpus* clade, which include four genera with actinomorphic flowers (*Acosmium* s.s., *Etaballia*, *Inocarpus* and *Riedeliella*). Our results reinforce the hypothesis that flower evolvability is high in early-branching legume lineages, and that actinomorphy has evolved independently four times in the *Pterocarpus* clade. In light of our results, the taxonomic status of the monospecific genus *Etaballia dubia* Benth. was revisited, and the species is synonymized as belonging to *Pterocarpus*, under the name *Pterocarpus dubius* Spreng., published in 1827, but hiding in synonymy for nearly two centuries.

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1. Introduction

The decrease in costs and increase in methodological efficiency in molecular techniques in the past decade have resulted in an explosion in molecular phylogenetic research in general, including studies focused on the legume family. Among flowering plant families, Leguminosae encompasses one of the widest ranges in geographic distribution, habitat preference, habit type, leaf, flower and fruit morphology, thus the family serves as an excellent

model for evolutionary studies [e.g. Dalbergioids (Lavin et al., 2001), *Aeschynomene* (Ribeiro et al., 2007), *Acosmium* (Cardoso et al., 2012a), *Lonchocarpus* (da Silva et al., 2012), *Steinbachiella* (Lewis et al., 2012)]. Phylogenetic studies within the Leguminosae have not only contributed to a much better understanding of relationships among legume genera, but they have also sometimes highlighted cases where a recircumscription of the generic and/or tribal concepts was necessary [e.g. Dalbergioids (Lavin et al., 2001), *Aeschynomene* (Ribeiro et al., 2007), *Acosmium* (Cardoso et al., 2012a), *Lonchocarpus* (da Silva et al., 2012), *Steinbachiella* (Lewis et al., 2012)]. Similarly, these studies have often required a rethink of widely accepted views about habitat preference and morphological evolvability (e.g. Cardoso et al., 2012a,b,c; Lavin et al., 2001; McMahon and Hufford, 2004; Pennington et al., 2000;

* Corresponding author. Tel.: + 44(0)2083325257.

E-mail address: B.Klitgaard@kew.org (B.B. Klitgård).

Saslis-Lagoudakis et al., 2008, 2011). Pennington et al. (2000) first drew attention to 23 papilionoid genera with radially symmetric flowers, representing nine reversals from zygomorphy to actinomorphy in their phylogenetic analyses of early-diverging papilionoids. This number increased to twelve with the additional three discovered subsequently by Lavin et al. (2001) within the relatively early-branching Dalbergioid clade. These taxa were thought to be “primitive” by authors of earlier legume classifications (e.g. Polhill, 1981, 1994; Yakovlev, 1975), but showed to be scattered among early-branching papilionoid lineages including mainly genera with “less primitive” papilionoid flowers (Lavin et al., 2001; Pennington et al., 2000, 2001). Those authors also noted that despite apparent multiple origins of actinomorphic flowers in these lineages, the non-papilionoid flower morphologies do not occur in more derived lineages of the Papilionoideae. Explaining this phylogenetic pattern in the distribution of actinomorphic flowers, Pennington and co-authors (2000) suggested that in groups where papilionoid flowers have become more canalized (e.g. a zygomorphic corolla with fusion of petals and stamens, often seen in the more derived legume taxa such as *Medicago* spp., *Pisum* spp., and *Swainsona* spp.), it is more difficult to revert to a non-papilionoid flower morphology. Furthermore, zygomorphy might be conserved in late-branching lineages, as it has been a key innovation associated with high diversification rates in various lineages (e.g. Arroyo, 1981; Citerne et al., 2010; Endress, 1999, 2001; Sargent, 2004). Recently, this evolutionary pattern of repeated reversal from zygo- to actinomorphy has proven even more widespread among the early-branching papilionoids (Boatwright et al., 2008; Cardoso et al., 2012a, 2012b, 2013).

Since Bronn ex De Candolle (1825) coined the tribe name Dalbergieae it has taken several shapes and guises until Lavin et al.'s (2001) groundbreaking paper united 44 genera, previously thought to belong to five different tribes, in one monophyletic group. They called this expanded group the “Dalbergioid clade”, and subdivided it into three well-supported subclades: the Adesmia, Pterocarpus, and Dalbergia clades. This paper also formed the basis for the circumscription of the Dalbergieae (Klitgård and Lavin, 2005) in Legumes of the World (Lewis et al., 2005). Since 2005, three new genera have been added to the group, increasing the number of genera assigned to the Dalbergieae to a current total of 47 members. *Steinbachiella* Harms was reinstated and placed in the Dalbergia clade (Lewis et al., 2012), while the Pterocarpus clade acquired two new additions: the monospecific *Maraniona lavinii* C.E. Hughes, G.P. Lewis, Daza & Reynel., a new discovery from the interandean valleys of Peru (Hughes et al., 2004), and *Acosmium* Schott s.s. (three spp.) joining the Pterocarpus clade segregated from the other members of *Acosmium* which are placed in the Bowdichia clade of the Genistoids under the new generic names *Leptolobium* and *Guianodendron* (Cardoso et al., 2012a). In the Pterocarpus clade a number of genera have been the focus of recent species level phylogenetic studies: *Platymiscium* (Klitgård, 2005; Saslis-Lagoudakis et al., 2008); *Centrolobium* (Pirie et al., 2009); *Pterocarpus* (Saslis-Lagoudakis et al., 2011); and *Acosmium* (Cardoso et al., 2012a), which have improved the resolution of the core Pterocarpus clade. Nevertheless, infrageneric relationships within the wider Pterocarpus clade are still not well-resolved.

Etaballia Benth. is a monospecific legume tree genus, restricted to periodically inundated humid tropical rainforests of Brazil, the Guianas, and Venezuela, and has recently also been recorded from Pando in the Bolivian Amazon (voucher Klitgård et al. 1394; Figs. 1–2). Largely due to its unusual morphology with unifoliolate leaves, radially symmetric flowers and samaroid fruits, *Etaballia* has had a turbulent taxonomic history, since Bentham (1840a) first published *Etaballia guianensis* Benth. [= *E. dubia* (Kunth) Rudd] as a member of the Bauhinieae, “allied to [the genus



Fig. 1. *Pterocarpus dubius* Spreng. (= *Etaballia dubia* (Kunth) Rudd [as *Etaballia guianensis* Benth.]), plates first published in Hooker's *Icones* (1842).

Schnella...”. In *Genera Plantarum* (Bentham, 1865), *Etaballia* was placed in synonymy under *Inocarpus* Forst., a Southeast Asian monospecific genus also with unifoliolate leaves and radially symmetric flowers, but with drupaceous fruits, and placed as “genus anomalum” in tribe Dalbergieae. Subsequently, most authors have given *Etaballia* independent generic status in the tribe Dalbergieae (Dalla Torre and Harms, 1900–1907; Ducke, 1949; Funch and Santos, 1997; Klitgård and Lavin, 2005; Lavin et al., 2001; Polhill, 1981), while some have placed it elsewhere in the legume family: intermediate between subfamilies Mimosoideae and Papilionoideae (Kuhlmann, 1949); in a “primitive position” in tribe Sophoreae or Cadieae (Hutchinson, 1964 – in synonymy under *Inocarpus*; Polhill, 1994; Yakovlev, 1975); and between subfamilies Caesalpinioideae and Papilionoideae (Barroso et al., 1984). Some authors have commented on the resemblance of the fruits of *Etaballia dubia* to those of the two amphiatlantic species, *Pterocarpus officinalis* Jacq. [e.g. Kunth, 1824 – when publishing *Hecastaphyllum dubia* Kunth (= *E. dubia*); Rudd, 1970], and *P. santalinoides* DC. (Rojo, 1972), which share a samaroid (sometimes appearing drupaceous) fruit with a narrow wing encircling 1/3 to 2/3 of the circumference of the seed chamber (Fig. 2).

Another member of the Pterocarpus clade which has had a complex taxonomic history is *Paramachaerium* Ducke, currently consisting of five species distributed in the Amazonian regions of the Guianas, Venezuela, Brazil, Peru, and Panama (Klitgård and Lavin, 2005; Rudd, 1981). In 1925 Ducke segregated *Machaerium schomburgkii* Benth. (Bentham, 1840b) [synonymous with *Pterocarpus kuhlmannii* Ducke (Ducke, 1922)] from *Machaerium*, published the genus *Paramachaerium* and based it on the type species *Paramachaerium schomburgkii* (Benth.) Ducke. In 1935 he added *Paramachaerium ormosioides* Ducke [= *Pterocarpus ormosioides* Ducke (Ducke, 1922)]. To-date three additional

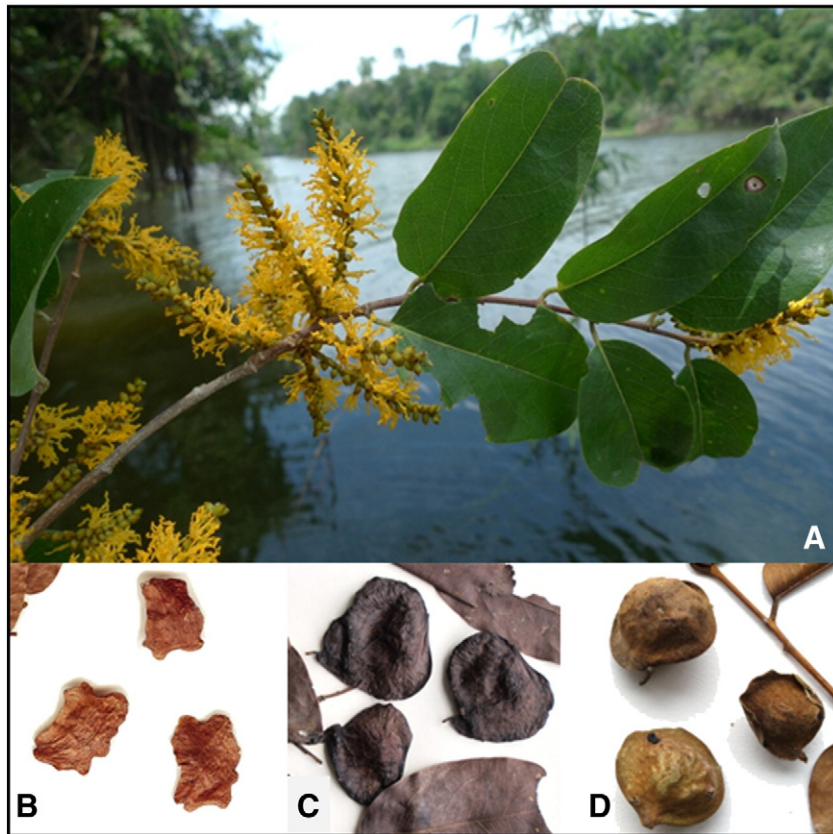


Fig. 2. *Pterocarpus dubius* Spreng. A. Flowering branch of [B.B. Klitgård 1394 et al. (USZ)], photograph © B. Klitgård, RBG, Kew. B. Fruits of *Pterocarpus dubius* [L. William 1308 (F)]. C. Fruits of *Pterocarpus officinalis* [B.V. Rabelo et al. 2071 (K)]. D. Fruits of *Pterocarpus santalinoides* [D. Zappi et al. 1100 (K)].

species have been added: *Paramachaerium gruberi* Brizicky (Brizicky, 1960), *P. krukovii* Rudd and *P. schunkei* Rudd (Rudd, 1981). It is therefore evident that there has been a close connection between *Paramachaerium* and *Pterocarpus* already from its inception. Although Lavin et al. (2001) resolved *Paramachaerium* as closely related to *Pterocarpus*, its exact systematic position has remained unclear.

Here we present an updated phylogeny of the *Pterocarpus* clade with higher resolution for some critical nodes, and a taxonomic evaluation of the monospecific genus *Etaballia*. The present study investigates intrageneric relationships and patterns of floral evolvability in the *Pterocarpus* clade of the tribe Dalbergieae, which currently includes four genera with actinomorphic flowers (*Acosmium* s.s., *Etaballia*, *Inocarpus* and *Riedelliella*). Our results further reinforce the hypothesis that flower evolvability is high in early-branching legume lineages, and that actinomorphy has evolved independently four times in the *Pterocarpus* clade.

2. Material and methods

2.1. Taxon sampling

We included all *Pterocarpus* species as in our previous phylogenetic study (Saslis-Lagoudakis et al., 2011), as well as eight more accessions of American *Pterocarpus* species belonging to the *P. rohrii* complex, currently under study by Mansfield-Williams & Hawkins at Reading University, and Klitgård & Saslis-Lagoudakis at RBG, Kew. For *Etaballia* and *Paramachaerium*, we included the

accessions available from a previous study (Lavin et al., 2001) and extended the sampling by including three additional samples from both genera. Outgroup selection was based on previous

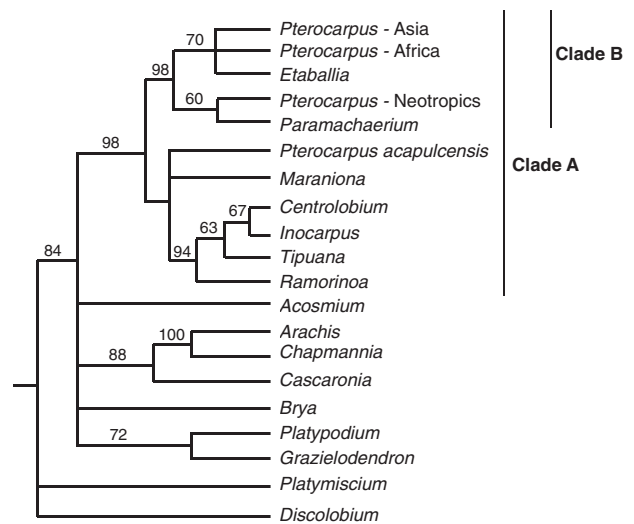


Fig. 3. Synopsis of the phylogenetic tree recovered from the maximum likelihood (ML) analysis, using all DNA markers (nrITS2, *rbcl*, *matK*, *trnL* and *ndhF-rpl32*). Numbers above branches show bootstrap percentages (BP). Branches with BP < 50 were collapsed.

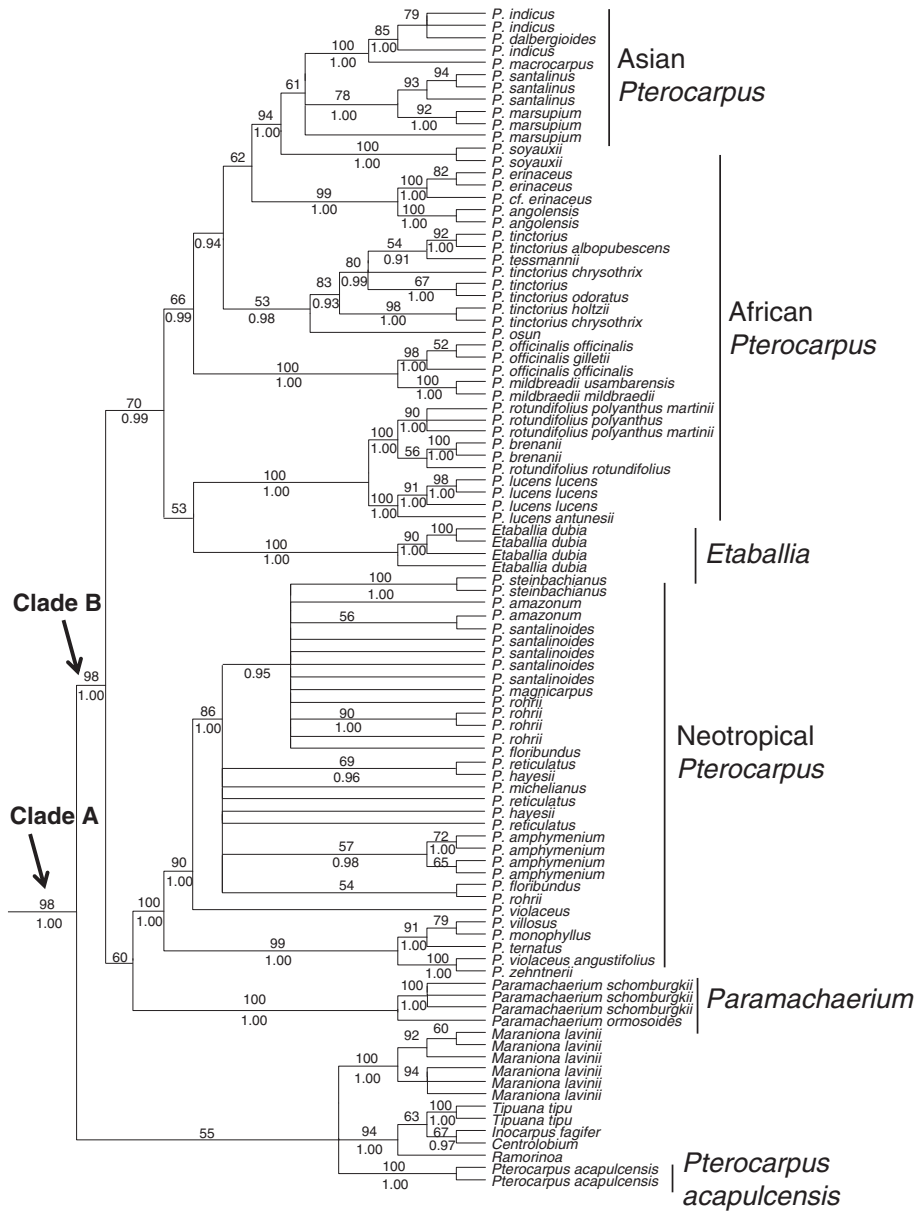


Fig. 4. Phylogenetic tree recovered from the maximum likelihood (ML) analysis, using all DNA markers (nrITS2, *rbcL*, *matK*, *trnL* and *ndhF-rpl32*). Numbers above branches show bootstrap percentages (BP) and those below branches show posterior probabilities (PP) from a Bayesian analysis of the same dataset. Only values above 50 (BP) and 0.90 (PP) are shown. Branches with both BP < 50 and PP < 0.90 were collapsed.

phylogenetic studies of the *Pterocarpus* clade (Hughes et al., 2004; Lavin et al., 2001; Pirie et al., 2009; Saslis-Lagoudakis et al., 2008, 2011), ensuring that exemplar sequences from all major lineages within the clade were represented. *Acosmium*, recently identified as a member of the clade (Cardoso et al., 2012a), was also included. Our sampling includes five additional accessions for *Maraniona* and one for *Tipuana*. *Discolobium* was used as outgroup taxon, representing the *Discolobium*–*Riedeliella* clade. Voucher information is shown in Appendix 1. Additionally, we collated all *matK* sequences that are publicly available in GenBank for the *Pterocarpus* clade from previous studies, and added our newly generated *matK* sequences to that dataset in order to produce a phylogenetic tree with wider and denser sampling across the clade. Exemplar species from the *Dalbergia* and *Adesmia* clades were also included, and

Amicia and *Adesmia* were used as outgroup taxa. Taxon sampling for this analysis is shown in Appendix 2.

2.2. Molecular methods and phylogenetic analyses

Total DNA was extracted from 0.2 to 0.3 g of leaf and/or flower tissue from herbarium or silica gel dried material using a modification of the Doyle and Doyle method (Csiba and Powell, 2006; Doyle and Doyle, 1987). DNA was purified using QIAquick PCR columns (Qiagen, Crawley, West Sussex, UK) following the manufacturer's protocol.

Five DNA markers were amplified, one nuclear (internal transcribed spacer 2, ITS2) and four plastid (*trnL*-*F* intergenic spacer, the barcoding fragment of *matK*, the first half of *rbcL*, and the

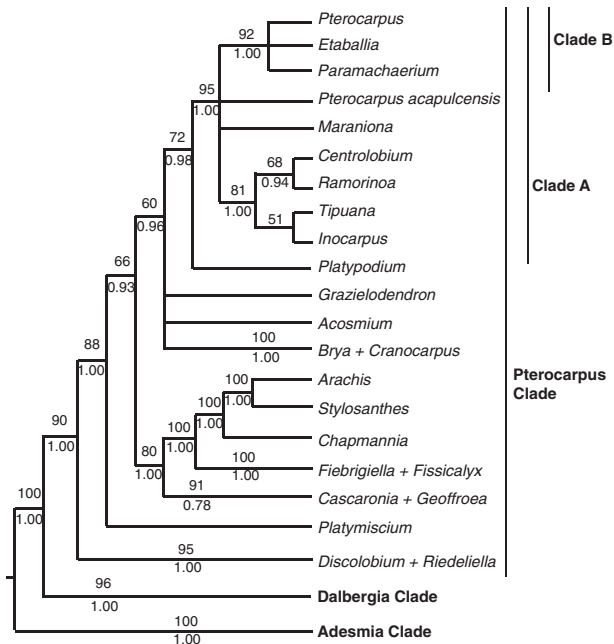


Fig. 5. Synopsis of the phylogenetic tree recovered from the maximum likelihood analysis of 199 *matK* sequences from the Adesmia, Dalbergia and Pterocarpus clades. Numbers above branches show bootstrap percentages (BP) and those below branches show posterior probabilities (PP) from a Bayesian analysis of the same dataset. Only values above 50 (BP) and 0.90 (PP) are shown. Branches with both BP < 50 and PP < 0.90 were collapsed.

ndhF-rpL32 intergenic spacer). Primers and protocols used were the same as in Saslis-Lagoudakis et al. (2011). All amplifications were performed in 30- μ L volume reactions and PCR products were purified using the QIAquick PCR columns (Qiagen, Crawley, West Sussex, UK) following the manufacturer's instructions. DNA sequencing was performed with an Applied Biosystems 3730 DNA automated sequencer (ABI, Warrington, Cheshire, UK) using Big Dye terminator v3.1 chemistry, following the manufacturer's protocols (ABI). Complementary strands were assembled and edited with Sequencher version 4.5 (GeneCodes, Ann Arbor, Michigan, USA). Alignments for *rbcL* and *matK* sequences were performed manually in BioEdit v. 7.0. ITS2, and the *trnL-F* and *ndhF-rpL32* intergenic spacer sequences were aligned using CLUSTAL W (Thompson et al., 1994) in BioEdit v. 7.0, and adjustments were made manually.

Phylogenetic analyses were performed under the maximum likelihood (ML) criterion as implemented in the programme RAxML v7.2.8 (Stamatis et al., 2008) and using the partitioned model option. Bayesian analyses were run using MrBayes v3.2.1 (Ronquist and Huelsenbeck, 2003) using two simultaneous runs of four MCMC chains for 10,000,000 generations, sampling every 1000th generation. The first 20% of the trees were removed (burn-in) and parameter convergence and effective sample size were examined using Tracer v 1.5 (Rambaut and Drummond, 2007). For all analyses, the GTR + Γ model was used, as it was found to be the best fitted model across all partitions in MrModeltest v2.3 (Nylander, 2004).

2.3. Taxonomic methodology

For the taxonomic analysis of the morphological and anatomical features of *Etaballia dubia* and *Pterocarpus*, available literature

(Bentham, 1840a; Cuello, 1999; de Lima, 1990; Funch and Santos, 1997; Kirkbride et al., 2003; Lavin et al., 2001; Kuhlmann, 1949; Rojo, 1972; Rudd, 1970) and herbarium material on loan to RBG, Kew from the herbaria CAL, F, MEXU, MO and NY were studied.

3. Results

3.1. Five-marker phylogenetic analysis – core Pterocarpus clade

This matrix includes 106 accessions and has an aligned length of 3501 bp. A synopsis of the ML analysis is shown in Fig. 3. Two robustly supported clades were recovered of which the detailed relationships are shown in Fig. 4. The first clade includes *Centrolobium*, *Etaballia*, *Inocarpus*, *Maraniona*, *Paramachaerium*, *Pterocarpus*, *Ramorinoa*, and *Tipuana* and is strongly supported with a bootstrap percentage (BP) of 98 and a posterior probability (PP) of 1.00 (Clade A; Figs. 3–4). The second includes all species of *Pterocarpus*, with the exception of *P. acapulcensis*, along with all *Etaballia* and *Paramachaerium* accessions (BP 98, PP 1.00; Clade B, Figs. 3–4). *Paramachaerium* is placed as sister to the several *Pterocarpus* species from South America (BP 60, PP < 0.90), while *Etaballia* is resolved within the clade containing the African and Asian species of *Pterocarpus* (BP 70, PP 0.99).

3.2. Broader-sampling for the *matK* analysis – wider Pterocarpus clade

The *matK* data set includes 199 accessions and has an aligned length of 2874 bp. A summary of the topology of the phylogenetic tree from this analysis is shown in Fig. 5, and the detailed topology is presented in Figs. 6–7. *Discolobium* and *Riedeliella* are recovered as sister to the rest of the Pterocarpus clade (BP 90, 95 and 88 and PP 1.00, 1.00 and 1.00, for the three nodes respectively), and *Platymiscium* is sister to the remaining members of the clade (BP 88, 100 and 66 and PP 1.00, 1.00 and 0.93, for the three nodes respectively), as shown in Figs. 5–7. This analysis also recovered Clades A and B from the five-marker analysis with strong support (BP 95, PP 1.00 and BP 92, PP 1.00, respectively; Figs. 5–7). Within clade A, *Pterocarpus acapulcensis* is also here resolved as a separate lineage from the remaining *Pterocarpus* accessions (Figs. 3–7), as was also found in our previous analyses (Saslis-Lagoudakis et al., 2011).

4. Discussion

4.1. Comparison with previous studies

Our results are largely in agreement with previous phylogenetic studies, in particular Clade A (Figs. 3–7) (Cardoso et al., 2012a,b,c; Hughes et al., 2004; Lavin et al., 2001, 2004; Saslis-Lagoudakis et al., 2008). Within this clade, a strongly supported relationship among *Centrolobium*, *Inocarpus*, *Ramorinoa* and *Tipuana* is recovered, as previously found in other studies (Cardoso et al., 2012a,b,c; Pirie et al., 2009; Saslis-Lagoudakis et al., 2011). Relationships within that group remain unresolved, however, as different analyses support different topologies, none of which are extremely well-supported (Figs. 3–7). *Maraniona* is affiliated to this group (Figs. 3–7), but our results do not support its previously suggested putative sister relationship with *Tipuana* (Hughes et al., 2004). Previous studies have variously proposed that *Platymiscium* is sister to the *Brya-Cranocarpus* pairing (Lavin et al., 2001). Here, similar to Cardoso et al. (2012a, 201c), we resolve the genus as the second earliest branch of the Pterocarpus clade (BP 88%, PP 1.00). Within clade A, *Pterocarpus acapulcensis* is resolved in a separate lineage from the remaining *Pterocarpus* accessions (Figs. 3–7), as was also

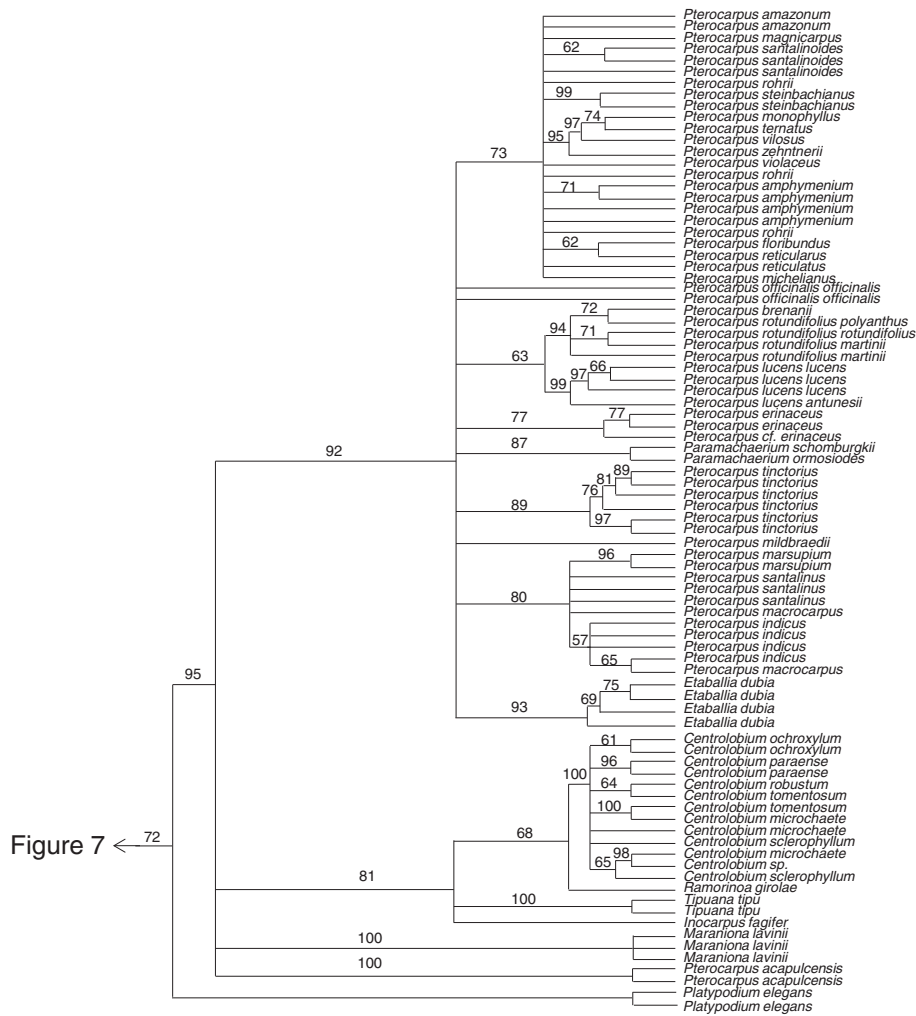


Fig. 6. Part of the phylogenetic tree recovered from the maximum likelihood analysis of 199 *matK* sequences from the Adesmia, Dalbergia and Pterocarpus clades, focusing on the “core” Pterocarpus clade. Numbers above branches show bootstrap percentages (BP). Only values above 50 (BP) are shown.

found in our previous analyses (Saslis-Lagoudakis et al., 2011). All these taxa are resolved together in the five-marker analysis (Figs. 3, 4), a result which is not contradicted by the larger *matK* analysis (Figs. 5–7). This clade is, however, weakly supported and requires further investigation (currently being undertaken at RBG, Kew; Saslis-Lagoudakis, in prep.). *Pterocarpus acapulcensis* was included in an analysis based on the nuclear ITS marker in Lavin et al. (2001). In that analysis, this taxon was strongly placed as sister to *P. macrocarpus*, the only other *Pterocarpus* species included in that analysis. However, we note that *Maraniona*, *Inocarpus*, and *Centrolobium*, to which *P. acapulcensis* shows weak affinities in our analyses, were not included in that analysis, while the other taxa from that subclade (*Tipuana* and *Ramorinoa*) are resolved in basal polytomies in the same tree presented in Lavin et al. (2001). Also absent from that analysis are the majority of *Pterocarpus* species and *Etaballia*, the inclusion of which certainly influences the topology of our trees. Therefore, we believe that the results presented in the present study are not directly comparable to the ITS phylogenetic tree in Lavin et al. (2001). Even though superficially *Pterocarpus acapulcensis* seems well-placed in *Pterocarpus*, there is morphological evidence supporting a segregation of this taxon as e.g. the shape and size of the leaflets, the flower morphology, and even the fruit morphology differ from a

“typical” *Pterocarpus* groundplan, as also pointed out by Rojo (1972) in his monograph of *Pterocarpus*.

4.2. Systematic position of *Etaballia*, *Paramachaerium*, and *Pterocarpus acapulcensis*

Our results, based on a wide sampling within genus *Pterocarpus* and the Pterocarpus clade, and including multiple accessions of *Etaballia* and *Paramachaerium*, strongly support that these two genera are nested within *Pterocarpus* (Figs. 3–7). This was recovered in both analyses. As shown in Fig. 4, *Etaballia* is resolved within a clade comprising the African and Asian species of *Pterocarpus* (BP 70; PP 0.99), and *Paramachaerium* is sister to the clade that includes the neotropical species of *Pterocarpus*, although with lower support (BP 60; PP < 0.90). The close relationship among these genera had been suggested originally in the analysis of Lavin et al. (2001), where a *matK* sequence dataset resolved *Etaballia* and *Paramachaerium* with the two accessions of *Pterocarpus* included (BP 98), and a combined analysis of that dataset with non-molecular data also supported this relationship (BP 81) in the same study. Furthermore, in the study of Hughes et al. (2004), who used the *matK* dataset of Lavin et al. (2001) to position the newly described genus *Maraniona* within the

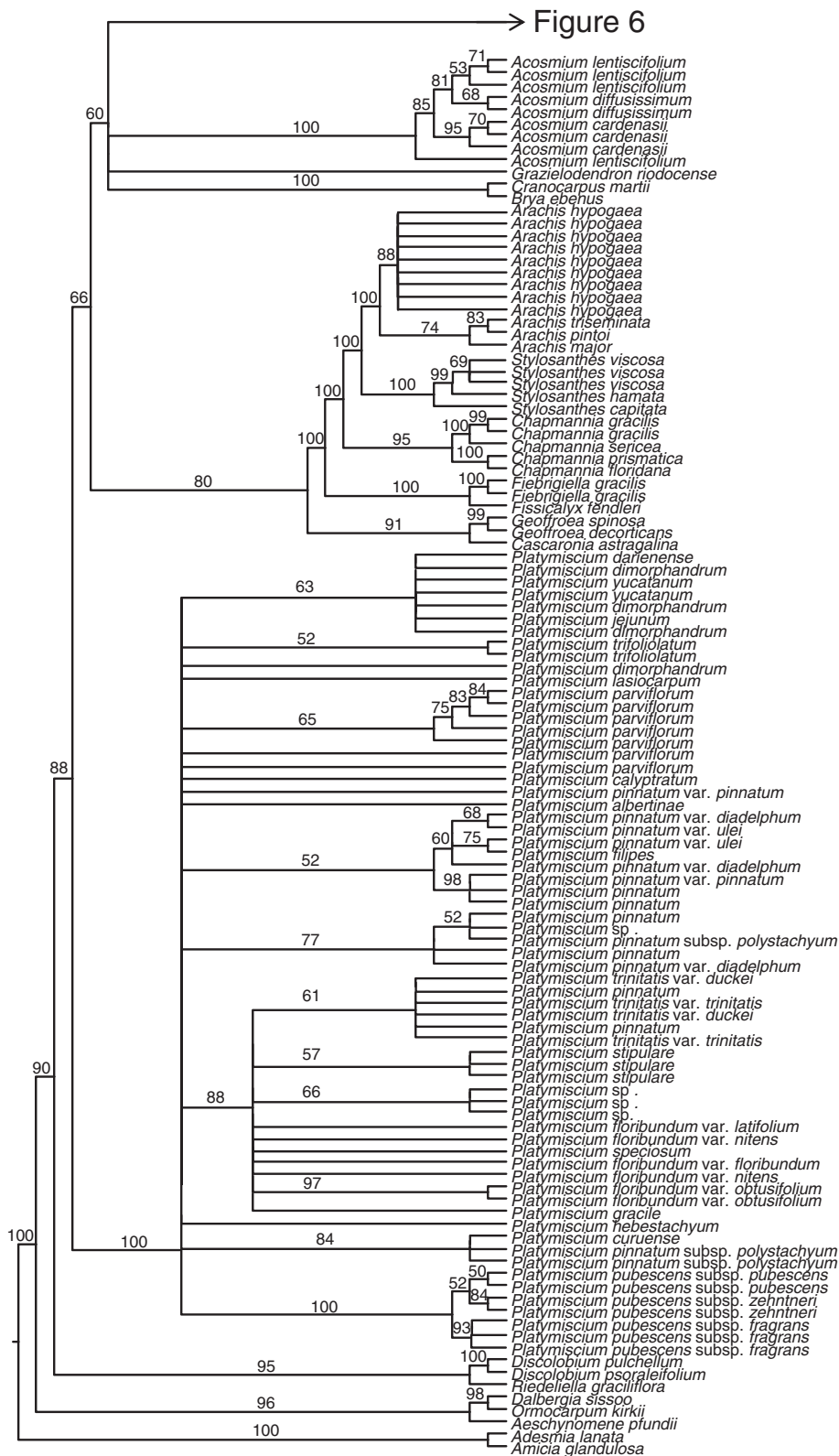


Fig. 7. Part of the phylogenetic tree recovered from the ML analysis of 199 *matK* sequences from the Adesmia, Dalbergia and Pterocarpus clades. Numbers above branches show bootstrap percentages (BP). Only values above 50 (BP) are shown.

Pterocarpus clade, the same result was found (BP 73). A later study found a strong relationship between *Etaballia* and *Pterocarpus* (BP 83, PP 0.91; Saslis-Lagoudakis et al., 2008),

although only one accession of each genus was included in that analysis. Finally, Pirie et al. (2009) recovered a sister relationship between *Paramachaerium* and *Pterocarpus* (BP 67, PP 1.00).

However, that study also used only one and two accessions of these genera, respectively; *Etaballia* was not included in this study.

Paramachaerium is found in the Amazonian regions of the Guianas, Venezuela, Brazil, Peru, and Panama (Klitgård and Lavin, 2005; Rudd, 1981), and hence, its placement with the neotropical species of *Pterocarpus* agrees with biogeography. However, since we only sampled two of the five accepted *Paramachaerium* species for this study, further sequencing leading to a more complete *Paramachaerium* sampling is under way to elucidate the correct placement and taxonomic status of this genus, and the constituent species (Saslis-Lagoudakis et al., in prep.). The placement of the monospecific *Etaballia*, also found in the Amazonian regions of the Guianas, Brazil, and Venezuela (Klitgård and Lavin, 2005), and recently (in 2010) also recorded from Bolivia [Klitgård et al., voucher 1493 (USZ)] and resolved with the African and Asian *Pterocarpus* species, might seem more unexpected. The topology (Fig. 4) shows *Etaballia* as one of the basally branching lineages of the clade that also includes the African and Asian *Pterocarpus* species, and the amphiatlantic species *P. officinalis* with which the fruits of *E. dubia* (as *Hecastaphyllum dubium*) were compared in the past (Kunth, 1824; Rudd, 1970). The weak support (BP 53) for the exact placement of *Etaballia* within that clade indicates that the genus could be sister to the remaining species of that clade, in which case *Etaballia* most likely originated in the Neotropics, while *P. officinalis* and other species of *Pterocarpus* from this clade (or their ancestors) dispersed to Africa and Asia. Alternatively, *Etaballia* could represent a lineage that dispersed from Africa to the Neotropics. In either case, long distance dispersal has repeatedly taken place within the *Pterocarpus* clade. The whole clade evolved after the split of Gondwana (Lavin et al., 2000, 2004, 2005), and therefore its pantropical distribution, as well as the transoceanic disjunctions found in three genera in the clade (*Chapmannia*, *Pterocarpus* and *Stylosanthes*) must have resulted from long distance dispersal rather than vicariant biogeography. Therefore, the biogeographic disjunction seen between *Etaballia* and the rest of the clade in which it is nested is not a unique phenomenon in this group. Finally, *Etaballia* has similar fruit morphology with the amphiatlantic species *P. officinalis* and

P. santalinoides, which have clear potential for long distance dispersal, also suggesting that a scenario of long distance dispersal in the ancestor of *Etaballia* is realistic.

4.3. Evolution of radially symmetric flowers in the *Pterocarpus* clade

Our results show clearly that the putative sister relationship, suggested by previous researchers (Bentham, 1865; Hutchinson, 1964; Polhill, 1994; Yakovlev, 1975), between *Etaballia* and *Inocarpus* is not supported. The two genera were assumed to be related mainly based on similar actinomorphic flower types. The two other genera with actinomorphic flowers belonging to the *Pterocarpus* clade, *Riedeliella* and *Acosmium* s.s. [reduced to three species by Cardoso et al. (2012a)], are resolved as sister to the remainder of the *Pterocarpus* clade, and in a well-supported grade with clade A (the core *Pterocarpus* clade), *Platypodium*, *Grazielodendron*, *Brya*, and *Cranocarpus*, respectively (Figs. 3–7), respectively. These genera with actinomorphic flowers are thus scattered among lineages with well-developed papilionoid flowers suggesting that actinomorphic flower morphology has arisen independently four times in the *Pterocarpus* clade, as also suggested by Pennington et al., 2000 and Cardoso et al. (2012a).

The molecular bases of flower symmetry are being unravelled in core eudicots and available evidence underlines the repeated recruitment of CYC and DIVARICATA genes in association with frequent gene duplications and a better understanding of the role of the MADS-box genes in regulating floral symmetry (e.g. Citerne et al., 2000, 2003, 2006, 2010; Endress, 1999, 2001; Lou et al., 1996, 1999; Theissen, 2000, 2001, 2006; Zhang et al., 2010). In legumes, developmental genetic studies of flower symmetry have focused on the model organisms *Lotus japonicus* (Regel) K. Larsen (Feng et al., 2006) and *Pisum sativum* L. (Wang et al., 2008), with *Cadia purpurea* (Citerne et al., 2006) representing the only non-model example to-date. At this stage we can therefore but speculate that the underlying early developmental pattern will turn out to be unidirectional in the four genera discussed here, i.e. similar to that of most papilionoid legumes, including *Pterocarpus rotundifolius* (Sond.) Druce and three other dalbergioid taxa (Klitgård, 1999), and *Cadia purpurea*

Table 1

Comparison between *Etaballia* and *Pterocarpus*. References: Bentham (1840); Kuhlmann (1949); Rudd (1970); Rojo (1972); de Lima (1990); Funch and Santos (1997); Cuello (1999); Lavin et al. (2001); Kirkbride et al. (2003); Klitgård and Lavin (2005); Klitgård pers. obs.

Characteristics	<i>Etaballia</i>	<i>Pterocarpus</i>
Habitat	Varzea – seasonally inundated, lowland rainforest	Both in seasonally and humid, lowland habitats, from sea level to c. 1000 m altitude (<i>P. officinalis</i> and <i>P. santalinoides</i> along riverbanks in seasonally inundated, lowland rainforest)
Habit	4–36 m tall, evergreen trees	4–40 m tall trees, some spp. evergreen, some deciduous
Bark	Exuding red sap when cut	Exuding red sap when cut
Leaves	Alternate, unifoliolate, coriaceous	Alternate, usually imparipinnate, rarely unifoliolate (<i>P. monophyllus</i> Klitgård, L.P. Queiroz & G.P. Lewis; <i>P. lucens</i> Guill. & Perr., but not species-specifically so), coriaceous or chartaceous
Inflorescence	Racemose: catkin-like, simple or fasciculate spikes	Racemose: simple, fasciculate or paniculate
Flower bud	Erect, ovoid	Curved, appearing hunched
Calyx	Tubular, erect, with five triangular lobes	Tubular, hunched, with five triangular lobes.
Corolla	Five free, yellow, thread-like petals, staying crimped until maturity	Five free, yellow petals differentiated into standard, two wings and two keel petals, staying crimped until maturity
Stamens	10(11) monadelphously fused	10(11) mona- or diadelphously fused
Ovary	Sessile, 1–3 ovules	Stipitate or sessile, with 1–3 ovules
Fruits	Sessile, 1–2-seeded, samaroid (sometimes wingless) with a narrow wing encircling 1/3 to 2/3 of the circumference of the seed chamber	Sessile or stipitate, 1–3-seeded, samaroid (sometimes wingless, e.g. in the two amphiatlantic species <i>P. officinalis</i> and <i>P. santalinoides</i>), usually with a wide wing encircling the whole seed chamber
Seeds	Seed chamber chartaceous, glabrous	Seed chamber chartaceous to woody, glabrous to spiny
Seedlings	?	Germination cryptohypogaeal- or phaneroepigeal, eophylls unifoliolate ^a

^a Species from several dalbergioid genera have seedlings with unifoliolate first eophylls (de Lima, 1990).

with actinomorphic flowers (Tucker, 2002). However, a late stage switch from zygomorphy has been brought about by homeotic changes in the gene regulatory network (principally in genes members of the CYCLOIDEA and DICHOTOMA families, as shown by Citerne and co-workers (2006) to occur in *Cadia*), resulting in the flowers observed in all four actinomorphic taxa in the Pterocarpus clade. These may turn out to have originated as peloric forms of the zygomorphic flowers of their closest ancestors. A manuscript on floral ontogeny in *Etaballia dubia* is in preparation at RBG, Kew (Prenner, in prep.), which will shed light on the developmental floral pattern of actinomorphic flowers in the Dalbergioids.

4.4. Actinomorphy as a dead end in papilionoid legumes

In her paper on “Floral symmetry affects speciation rates in angiosperms”, Sargent (2004) surveys 19 zygomorphy–actinomorphy sister-relationships in Angiosperm families and concludes that “there is a correlation between zygomorphy and increased species richness in Angiosperms caused by the ability of this trait to promote reproductive isolation through improved precision of pollen placement and the tendency for specialist pollinators to be attracted to zygomorphic flowers.” She admits, however, that “a major weakness of a sister-group analysis is that it cannot distinguish whether differences between sister lineages in species richness are caused by more speciation events in one lineage or by more extinction events in the other.” Other authors (e.g. Bond, 1994; Cronk & Möller, 1997; Jonhson & Steiner, 2000) have, however, argued that actinomorphy may lead to lower extinction rates because of its association with generalist pollinators. Cronk & Möller (1997) even hypothesized that the successful reversion to actinomorphy in the genus *Ramonda* (Gesneriaceae), native to mountainous regions of southern Europe, has come about by loss of its specialist pollinator. They go on to say that it may be that reversals to actinomorphy are to be expected in extreme habitats, such as mountains, where there is an excess of generalist pollinators. To test the idea that actinomorphy leads to species poor clades, we carried out a simple survey of species number in the 36 genera of early-branching papilionoids first pointed out to have non-papilionoid flowers by Pennington and co-workers (2000) with the addition of the newly described or reinstated genera *Leptolobium* Vogel and *Guianodendron* Sch. Rodr. & A.M.G. Azevedo (Cardoso et al., 2012a). Assuming monophyly of these genera, then of these 38 lineages eight contain 10 or more species, with *Adesmia* and *Swartzia* topping with 240 and 180, respectively. On the other hand, eight lineages contain between 4 and 9 species and 22 lineages consist of 1–3 species with 11 being monospecific. The trend is similar within the Pterocarpus clade, where lineages with actinomorphic flowers are species poor; *Acosmium* s.s. and *Riedeliella* contain three species, while *Etaballia* and *Inocarpus* are monospecific. Despite the fact that radial symmetry in members of the Dalbergioid legumes is found mainly in the Pterocarpus clade, a few instances of such floral symmetry have evolved (e.g., species of *Pictetia* in the Dalbergia clade) (Lavin et al., 2001). This is similar to the *Pterocarpus* example in that the species with radial flowers were originally segregated as a distinct genus but found with phylogenetic results to be nested within *Pictetia*. The relatively high number of lineages with actinomorphic flowers that contain few species leads us to speculate that having non-papilionoid (often actinomorphic) flowers in the early-branching papilionoids may be an evolutionary dead end. This conclusion cannot be drawn by the simple observations we have recorded here, but this hypothesis can be tested explicitly in an evolutionary context using zygomorphy–actinomorphy sister-clade comparisons in the legumes, in a similar way to Sargent (2004). The recently published phylogenies of early-branching

papilionoid clades (e.g. Boatwright et al., 2008; Cardoso et al., 2012a,b,c, 2013; Hughes et al., 2004; Lewis et al., 2012; Pirie et al., 2009; Salsis-Lagoudakis et al., 2008, 2011), some of which contain dated clades, provide the framework to carry out such a survey across legume lineages.

4.5. Taxonomy – synonymizing *Etaballia dubia* (Kunth) Rudd under *Pterocarpus*

Seeing that *Etaballia dubia* is nested within *Pterocarpus* in our five-marker molecular analysis, we compared their morphological and anatomical features (see Table 1), and concluded that in light of all available evidence, morphological and molecular, this species is better included in *Pterocarpus*. In our search for the earliest available accepted name, we came across *Pterocarpus dubius* Spreng., which Sprengel published in 1827, and under which he synonymized the basionym of *Etaballia dubia* Benth. (= *Hecastophyllum dubium* Kunth). The name *Pterocarpus dubius* has not been in use since then, and Rojo (1972) excluded it from his monograph of *Pterocarpus*, but Sprengel may already have had a similar idea 200 years ago.

Pterocarpus dubius (Kunth) Spreng., Syst. Veg., editio decima sexta 4: Cur. Post. 268 (1827). *Etaballia dubia* (Kunth) Rudd, phytologia 20: 427 (1970). *Hecastophyllum* [*Ecstaphyllum*] *dubium* Kunth., Nov. Gen. 7 sp. Pl. 6, 388 (1824). Holotype: Venezuela, Bolívar, Caicara, Humboldt & Bonpland s.n. (photo P!).

Etaballia guianensis Benth., Jour. Bot. Hooker 2: 99 (1840a); Hook. Icones, Tabs. 453–454 (1842). Lectotype: Guyana, Essequibo River, R. Schomburgk 169 (K!), designated by Rudd (1970).

Description. For full descriptions of the species see Rudd (1970), Funch and Santos (1997), and Cuello (1999).

Geographic distribution. The Guianas, Venezuela, Brazil, Bolivia.

Ecology. Restricted to periodically inundated, humid tropical rainforests, varzea and igapó.

Selection of specimens studied. Guyana. V. TAKUTU-U., ESSEQUIBO REGION: Karanambo–Rupununi river, 17–18 May 1997, A. Chandlerbali 210 (K!). Venezuela. AMAZONAS: Pto. Ayacucho, Río el Bagre, 20 May 1940, L. Williams 13048 (photo F!); Río Ventuari, below los Carmelitos, 20 Feb. 1951, R.S. Cowan & J.J. Wurdack 31582 (K!). Brazil. RORAIMA: Igarape Agua boa, Rio Mucajaí between Pratinha and Rio Apiau, 24 Jan. 1967, G.T. Prance et al. 4048 (K!). PARA: Rio Takutu, opposite St. Ignatius Mission, 13 May 1939, H.C. Mather s.s. (K!). AMAZONAS: Mun. Humagta, near Tres Casas, 14 Sept.–11 Oct. 1934, B.A. Krukoff 6215 (K!). RONDONIA: Rio Machado, Jan. 1981, M. Goulding 1011 (K!). Bolivia. BENI: Mun. Guayaramerin, Río Yata, left bank up from Sta. Teresita, 19 Oct. 2010, B.B. Klitgård et al. 1394 (USZ!).

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Appendix 1

Taxon	Collector	Collection locality	Collection date	GenBank accession number				
				ITS2	matK	ndhF-rpL32	trnL-F	rbcl
<i>Acosmium cardenasii</i> H.S.Irwin & Arroyo	Silva, R.R. & Velasquez, J.S. 1246 (UEC)	Brazil, Mato Grosso do Sul, Corumba	-	JQ955617	JX124426	-	-	-
<i>Arachis</i> L. spp.	*	-	-	AF203552	AF203597	-	EU735856	U74247
<i>Brya ebenus</i> (L.) DC.	*	-	-	AF068142	AF270876	-	EU735857	AB045788
<i>Casuarina astragalina</i> Griseb.	*	-	-	AF204235	AF272072	-	EU735858	-
<i>Centropogon microchaete</i> (Mart. ex Benth.) Lima ex G.P.Lewis	Klitgård, B.B. 17 (AAU)	Brazil, Minas Gerais	1993	JN083771	EU401408	EU735853	EU735859	JN083700
<i>Chapmannia gracilis</i> (Balf. f.) Thulin	*	-	-	AF203546	AF203593	-	EU735860	-
<i>Discolobium psoraleifolium</i> Benth.	*	-	-	AF189058	AF270874	-	EU735861	-
<i>Etaballia dubia</i> (Kunth) Rudd	Chanderbali, A. 210 (K)	Guyana, Takutu, Upper Essequibo	18.05.1997	KF436420	KF436437	-	KF436477	KF436459
<i>Etaballia dubia</i> (Kunth) Rudd	Jansen-Jacobs, M.J. et al. 107 (K)	Guyana, Rupununi District	09.02.1985	KF436421	AH009902	-	KF436478	KF436460
<i>Etaballia dubia</i> (Kunth) Rudd	Jansen-Jacobs, M.J. et al. 2035 (K)	Guyana, Rupununi District	1991	-	-	KF436447	EU735862	KF436461
<i>Etaballia dubia</i> (Kunth) Rudd	Klitgård, B.B. 1394 (K)	Bolivia, Beni	10.2010	-	KF436438	KF436448	KF436479	KF436462
<i>Grazielodendron riodecensis</i> H.C.Lima	Klitgård, B.B. 23 (AAU)	Brazil, Espirito Santo	1993	JN083772	AF270862	EU735854	EU735864	JN083701
<i>Incarpurnus fagifolius</i> (Parkinson) Fosberg	Fager & Junaai 30 (MT)	Singapore Botanic Garden (cult.)		JN083773	AF270878	JN083707	EU735865	JN083702
<i>Maranionia lavinii</i> C.E.Hughes, G.P.Lewis, Daza & Reynel	Pennington, T.D., Pennington R.T. & Daza, A. 17573 (K)	Peru, Cajamarca	2003	JN083774	AY247263	EU735855	EU735866	JN083703
<i>Maranionia lavinii</i> C.E.Hughes, G.P.Lewis, Daza & Reynel	Hughes, C.E. 2209 (K)	Peru, Cajamarca, Balsas	-	KF436422	KF436439	KF436449	KF436480	KF436463
<i>Maranionia lavinii</i> C.E.Hughes, G.P.Lewis, Daza & Reynel	Hughes, C.E. 2647 (K)	Peru, Amazonas	-	KF436423	KF436440	KF436450	KF436481	KF436464
<i>Maranionia lavinii</i> C.E.Hughes, G.P.Lewis, Daza & Reynel	Hughes, C.E. 3093 (K)	Peru, Cajamarca, Celendin	-	KF436424	-	KF436451	KF436482	KF436465
<i>Maranionia lavinii</i> C.E.Hughes, G.P.Lewis, Daza & Reynel	Hughes, C.E. 3094 (K)	Peru, Cajamarca, Celendin	-	KF436425	-	KF436452	KF436483	KF436466
<i>Maranionia lavinii</i> C.E.Hughes, G.P.Lewis, Daza & Reynel	Hughes, C.E. 3103 (K)	Peru, La Libertad, Bolivar	-	KF436426	-	-	KF436484	-
<i>Paramachaerium ormosoides</i> (Ducke) Ducke	Sabatier, D. & Molino, J.-F. 5206 (K)	French Guiana, Inselbergs de la Haute Wanapi	24.03.2007	KF436427	KF436441	-	KF436485	-
<i>Paramachaerium schomburgkii</i> (Benth.) Ducke	Steege, H. & De Jager, P. 319 (K)	Guyana, Demerara	1998	AF204237	AF272062	-	-	KF436467
<i>Paramachaerium schomburgkii</i> (Benth.) Ducke	Jansen-Jacobs, M.J. et al. 97 (K)	Guyana, Rupununi District	09.02.1985	KF436428	-	KF436453	KF436486	-
<i>Paramachaerium schomburgkii</i> (Benth.) Ducke	Jansen-Jacobs, M.J. et al. 4662 (K)	Guyana, Rupununi District	26.07.1995	KF436429	-	KF436454	KF436487	KF436468
<i>Platymiscium pubescens</i> Micheli subsp. <i>fragrans</i> (Rusby) Klitgård	Nee, M. 37050 (K)	Bolivia, Santa Cruz	1998	JN083775	EU735968	EU735910	EU736077	JN083704
<i>Platymiscium trifoliolatum</i> Benth.	Calzada, I.J. et al. 19160	Mexico, Nayarit	1994	EU735923	EU735981	KF436455	EU736089	KF436469
<i>Platypodium elegans</i> Vogel	*	-	-	-	AF270877	-	-	GQ981836
<i>Pterocarpus acapulcensis</i> Rose	Hughes, C.E. 769 (K)	Venezuela, Trujillo	07.03.1986	JN083464	JN083532	JN083584	JN083638	JN083708
<i>Pterocarpus acapulcensis</i> Rose	Wurdack, J.J. et al. 41202 (K)	Venezuela, Bolivar	12.02.1956	JN083465	JN083533	JN083585	JN083639	JN083709
<i>Pterocarpus amazonum</i> (Mart. ex Benth.) Amshoff	Schunke, J. 6192 (K)	Peru, Huanuco	-	JN083466	JN083534	JN083586	JN083640	JN083710
<i>Pterocarpus amazonum</i> (Mart. ex Benth.) Amshoff	Klitgård, B.B. et al. 637 (BM)	Ecuador, Napo	-	JN083467	JN083535	JN083587	JN083641	JN083711
<i>Pterocarpus amphymenium</i> DC.	Medrano, F.G. 11805 (K)	Mexico, Oaxaca	02.03.1981	JN083468	JN083536	JN083588	JN083642	JN083712
<i>Pterocarpus amphymenium</i> DC.	Sousa, M. et al. 11937 (K)	Mexico, Oaxaca	17.03.1981	JN083469	JN083537	JN083589	JN083643	JN083713
<i>Pterocarpus amphymenium</i> DC.	Morton, C.V. & Makrinius, E. 2399 (K)	Mexico, Oaxaca	15.04.1933	JN083470	JN083538	JN083590	JN083644	JN083714
<i>Pterocarpus amphymenium</i> DC.	Hughes, C.E. 1167 (K)	Mexico, Guerrero	17.04.1988	JN083471	JN083539	JN083591	JN083645	JN083715
<i>Pterocarpus angolensis</i> DC.	Lisowski, S. 20268 (K)	Dem. Rep. Congo (Congo/Kinshasa), Haut-Katanga, Preto, Kashengeke	11.11.1970	JN083472	-	JN083592	-	JN083716
<i>Pterocarpus angolensis</i> DC.	Rodin, R.J. 8929 (K)	Namibia, Oshikango	14.02.1973	JN083473	-	JN083593	JN083646	JN083717
<i>Pterocarpus brenanii</i> L.Barb. & Torre	Macedo, J.M. de Aguiar 4693 (K)	Mozambique, Distr. Tete, Estima-Inhacapirire	25.01.1972	JN083474	-	-	-	-
<i>Pterocarpus brenanii</i> L.Barb. & Torre	Cannell, I. 16 (K)	Zimbabwe (Rhodesia), Distr. Kariba, (Sanyati river)	14.11.1966	JN083475	JN083540	JN083594	JN083647	JN083718
<i>Pterocarpus</i> cf. <i>erinaceus</i> Poir.	Chapman, J.D. 5213 (K)	Nigeria, Gongola State, Sarduana L.G. area, Mambilla Plateau, Akwaijantar forest	06.02.1978	JN083476	JN083541	JN083595	JN083648	JN083719
<i>Pterocarpus</i> cf. <i>reticulatus</i> Standl.	Ireland, H. 1 (K)	Mexico, Chiapas	27.02.1998	KF436430	-	-	KF436488	KF436470
<i>Pterocarpus</i> cf. <i>reticulatus</i> Standl.	Monro, A. 3646 (BM)	El Salvador, La Libertad	07.03.2002	-	KF436442	KF436456	-	KF436471
<i>Pterocarpus dalbergioides</i> Roxb.	Puy, D. du 213 (K)	Madagascar, Toamasina (Tamatave Prov.), NE of Maroansetta	26.04.1989	JN083477	-	JN083596	JN083649	JN083720
<i>Pterocarpus erinaceus</i> Poir.	Pilz, G.E. 2290 (K)	Nigeria, Ogun	03.06.1979	JN083478	JN083542	JN083597	JN083650	JN083721
<i>Pterocarpus erinaceus</i> Poir.	Velakamp, J.F. 6117 (K)	Ghana, Amezofe	03.01.1974	JN083479	JN083543	JN083598	JN083651	JN083722
<i>Pterocarpus floribundus</i> (Benth.) Kuntze	Croat T.B. 14866 (K)	Panama, Canal Zone, Barro Colorado island	01.06.1971	KF436431	-	-	KF436489	KF436472
<i>Pterocarpus hayesii</i> Hemsl.	Monro, A. 3668 (BM)	El Salvador, La Libertad,	07.03.2002	KF436432	-	-	KF436490	KF436473
<i>Pterocarpus indicus</i> Willd.	Stancik & Nathaniel 5198 (K)	Papua New Guinea, Madang, Baitabag	17.09.2003	JN083480	JN083544	-	JN083652	JN083723

(continued on next page)

Appendix 1 (continued)

Taxon	Collector	Collection locality	Collection date	GenBank accession number				
				ITS2	matK	ndhF-rpl32	trnL-F	rbcL
<i>Pterocarpus indicus</i> Willd.	Ambri & Arifin AA401 (K)	Indonesia, Wanariset, Kalimantan Timur	04.02.1992	JN083481	JN083545	JN083599	–	JN083724
<i>Pterocarpus indicus</i> Willd.	L. Lugas 2773 (K)	Malaysia, Borneo, Kota Belud district	13.07.1998	JN083482	JN083546	JN083600	JN083653	JN083725
<i>Pterocarpus lucens</i> Lepr. ex Guill. & Perr. subsp. <i>antunesii</i> (Taub.) Rojo	Pereira, A. & Correia, M.F. 2121 (K)	Mozambique (Mocambique), Cabora Bassa	18.04.1972	JN083483	JN083547	JN083601	JN083654	JN083726
<i>Pterocarpus lucens</i> Lepr. ex Guill. & Perr. subsp. <i>lucens</i>	Sebsebe, D. 1925 (K)	Ethiopia, Gojam Adm. Region, Metekel Awraja	20.08.1986	JN083484	JN083548	JN083602	JN083655	JN083727
<i>Pterocarpus lucens</i> Lepr. ex Guill. & Perr. subsp. <i>lucens</i>	Breteler, F.J. 1155 (K)	Cameroon, Savannah, Money, Betare Oya	28.02.1961	JN083485	JN083549	JN083603	JN083656	JN083728
<i>Pterocarpus lucens</i> Lepr. ex Guill. & Perr. subsp. <i>lucens</i>	Diallo, D. et al. 295 (K)	Mali, (French Sudan), Azzanturi, Ilahatan	29.08.1989	JN083486	JN083550	JN083604	JN083657	JN083729
<i>Pterocarpus macrocarpus</i> Kurz	Monyrak & Meng 223 (K)	Cambodia, Prov. Stung Treng, Distr., Thala Barevath, Kalay Island Ramsar site	–	JN083487	JN083551	JN083605	JN083658	JN083730
<i>Pterocarpus magnicarpus</i> Schery	Daza, A. 1376 (K)	Peru, San Ramon	07.08.1999	–	KF436443	–	KF436491	KF436474
<i>Pterocarpus marsupium</i> Roxb.	Klackenberg, J. & Lundin, R. 253 (K)	India, Tamil Nadu, Nilgiris, Ootacamund area	05.10.1982	JN083488	–	–	JN083659	JN083731
<i>Pterocarpus marsupium</i> Roxb.	Saslis-Lagoudakis, C.H.	cult, Botanical gardens of Forest Research Institute of India, Dehra Dun	–	JN083489	JN083552	JN083606	JN083660	JN083732
<i>Pterocarpus marsupium</i> Roxb.	Saslis-Lagoudakis, C.H.	cult, Botanical gardens of Forest Research Institute of India, Dehra Dun	–	JN083490	JN083553	JN083607	JN083661	JN083733
<i>Pterocarpus michelianus</i> N. Zamora	V. Ramirez et al. 263 (MO)	Costa Rica, San Jose	23.02.1994	JN083491	JN083554	–	JN083662	JN083734
<i>Pterocarpus mildbraedii</i> Harms subsp. <i>mildbraedii</i>	Chapman, J.D. 3849 (K)	Nigeria, NE State, Sardauna Prov., River Nwam Forest Reserve, Mambilla Plateau	12.04.1975	JN083492	JN083555	JN083608	JN083663	JN083735
<i>Pterocarpus mildbraedii</i> Harms subsp. <i>usambarensis</i> (Verdc.) Polhill	Greenway, P.J. 7923 (K)	Tanzania, E of Usambara	26.01.1947	JN083493	–	JN083609	JN083664	JN083736
<i>Pterocarpus monophyllus</i> Klitgård, L.P. Queiroz & G.P. Lewis	Rocha, P. 23 (K)	Brazil, Bahia	–	JN083494	JN083556	–	JN083665	–
<i>Pterocarpus officinalis</i> Jacq. subsp. <i>gilletii</i> (De Wild.) Rojo	Jans 810 (K)	Dem. Rep. Congo (Congo/Leopoldville), Kutu, Bokoro	26.10.1948	JN083495	–	–	–	–
<i>Pterocarpus officinalis</i> Jacq. subsp. <i>officinalis</i>	Martinez, E.M. et al. 23116 (K)	Guatemala	26.07.1988	JN083496	JN083557	JN083610	JN083666	JN083737
<i>Pterocarpus officinalis</i> Jacq. subsp. <i>officinalis</i>	Boom, B.M. 7054 (K)	Puerto Rico	10.01.1987	JN083497	JN083558	JN083611	JN083667	JN083738
<i>Pterocarpus osun</i> Craib	Lowe, J. 4702 (K)	Nigeria, Ibadan	05.11.1985	JN083498	–	–	JN083668	JN083739
<i>Pterocarpus reticulatus</i> Standl.	Tenorio, P. et al. 19712 (K)	Mexico, Chiapas	23.02.1998	JN083499	JN083559	JN083612	JN083669	JN083740
<i>Pterocarpus hayesii</i> Hemsl.	Hughes, C.E. 1190 (K)	Guatemala	03.05.1988	JN083500	JN083560	JN083613	JN083670	JN083741
<i>Pterocarpus rohrii</i> Vahl	Mori, S.A. & Smith, N.P. 25173 (K)	French Guiana	15.09.2000	JN083501	JN083561	–	JN083671	JN083742
<i>Pterocarpus violaceus</i> var. <i>angustifolius</i> Benth.	Klitgård, B.B. et al. 61 (BM)	Brazil, Espírito Santo	30.12.1993	JN083502	–	JN083614	JN083672	JN083743
<i>Pterocarpus rohrii</i> Vahl	Irwin, H.S. 48775 (K)	Brazil, Amapa	17.10.1960	JN083503	–	–	JN083673	JN083744
<i>Pterocarpus rohrii</i> Vahl	Klitgård, B.B. 1325 (K)	Bolivia, Beni	19.10.2010	KF436433	–	KF436457	–	–
<i>Pterocarpus rohrii</i> Vahl	Lewis, G.P. & P. Lozano 2877 (K)	Ecuador, Azuay	01.12.1996	KF436434	KF436444	–	KF436492	–
<i>Pterocarpus floribundus</i> (Benth.) Kuntze	Elias, B. 1209 (K)	Colombia, Barranquilla	05.1934	JN083504	JN083562	JN083615	JN083674	JN083745
<i>Pterocarpus violaceus</i> Vogel	Pirani, J.R. et al. 26889 (K)	Brazil, Espírito Santo	10.05.1993	JN083506	JN083564	JN083617	JN083676	JN083747
<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>polyanthus</i> (Harms) Mend. & Sousa	Bingham, M.G. & Jeffery, R. 11799 (K)	Zambia, S Prov., Mazabuka Distr., Kaley Ranch	12.01.1999	JN083507	JN083565	JN083618	JN083677	JN083748

<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>polyanthus</i> var. <i>martinii</i> (Dunkley) Mend. & Sousa	White, F. 6492 (K)	Zambia, S Prov., Mazabuka	26.01.1960	JN083508	JN083566	JN083619	JN083678	JN083749
<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>polyanthus</i> var. <i>martinii</i> (Dunkley) Mend. & Sousa	Leach, L.C. et al. 14991 (K)	Zimbabwe (Rhodesia), Distr. Lomagundi	15.02.1973	JN083509	JN083567	JN083620	JN083679	JN083750
<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>rotundifolius</i>	Balsinhas, A. 2841 (K)	South Africa, Transvaal, Pretoria Bot. Res. Inst., Botanic Gardens, Kloof Forest Section	06.01.1976	JN083510	JN083568	JN083621	JN083680	JN083751
<i>Pterocarpus santalinoides</i> L'Hér. ex DC.	van Andel, T. et al. 1925 (K)	Guyana	03.10.1997	JN083511	–	–	JN083681	JN083752
<i>Pterocarpus santalinoides</i> L'Hér. ex DC.	Tutin, C.E.G. s.n. (K)	Senegal, Lingue Koto, Senegal Oriental	20.02.1980	JN083512	–	JN083622	JN083682	JN083753
<i>Pterocarpus santalinoides</i> L'Hér. ex DC.	Martin, J.K. SL871 (K)	Sierra Leone, Taiama	23.02.1964	JN083513	JN083569	JN083623	JN083683	JN083754
<i>Pterocarpus santalinoides</i> L'Hér. ex DC.	Lock, J.M. 84/29 (K)	Togo, banks of River Koumangou at Naboulgou, Sansanne Mango	23.03.1984	JN083514	JN083570	JN083624	JN083684	JN083755
<i>Pterocarpus santalinoides</i> L'Hér. ex DC.	Hatschbach, G. et al. 65625 (K)	Brazil, Mato Grosso	16.11.1996	JN083515	JN083571	JN083625	JN083685	JN083756
<i>Pterocarpus santalinus</i> Buch.-Ham. ex Wall.	Saslis-Lagoudakis, C.H.	cult, Botanical gardens of Forest Research Institute of India, Dehra Dun	–	JN083516	JN083572	JN083626	JN083686	JN083757
<i>Pterocarpus santalinus</i> Buch.-Ham. ex Wall.	Saslis-Lagoudakis, C.H.	cult, Botanical gardens of Forest Research Institute of India, Dehra Dun	–	JN083517	JN083573	JN083627	JN083687	JN083758
<i>Pterocarpus santalinus</i> Buch.-Ham. ex Wall.	Saslis-Lagoudakis, C.H.	bark from market	–	JN083518	JN083574	JN083628	JN083688	JN083759
<i>Pterocarpus soyauxii</i> Taub.	Lisowski, S. 42883 (K)	Democratic Republic of Congo, Kisangani	14.05.1976	JN083519	–	–	–	–
<i>Pterocarpus soyauxii</i> Taub.	McPherson, G. 16252 (K)	Gabon, Ogooe-Ivindo, Booue	23.11.1993	JN083520	–	–	–	JN083760
<i>Pterocarpus steinbachianus</i> Harms	Nee, M. 50163 (K)	Bolivia, Santa Cruz	16.10.1999	JN083505	JN083563	JN083616	JN083675	JN083746
<i>Pterocarpus steinbachianus</i> Harms	Klitgård, B.B. 1465 (K)	Bolivia, Beni	26.10.2010	KF436435	KF436445	KF436458	–	KF436475
<i>Pterocarpus ternatus</i> Rizzini	Harley, R.M. et al. 26138 (K)	Brazil, Bahia	12.12.1988	JN083521	JN083575	JN083629	JN083689	JN083761
<i>Pterocarpus tinctorius</i> Welw.	Schmitz 5970 (K)	Dem. Rep. Congo (Congo), Katanga, Terr. Jadotville	04.1958	JN083522	JN083576	JN083630	JN083690	JN083762
<i>Pterocarpus tinctorius</i> Welw.	Reekmans, M. 9232 (K)	Burundi	01.05.1980	JN083523	JN083577	JN083631	JN083691	JN083763
<i>Pterocarpus tinctorius</i> Welw.	Delvaux, J. 650 (K)	Democratic Republic of Congo, Katanga	15.06.1957	JN083524	JN083578	JN083632	JN083692	JN083764
<i>Pterocarpus tinctorius</i> Welw.	Mwasumbi, L. & Clarke, P. 3608 (K)	Tanzania, Lindi Distr., between lake Lutamba and lake Tandangogoro	23.07.1993	JN083525	JN083579	JN083633	JN083693	JN083765
<i>Pterocarpus tinctorius</i> Welw.	Wageman 1769 (K)	Dem. Rep. Congo (Congo/Leopoldville), Boma, INEAC-Luki	25.09.1957	JN083526	JN083580	JN083634	JN083694	JN083766
<i>Pterocarpus tinctorius</i> Welw.	Lovett, J. & Congden, C. 1955 (K)	Tanzania, Iringa Region, Mufindi Distr.	05.03.1987	JN083527	–	–	JN083695	–
<i>Pterocarpus tinctorius</i> Welw.	Rees, A.F. T151 (K)	Tanzania, T8, Yerende Ferry Selous Game Reserve	21.07.1971	JN083528	JN083581	–	JN083696	JN083767
<i>Pterocarpus tinctorius</i> Welw.	Procter 1142 (K)	Tanzania, Biharamulo	01.02.1959	JN083529	–	JN083635	JN083697	JN083768
<i>Pterocarpus villosus</i> (Mart. ex Benth.) Benth.	Alencar, M.E. 237 (K)	Brazil, Piaui	20.05.1995	JN083530	JN083582	JN083636	JN083698	JN083769
<i>Ramoriaoa girolae</i> Speg.	Ribon, R. 23137 (K)	Brazil, Espirito Santo	29.12.1999	JN083531	JN083583	JN083637	JN083699	JN083770
<i>Tipuana tipu</i> (Benth.) Kuntze	Royal Botanic Gardens Kew (cult.)	–	–	JN083776	AF270881	AF204236	EU735868	JN083705
<i>Tipuana tipu</i> (Benth.) Kuntze	Klitgård, B.B. 13 (AAU)	Brazil, Minas Gerais	1993	JN083777	AF270882	AF189056	EU735869	JN083706
<i>Tipuana tipu</i> (Benth.) Kuntze	Hughes, C.E. 2454 (K)	Bolivia, Aiquile	–	KF436436	KF436446	–	–	KF436476

Appendix 2

Taxon	GenBank accession number
<i>Acosmium cardenasii</i> H.S.Irwin & Arroyo	JX124414
<i>Acosmium cardenasii</i> H.S.Irwin & Arroyo	JX124425
<i>Acosmium cardenasii</i> H.S.Irwin & Arroyo	JX124426
<i>Acosmium diffusissimum</i> (Mohlenbr.) Yakovlev	JX124415
<i>Acosmium diffusissimum</i> (Mohlenbr.) Yakovlev	JX124421
<i>Acosmium lentiscifolium</i> Schott	JX124417
<i>Acosmium lentiscifolium</i> Schott	JX124427
<i>Acosmium lentiscifolium</i> Schott	JX124422
<i>Acosmium lentiscifolium</i> Schott	JX124416
<i>Adesmia lanata</i> Hook.f.	AF270863
<i>Aeschynomene pfundii</i> Taub.	AF203587
<i>Amicia glandulosa</i> Kunth	AF203583
<i>Arachis hypogaea</i> L.	EU307349
<i>Arachis hypogaea</i> L.	EU307341
<i>Arachis hypogaea</i> L.	EU307345
<i>Arachis hypogaea</i> L.	EU307346
<i>Arachis hypogaea</i> L.	EU307347
<i>Arachis hypogaea</i> L.	EU307344
<i>Arachis hypogaea</i> L.	EU307348
<i>Arachis hypogaea</i> L.	EU307342
<i>Arachis hypogaea</i> L.	EU307343
<i>Arachis major</i> Krapov. & W.C.Greg.	AF203597
<i>Arachis pintoii</i> Krapov. & W.C.Greg.	AF203596
<i>Arachis triseminata</i> Krapov. & W.C.Greg.	AF203599
<i>Brya ebenus</i> (L.) DC.	AF270876
<i>Cascaronia astragalina</i> Griseb.	AF272072
<i>Centrolobium microchaete</i> (Benth.) H.C.Lima	EU401409
<i>Centrolobium microchaete</i> (Benth.) H.C.Lima	EU401408
<i>Centrolobium microchaete</i> (Benth.) H.C.Lima	EU401407
<i>Centrolobium ochroxylum</i> Rudd	EU401410
<i>Centrolobium ochroxylum</i> Rudd	EU401411
<i>Centrolobium paraense</i> Tul.	EU401413
<i>Centrolobium paraense</i> Tul.	EU401412
<i>Centrolobium robustum</i> (Vell.) Benth.	EU401414
<i>Centrolobium sclerophyllum</i> H.C.Lima	EU401415
<i>Centrolobium sclerophyllum</i> H.C.Lima	EU401416
<i>Centrolobium</i> sp.	AF270883
<i>Centrolobium tomentosum</i> Benth.	EU401418
<i>Centrolobium tomentosum</i> Benth.	EU401417
<i>Chapmannia floridana</i> Torr. & A.Gray	AF203600
<i>Chapmannia gracilis</i> (Balf. f.) Thulin	AF203593
<i>Chapmannia gracilis</i> (Balf. f.) Thulin	AF203592
<i>Chapmannia prismatica</i> (Sessé & Moc.) Thulin	AF203598
<i>Chapmannia sericea</i> Thulin & McKean	AF203591
<i>Cranocarpus martii</i> Benth.	AF270875
<i>Dalbergia sissoo</i> DC.	AF203582
<i>Discolobium psoraleifolium</i> Benth.	AF270874
<i>Discolobium pulchellum</i> Benth.	AF270873
<i>Etaballia dubia</i> (Kunth) Rudd	AH009902
<i>Etaballia dubia</i> (Kunth) Rudd	KF436437
<i>Etaballia dubia</i> (Kunth) Rudd	KF436438
<i>Fiebrigiella gracilis</i> Harms	AF203590
<i>Fiebrigiella gracilis</i> Harms	AF203589
<i>Fissicalyx fendleri</i> Benth.	AF272063
<i>Geoffroea decorticans</i> (Hook. & Arn.) Burkart	AF270880
<i>Geoffroea spinosa</i> Jacq.	AF270879
<i>Grazielodendron riococense</i> H.C.Lima	AF270862
<i>Inocarpus fagifer</i> (Parkinson) Fosberg	AF270878
<i>Maraniona lavinii</i> C.E.Hughes, G.P.Lewis, Daza & Reynel	AY247263
<i>Maraniona lavinii</i> C.E.Hughes, G.P.Lewis, Daza & Reynel	KF436439
<i>Maraniona lavinii</i> C.E.Hughes, G.P.Lewis, Daza & Reynel	KF436440
<i>Ormocarpus kirkii</i> S.Moore	AF203571
<i>Paramachaerium ormosioides</i> (Ducke) Ducke	KF436441
<i>Paramachaerium schomburgkii</i> (Benth.) Ducke	AF272062
<i>Platymiscium albertinae</i> Standl. & L. O. Williams	EU735932.
<i>Platymiscium calyptratum</i> M. Sousa & Klitgård	EU735933
<i>Platymiscium curuense</i> N. Zamora & Klitgård	EU735934
<i>Platymiscium darienense</i> Dwyer	EU735935
<i>Platymiscium dimorphandrum</i> Donn. Sm.	EU735936
<i>Platymiscium dimorphandrum</i> Donn. Sm.	EU735937
<i>Platymiscium dimorphandrum</i> Donn. Sm.	EU735938
<i>Platymiscium dimorphandrum</i> Donn. Sm.	EU735939
<i>Platymiscium filipes</i> Benth.	EU735940
<i>Platymiscium floribundum</i> Vogel var. <i>floribundum</i>	EU735941
<i>Platymiscium floribundum</i> Vogel var. <i>latifolium</i> (Benth.) Benth.	EU735942

Appendix 2 (continued)

Taxon	GenBank accession number
<i>Platymiscium floribundum</i> Vogel var. <i>nitens</i> (Vogel) Klitgård	EU735943
<i>Platymiscium floribundum</i> Vogel var. <i>nitens</i> (Vogel) Klitgård	EU735944
<i>Platymiscium floribundum</i> Vogel var. <i>obtusifolium</i> (Harms) Klitgård	EU735945
<i>Platymiscium floribundum</i> Vogel var. <i>obtusifolium</i> (Harms) Klitgård	EU735946
<i>Platymiscium gracile</i> Benth.	EU735947
<i>Platymiscium hebestachyum</i> Benth.	EU735948
<i>Platymiscium jejunum</i> Klitgård	EU735949
<i>Platymiscium lasiocarpum</i> Sandwith	EU735950
<i>Platymiscium parviflorum</i> Benth.	EU735951
<i>Platymiscium parviflorum</i> Benth.	EU735952
<i>Platymiscium parviflorum</i> Benth.	EU735953
<i>Platymiscium parviflorum</i> Benth.	EU735954
<i>Platymiscium parviflorum</i> Benth.	JQ587816
<i>Platymiscium parviflorum</i> Benth.	JQ587817
<i>Platymiscium parviflorum</i> Benth.	JQ587818
<i>Platymiscium pinnatum</i> (Jacq.) Dugand	EU735965
<i>Platymiscium pinnatum</i> (Jacq.) Dugand	EU735966
<i>Platymiscium pinnatum</i> (Jacq.) Dugand	EU735967
<i>Platymiscium pinnatum</i> (Jacq.) Dugand	GQ982064
<i>Platymiscium pinnatum</i> (Jacq.) Dugand	JQ626473
<i>Platymiscium pinnatum</i> (Jacq.) Dugand	FJ037916
<i>Platymiscium pinnatum</i> (Jacq.) Dugand subsp. <i>pinnatum</i> var. <i>diadelphum</i> (S. F. Blake) Klitgård	EU735955
<i>Platymiscium pinnatum</i> (Jacq.) Dugand subsp. <i>pinnatum</i> var. <i>diadelphum</i> (S. F. Blake) Klitgård	EU735956
<i>Platymiscium pinnatum</i> (Jacq.) Dugand subsp. <i>pinnatum</i> var. <i>diadelphum</i> (S. F. Blake) Klitgård	EU735957
<i>Platymiscium pinnatum</i> (Jacq.) Dugand subsp. <i>pinnatum</i> var. <i>diadelphum</i> (S. F. Blake) Klitgård	EU735958
<i>Platymiscium pinnatum</i> (Jacq.) Dugand subsp. <i>pinnatum</i> var. <i>pinnatum</i>	EU735959
<i>Platymiscium pinnatum</i> (Jacq.) Dugand subsp. <i>pinnatum</i> var. <i>pinnatum</i>	EU735960
<i>Platymiscium pinnatum</i> (Jacq.) Dugand subsp. <i>pinnatum</i> var. <i>ulei</i> (Harms ex Harms) Klitgård	EU735961
<i>Platymiscium pinnatum</i> (Jacq.) Dugand subsp. <i>pinnatum</i> var. <i>ulei</i> (Harms ex Harms) Klitgård	EU735962
<i>Platymiscium pinnatum</i> (Jacq.) Dugand subsp. <i>polystachyum</i> (Benth.) Klitgård	EU735963
<i>Platymiscium pinnatum</i> (Jacq.) Dugand subsp. <i>polystachyum</i> (Benth.) Klitgård	EU735964
<i>Platymiscium pubescens</i> Micheli subsp. <i>fragrans</i> (Rusby) Klitgård	EU735968
<i>Platymiscium pubescens</i> Micheli subsp. <i>fragrans</i> (Rusby) Klitgård	EU735969
<i>Platymiscium pubescens</i> Micheli subsp. <i>fragrans</i> (Rusby) Klitgård	EU735970
<i>Platymiscium pubescens</i> Micheli subsp. <i>pubescens</i>	EU735971
<i>Platymiscium pubescens</i> Micheli subsp. <i>pubescens</i>	EU735972
<i>Platymiscium pubescens</i> Micheli subsp. <i>zehntneri</i> (Harms) Klitgård	EU735973
<i>Platymiscium pubescens</i> Micheli subsp. <i>zehntneri</i> (Harms) Klitgård	EU735974
<i>Platymiscium</i> sp.	EU735975
<i>Platymiscium</i> sp.	EU735976
<i>Platymiscium</i> sp.	AF270871
<i>Platymiscium</i> sp.	EU735977
<i>Platymiscium speciosum</i> Vogel	EU735978
<i>Platymiscium stipulare</i> Benth.	EU735979
<i>Platymiscium stipulare</i> Benth.	AF270872
<i>Platymiscium stipulare</i> Benth.	EU735980
<i>Platymiscium trifoliolatum</i> Benth.	EU735981
<i>Platymiscium trifoliolatum</i> Benth.	EU735982
<i>Platymiscium trinitatis</i> Benth. var. <i>duckei</i> (Huber) Klitgård	EU735983
<i>Platymiscium trinitatis</i> Benth. var. <i>duckei</i> (Huber) Klitgård	EU735984
<i>Platymiscium trinitatis</i> Benth. var. <i>trinitatis</i>	EU735985
<i>Platymiscium trinitatis</i> Benth. var. <i>trinitatis</i>	EU735986
<i>Platymiscium yucatanum</i> Standl.	EU735987
<i>Platymiscium yucatanum</i> Standl.	EU735988
<i>Platypodium elegans</i> Vogel	AF270877
<i>Platypodium elegans</i> Vogel	GQ982065
<i>Pterocarpus acapulcensis</i> Rose	JN083532
<i>Pterocarpus acapulcensis</i> Rose	JN083533
<i>Pterocarpus amazonum</i> (Mart. ex Benth.) Amshoff	JN083534

Appendix 2 (continued)

Taxon	GenBank accession number
<i>Pterocarpus amazonum</i> (Mart. ex Benth.) Amshoff	JN083535
<i>Pterocarpus amphymenium</i> DC.	JN083536
<i>Pterocarpus amphymenium</i> DC.	JN083537
<i>Pterocarpus amphymenium</i> DC.	JN083538
<i>Pterocarpus amphymenium</i> DC.	JN083539
<i>Pterocarpus brenanii</i> L.Barb. & Torre	JN083540
<i>Pterocarpus</i> cf. <i>erinaceus</i> Poir.	JN083541
<i>Pterocarpus erinaceus</i> Poir.	JN083542
<i>Pterocarpus erinaceus</i> Poir.	JN083543
<i>Pterocarpus floribundus</i> (Benth.) Kuntze	JN083562
<i>Pterocarpus indicus</i> Willd.	AF142691
<i>Pterocarpus indicus</i> Willd.	JN083544
<i>Pterocarpus indicus</i> Willd.	JN083545
<i>Pterocarpus indicus</i> Willd.	JN083546
<i>Pterocarpus lucens</i> Lepr. ex Guill. & Perr. subsp. <i>antunesii</i> (Taub.) Rojo	JN083547
<i>Pterocarpus lucens</i> Lepr. ex Guill. & Perr. subsp. <i>lucens</i>	JN083548
<i>Pterocarpus lucens</i> Lepr. ex Guill. & Perr. subsp. <i>lucens</i>	JN083549
<i>Pterocarpus lucens</i> Lepr. ex Guill. & Perr. subsp. <i>lucens</i>	JN083550
<i>Pterocarpus macrocarpus</i> Kurz	JN083551
<i>Pterocarpus macrocarpus</i> Kurz	AF203588
<i>Pterocarpus magnicarpus</i> Schery	KF436443
<i>Pterocarpus marsupium</i> Roxb.	JN083552
<i>Pterocarpus marsupium</i> Roxb.	JN083553
<i>Pterocarpus michelianus</i> N. Zamora	JN083554
<i>Pterocarpus mildbraedii</i> Harms subsp. <i>mildbraedii</i>	JN083555
<i>Pterocarpus monophyllus</i> Klitgård, L.P. Queiroz & G.P. Lewis	JN083556
<i>Pterocarpus officinalis</i> Jacq. subsp. <i>officinalis</i>	JN083557
<i>Pterocarpus officinalis</i> Jacq. subsp. <i>officinalis</i>	JN083558
<i>Pterocarpus reticulatus</i> Standl.	KF436442
<i>Pterocarpus reticulatus</i> Standl.	JN083559
<i>Pterocarpus rohrii</i> Vahl	KF436444
<i>Pterocarpus rohrii</i> Vahl	JN083560
<i>Pterocarpus rohrii</i> Vahl	JN083561
<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>polyanthus</i> (Harms) Mend. & Sousa	JN083565
<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>polyanthus</i> var. <i>martinii</i> (Dunkley) Mend. & Sousa	JN083566
<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>polyanthus</i> var. <i>martinii</i> (Dunkley) Mend. & Sousa	JN083567
<i>Pterocarpus rotundifolius</i> (Sond.) Druce subsp. <i>rotundifolius</i>	JN083568
<i>Pterocarpus santalinoides</i> L'Hér. ex DC.	JN083569
<i>Pterocarpus santalinoides</i> L'Hér. ex DC.	JN083570
<i>Pterocarpus santalinoides</i> L'Hér. ex DC.	JN083571
<i>Pterocarpus santalinus</i> Buch.-Ham. ex Wall.	JN083572
<i>Pterocarpus santalinus</i> Buch.-Ham. ex Wall.	JN083573
<i>Pterocarpus santalinus</i> Buch.-Ham. ex Wall.	JN083574
<i>Pterocarpus steinbachianus</i> Harms	KF436445
<i>Pterocarpus steinbachianus</i> Harms	JN083563
<i>Pterocarpus ternatus</i> Rizzini	JN083575
<i>Pterocarpus tinctorius</i> Welw.	JN083576
<i>Pterocarpus tinctorius</i> Welw.	JN083577
<i>Pterocarpus tinctorius</i> Welw.	JN083578
<i>Pterocarpus tinctorius</i> Welw.	JN083579
<i>Pterocarpus tinctorius</i> Welw.	JN083580
<i>Pterocarpus tinctorius</i> Welw.	JN083581
<i>Pterocarpus villosus</i> (Mart. ex Benth.) Benth.	JN083582
<i>Pterocarpus violaceus</i> Vogel	JN083564
<i>Pterocarpus zehntneri</i> Harms	JN083583
<i>Ramorinoa girolae</i> Speg.	AF270881
<i>Riedeliella graciliflora</i> Harms	AH009910
<i>Stylosanthes capitata</i> Vogel	AF203595
<i>Stylosanthes hamata</i> (L.) Taub.	AF203594
<i>Stylosanthes viscosa</i> Sw.	AF203595
<i>Stylosanthes viscosa</i> Sw.	JQ587858
<i>Stylosanthes viscosa</i> Sw.	JQ587859
<i>Tipuana tipu</i> (Benth.) Kuntze	AF270882
<i>Tipuana tipu</i> (Benth.) Kuntze	KF436446

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