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1 New generic recircumscription of the Loxocarpinae (Gesneriaceae), as inferred by
2 phylogenetic and morphological data

3

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12 **Abstract**

13 The Loxocarpinae, also known as the “*Boea* group”, are the subtribe of Gesneriaceae
14 which includes *Boea* and a number of segregated genera and close relatives. This group
15 currently comprises over 200 species in 15 genera. Here we present the most up-to-date
16 phylogeny, covering all the genera known to belong to the group, based on Bayesian
17 Inference and Parsimony of the nuclear ITS and the plastid regions *trnL-trnF* (intron
18 and spacer) and *ndhF-trnL^{UAG}* (spacers). The results show discrepancies between the
19 current generic delimitation in the subtribe and the clades delineated by the phylogeny.
20 As a result *Boea*, *Damrongia*, *Streptocarpus* and *Paraboea* are recircumscribed in an
21 attempt to establish a more natural classification and a number of new combinations are
22 made. The new genus *Middletonia* is described.

23 Keywords: *Boea*, *Damrongia*, *Paraboea*, Southeast Asia, *Streptocarpus*.

24 Phylogeny of Loxocarpinae.

25 **Introduction**

26 The Gesneriaceae are a large family with an estimated 3500 species in 147-150 genera
27 (Stevens, 2001 onwards; Skogg & Boggan, 2007; Möller & Clark, 2013; Weber & al.,
28 2013), distributed mostly in the tropics and subtropics, with some outliers in the
29 temperate areas of both hemispheres (Weber, 2004). The subject of this investigation is
30 the group formerly referred to informally as the “advanced Asiatic and Malesian
31 Gesneriaceae with twisted fruit” (Möller & al., 2009) and now formally classified as the
32 subtribe Loxocarpinae, part of the tribe Trichosporeae, subfamily Didymocarpoideae
33 (Weber & al., 2013). It is also informally known as the ‘*Boea* group’ (Möller & al.,
34 2009; Puglisi, 2014).

35 The Loxocarpinae are found throughout Southeast Asia, reaching Australia and the
36 Solomon Islands, and are characterised by having a predominantly twisted capsule.
37 However, in some genera all the species have a ‘straight’ fruit, with valves not twisting
38 (e.g. *Loxocarpus* R.Br.), and in other genera there are species with a twisted fruit and
39 species with a straight fruit (e.g. *Paraboea* (C.B. Clarke) Ridl., Fig. 1).

40 The first genus in the subtribe described to accommodate twisted-fruited species was
41 *Boea* Comm. ex Lam. *Boea* grew larger, and became rather heterogeneous, as more
42 species with the same fruit type were discovered and were described in the genus.
43 Progressively, the majority of the species was then transferred to other genera, many of
44 which were directly segregated from *Boea*, in order to establish morphologically
45 distinct units.

46 Key publications, in which many species of *Boea* were described, are the works by
47 Brown (1839, 1840) and Clarke (1883). The most important recent work on the *Boea*
48 group is that by Burt (1984), in which the generic concepts formed around a twisted-
49 fruited *Boea* and a straight-fruited *Paraboea* were profoundly modified with new
50 generic concepts based on indumentum type rather than on the fruit twisting. This
51 change led to a large number of species being transferred from *Boea* to *Paraboea*.
52 Later, the new genera *Kaisupeea* B.L.Burt (Burt, 2001), *Senyumia* Kiew, A. Weber &
53 B.L.Burt, *Spelaeanthus* Kiew, A. Weber & B.L.Burt and *Emarhendia* Kiew, A. Weber

54 & B.L.Burt (Kiew & al., 1997), were created to accommodate the few remaining
55 doubtful species of *Boea* and *Paraboea*.

56 The study by Möller & al. (2009) was the first phylogenetic investigation focusing on
57 the tribe Trichosporeae (then referred to as Didymocarpoid Gesneriaceae). In a
58 subsequent study, Möller & al. (2011) expanded their sampling and confirmed that the
59 straight-fruited genera *Chirita* Buch.-Ham. and *Henckelia* Spreng. were both
60 polyphyletic and that taxa of both were to be found in the *Boea* group. Weber & al.
61 (2011), Yao (2012) and Middleton & al. (2013) focused on these problematic genera
62 and, as a result, *Chirita* was split into five genera, including *Damrongia* Kerr ex Craib
63 within the *Boea* group, comprising a few species from the former *Chirita* sect. *Chirita*.
64 Likewise, *Henckelia* was split into three genera, including *Loxocarpus* in the *Boea*
65 group (formerly *Henckelia* sect. *Loxocarpus* (R.Br.) A.Weber & B.L.Burt). Puglisi &
66 al. (2011a) also examined relationships within the *Boea* group, focusing on the genera
67 *Paraboea*, *Trisepalum* C.B.Clarke and *Phylloboea* Benth., resulting in them all being
68 synonymised under *Paraboea* (following conservation of the name by Middleton & al.,
69 2010), by far the largest genus in the Loxocarpaceae.

70 The aims of this new study are to reconstruct the molecular phylogenetic tree for the
71 entire subtribe Loxocarpaceae, to test whether the current classification is in agreement
72 with the phylogenetic structure of the group, to identify robust phylogenetic entities
73 suitable for a redefinition of the generic limits, and to propose a new generic
74 classification accordingly.

75 **Materials and methods**

76 In this study, 140 ingroup accessions belonging to 110 taxa of Loxocarpaceae were
77 sequenced, and all the genera recognised in the subtribe were included. The outgroup
78 consisted of six accessions of the closely related subtribes Didissandrinae,
79 Didymocarpaceae and Streptocarpaceae (Weber & al., 2013), represented by two taxa of
80 *Didissandra* C.B.Clarke, *Codonoboea* Ridl. and African *Streptocarpus* Lindl.
81 respectively.

82 The material used in the analyses consisted of silica gel-dried leaves samples with the
83 exception of the sample called “*Boea* sp.”, which was taken from a herbarium specimen

84 (*Hoogland 5129*, CANB herbarium). Generic types have been included for all the
85 genera with the exception of *Boea* and *Ornithoboea* Parish ex C.B. Clarke, for which no
86 material suitable for DNA extraction was available. Information on the accessions,
87 including collection data, repository of the vouchers and GenBank numbers, is available
88 as supplemental material.

89

90 Total genomic DNA was extracted following a modified version of the cetyltrimethyl
91 ammonium bromide (CTAB) method by Doyle & Doyle (1987), with no further
92 purification.

93 The markers used in the phylogenetic analyses were chosen based on previous work on
94 the Didymocarpoideae (e.g. Atkins & al., 2001; Bramley & al., 2004; Clark & al., 2009;
95 Möller & al., 2009, 2011; Puglisi & al., 2011a, 2011b; Puglisi, 2014). These were the
96 nuclear ITS and the plastid regions *trnL-trnF* (including both the *trnL* intron and the
97 *trnL-trnF* spacer) and *ndhF-trnL^{UAG}* (*ndhF-rpl32* and *rpl32-trnL^{UAG}* spacers).

98 The PCR of the ITS and *trnL-trnF* regions followed an optimised recipe already tested
99 in previous studies (Puglisi & al., 2011a, 2011b). The 20 µl reaction contained 2 µl 2
100 mM dNTPs, 2 µl 10x NH₄ buffer, 0.6 µl 25 mM MgCl₂, 2µl each 10 µM forward and
101 reverse primer, 0.4 µl 0.4% BSA, 0.4 µl Biotaq polymerase (Bioline), 1 µl DNA
102 template and 9.6 µl dH₂O. In some cases, TBT-PAR was employed as recommended by
103 Samarakoon & al. (2013) and it seemed to have a positive effect on problematic PCRs.
104 The 20 µl PCR reaction mix containing TBT-PAR was: 2 µl 2 mM dNTPs, 2 µl 10x
105 NH₄ buffer, 0.6 µl 25 mM MgCl₂, 2 µl each 10 µM forward and reverse primer, 4 µl 5x
106 TBT-PAR, 0.4 µl Biotaq polymerase (Bioline), 1 µl DNA template and 6 µl dH₂O. The
107 primers used to amplify the ITS were 5P and 8P (Möller & Cronk, 1997). Occasionally,
108 the internal primers 2G and 3P (Möller & Cronk, 1997) were used when the sequencing
109 signal strength was low. The thermocycle settings used in the PCR were: 94°C for 3',
110 30× [94°C for 1', 55°C for 1', 72°C for 1.5'], 72°C for 5', 10°C forever. The *trnL-trnF*
111 region was amplified using the universal primers c, d, e and f (Taberlet & al., 1991).
112 While this intron-spacer region is generally amplifiable with just the external primers c
113 and f, a number of samples proved problematic and needed several adjustments to the
114 PCR reaction and thermocycle settings. However, none of these variations appeared
115 optimal or widely applicable. The following PCR thermocycle settings were used: 94°C

116 for 4', 35× [94°C for 45", 55°C for 45", 72°C for 3'], 72°C for 10', 10°C forever. The
117 primers used for the amplification of the *ndhF-trnL^{UAG}* were *ndhF*, *rpl32F*, *rpl32R* and
118 *trnL^{UAG}* (Shaw & al., 2007).

119 The two spacers *ndhF-rpl32* and *rpl32-trnL^{UAG}* were tentatively co-amplified or, when
120 necessary, treated individually. The thermocycle settings used in the PCR of the entire
121 region were 80°C for 5', 30× [95°C for 1', 50°C for 1', 65°C for 1' 7" with ramp of 0.3
122 C/sec, 72°C for 2'], 72°C for 5', 4°C forever. Individual spacers, instead, followed the
123 thermocycle 80°C for 5', 30× [95°C for 1', 50°C for 1', 65°C for 1' 7" with ramp of 0.3
124 C/sec, 65°C for 4'], 65°C for 5', 4°C forever.

125 PCR products were stained with SYBR Safe (Invitrogen) and checked by
126 electrophoresis on 1% agarose gel. Successful PCR products were purified with
127 ExoSAP-IT (Affymetrix), following the manufacturer's protocol. Sequencing PCRs
128 were 1/8 reactions with BigDye Terminator v.3.1 (Applied Biosystems). The
129 thermocycle was: 25× [95°C for 30", 50°C for 20", 60°C for 4'], 4°C forever.

130 Sequencing products were processed at the GenePool laboratory of the University of
131 Edinburgh on an ABI3730 DNA Analyser (Applied Biosystems). Sequences were
132 edited in Sequencher v.4.7 (Gene Code Corporation) and aligned manually in Mesquite
133 v.2.74 and v.2.75 (Maddison & Maddison, 2010, 2011).

134 Given the relatively low number of sequences available for the *ndhF-trnL^{UAG}* plastid
135 DNA region, two different datasets were analysed: the "2-markers" dataset with 142
136 accessions, including only ITS and *trnL-trnF* data, and the "3-markers" dataset with 68
137 accessions, but with the additional contribution of the *ndhF-trnL^{UAG}* region (Table 1).
138 Four of the accessions included in the 3-markers dataset were not analysed in the larger
139 2-markers dataset, due to the low quality of some sequences, especially the *trnL-trnF*,
140 and the simultaneous presence in the matrix of other accessions of the same species
141 with more reliable sequences.

142 Parsimony analyses were run in PAUP* v.4.0b10 (Swofford, 2003) on unordered and
143 unweighted characters with the following settings: heuristic search running over
144 100,000 stepwise random addition replicates, with two trees held at each step; tree
145 bisection reconnection (TBR) branch swapping algorithm with steepest descent and
146 MulTrees options enabled; MaxTrees setting fixed at 1,000,000. The resulting
147 parsimonious trees were filtered to retain the 'best score' trees only. Topological

148 support for the phylogenies was estimated by bootstrap analyses. These were run with
149 10,000 pseudo-replicate samples, following the parsimony criterion and the following
150 heuristic search settings: stepwise random addition, one replicate and TBR on; steepest
151 descent and MulTrees options disabled.
152 Evolution models for Bayesian Inference were inferred in jmodeltest2 (Guindon &
153 Gascuel, 2003; Darriba & al., 2012) according to the Akaike Information Criterion (AIC
154 - Akaike, 1974). While the plastid markers *trnL-trnF* and *ndhF-trnL^{UAG}* were not
155 partitioned, thus assuming a uniform evolutionary rate across the regions, two distinct
156 elements were identified within the nuclear ITS: the highly conserved *5.8S* gene and the
157 combined, highly variable spacers ITS1 and ITS2. Sequences and models were analysed
158 for Bayesian Inference in MrBayes v.3.2.2 (Ronquist & Huelsenbeck, 2003; Ronquist &
159 al., 2011). Preliminary tests were run to help choose the most suitable parameter
160 settings. The number of generations was fixed at 10 million, with a sample frequency of
161 1000 and a burn-in of 2000, for both matrices. The Bayesian analyses were run on the
162 CIPRES Science Gateway V 3.3 (Miller & al., 2010). The output trees were edited in
163 FigTree v.1.3.1 (Rambaut & Drummond, 2009).

164 **Results**

165 The combinability of the different partitions was assessed through preliminary
166 individual Bayesian analyses (not shown). Overall, the resulting trees did not highlight
167 any topological conflict, with the exception of minor discrepancies generated by the low
168 resolution at the backbone of the trees and among the branches subtending the genera
169 *Loxocarpus*, *Emarhendia* and *Orchadocarpa* Ridl. However, since the clades defined
170 by the phylogenies remained consistent, the partitions were combined for analysis.

171 The outputs of the Parsimony and Bayesian Inference of the two datasets, 2-markers
172 and 3-markers, have been summarized in four consensus trees (strict for Parsimony,
173 50% majority rule for Bayesian Inference, all presented as electronic supplement). The
174 trees do not have fully matching topologies especially towards the backbone, but
175 consistently outline the same well-defined seven clades (Fig. 2), which are the focus of
176 this study. These clades all receive maximum support in the Bayesian 3-markers
177 analysis, as do all except clade 3 in the Bayesian 2-markers analysis (0.64 posterior
178 probability). Clade 3 has no support in either Parsimony analysis. Of the other groups,

179 all but clade 4 receive 100% bootstrap support in the Parsimony 3-markers analysis,
180 whereas in the Parsimony 2-markers analysis clades 4 and 6 receive less than 95%
181 support (Table 2).

182 The first clade to diverge within the ingroup is clade 1 (Fig. 2), formed by a group of
183 species ascribed to *Paraboea*, specifically *P. monticola* Triboun & D.J.Middleton which
184 is sister to *P. evrardii* (Pellegr.) B.L.Burttt and *P. multiflora* (R.Br.) B.L.Burttt. The
185 position of this group, with respect to the remaining ingroup taxa and the core of
186 *Paraboea*, is consistent in all the trees generated in this study, although is statistically
187 supported only by the Bayesian analyses.

188 With an increased sampling since Puglisi & al. (2011a), all the remaining species of
189 *Paraboea* form a strongly supported monophyletic group (hereafter referred to as
190 *Paraboea sensu stricto*), i.e., clade 7.

191 Similarly, *Boea* is polyphyletic, with species spread across clades 2, 3 and 6. Clade 2
192 comprises *B. geoffrayi* Pellegr., *B. hygrometrica* (Bunge) R.Br., *B. philippensis*
193 C.B.Clarke and a new species (*Boea* sp. nov.). The relative position of *Boea geoffrayi* is
194 not stable, as it appears as either sister to the new species (2-markers dataset) or to *B.*
195 *philippensis* (3-markers dataset).

196 Clade 3 contains all the examined species of *Loxocarpus*, nested within which are
197 *Emarhendia* and *Orchadocarpa*, plus a well-supported subclade (bootstrap 97-100%,
198 posterior probability 1) comprising *Senyumia*, *Spelaeanthus* and the Australasian
199 species of *Boea*. In *Boea*, the Australian *B. hygroskopica* F.Muell. is sister to the
200 accessions from Papua New Guinea, *B. lawesii* H.O.Forbes and *Boea* sp. Sister to this
201 subclade in most analyses (the 2-marker parsimony analysis is equivocal) is a clade of
202 *Loxocarpus* which includes *L. rufescens* (C.B.Clarke) B.L.Burttt, *L. sericiflavus* (Kiew
203 & Banka) T.L.Yao, *L. holttumii* M.R.Hend. and related species. A second clade of
204 *Loxocarpus* is formed by the accessions of *L. incanus* R.Br. and is most closely related
205 to *Orchadocarpa*. The remaining accessions of *Loxocarpus*, *L. argenteus* B.L.Burttt, *L.*
206 *violoides* (C.B.Clarke) T.L.Yao, *L. verbeniflos* (C.B.Clarke) B.L.Burttt and *L. repens*
207 B.L.Burttt, form a further, well supported clade. The affinities of *Emarhendia* are not
208 entirely clear.

209 The remaining *Boea* species, *B. clarkeana* Hemsl., is nested within *Damrongia* in clade
210 6 in all the analyses, and is sister to *D. trisejala* (Barnett) D.J.Middleton & A.Weber
211 and *D. cyanantha* Triboun. Likewise, *Streptocarpus sumatranus* B.L.Burt is
212 consistently nested inside *Damrongia* and is likely related to *D. lacunosa* (Hook.f.)
213 D.J.Middleton & A.Weber or *D. fulva* (Barnett) D.J.Middleton. All these species
214 together form a well-supported clade, which is sister to *Streptocarpus orientalis* Craib,
215 completing clade 6. Clade 6 is strongly supported as sister to clade 5, which
216 corresponds to a clearly monophyletic *Somrania* D.J.Middleton. Within *Somrania*, *S.*
217 *albiflora* D.J.Middleton is sister to *S. lineata* D.J.Middleton & Triboun plus *S. flavida*
218 D.J.Middleton & Triboun.

219 Clade 4 is formed by *Kaisupeea* and *Rhabdothamnopsis* Hemsl. (the latter genus not
220 represented in the 3-markers dataset) as sister genera to *Ornithoboea*. In *Kaisupeea*, the
221 relationships between the three species remain unclear, with poor support for the
222 placement of *K. cyanea* B.L.Burt. *Ornithoboea* receives maximum support as a
223 monophyletic genus.

224 **Discussion**

225 Our analyses reveal that the Loxocarpaceae comprise a number of well-supported clades,
226 with the exception of clade 3, and also reveal that many genera are not monophyletic
227 (*Boea*, *Damrongia*, *Loxocarpus*, *Paraboea* and *Streptocarpus*). Among the genera with
228 more than one species, only the monophyly of *Ornithoboea*, *Somrania* and *Kaisupeea* is
229 supported. However, relationships between many of these clades are poorly resolved or
230 supported, providing only limited information about higher level relationships within
231 the subtribe. Relationships involving *Loxocarpus*, *Emarhendia* and *Orchadocarpa*
232 within clade 3 are particularly complex.

233
234 **Boea.**--- This study confirms the polyphyly of *Boea* already shown by Möller & al.
235 (2009, 2011). Six out of 14 species were included in the analyses. They are found in
236 three different clades (2, 3 and 6): *Boea clarkeana* (Fig. 3: 6c) is nested in *Damrongia*
237 (clade 6), whereas *B. hygroscopica* (Fig. 3: 3f), *B. lawesii* and an unnamed species form
238 a clade with *Senyumia* (Fig. 3: 3d) and *Spelaeanthus* (Fig. 3: 3e), nested within
239 *Loxocarpus* (clade 3). The remaining four species examined form a clade on their own

240 (clade 2, Fig. 3: 2). These results indicate that *Boea*, already greatly reduced in size by
241 the removal of several segregate genera and the realignment with *Paraboea*, is not
242 tenable in its current delimitation and should be split. Morphological characters, such as
243 the shape of the corolla, also support a formal separation. The type species of *Boea*, *B.*
244 *magellanica* Comm. ex Lam., from Papua New Guinea and the Solomon Islands, was
245 not examined here, but has the same corolla morphology as the other members of the
246 Australasian group, especially *Boea lawesii*: the flower has a flat-faced, unevenly
247 coloured corolla and the stamens are exserted; the filaments are bent and they appear
248 bright yellow and fleshy. Conversely, the corolla of all the species forming clade 2 is
249 uniformly lilac to blue, obliquely campanulate with a ventricose tube, reflexed upper
250 lobes and a broad throat; the stamens are included in the throat, have slender filaments
251 and the anthers are erect (Fig. 3: 2). Under the new circumscription suggested here, the
252 name *Boea* remains with the Australasian group (*B. magellanica*, *B. hygroskopica*, *B.*
253 *lawesii*, etc.), whereas clade 2 acquires the resurrected name *Dorcoceras* Bunge (1832),
254 coined for *Dorcoceras hygrometricum* Bunge. The hitherto inclusion of the species of
255 *Dorcoceras* within *Boea* is a relic of the very broad generic concept adopted by Clarke
256 (1883) which neither Schlechter (1923) nor Burt (1984) effectively resolved. The
257 resurrected *Dorcoceras* includes the four Southeast Asian species of *Boea* with a
258 campanulate corolla: *B. geoffrayi*, *B. hygrometrica*, *B. philippensis* and *B. wallichii*
259 R.Br. The new combinations are provided below.

260 *Boea clarkeana*, instead, is transferred to *Damrongia*, based on the results of the
261 phylogenetic analysis and its morphological similarity to *D. trisepala* (Fig. 3: 6b). There
262 are also substantial differences between *Boea clarkeana* and the existing species of
263 *Damrongia*, the most obvious of which are in the fruit. *Boea clarkeana* has an
264 orthocarpic, twisted capsule that bears little resemblance to the plagiocarpic, straight
265 fruit of the other *Damrongia* species. However, *Paraboea* (Puglisi & al., 2011a and see
266 below) and *Ornithoboea* (Scott & Middleton, 2014) also contain species with twisted
267 and species with non-twisted capsules, indicating that this character is variable within
268 genera, and hence not a good argument against transferring *Boea clarkeana* to
269 *Damrongia*.

270

271 **Paraboea.**--- *Paraboea* was found to be non-monophyletic, with clade 1 forming a
272 group separate from all the other species (Fig. 2). *Paraboea s.s.* (clade 7, Fig. 3: 7) is
273 monophyletic with high statistical support and the same overall structure as found by
274 Puglisi & al. (2011a). The first subclade to diverge includes all species with a calyx
275 divided into five equal parts that are found north of the Isthmus of Kra in the Thai
276 Peninsula. Of the two other sister subclades, one comprises species formerly placed in
277 *Trisepalum* and *Phylloboea*, and is characterised morphologically by a strongly
278 bilabiate calyx; the other, instead, comprises species with a calyx divided into five equal
279 parts and distributed south of the Isthmus of Kra and in Malesia.

280 Clade 1 possesses characters typical of *Paraboea*, such as the interwoven indumentum
281 on the lower surface of the leaves, the flat-faced corolla and the twisted capsules.
282 However, these plants also have stamens with free, erect anthers opening upwards, with
283 the apices of the anthers parallel to the axis of the flower. The species of *Paraboea s.s.*,
284 conversely, have anthers with the apex rotated towards the gynoecium, coherent,
285 divergent and opening along the median line. The gynoecia also differ, as in clade 1
286 there is an indumentum of minute white, greenish or yellow glands on the ovary and the
287 capsule which is absent in clade 7. The clear phylogenetic and morphological
288 distinction of this group from the rest of *Paraboea* supports the segregation of a new
289 genus, *Middletonia* C.Puglisi (Fig. 3: 1).

290 It should be noted that the sample of *Paraboea multiflora* in Puglisi & al. (2011a),
291 which formed a monophyletic clade with the core *Paraboea* species, was misidentified.
292 The voucher (*Wen 2010-01*, collected in Guangdong, China) could not be located but a
293 new specimen said to be from the same locality and of the same species by the original
294 collector has been identified as *Paraboea cf. dictyoneura* (Hance) B.L.Burt, which is
295 morphologically similar to the species in its clade and not to *P. multiflora*. The sample
296 was omitted from the analyses presented here.

297

298 **Streptocarpus.**--- *Streptocarpus* is an Afro-Madagascan genus with c. 140 species, first
299 described in 1828. Due to the presence of a twisted capsule, Franchet (1899), Craib
300 (1911, 1919) and Burt (1962) decided to ascribe to this genus some Asian plants which
301 did not have a better alternative placement. There are currently three species of
302 *Streptocarpus* in Asia: *S. burmanicus* Craib from Burma, *S. orientalis* from Thailand

303 and *S. sumatranus* from West Sumatra (Indonesia). Despite the carpological similarity,
304 Möller & al. (2009), Puglisi (2014) and the present study all show that *Streptocarpus*
305 *orientalis* does not form a monophyletic group with the other species of the genus
306 (represented by the African *S. rexii* and *S. glandulosissimus* in the present study).
307 Puglisi (2014) and the present study additionally show that *Streptocarpus sumatranus*
308 does not form a monophyletic group either with the African species or with *S.*
309 *orientalis*.

310 In the present study, *Streptocarpus sumatranus* is nested within *Damrongia*. When he
311 described it, Burtt (1962) was unable to place it in any existing Southeast Asian genus
312 of Gesneriaceae and opted, cautiously, for *Streptocarpus* because of its caulescent habit,
313 the narrowly campanulate corolla and the twisted capsule. Moving *Streptocarpus*
314 *sumatranus* into *Damrongia* is currently the best option, or at least the only viable
315 option, given its current, untenable position as a species of *Streptocarpus*. This
316 inclusion deeply alters the morphological characterisation of *Damrongia*, especially
317 through the introduction of the caulescent habit in the genus. A twisted fruit has already
318 been introduced into *Damrongia* by the inclusion of *Boea clarkeana*, incidentally a
319 species also formerly ascribed to *Streptocarpus* (Hilliard & Burtt, 1971).

320 *Streptocarpus orientalis* is sister to *Damrongia* (incl. *Boea clarkeana* and *Streptocarpus*
321 *sumatranus*, Fig. 3D). Its inclusion in *Streptocarpus* is clearly erroneous and the species
322 requires a more appropriate generic placement. As the expanded *Damrongia*, including
323 *Boea clarkeana* and *Streptocarpus sumatranus*, already possesses morphological
324 characters such as the twisted capsule, caulescent habit and chiritoid stigma (two-lipped
325 stigma with the upper lip strongly reduced and the lower bilobed), which are characters
326 also present in *S. orientalis*, the most appropriate course of action is to place *S.*
327 *orientalis* in *Damrongia*, rather than in a separate genus. Although no sample of
328 *Streptocarpus burmanicus* was available for DNA extraction, its morphology suggests
329 this species to be very closely related to *S. orientalis*. With these changes, the
330 distribution of *Damrongia* becomes much wider, from China to Sumatra.

331

332 **Loxocarpus.**--- *Loxocarpus* was found to be non-monophyletic in this and previous
333 phylogenies (Yao, 2012; Puglisi, 2014), forming three distinct, well-supported clades.

334 Mixed in with these, and together forming clade 3, are *Orchadocarpa*, *Emarhendia* and
335 the *Boea/Spelaeanthus/Senyumia* subclade, but relationships among these lineages are
336 not fully resolved.

337 One *Loxocarpus* clade contains all the accessions of the type species of the genus,
338 *Loxocarpus incanus*, including *L. incanus* var. *sekayuensis* (Banka & Kiew) T.L.Yao.
339 In the 2-markers trees, the separation of *Loxocarpus incanus* var. *sekayuensis* from *L.*
340 *incanus* var. *incanus* does not receive strong support. Further investigation of this
341 species is needed as perhaps the identifications were not accurate at the varietal level. A
342 second clade of *Loxocarpus*, including e.g. *L. violoides* (C.B.Clarke) T.L.Yao, is
343 entirely composed of species from Borneo and is morphologically heterogeneous in that
344 it includes one species, *L. argenteus* B.L.Burt, with a campanulate corolla, in contrast
345 to the other members of the group, all with flat-faced corollas (Yao, 2012). The third
346 *Loxocarpus* clade is entirely made of species with a campanulate corolla, comprising *L.*
347 *rufescens* (C.B.Clarke) B.L.Burt from Borneo and species from the Malay Peninsula.
348 This clade is sister to the *Senyumia/Spelaeanthus/Boea* alliance in all the analyses, but
349 this relationship receives significant support only in the 3-markers Bayesian Inference.
350 Nevertheless, *Loxocarpus* is clearly paraphyletic and perhaps best split into three
351 different genera, since the morphologies of *Boea*, *Senyumia* and *Spelaeanthus* are too
352 different to encourage the synonymisation into a large genus encompassing the entire
353 clade 3 (Fig. 3: 3). However, the geographical and morphological ranges present in
354 *Loxocarpus* remain relatively poorly sampled, and these, plus the incomplete resolution
355 of clade 3, make the proposition of formal taxonomic changes premature. Hence
356 *Loxocarpus* is left unaltered, until further studies provide more data.

357

358 **Patterns of diversity.**--- Gesneriaceae present several fruit types: fleshy or dry berries
359 and capsules, these orthocarpic or plagiocarpic, cylindrical or conical and varying
360 greatly in length and mode of dehiscence (Weber, 2004). In the Loxocarpaceae only dry
361 capsules are found. The most common shape is cylindrical, with longitudinal dehiscence
362 into two valves (Fig. 1A-1B). Most twisted capsules have this structure, or, less
363 frequently, are conical, as in the group of *Paraboea* species with a bilabiate calyx.
364 Straight fruit types need to be further categorised. Most straight capsules, like the
365 twisted ones, dehisce into two valves along two suture lines. The straight fruits of

366 *Orchadocarpa* and *Paraboea* (except for *P. incudicarpa* B.L.Burt) have this
367 morphology, and ortho- and plagiocarpic forms exist. A variation of this morphology is
368 seen in *Loxocarpus*, where the short, conical and plagiocarpic capsule has two dorso-
369 ventral valves which are strongly unequal and whose dehiscence results in a cup for
370 splash dispersal (Fig. 1C). *Paraboea incudicarpa*, *Somrania* and *Emarhendia*, instead,
371 produce capsules that are plagiocarpic and cylindrical but, unlike those of e.g.
372 *Orchadocarpa*, dehisce only along the upper suture line (Fig. 1D).

373 While most genera of Loxocarpaceae have exclusively twisted or straight fruits, few have
374 both types represented among their species. Genera with an exclusively straight fruit are
375 *Emarhendia*, *Loxocarpus*, *Orchadocarpa* and *Somrania*, although all with substantially
376 different types of capsules. Genera with an exclusively twisted fruit are *Dorcoceras*,
377 *Rhabdothamnopsis*, *Senyumia* and *Spelaeanthus*. Finally, genera where both states are
378 present are *Boea*, *Damrongia*, *Kaisupeea*, *Middletonia*, *Ornithoboea* and *Paraboea*.

379 Despite the obvious difference in fruit morphologies, there does not appear to be any
380 clear pattern across the phylogenetic trees. A lack of consistency was already inferred
381 by Burt (1984), when he modified the generic boundaries of *Boea* and *Paraboea*
382 hitherto based on the fruit twisting. In our phylogeny, the position of *Middletonia* and
383 *Dorcoceras* suggests that a twisted fruit is the ancestral condition, and that straight
384 fruits have evolved several times in the Loxocarpaceae. This mirrors the evolution of the
385 other subtribe of Gesneriaceae with a predominantly twisted fruit, the Streptocarpaceae,
386 where multiple independent losses of fruit twist have been inferred by Nishii et al. (in
387 press). In order to make further progress in our understanding of the evolution of the
388 fruit in the Loxocarpaceae, however, a more in-depth carpological study is necessary.

389 While the variation in fruit type does not form a clear pattern in the tree topology,
390 distribution data show a geographic line along the Isthmus of Kra in Peninsular
391 Thailand. This is most remarkable in *Paraboea*, where two subclades (with e.g. *P.*
392 *crassifolia* (Hemsl.) B.L.Burt and *P. acutifolia* (Ridl.) B.L.Burt) comprise species
393 predominantly from south and north of the Isthmus, respectively. Species of the two
394 groups are not as distinct morphologically as they are geographically and genetically.
395 The same situation is present in the third subclade of *Paraboea* (with e.g. *P. subplana*
396 (B.L.Burt) C.Puglisi), sister to the species found south of Kra, where the two main

397 branches show a well-supported separation between species found on either side of the
398 Isthmus.

399 In *Ornithoboea*, conversely, the three species found south of the Isthmus of Kra are
400 morphologically distinct from their northern congeners (Scott & Middleton, 2014),
401 although the current phylogeny does not provide unambiguous support for a matching
402 genetic differentiation.

403 *Emarhendia*, *Orchadocarpa*, *Senyumia*, *Somrania*, *Spelaeanthus* and all the species
404 currently placed in *Loxocarpus* are entirely restricted to south of the Isthmus of Kra.
405 *Boea* is only present much further east. *Middletonia* and *Damrongia* have species both
406 south and north of the Isthmus of Kra, but the relationships between the species are not
407 yet sufficiently resolved to test whether there is a significant biogeographical element to
408 them. Additionally, *Damrongia trisejala* has a distribution that straddles the Isthmus of
409 Kra, a rare occurrence in the Loxocarpaceae.

410 *Dorcoceras* has a different distribution pattern from the other Loxocarpaceae. Most
411 species occur on the Asian continent, and one species, *D. philippense*, is broadly
412 distributed in China, Laos, Vietnam, the Philippines and central Indonesia. This might
413 suggest a migration from the continent to Indonesia through the Philippines, which
414 differs from the pattern observed in the rest of the tribe Trichosporeae (Weber, 2004;
415 Cronk & al., 2005; Möller & al., 2009, 2011), involving migration from China
416 southwards, along the Thai/Malay Peninsula and then west to east across Malesia. The
417 different route of migration of *Dorcoceras* does not touch the Isthmus of Kra and
418 neither seems to cross any other discontinuity line to the east or the west.

419 **Taxonomic treatment**

420 **Boea** Comm. ex Lam., Encycl. 1: 401. 1785 – Type: *Boea magellanica* Comm. ex Lam.
421 Fig. 3: 3f.

422 Ten species, distributed in Eastern Indonesia, Papua New Guinea, the Solomon Islands
423 and Queensland (Australia). This is the only genus of the Loxocarpaceae to have an
424 Australasian distribution. *Boea* has a flat-faced corolla, exserted stamens, a twisted,
425 orthocarpic capsule and a thin, simple indumentum on the lower surface of the leaf.

426 Species list: *Boea dennisii* B.L.Burtt, *Boea hemsleyana* B.L.Burtt, *Boea hians* Burkill,
427 *Boea hygroskopica* F.Muell., *Boea kinnearii* (F.Muell.) B.L.Burtt, *Boea lawesii*
428 H.O.Forbes, *Boea magellanica* Comm. ex Lam., *Boea mollis* Schltr., *Boea rosselensis*
429 B.L.Burtt, *Boea urvillei* C.B.Clarke.

430

431 **Damrongia** Kerr ex Craib in Bull. Misc. Inform. Kew 1918(10): 364. 1918 – Type:
432 *Damrongia purpureolineata* Kerr ex Craib. Fig. 3: 6a-6c.

433 With the inclusion of *Boea clarkeana* and the three Asian species of *Streptocarpus*, and
434 with the synonymisation of *Damrongia cyanantha* into *D. trisepala*, *Damrongia* is now
435 a genus of ten species, centred in Thailand and distributed from China to Sumatra. All
436 species have an infundibuliform-tubular corolla and a chiritoid stigma, and the species
437 for which a count is available, all have chromosome number $2n=18$ (Christie et al.,
438 2012; Möller & Pullan, 2015 onwards). The new circumscription has broadened the
439 range of morphological variation of *Damrongia*, with the addition of characters such as
440 the caulescent habit and the twisted, orthocarpic fruit.

441 The following are the new combinations in *Damrongia*.

442 **Damrongia burmanica** (Craib) C.Puglisi, **comb. nov.** \equiv *Streptocarpus burmanicus*
443 Craib in Notes Roy. Bot. Gard. Edinburgh 11(55): 253. 1919 – Lectotype (designated
444 by Hilliard & Burtt, 1971: 370): Upper Burma, Meiktila district, Taunggyigon Reserve,
445 *Mg Tha Myaing 262* (E barcode E00155311 (sheet 1) – E00155312 (sheet 2);
446 islectotype K, n.v.).

447 **Damrongia clarkeana** (Hemsl.) C.Puglisi, **comb. nov.** \equiv *Boea clarkeana* Hemsl. in J.
448 Linn. Soc., Bot. 26(174): 232–233. 1890 \equiv *Dorcoceras clarkeanum* (Hemsl.) Schltr. in
449 Bot. Jahrb. Syst. 58: 259. 1923 \equiv *Streptocarpus clarkeanus* (Hemsl.) Hilliard &
450 B.L.Burtt, *Streptocarpus*: Afr. Pl. Study: 388. 1971 – Holotype: China, Hupeh (Hubei),
451 Nanto and mountains to the northward and South Tunghu, *Henry 7584* (K barcode
452 K000249894; isotypes NY barcode NY01287860, US barcode US00064695).

453 = *Boea mairei* H.Lév. in Repert. Spec. Nov. Regni Veg. 12(325–330): 286. 1913 –

454 **Lectotype (designated here)**: China, Yunnan, rochers inaccessibles au soleil, pied des

455 montagnes a La-Kou, *Maire s.n.* (E barcode E00175310; isolectotype: G barcode
456 G00303008).

457 = *Boea densihispidula* S.B.Zhou & X.H.Guo in Acta Phytotax. Sin. 29(5): 477–478, t.1.
458 1991 – Holotype: China, Anhui, Guichi, Tanxi, *Zhou Xiu-Fang 89053* (ANU n.v.;
459 isotype: PE n.v.).

460 **Damrongia orientalis** (Craib) C.Puglisi, **comb. nov.** ≡ *Streptocarpus orientalis* Craib
461 in Bull. Misc. Inform. Kew 1911(10): 432. 1911 – Lectotype (first step, designation of
462 *Kerr 769* (K) by Hilliard & Burt, 1971: 371, second step designated here): Thailand,
463 Chiangmai [=Chiang Mai], Doi Sutep, *Kerr 769* (K barcode K000545610;
464 isolectotypes: K barcode K000545611 and barcode K000545612, PH barcode
465 PH00029114).

466 **Damrongia sumatrana** (B.L.Burt) C.Puglisi, **comb. nov.** ≡ *Streptocarpus sumatranus*
467 B.L.Burt in Notes Roy. Bot. Gard. Edinburgh 24: 48. 1962 – Holotype: Indonesia, W.
468 Sumatra, near Halaban, Pajakumbuh region, *Meijer 7560* (L barcode L0790314;
469 isotype: SING barcode SING0194684).

470 **Damrongia trisejala** (Barnett) D.J.Middleton & A.Weber in Taxon 60(3): 778. 2011 ≡
471 *Chirita trisejala* Barnett in Nat. Hist. Bull. Siam Soc. 20: 18. 1961 – Lectotype
472 (designated by Barnett, 1961: 255): Thailand, Chantaburi, Kao Sabap, *Put 905* (K
473 barcode K000545608; isolectotypes: ABD, BK barcode BK257925, BKF n.v., BM
474 barcode BM000997773).

475 = *Damrongia cyanantha* Triboun in Thai For. Bull., Bot. 38: 109. 2010, **syn. nov.** –
476 Holotype: Thailand, Kamphaeng Phet, Khlong Lan Waterfall, *Triboun & Yothakaew*
477 *4289* (BK n.v.; isotypes: BKF n.v., E barcode E00576669).

478 Species list: *Damrongia burmanica* (Craib) C.Puglisi, *Damrongia clarkeana* (Hemsl.)
479 C.Puglisi, *Damrongia cyanea* (Ridl.) D.J.Middleton & A.Weber, *Damrongia fulva*
480 (Barnett) D.J.Middleton & A.Weber, *Damrongia integra* (Barnett) D.J.Middleton &
481 A.Weber, *Damrongia lacunosa* (Hook. f.) D.J.Middleton & A.Weber, *Damrongia*
482 *orientalis* (Craib) C.Puglisi, *Damrongia purpureolineata* Kerr ex Craib, *Damrongia*

483 *sumatrana* (B.L.Burt) C.Puglisi, *Damrongia trisejala* (Barnett) D.J.Middleton &
484 A.Weber.

485

486 **Dorcoceras** Bunge, Enum. Pl. Chin. Bor.: 54. 1832 (1833) – Type: *Dorcoceras*
487 *hygrometricum* Bunge. Fig. 3: 2.

488 This genus is resurrected to accommodate the four species with a campanulate corolla
489 excluded from *Boea*. *Dorcoceras* is found in China, Thailand, Cambodia, Vietnam,
490 Philippines and Indonesia. *Dorcoceras* has a rosulate habit, simple indumentum, free
491 calyx lobes and an obliquely campanulate, lilac corolla, with inserted stamens arising at
492 the mouth. The new combinations needed are below.

493 **Dorcoceras geoffrayi** (Pellegr.) C.Puglisi, **comb. nov.** ≡ *Boea geoffrayi* Pellegr. in
494 Bull. Soc. Bot. France 73: 425. 1926 – Lectotype (designated by Burt, 1984: 420):
495 Cambodia, Kampot, mont Pnom-Dong, *Geoffray 58* (P barcode P00606312).

496 **Dorcoceras wallichii** (R.Br.) C.Puglisi, **comb. nov.** ≡ *Boea wallichii* R.Br., On
497 *Cyrtandreae* 124. 1839 ≡ *Didymocarpus helicteroides* Wall., Numer. List n. 789. 1829,
498 *nom. nud.* – Type: Upper Burma, Toong Dong, *Wallich list n. 789* (BM barcode
499 BM000906643, K barcode K000249883).

500 Species list: *Dorcoceras geoffrayi* (Pellegr.) C.Puglisi, *Dorcoceras hygrometricum*
501 Bunge, *Dorcoceras philippense* (C.B.Clarke) Schltr., *Dorcoceras wallichii* (R.Br.)
502 C.Puglisi.

503

504 **Emarhendia** Kiew, A.Weber & B.L.Burt in Beitr. Biol. Pflanzen 70(2–3): 398. 1997
505 (1998) – Type: *Emarhendia bettiana* (M.R.Hend) Kiew, A.Weber & B.L.Burt
506 (≡*Paraboea bettiana* M.R.Hend.). Fig. 3: 3b.

507 One species, endemic to Peninsular Malaysia, characterised by the plagiocarpic, straight
508 fruit and the patch of glandular hairs between the two upper corolla lobes. Its
509 relationships with *Loxocarpus* and *Orchadocarpa* are in need of further clarification.

510

511 **Kaisupeea** B.L.Burt in Nordic J. Bot. 21(2): 115–119. 2001 – Type: *Kaisupeea*
512 *herbacea* (C.B.Clarke) B.L.Burt (≡ *Boea herbacea* C.B.Clarke). Fig. 3: 4a.

513 Three species from Burma and Thailand, characterised by the indumentum
514 predominantly consisting of glandular hairs and the anthers hairy at the back. *Kaisupeea*
515 is most closely related to *Rhabdothamnopsis*.

516 Species list: *Kaisupeea cyanea* B.L.Burt, *Kaisupeea herbacea* (C.B.Clarke) B.L.Burt,
517 *Kaisupeea orthocarpa* B.L.Burt.

518

519 **Loxocarpus** R.Br., Cyrtandreae: 120. 1839 – Type: *Loxocarpus incanus* R.Br. Fig. 3:
520 3a.

521 This recently revised genus (Yao, 2012) comprises 20–23 species, distributed in the
522 Thai-Malay Peninsula, Sumatra and Borneo. Its most characteristic feature is the
523 conical, plagiocarpic capsule, but it is otherwise highly variable in morphology. The
524 phylogenetic analysis confirmed its non-monophyly and revealed the consistent
525 presence of three distinct groups of species. Given the paucity of the material currently
526 available for *Loxocarpus*, the genus is left untouched until further focused research, also
527 involving the other Malaysian genera *Emarhendia* and *Orchadocarpa*.

528 Species list: *Loxocarpus angustifolius* Ridl., *Loxocarpus argenteus* B.L.Burt,
529 *Loxocarpus caeruleus* (Ridl.) Ridl., *Loxocarpus caulescens* B.L.Burt, *Loxocarpus*
530 *conicapsularis* (C.B.Clarke) B.L.Burt, *Loxocarpus coodei* (B.L.Burt) T.L.Yao,
531 *Loxocarpus holttumii* M.R.Hend., *Loxocarpus incanus* R.Br., *Loxocarpus incanus* var.
532 *sekayuensis* (Banka & Kiew) T.L.Yao, *Loxocarpus meijeri* B.L.Burt, *Loxocarpus*
533 *pauzii* T.L.Yao, *Loxocarpus repens* B.L.Burt, *Loxocarpus rufescens* (C.B.Clarke)
534 B.L.Burt, *Loxocarpus semitortus* (C.B.Clarke) Ridl., *Loxocarpus sericeus* (Ridl.)
535 B.L.Burt, *Loxocarpus sericiflavus* (Banka & Kiew) T.L.Yao, *Loxocarpus stapfii*
536 (Kraenzl.) B.L.Burt, *Loxocarpus taeniophyllus* (B.L.Burt) T.L.Yao, *Loxocarpus tunkui*
537 Kiew, *Loxocarpus verbeniflos* (C.B.Clarke) B.L.Burt, *Loxocarpus violoides*
538 (C.B.Clarke) T.L.Yao.

539

540 **Middletonia** C.Puglisi, **gen. nov.** – Type: *Middletonia multiflora* (R.Br.) C.Puglisi. (=
541 *Boea multiflora* R.Br.). Fig. 3: 1.

542 Similar to *Paraboea* (C.B.Clarke) Ridl. in having a matted indumentum on the abaxial
543 side of the leaves but distinct by the farinose glandular indumentum on the ovary and
544 the free and erect anthers.

545 = *Boea* sect. *Caulescentes* Fritsch in Engler & Prantl, Nat. Pflanzenfam. 4(3B): 150.
546 1894 – Lectotype (designated by Burtt, 1954: 194): *Boea multiflora* R.Br.

547 Lithophytic, shortly caulescent, perennial herbs. Leaves opposite, those of a pair equal;
548 lamina oblong to elliptic, apex obtuse to acute, base cuneate to obtuse, sometimes
549 oblique, margin crenate or serrate, adaxial surface glabrescent, furfuraceous or
550 pubescent, abaxial surface with a matted indumentum; veins raised beneath, more or
551 less smooth above, tertiary veins reticulate and visible on the abaxial surface, especially
552 in proximity to the leaf margin. Inflorescence an axillary cyme, many-flowered, densely
553 tomentose; peduncles longer or shorter than the leaves; bracts inconspicuous. Calyx 5-
554 merous, lobes divided to the base; lobes 1–3 mm long, narrowly ovate, glabrous or
555 glandular inside, more or less tomentose outside. Corolla 5-merous, white, violet or
556 blue, slightly bilabiate, 4–8(–10) mm long, 4–10 mm across, with or without an
557 indumentum; tube 1–3 mm long; limb slightly 2-lipped, upper lip with 2 lobes 2–6(–9)
558 × 1–6.5 mm, lower lip 3-lobed, lobes 2–6(–9) × 1–6.5 mm, all lobes spreading, flat.
559 Stamens 2; filaments straight; anthers with a minute, glandular indumentum, not
560 coherent, opening towards the top; staminodes 2, reduced or aborted. Ovary syncarpous,
561 2-carpellate, ovoid, with a farinose glandular indumentum, 1–2.5 × c. 1 mm, ovules
562 many; style glabrous, 2.5–3 mm long; stigma capitate. Fruit a capsule, to 1.3 cm long,
563 straight or twisted, retaining the indumentum of the ovary. Seeds minute, compressed.

564 Distribution: India, Bangladesh, Bhutan, China, Burma, Thailand, Laos, Cambodia,
565 Vietnam, Malaysia.

566 Habitat: limestone or granite.

567 This new genus is segregated from *Paraboea* following the results of the phylogenetic
568 study and the subsequent morphological investigation. The new combinations in
569 *Middletonia* are given below.

570 **Middletonia evrardii** (Pellegr.) C.Puglisi, **comb. nov.** \equiv *Boea evrardii* Pellegr. in
571 Lecomte, Fl. Indo-Chine 4: 550. 1930 \equiv *Paraboea evrardii* (Pellegr.) B.L.Burtt in Notes
572 Roy. Bot. Gard. Edinburgh 41(3): 428. 1984 – Isolectotypes (designated by Burtt, 1984:
573 428): Vietnam, Lam Dong, Pongour near Di Linh, *Evrard 1177* (P barcode P00556499,
574 P barcode P00622885).

575 = *Boea multiflora* var. *villosa* Pellegr. in Bull. Soc. Bot. France 73: 424. 1926. [pro
576 parte] – Lectotype (designated by Xu & al., 2008: 276): Laos, Savannakhet, haut vours
577 de la Tchépone a 500–600 m, dans les roches, *E. Poilane 12188* (P barcode
578 P00634326).

579 **Middletonia monticola** (Triboun & D.J.Middleton) C.Puglisi, **comb. nov.** \equiv *Paraboea*
580 *monticola* Triboun & D.J.Middleton in Gard. Bull. Singapore 64(2): 346. 2012 –
581 Holotype: Thailand, Phangnga, Tai Toy, *Triboun 3662* (BK n.v.; isotype: E n.v.).

582 **Middletonia multiflora** (R.Br.) C.Puglisi, **comb. nov.** \equiv *Boea multiflora* R.Br., Pl. Jav.
583 Rar. Cyrtandreae: 120. 1840 \equiv *Paraboea multiflora* (R.Br.) B.L.Burtt in Notes Roy.
584 Bot. Gard. Edinburgh 41(3): 433. 1984 \equiv *Didymocarpus multiflorus* Wall., Numer. List.
585 No.: 793. 1829, *nom. nud.* – Lectotype (designated by Xu & al., 2008: 276):
586 Bangladesh, Pundua, Sylhet Mt., *De Silva in Wallich 793* (BM barcode BM000797995;
587 isotype: K barcode K001111906).

588 = *Boea flocculosa* C.B.Clarke in Commelyn. Cyrtandr. Bengal. t. 83. 1874 – Lectotype
589 (designated by Burtt, 1984: 434): India, Khasia Hills, *Hooker & Thomson s.n.* (K n.v.).

590 = *Boea multiflora* R.Br. var. *burmannica* C.B.Clarke in A.DC. & C.DC., Monogr. Phan.
591 5(1): 144. 1883 – Lectotype (designated by Burtt, 1984: 434): Burma, Moulmein,
592 *Parish 436* (K n.v.).

593 = *Boea microcarpa* Drake in Bull. Soc. Philom. Paris, ser. 8, 2: 130. 1890 ≡ *Paraboea*
594 *microcarpa* (Drake) B.L.Burtt in Notes Roy. Bot. Gard. Edinburgh 41(3): 433. 1984 –
595 Holotype: Vietnam, Quang Ninh, Tangkeuin, *Balansa 4302* (P barcode P00556510).

596 = *Boea thirionii* H.Lév. in Repert. Spec. Nov. Regni Veg. 11(286–290): 301. 1912 ≡
597 *Paraboea thirionii* (H.Lév.) B.L.Burtt in Notes Roy. Bot. Gard. Edinburgh 41(3): 439.
598 1984 – Holotype: China, Kweichow, Gny-ken, *Esquirol 2699* (E barcode E00265058),

599 = *Boea multiflora* R.Br. var. *villosa* Pellegr. in Lecomte, Fl. Indo-Chine 4: 549. 1930
600 [pro parte] – Lectotype (designated by Xu & al., 2008: 276): Laos, Savannakhet, haut
601 vours de la Tchépone a 500–600 m, dans les roches, *Poilane 12188* (P barcode
602 P00634326).

603 = *Boea reticulata* Barnett, Nat. Hist. Bull. Siam Soc. 20: 20. 1961. Lectotype
604 (designated by Barnett, 1961: 256): Thailand, Chiangmai, Me Wang, *Kerr 6356* (K
605 barcode K000196614; isolectotype: ABD, BK barcode BK257920, BM barcode
606 BM000906647).

607 **Middletonia multiflora var. caulescens** (Z.R.Xu & B.L.Burtt) C.Puglisi, **comb. nov.** ≡
608 *Paraboea multiflora* var. *caulescens* Z.R.Xu & B.L.Burtt in Edinburgh J. Bot. 48(1):
609 7–8. 1991 – Holotype: Thailand, Kanchanaburi, near Neekey, near Wangka, *G. Den*
610 *Hoed Exp. No. 946* (L barcode L0003189).

611 **Middletonia regularis** (Ridl.) C.Puglisi, **comb. nov.** ≡ *Didymocarpus regularis* Ridl. J.
612 Linn. Soc., Bot 32: 515. 1896 ≡ *Paraboea regularis* (Ridl.) Ridl. in J Straits Branch
613 Roy. Asiat. Soc. 44: 68. 1905 – Lectotype (designated by Burtt, 1984: 435): *Curtis s.n.*
614 (SING barcode SING0042998; isolectotype: E barcode E00451499).

615

616 **Orchadocarpa** Ridl. in J. Straits Branch Roy. Asiat. Soc. 44: 78. 1905 – Type:
617 *Orchadocarpa lilacina* Ridl. Fig. 3: 3c.

618 Monotypic genus from Peninsular Malaysia. It is recognisable by the short fruit,
619 completely enclosed by the calyx, and the flat-faced corolla with a lower lip longer than

620 the upper. The placement of *Orchadocarpa* in the phylogeny remains, like that of
621 *Emarhendia*, unresolved but likely to be somewhat close to part of *Loxocarpus*.

622

623

624 **Ornithoboea** Parish ex C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 147. 1883
625 – Type: *Ornithoboea parishii* C.B.Clarke. Fig. 3: 4c.

626 This genus was revised recently (Scott & Middleton, 2014) and consists of 16 species
627 from China, Thailand, Burma, Vietnam, Laos and Malaysia. It is easily recognisable by
628 the palatal beard and the circlet of hairs around the corolla mouth. *Ornithoboea* was
629 found to be monophyletic and its closest relatives are *Rhabdothamnopsis* and
630 *Kaisupeea*.

631 Species list: *Ornithoboea arachnoidea* (Diels) Craib, *Ornithoboea barbanthera*
632 B.L.Burt, *Ornithoboea calcicola* C.Y.Wu ex H.W.Li, *Ornithoboea emarginata*
633 D.J.Middleton & N.S.Lý, *Ornithoboea feddei* (H.Lév.) B.L.Burt, *Ornithoboea flexuosa*
634 (Ridl.) B.L.Burt, *Ornithoboea henryi* Craib, *Ornithoboea lacei* Craib, *Ornithoboea*
635 *maxwellii* S.M.Scott, *Ornithoboea multitorta* B.L.Burt, *Ornithoboea obovata*
636 S.M.Scott, *Ornithoboea occulta* B.L.Burt, *Ornithoboea parishii* C.B.Clarke,
637 *Ornithoboea pseudoflexuosa* B.L.Burt, *Ornithoboea puglisiae* S.M.Scott, *Ornithoboea*
638 *wildeana* Craib.

639 **Paraboea** (C.B.Clarke) Ridl. in J. Straits Branch Roy. Asiat. Soc. 44: 63. 1905, *nom.*
640 *cons.* – Type: *Paraboea clarkei* B.L.Burt. Fig. 3: 7.

641 The circumscription of *Paraboea*, recently modified by Puglisi & al. (2011a) is
642 modified again by the segregation of the new genus *Middletonia*. *Paraboea* now
643 consists of 127 species distributed throughout Southeast Asia. It is easily recognised by
644 the combination of a matted, interwoven indumentum on the lower side of the leaves,
645 the flat-faced to shortly campanulate corolla, the non-erect anthers and the lack of
646 sessile glands on the ovary.

647 Species list: *Paraboea acaulis* (Barnett) C.Puglisi, *Paraboea acuta* (C.B.Clarke)
 648 C.Puglisi, *Paraboea albida* (Barnett) C.Puglisi, *Paraboea amplexicaulis* (Parish ex
 649 C.B.Clarke) C.Puglisi, *Paraboea angustifolia* Yan Liu & W.B.Xu, *Paraboea*
 650 *arachnoidea* Triboun, *Paraboea axillaris* Triboun, *Paraboea bakeri* M.R.Hend.,
 651 *Paraboea banyengiana* B.L.Burtt, *Paraboea barnettiae* C.Puglisi, *Paraboea*
 652 *berouwensis* Z.R.Xu & B.L.Burtt, *Paraboea bhumiboliana* Triboun & Chuchan,
 653 *Paraboea bintangensis* B.L.Burtt, *Paraboea birmanica* (Craib) C.Puglisi, *Paraboea*
 654 *brachycarpa* (Ridl.) B.L.Burtt, *Paraboea brunnescens* B.L.Burtt, *Paraboea burttii*
 655 Z.R.Xu, *Paraboea caerulescens* (Ridl.) B.L.Burtt, *Paraboea candidissima* B.L.Burtt,
 656 *Paraboea capitata* Ridl., *Paraboea capitata* var. *oblongifolia* Ridl., *Paraboea*
 657 *changjiangensis* F.W.Xing & Z.X.Li, *Paraboea chiangdaoensis* Z.R.Xu & B.L.Burtt,
 658 *Paraboea clarkei* B.L.Burtt, *Paraboea cochinchinensis* (C.B.Clarke) B.L.Burtt,
 659 *Paraboea crassifolia* (Hemsl.) B.L.Burtt, *Paraboea culminicola* K.G.Pearce, *Paraboea*
 660 *detergibilis* (C.B.Clarke) B.L.Burtt, *Paraboea dictyoneura* (Hance) B.L.Burtt,
 661 *Paraboea divaricata* (Ridl.) B.L.Burtt, *Paraboea doitungensis* Triboun &
 662 D.J.Middleton, *Paraboea eburnea* Triboun, *Paraboea effusa* B.L.Burtt, *Paraboea*
 663 *elegans* (Ridl.) B.L.Burtt, *Paraboea ferruginea* (Ridl.) Ridl., *Paraboea filipes* (Hance)
 664 B.L.Burtt, *Paraboea glabra* (Ridl.) B.L.Burtt, *Paraboea glabrescens* (Barnett)
 665 C.Puglisi, *Paraboea glabriflora* (Barnett) B.L.Burtt, *Paraboea glabrisepala* B.L.Burtt,
 666 *Paraboea glandulifera* (Barnett) C.Puglisi, *Paraboea glanduliflora* Barnett, *Paraboea*
 667 *glandulosa* (B.L.Burtt) C.Puglisi, *Paraboea glutinosa* (Hand.-Mazz.) K.Y.Pan,
 668 *Paraboea gracillima* Kiew, *Paraboea graniticola* Z.R.Xu, *Paraboea guilinensis* L.Xu
 669 & Y.G.Weï, *Paraboea hainanensis* (Chun) B.L.Burtt, *Paraboea halongensis* Kiew &
 670 T.H.Nguyên, *Paraboea harroviana* (Craib) Z.R.Xu, *Paraboea harroviana* var. *ovata*
 671 Z.R.Xu, *Paraboea havilandii* (Ridl.) B.L.Burtt, *Paraboea hekouensis* Y.M. Shui &
 672 W.H. Chen, *Paraboea incudicarpa* B.L.Burtt, *Paraboea insularis* Triboun, *Paraboea*
 673 *kalimantanensis* Z.R.Xu & B.L.Burtt, *Paraboea lambokensis* Kiew, *Paraboea lanata*
 674 (Ridl.) B.L.Burtt, *Paraboea lancifolia* (Ridl.) B.L.Burtt, *Paraboea lavandulodora*
 675 Triboun, *Paraboea laxa* Ridl., *Paraboea leopoldii* K.M.Wong, J.T.Pereira, Sugau &
 676 S.P.Lim, *Paraboea leporina* (H.J.Lam) B.L.Burtt, *Paraboea leuserensis* B.L.Burtt,
 677 *Paraboea longipetiolata* (B.L.Burtt) C.Puglisi, *Paraboea luzoniensis* Merr., *Paraboea*
 678 *maculata* C.Puglisi, *Paraboea mahaxayana* Z.R.Xu & B.L.Burtt, *Paraboea*

679 *manhaoensis* Y.M. Shui & W.H. Chen, *Paraboea martinii* (H.Lév.) B.L.Burt,
680 *Paraboea mataensis* Z.R.Xu & B.L.Burt, *Paraboea meiophylla* B.L.Burt, *Paraboea*
681 *middletonii* Triboun, *Paraboea minahassae* (Teijsm. & Binn.) B.L.Burt, *Paraboea*
682 *minor* (Barnett) B.L.Burt, *Paraboea minuta* (Kraenzl.) B.L.Burt, *Paraboea nana*
683 Triboun & Dongkumfu, *Paraboea nervosissima* Z.R.Xu & B.L.Burt, *Paraboea*
684 *neurophylla* (Collett & Hemsl.) B.L.Burt, *Paraboea nobilis* Triboun & D.J. Middleton,
685 *Paraboea nutans* D.Fang & D.H.Qin, *Paraboea obovata* Ridl., *Paraboea obtusa*
686 (C.B.Clarke) C.Puglisi, *Paraboea paniculata* (Ridl.) B.L.Burt, *Paraboea paramartinii*
687 Z.R.Xu & B.L.Burt, *Paraboea paraprimuloides* Z.R.Xu, *Paraboea parviflora* (Ridl.)
688 B.L.Burt, *Paraboea patens* (Ridl.) B.L.Burt, *Paraboea peltifolia* D.Fang & L.Zeng,
689 *Paraboea peninsularis* Triboun & D.J. Middleton, *Paraboea phanomensis* Triboun &
690 D.J. Middleton, *Paraboea prazeri* (B.L.Burt) C.Puglisi, *Paraboea primuloides* Z.R.Xu,
691 *Paraboea prolixa* (C.B.Clarke) B.L.Burt, *Paraboea pubicorolla* Z.R.Xu & B.L.Burt,
692 *Paraboea punggulensis* Kiew, *Paraboea quercifolia* Triboun, *Paraboea rabilii* Z.R.Xu
693 & B.L.Burt, *Paraboea robusta* (B.L.Burt) C.Puglisi, *Paraboea rosea* Triboun,
694 *Paraboea rufescens* (Franch.) B.L.Burt, *Paraboea rufescens* var. *tomentosa* (Barnett)
695 Z.R.Xu, *Paraboea sabahensis* Z.R.Xu & B.L.Burt, *Paraboea sangwaniae* Triboun,
696 *Paraboea scabriflora* B.L.Burt, *Paraboea schefferi* (H.O.Forbes) B.L.Burt, *Paraboea*
697 *schefferi* var. *ambigua* (C.B.Clarke) Z.R.Xu, *Paraboea siamensis* Triboun, *Paraboea*
698 *sinensis* (Oliv.) B.L.Burt, *Paraboea speciosa* (Rech.) B.L.Burt, *Paraboea*
699 *speluncarum* (B.L.Burt) B.L.Burt, *Paraboea strobilacea* (Barnett) C.Puglisi,
700 *Paraboea subplana* (B.L.Burt) C.Puglisi, *Paraboea suffruticosa* (Ridl.) B.L.Burt,
701 *Paraboea swinhoei* (Hance) B.L.Burt, *Paraboea takensis* Triboun, *Paraboea*
702 *tarutaoensis* Z.R.Xu & B.L.Burt, *Paraboea tenuicalyx* Triboun, *Paraboea*
703 *tetrabracteata* F.Wen, Xin Hong & Y.G.We, *Paraboea thorelii* (Pellegr.) B.L.Burt,
704 *Paraboea trachyphylla* Z.R.Xu & B.L.Burt, *Paraboea treubii* (H.O.Forbes) B.L.Burt,
705 *Paraboea trisepala* W.H.Chen & Y.M.Shui, *Paraboea umbellata* (Drake) B.L.Burt,
706 *Paraboea uniflora* Z.R.Xu & B.L.Burt, *Paraboea vachareea* Triboun & Sonsupab,
707 *Paraboea variopila* Z.R.Xu & B.L.Burt, *Paraboea velutina* (W.T.Wang & C.Z.Gao)
708 B.L.Burt, *Paraboea verticillata* (Ridl.) B.L.Burt, *Paraboea vulpina* Ridl., *Paraboea*
709 *xylocaulis* Triboun.

710 **Rhabdothamnopsis** Hemsl. in J. Linn. Soc., Bot. 35(247): 517–518. 1903 – Type:
711 *Rhabdothamnopsis sinensis* Hemsl. Fig. 3: 4b.

712 Monotypic genus from China whose closest relative is *Kaisupeea*. It is characterised by
713 the solitary flowers with infundibuliform corollas and the twisted fruit.

714

715 **Senyumia** Kiew, A.Weber & B.L.Burt in Beitr. Biol. Pflanzen 70(2–3): 400. 1997.
716 (1998) – Type: *Senyumia minutiflora* (Ridl.) Kiew, A.Weber & B.L.Burtt ≡ *Boea*
717 *minutiflora* Ridl. Fig. 3: 3d.

718 This is another monotypic genus from Peninsular Malaysia. Its closest relatives are
719 *Boea* and *Spelaeanthus*. It is the only twisted-fruited genus to have a resupinate flower.

720

721 **Somrania** D.J.Middleton in Thai For. Bull. (Bot.) 40: 10. 2012 – Type: *Somrania*
722 *albiflora* D.J.Middleton. Fig. 3: 5.

723 *Somrania* is closely related to *Damrongia* and consists of three species endemic to
724 southern Thailand. The genus is easily recognisable by its tubular corolla and the
725 indumentum of branched hairs.

726 Species list: *Somrania albiflora* D.J.Middleton, *Somrania flavida* D.J.Middleton &
727 Triboun, *Somrania lineata* D.J.Middleton & Triboun.

728

729 **Spelaeanthus** Kiew, A.Weber & B.L.Burt in Beitr. Biol. Pflanzen 70(2–3): 401. 1997.
730 (1998) – Type: *Spelaeanthus chinii* Kiew, A.Weber & B.L.Burtt. Fig. 3: 3e.

731 One species from Peninsular Malaysia, closely related to *Senyumia* and *Boea*.
732 *Spelaeanthus* has a characteristic white, bowl-shaped corolla.

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744 Some sequences of *Didissandra* were generated by L. Forrest (RBGE), some sequences
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872 (Gesneriaceae). *Edinburgh J. Bot.* 65: 161–347.

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874 University of Malaya, Kuala Lumpur, Malaysia.

875

876 **Tables**

877 Table 1: The ‘2-markers’ dataset comprises ITS and *trnL-trnF* sequences; the ‘3-
878 markers’ dataset comprises ITS, *trnL-trnF* and *ndhF-trnL^{UAG}* sequences.

Dataset	Taxa ingroup	Taxa outgroup	Total characters	Included characters	PICs
2-markers	136	6	2271	1913	677
3-markers	64	4	4499	3997	1013

879

880

881 Table 2: Statistical support for the main clades identified. Values are shown as
882 ‘bootstrap/posterior probability’.

883

Clade	2-markers	3-markers
Ingroup	85/1	98/1
Clade 1 (<i>Middletonia</i>)	100/1	100/1

Clade 2 (<i>Dorcoceras</i>)	100/1	100/1
Clade 3 (<i>Loxocarpus/Orchadocarpa/Emarhendia/Senyumia/Spelaeanthus/Boea</i>)	-/0.64	-/1
Clade 4 (<i>Ornithoboea/Kaisupeea/Rhabdothamnopsis</i>)	59/1	88/1
Clade 5 (<i>Somrania</i>)	100/1	100/1
Clade 6 (<i>Damrongia</i>)	91/1	100/1
Clade 7 (<i>Paraboea</i>)	95/1	100/1

884

885 **Figure captions**

886 Figure 1: Capsule diversity in the Loxocarpinae. A: straight capsule with two
887 longitudinal dehiscence lines. *Paraboea burttii* Z.R.Xu. B: twisted capsule with two
888 longitudinal dehiscence lines. *Ornithoboea puglisiae* S.M.Scott. C: splash cup with
889 dorso-ventral dehiscence. *Loxocarpus incanus* R.Br.. D: straight capsule dehiscing only
890 along the upper suture. *Paraboea incudicarpa* B.L.Burt. Photo credits: D. Middleton
891 (A, D), P. Karaket (B) and T. Phutthai (C)

892 Figure 2: Phylogeny of the Loxocarpinae. The overall structure of the subtribe is
893 represented by this 50% majority rule consensus tree derived from the Bayesian
894 analysis of the dataset available for the three markers ITS, *trnL-trnF* and *ndhF-trn^{LUAG}*.
895 The numbers in bold font inside circles refer to the clade numbering used in the text.
896 The numbers by the nodes are the posterior probabilities, followed by the bootstrap
897 values returned by the Parsimony analysis of the same dataset. The bars at the right of
898 the tree mark the placement of the recircumscribed genera. Asterisks mark accessions of
899 the type species.

900 Figure 3: The seven clades of Loxocarpinae. 1: *Middletonia* C.Puglisi, a new genus
901 including the species with a farinose indumentum on the ovary, segregated from
902 *Paraboea* (C.B.Clarke) Ridl.. *Middletonia multiflora* (R.Br.) C.Puglisi. Photos by D.
903 Middleton. 2: *Dorcoceras* Bunge is resurrected to include the Southeast Asian species
904 with a campanulate corolla previously ascribed to *Boea*. Left: *Dorcoceras* sp. nov.;

905 right: *D. philippense* (C.B.Clarke) Schltr.. Photos by P. Karaket. 3: clade dominated by
906 a paraphyletic *Loxocarpus*, including the small Malesian genera. 3a: *Loxocarpus*
907 *incanus* R.Br.. Photo by T. Putthai. 3b: *Emarhendia bettiana* (M.R.Hend) Kiew,
908 A.Weber & B.L.Burt. Photo by J. Tan. 3c: *Orchadocarpa lilacina* Ridl.. Photo by T.L.
909 Yao. 3d: *Senyumia minutiflora* (Ridl.) Kiew, A.Weber & B.L.Burt. Photo by P.T. Ong.
910 3e: *Spelaeanthus chinii* Kiew, A.Weber & B.L.Burt. Photo by P.T. Ong. 3f: *Boea*
911 *hygroskopica* F.Muell.. Photo by D. Middleton. 4: clade of three well-defined genera,
912 left unaltered by this study. 4a: *Kaisupeea herbacea* (C.B.Clarke) B.L.Burt. Photo by
913 P. Triboun. 4b: *Rhabothamnopsis sinensis* Hemsl.. Photo by M. Möller. 4c:
914 *Ornithoboea pseudoflexuosa* B.L.Burt. Photo by P. Karaket. 5: *Somrania*
915 D.J.Middleton, a small Thai genus, sister to *Damrongia* Kerr ex Craib. *Somrania*
916 *flavida* D.J.Middleton & Triboun. Photo by D. Middleton. 6: *Damrongia*, expanded to
917 include *Boea clarkeana* Hemsl. and the Asian species of *Streptocarpus* Lindl.. 6a:
918 *Damrongia orientalis* (Craib) C.Puglisi. Photo by D. Middleton. 6b: *Damrongia*
919 *trisepala* (Barnett) D.J.Middleton & A.Weber. Photo by P. Triboun. 6c: *Damrongia*
920 *clarkeana* (Hemsl.) C.Puglisi. Photo by C. Puglisi. 7: *Paraboea*, recircumscribed in this
921 study by the segregation of *Middletonia*. *Paraboea middletonii* Triboun. Photo by P.
922 Karaket.

923 **Electronic supplements**

924 S1: Strict consensus of the six most parsimonious trees based on Parsimony analysis of
925 the 2-markers dataset, including ITS and *trnL-trnF* sequences. Tree length=4049,
926 CI=0.3779, HI=0.6221, RI=0.7310. The numbers inside the circles refer to the clades as
927 treated in the text. The numbers above the branches represent bootstrap values. The bars
928 at the right of the tree mark the placement of the recircumscribed genera. Asterisks
929 mark accessions of the type species.

930 S2: 50% majority rule consensus tree based on Bayesian Inference of the 2-markers
931 dataset, including ITS and *trnL-trnF* sequences. Number of generations: 10 mln, sample
932 frequency: 1000, burn-in: 2000, average standard deviation: 0.002797. The numbers
933 beside nodes represent posterior probabilities. The scalebar represents the number of
934 substitutions per site. The numbers inside the circles refer to the clades as treated in the
935 text. The bars at the right of the tree mark the placement of the recircumscribed genera.

936 Asterisks mark accessions of the type species.

937 S3: Strict consensus of the eight most parsimonious trees based on Parsimony analysis
938 of the 3-markers dataset, including ITS, *trnL-trnF* and *ndhF-trnL^{UAG}* sequences. Tree
939 length=4271, CI=0.5273, HI=0.4727, RI=0.6824. The numbers inside the circles refer
940 to the clades as treated in the text. The numbers above the branches represent bootstrap
941 values. The bars at the right of the tree mark the placement of the recircumscribed
942 genera. Asterisks mark accessions of the type species.

943 S4: 50% majority rule consensus tree based on Bayesian Inference of the 3-markers
944 dataset, including ITS, *trnL-trnF* and *ndhF-trnL^{UAG}* sequences. Number of generations:
945 10 mln, sample frequency: 1000, burn-in: 2000, average standard deviation: 0.001572.
946 The numbers beside nodes represent posterior probabilities. The scalebar represents the
947 number of substitutions per site. The numbers inside the circles refer to the clades as
948 treated in the text. The bars at the right of the tree mark the placement of the
949 recircumscribed genera. Asterisks mark accessions of the type species.

950 **Appendix**

951 **Appendix 1:** Accessions used in the phylogenetic study. Entries are in the format
952 ‘**voucher name**, updated taxon name, collection locality, collection date, *collector*,
953 *number*, (herbarium). ITS Genbank accession, *trnL-trnF* Genbank accession, *ndhF-*
954 *trnL^{UAG}* Genbank accession’. The asterisks indicate sequences newly submitted to
955 Genbank.

956 **Boea clarkeana 1**, *Damrongia clarkeana* (Hemsl.) C.Puglisi, China, Jiangxi, Tian Mu
957 Shan, 1 vii 2008, *H.F. Lu, JBS II-2*. ITS: *KU203805; *trnL-trnF*: *KU203900; *ndhF-*
958 *trnL^{UAG}*: *KU203995. **Boea clarkeana 2**, *Damrongia clarkeana* (Hemsl.) C.Puglisi,
959 China, Shaanxi, Mian Xian, 4 viii 2010, *P. Zhou & M. Möller, ZP 2010-019A*, (E). ITS:
960 *KU203806; *trnL-trnF*: *KU203901; *ndhF-trnL^{UAG}*: *KU203996. **Boea geoffrayi**,
961 *Dorcoceras geoffrayi* (Pellegr.) C.Puglisi, Thailand, Si Sa Ket, Kantharalak, 26 viii
962 2012, *D.J. Middleton & al., 5658*, (E, BK, BKF). ITS: *KU203781; *trnL-trnF*:
963 *KU203876; *ndhF-trnL^{UAG}*: *KU203977. **Boea hygrometrica 1**, *Dorcoceras*
964 *hygrometricum* Bunge, China, Zhejiang, Jinhua, 16 vii 2009, *M. Möller & J.B. Chen*,
965 *MMO 09-1436*, (E). ITS: *KU203783; *trnL-trnF*: *KU203878; *ndhF-trnL^{UAG}*:

966 *KU203978. **Boea hygrometrica 2**, *Dorcoceras hygrometricum* Bunge, China,
 967 Shaanxi, Liu Ba, 31 viii 2005, ex cult. RBGE 20080104A, M. Möller & L.M. Gao,
 968 *MMO 05-687*, (E). ITS: *KU203782; *trnL-trnF*: *KU203877; *ndhF-trnL*^{UAG}:
 969 *KU203979. **Boea hygrometrica 3**, *Dorcoceras hygrometricum* Bunge, China,
 970 Shaanxi, Liu Ba, 31 viii 2005, M. Möller & L.M. Gao, *MMO 05-686*, (E). ITS:
 971 *KU203784; *trnL-trnF*: *KU203879. **Boea hygrosopica 1**, *Boea hygrosopica*
 972 F.Muell., Australia, Queensland, Tchupala Falls, 11 vii 1994, ex cult. RBGE 19970386,
 973 B. Tan & al., 443, (E). ITS: FJ501320; *trnL-trnF*: *KU203903; *ndhF-trnL*^{UAG}:
 974 *KU204000. **Boea hygrosopica 2**, *Boea hygrosopica* F.Muell., Australia,
 975 Queensland, Palmerston NP, A. Weber, 810808-1/1, (WU). ITS: xxxxxxxx; *trnL-trnF*:
 976 FJ501477. **Boea lawesii**, *Boea lawesii* H.O.Forbes, Papua New Guinea, Morobe,
 977 Mumeng, 16 iv 1987, *Lambinon*, 87/380, (L), formerly identified as *B. magellanica*.
 978 ITS: FJ501321; *trnL-trnF*: FJ501478. **Boea philippensis 1**, *Dorcoceras philippense*
 979 (C.B.Clarke) Schltr., China, Guangxi, Tian Ling, 27 viii 2006, M. Möller & Y.G. Wei,
 980 *MMO 06-814*, (E). ITS: *KU203785; *trnL-trnF*: *KU203880; *ndhF-trnL*^{UAG}:
 981 *KU203980. **Boea philippensis 2**, *Dorcoceras philippense* (C.B.Clarke) Schltr.,
 982 China, Yunnan, Huize, 23 vii 2010, M. Möller & P. Zhou, *MMO 10-1672A*, (E). ITS:
 983 *KU203786; *trnL-trnF*: *KU203881. **Boea philippensis 3**, *Dorcoceras philippense*
 984 (C.B.Clarke) Schltr., China, Hainan, Chang Jiang, 13 vii 2007, ex cult. RBGE
 985 20080217, M. Möller & Y.G. Wei *MMO 07-1156*, (E). ITS: *KU203787; *trnL-trnF*:
 986 *KU203882. **Boea philippensis 4**, *Dorcoceras philippense* (C.B.Clarke) Schltr.,
 987 Indonesia, Sulawesi, Gunung Ali, 28 iv 2002, ex cult. RBGE 20021242, S.M. Scott,
 988 *Scott 02-142*, (E). ITS: *KU203788; *trnL-trnF*: *KU203883; *ndhF-trnL*^{UAG}:
 989 *KU203981. **Boea sp.**, *Boea* sp., Papua New Guinea, Madang, 19 viii 1955, *Hoogland*,
 990 *5129*, (CANB). ITS: *KU203809; *trnL-trnF*: * KU203904. **Boea sp.nov.**, *Dorcoceras*
 991 sp. nov., Thailand, Kanchanaburi, Sai Yok, 7 viii 2012, D.J. Middleton & al., 5283, (E,
 992 BK, BKF). ITS: *KU203780; *trnL-trnF*: *KU203875; *ndhF-trnL*^{UAG}: *KU203976.
 993 **Codonoboena elata**, *Codonoboena elata* (Ridl.) Rafidah, Malaysia, Perak, Maxwell Hill,
 994 A.R. Rafidah, *FRI 64321*, (KEP). ITS: JF912550; *trnL-trnF*: JF912523. **Codonoboena**
 995 **leucocodon**, *Codonoboena leucocodon* (Ridl.) Ridl., Malaysia, Pahang, Gunung Tahan,
 996 C.L. Lim, s.n., (KEP). ITS: *KU203779; *trnL-trnF*: *KU203873. **Damrongia**
 997 **cyanantha**, *Damrongia trisepala* (Barnett) D.J.Middleton & A.Weber, Thailand,

998 Khampaeng Phet, Namtok Khlang An, *P. Triboun*, s.n. (EDNA09_02232), (BK). ITS:
 999 *KU203802; *trnL-trnF*: *KU203897. **Damrongia fulva**, *Damrongia fulva* (Barnett)
 1000 D.J.Middleton & A.Weber, Thailand, Nakhon Si Thammarat, Thung Song, 11 ix 2010,
 1001 *D.J. Middleton & al.*, 5393, (E). ITS: *KU203799; *trnL-trnF*: *KU203894; *ndhF-*
 1002 *trnL*^{UAG}: *KU203993. **Damrongia lacunosa 1**, *Damrongia lacunosa* (Hook. f.)
 1003 D.J.Middleton & A.Weber, Malaysia, Pahang, *A. Weber*, 870510-1/8, (WU). ITS:
 1004 FJ501308; *trnL-trnF*: FJ501458. **Damrongia lacunosa 2**, *Damrongia lacunosa* (Hook.
 1005 f.) D.J.Middleton & A.Weber, Malaysia, *Imin & al.*, *FRI 63238*, (KEP). ITS:
 1006 *KU203801; *trnL-trnF*: *KU203896; *ndhF-trnL*^{UAG}: *KU203991. **Damrongia**
 1007 **purpureolineata 1**, *Damrongia purpureolineata* Kerr ex Craib, Thailand, Lamphun,
 1008 Li, 9 ix 2009, *D.J. Middleton & al.*, 4812, (BK, BKF, E). ITS: JF912562; *trnL-trnF*:
 1009 JF912535. **Damrongia purpureolineata 2**, *Damrongia purpureolineata* Kerr ex Craib,
 1010 Thailand, Lamphun, Li, *P. Triboun*, s.n. (CH111), (BK). ITS: *KU203798; *trnL-trnF*:
 1011 *KU203893. **Damrongia trisepala 1**, *Damrongia trisepala* (Barnett) D.J.Middleton &
 1012 A.Weber, Thailand, Chanthaburi, Khao Khitchakut, 27 viii 2012, *D.J. Middleton & al.*,
 1013 5676, (BK, BKF, E). ITS: *KU203803; *trnL-trnF*: *KU203898; *ndhF-trnL*^{UAG}:
 1014 *KU203994. **Damrongia trisepala 2**, *Damrongia trisepala* (Barnett) D.J.Middleton &
 1015 A.Weber, Thailand, Prachin Buri, Na Di, 20 viii 2012, *D.J. Middleton & al.*, 5626,
 1016 (BK, BKF, E). ITS: *KU203804; *trnL-trnF*: *KU203899. **Didissandra elongata ssp.**
 1017 **minor**, *Didissandra elongata* (Jack) C.B.Clarke subsp. *minor* (Ridl.) A.Weber &
 1018 B.L.Burt, Indonesia, Sumatra, Bengkulu, 1 vii 2011, *C. Puglisi & al.*, *CP186*, (BO, E).
 1019 ITS: KP325420; *trnL-trnF*: KP325427; *ndhF-trnL*^{UAG}: *KU203975. **Didissandra sp.**,
 1020 *Didissandra* sp., Indonesia, Sumatra, West Sumatra, 24 vi 2011, *C. Puglisi & al.*,
 1021 *CP130*, (BO, E). ITS: KP325422; *trnL-trnF*: KP325429; *ndhF-trnL*^{UAG}: *KU203974.
 1022 **Emarhendia bettiana**, *Emarhendia bettiana* (M.R.Hend) Kiew, A.Weber & B.L.Burt,
 1023 Malaysia, Pahang, *R. Kiew & al.*, 55716, (KEP). ITS: HQ632955; *trnL-trnF*:
 1024 HQ632864; *ndhF-trnL*^{UAG}: *KU203997. **Kaisupeeia cyanea**, *Kaisupeeia cyanea*
 1025 B.L.Burt, Thailand, Chachoengsao, 6 xi 1993, ex cult. RBGE 19972918, *K. Larsen*
 1026 44272, (E), formerly identified as *K. herbacea*. ITS: FJ501309; *trnL-trnF*: FJ501459.
 1027 **Kaisupeeia herbacea 1**, *Kaisupeeia herbacea* (C.B.Clarke) B.L.Burt, Thailand, Chiang
 1028 Mai, Chom Tong, 19 ix 2008, *D.J. Middleton & al.*, 4518, (E). ITS: *KU203830; *trnL-*
 1029 *trnF*: *KU203925; *ndhF-trnL*^{UAG}: *KU204001. **Kaisupeeia herbacea 2**, *Kaisupeeia*

1030 *herbacea* (C.B.Clarke) B.L.Burt, Thailand, Prachin Buri, Na Di, 20 viii 2012, *D.J.*
1031 *Middleton & al.*, 5625, (BK, BKF, E). ITS: *KU203832; *trnL-trnF*: *KU203927.

1032 **Kaisupee herbacea 3**, *Kaisupee herbacea* (C.B.Clarke) B.L.Burt, Thailand,
1033 Kanchanaburi, Sai Yok, 7 viii 2012, *D.J. Middleton & al.*, 5282, (BK, BKF, E). ITS:
1034 *KU203831; *trnL-trnF*: *KU203926. **Kaisupee orthocarpa 1**, *Kaisupee orthocarpa*
1035 B.L.Burt, Thailand, Surat Thani, 27 ii 2006, ex cult. RBGE 20060623, *D.J. Middleton*,
1036 4200, (E). ITS: *KU203834; *trnL-trnF*: *KU203929. **Kaisupee orthocarpa 2**,
1037 *Kaisupee orthocarpa* B.L.Burt, Thailand, Surat Thani, Phanom , 7 ix 2008, *D.J.*
1038 *Middleton & al.*, 4356, (BKF, E). ITS: *KU203833; *trnL-trnF*: *KU203928; *ndhF-*
1039 *trnL*^{UAG}: *KU204002. **Loxocarpus angustifolius 1**, *Loxocarpus angustifolius* Ridl.,
1040 Malaysia, *FRIM staff*, *FRI 56313*, (KEP). ITS: *KU203824; *trnL-trnF*: *KU203919.

1041 **Loxocarpus angustifolius 2**, *Loxocarpus angustifolius* Ridl., Malaysia, Pahang,
1042 Gunung Tahan, *T.L. Yao*, *FRI 65288*, (KEP). ITS: *KU203825; *trnL-trnF*:
1043 *KU203920. **Loxocarpus argenteus**, *Loxocarpus argenteus* B.L.Burt, Malaysia,
1044 Sarawak, Bako NP, *T.L. Yao*, *FRI 57975*, (KEP). ITS: *KU203817; *trnL-trnF*:
1045 *KU203912; *ndhF-trnL*^{UAG}: *KU203985. **Loxocarpus holttumii 1**, *Loxocarpus*
1046 *holttumii* M.R.Hend., Malaysia, Johor, Gunung Pant, *T.L. Yao*, *FRI 65377*, (KEP).
1047 ITS: *KU203821; *trnL-trnF*: *KU203916; *ndhF-trnL*^{UAG}: *KU204012. **Loxocarpus**
1048 **holttumii 2**, *Loxocarpus holttumii* M.R.Hend., Malaysia, Malaya, *A. Weber*, 840723-
1049 1/2, (WU). ITS: HQ632956; *trnL-trnF*: FJ501479. **Loxocarpus incanus 1**, *Loxocarpus*
1050 *incanus* R.Br., Malaysia, Penang Hill, *T.L. Yao*, *KBG 2009-1300*, (KEP). ITS:
1051 *KU203814; *trnL-trnF*: *KU203909. **Loxocarpus incanus 2**, *Loxocarpus incanus*
1052 R.Br., Malaysia, Negeri Sembilan, Ulu Bendul, *T.L. Yao*, *FRI 65362*, (KEP). ITS:
1053 *KU203815; *trnL-trnF*: *KU203910; *ndhF-trnL*^{UAG}: *KU204013. **Loxocarpus**
1054 **incanus 3**, *Loxocarpus incanus* R.Br., Malaysia, Perak, Lata Puteh, *T.L. Yao*, *FRI*
1055 *65394*, (KEP). ITS: *KU203816; *trnL-trnF*: *KU203911. **Loxocarpus incanus 4**,
1056 *Loxocarpus incanus* R.Br., Malaysia, *D.J. Middleton*, 4379, (E). ITS: *KU203810;
1057 *trnL-trnF*: *KU203905. **Loxocarpus incanus 5**, *Loxocarpus incanus* R.Br., Thailand,
1058 Nakhon Si Thammarat, 23 ix 2010, *D.J. Middleton & al.*, 5517, (BK, BKF, E). ITS:
1059 *KU203811; *trnL-trnF*: *KU203906. **Loxocarpus incanus var. sekayuensis 1**,
1060 *Loxocarpus incanus* var. *sekayuensis* (Banka & Kiew) T.L.Yao, Malaysia, Terengganu,
1061 Gunung Tebu, *T.L. Yao*, *FRI 65450*, (KEP). ITS: *KU203813; *trnL-trnF*: *KU203908.

1062 **Loxocarpus incanus var. sekayuensis 2**, *Loxocarpus incanus* var. *sekayuensis* (Banka
1063 & Kiew) T.L.Yao, Malaysia, Terengganu, Lata Sekayu Recreational Forest, *T.L. Yao*,
1064 *FRI 65445*, (KEP). ITS: *KU203812; *trnL-trnF*: *KU203907; *ndhF-trnL*^{UAG}:
1065 *KU204014. **Loxocarpus repens**, *Loxocarpus repens* B.L.Burt, Malaysia, Sabah,
1066 Crocker Range Park, *T.L. Yao*, *FRI 65457*, (KEP). ITS: *KU203820; *trnL-trnF*:
1067 *KU203915. **Loxocarpus rufescens**, *Loxocarpus rufescens* (C.B.Clarke) B.L.Burt,
1068 Malaysia, Sarawak, Gunung Santubong, *T.L. Yao*, *FRI 57968*, (KEP). ITS:
1069 *KU203822; *trnL-trnF*: *KU203917; *ndhF-trnL*^{UAG}: *KU204011. **Loxocarpus**
1070 **semitortus**, *Loxocarpus semitortus* (C.B.Clarke) Ridl., Malaysia, Johor, Gunung
1071 Ledang, *T.L. Yao*, *FRI 67914*, (KEP). ITS: *KU203823; *trnL-trnF*: *KU203918.
1072 **Loxocarpus sericiflavus 1**, *Loxocarpus sericiflavus* (Banka & Kiew) T.L.Yao,
1073 Malaysia, Johor, Sungai Yong, *T.L. Yao*, *FRI 57986*, (KEP). ITS: *KU203826; *trnL-*
1074 *trnF*: *KU203921; *ndhF-trnL*^{UAG}: *KU204010. **Loxocarpus sericiflavus 2**,
1075 *Loxocarpus sericiflavus* (Banka & Kiew) T.L.Yao, Malaysia, Johor, Gunung Belumut,
1076 *T.L. Yao*, *FRI 57999*, (KEP). ITS: *KU203827; *trnL-trnF*: *KU203922. **Loxocarpus**
1077 **verbeniflos**, *Loxocarpus verbeniflos* (C.B.Clarke) B.L.Burt, Malaysia, Sabah, Tavui
1078 Forest Reserve, *T.L. Yao*, *FRI 65454*, (KEP). ITS: *KU203818; *trnL-trnF*:
1079 *KU203913. **Loxocarpus violoides**, *Loxocarpus violoides* (C.B.Clarke) T.L.Yao,
1080 Malaysia, Sabah, Kinabalu Park, *T.L. Yao*, *FRI 65458*, (KEP). ITS: *KU203819; *trnL-*
1081 *trnF*: *KU203914; *ndhF-trnL*^{UAG}: *KU203986. **Orchadocarpa lilacina**,
1082 *Orchadocarpa lilacina* Ridl, Malaysia, Pahang, *R. Kiew*, 5410, (KEP). ITS:
1083 HQ632954; *trnL-trnF*: HQ632863; *ndhF-trnL*^{UAG}: *KU204009. **Ornithoboea**
1084 **arachnoidea**, *Ornithoboea arachnoidea* (Diels) Craib, Thailand, Chiang Mai, Chiang
1085 Dao, 20 ix 2008, *D.J. Middleton & al.*, 4538, (BK, BKF, E). ITS: JN934709; *trnL-trnF*:
1086 JN934751; *ndhF-trnL*^{UAG}: *KU204003. **Ornithoboea barbanthera**, *Ornithoboea*
1087 *barbanthera* B.L.Burt, Thailand, Prachuap Khiri Khan, *D.J. Middleton & al.*, 4257,
1088 (E). ITS: *KU203839; *trnL-trnF*: *KU203934; *ndhF-trnL*^{UAG}: *KU204004.
1089 **Ornithoboea flexuosa**, *Ornithoboea flexuosa* (Ridl.) B.L.Burt, Malaysia, Kedah,
1090 Gunung Keriang, *A.R. Rafidah*, *FRI 64358*, (KEP). ITS: *KU203836; *trnL-trnF*:
1091 *KU203931; *ndhF-trnL*^{UAG}: *KU204005. **Ornithoboea maxwellii**, *Ornithoboea*
1092 *maxwellii* S.M.Scott, Thailand, Chiang Mai, Ban Pong, 6 vi 2004, *M. Möller & J.F.*
1093 *Maxwell*, *MMO 04-439*, (E). ITS: FJ501311; *trnL-trnF*: FJ501460. **Ornithoboea**

1094 **occulta**, *Ornithoboea occulta* B.L.Burt, Thailand, Tak, Mae Sot, 11 ix 2009, *D.J.*
1095 *Middleton*, 4858, (BK, BKF, E). ITS: *KU203838; *trnL-trnF*: *KU203933.

1096 **Ornithoboea pseudoflexuosa 1**, *Ornithoboea pseudoflexuosa* B.L.Burt, Thailand,
1097 Surat Thani, Phanom, 26 ix 2010, *D.J. Middleton*, 5545, (BK, BKF, E). ITS:
1098 *KU203837; *trnL-trnF*: *KU203932; *ndhF-trnL^{UAG}*: *KU204006. **Ornithoboea**
1099 **pseudoflexuosa 2**, *Ornithoboea pseudoflexuosa* B.L.Burt, Thailand, Surat Thani,
1100 Phanom, 7 ix 2008, *D.J. Middleton & al.*, 4336, (BK, BKF, E). ITS: *KU203968;
1101 *trnL-trnF*: *KU204040; *ndhF-trnL^{UAG}*: *KU204007. **Ornithoboea puglisiae**,
1102 *Ornithoboea puglisiae* S.M.Scott, Thailand, Nan, Muang Nan, 16 viii 2012, *D.J.*
1103 *Middleton & al.*, 5617, (BK, BKF, E). ITS: *KU203840; *trnL-trnF*: *KU203935.

1104 **Ornithoboea wildeana**, *Ornithoboea wildeana* Craib, Thailand, Chiang Mai, Doi
1105 Chiang Dao Wildlife Sanctuary, 20 ix 2008, *D.J. Middleton & al.*, 4531, (BKF, E).
1106 ITS: JN934752; *trnL-trnF*: JN934710 *ndhF-trnL^{UAG}*: *KU204008. **Paraboea**
1107 **acutifolia 1**, *Paraboea acutifolia* (Ridl.) B.L.Burt, Thailand, Satun, Manang, Phu Pha
1108 Phet Cave area, 10 ix 2010, *D.J. Middleton*, 5365, (BKF, E). ITS: *KU203867; *trnL-*
1109 *trnF*: *KU203962; *ndhF-trnL^{UAG}*: *KU204026. **Paraboea acutifolia 2**, *Paraboea*
1110 *acutifolia* (Ridl.) B.L.Burt, Thailand, Krabi, Wat Tham Sua, 11 ix 2008, *D.J.*
1111 *Middleton*, 4446, (BK, BKF, E). ITS: *KU203969; *trnL-trnF*: *KU204041; *ndhF-*
1112 *trnL^{UAG}*: *KU204027. **Paraboea amplifolia**, *Paraboea amplifolia* Z.R.Xu & B.L.Burt,
1113 Thailand, Trang, 30 viii 2009, *P. Triboun*, s.n. (EDNA09_02281), (BK). ITS:
1114 JN934754; *trnL-trnF*: JN934712; *ndhF-trnL^{UAG}*: *KU204033. **Paraboea axillaris**,
1115 *Paraboea axillaris* Triboun, Thailand, Tak, Tah Song Yang District, 10 ix 2009, ex
1116 cult. RBGE 20092055, *D.J. Middleton*, 4840, (E). ITS: *KU203848; *trnL-trnF*:
1117 *KU203943. **Paraboea banyengiana**, *Paraboea banyengiana* B.L.Burt, Malaysia,
1118 Sarawak, Gunung Mulu NP, 6 viii 2010, *C. Puglisi*, CP 28, (E). ITS: JN934755; *trnL-*
1119 *trnF*: JN934713. **Paraboea barnettiae**, *Paraboea barnettiae* C.Puglisi, Thailand,
1120 Peninsular Thailand, *K. Williams & al.*, 2118, (A). ITS: *KU203847; *trnL-trnF*:
1121 *KU203942; *ndhF-trnL^{UAG}*: *KU204030. **Paraboea bhumiboliana**, *Paraboea*
1122 *bhumiboliana* Triboun & Chuchan, Thailand, Lamphun, Li, 9 ix 2009, *D.J. Middleton*
1123 *& P. Triboun*, 4814G, (E). ITS: JN934791; *trnL-trnF*: JN934749. **Paraboea**
1124 **birmanica**, *Paraboea birmanica* (Craib) C.Puglisi, China, Guangxi, Jing Xi, Nan Po,
1125 1 ix 2006, *M. Möller & Y.G. Wei*, MMO 06-862b, (E). ITS: *KU203849; *trnL-trnF*:

1126 *KU203944. **Paraboea brachycarpa**, *Paraboea brachycarpa* (Ridl.) B.L.Burt, 1127
 Malaysia, Pahang, Lipis distr., Gua Bama, *A. Weber*, 870508-2/6, (WU). ITS: 1128
 *KU203870; *trnL-trnF*: *KU203965. **Paraboea brunnescens**, *Paraboea brunnescens* 1129
 B.L.Burt, Thailand, Kanchanaburi, Sisawat, Erawan National Park, 5 viii 2012, *D.J.* 1130
Middleton & al., 5253, (BK, BKF, E). ITS: *KU203859; *trnL-trnF*: *KU203954. 1131
Paraboea burttii, *Paraboea burttii* Z.R.Xu, Thailand, Phatthalung, Khao Banthat 1132
 Wildlife Sanctuary, Khao Kram Waterfall, 13 ix 2010, *D.J. Middleton*, 5407, (BKF, E). 1133
 ITS: *KU203858; *trnL-trnF*: *KU203953; *ndhF-trnL^{UAG}*: *KU204036. **Paraboea** 1134
caerulescens, *Paraboea caerulescens* (Ridl.) B.L.Burt, Malaysia, Perak, Gunung 1135
 Rapat, *FRIM, FRI 64604*, (KEP). ITS: *KU203871; *trnL-trnF*: *KU203966. **Paraboea** 1136
capitata, *Paraboea capitata* Ridl., Malaysia, Perak, *A. Weber*, 870522-5/2, (WU). ITS: 1137
 FJ501315; *trnL-trnF*: AJ492298. **Paraboea capitata var. oblongifolia**, *Paraboea* 1138
capitata var. oblongifolia Ridl., Malaysia, Perak, Gua Tempurung, *FRIM, FRI 64598*, 1139
 (KEP). ITS: *KU203861; *trnL-trnF*: *KU203956. **Paraboea clarkei**, *Paraboea clarkei* 1140
 B.L.Burt, Malaysia, Sarawak, Bau, Fairy cave, 17 vii 2010, *C. Puglisi, CP 10*, (E). 1141
 ITS: JN934757; *trnL-trnF*: JN934715. **Paraboea crassifolia 1**, *Paraboea crassifolia* 1142
 (Hemsl.) B.L.Burt, China, Guangxi, Ma Shan, 24 viii 2006, *M. Möller & Y.G. Wei*, 1143
MMO 06-804a, (E). ITS: *KU203841; *trnL-trnF*: *KU203936; *ndhF-trnL^{UAG}*: 1144
 *KU204016. **Paraboea crassifolia 2**, *Paraboea crassifolia* (Hemsl.) B.L.Burt, China, 1145
 Yunnan, Maguan, near Gulin Qing, 18 x 2001, *M. Möller & Y.D. Qi, MMO 01-83/2*, 1146
 (E). ITS: JN934758; *trnL-trnF*: JN934716. **Paraboea crassifolia 3**, *Paraboea* 1147
crassifolia (Hemsl.) B.L.Burt, China, Guizhou, Jiang Kou, 16 ix 2003, *M. Möller &* 1148
L.M. Gao, MMO 03-322a, (E). ITS: *KU203970; *trnL-trnF*: *KU204042; *ndhF-* 1149
trnL^{UAG}: *KU204017. **Paraboea divaricata**, *Paraboea divaricata* (Ridl.) B.L.Burt, 1150
 Thailand, Satun, La Ngu, Mu Ko Phetra National Park, 20 ix 2010, *D.J. Middleton*, 1151
 5488, (BKF, E). ITS: *KU203865; *trnL-trnF*: *KU203960; *ndhF-trnL^{UAG}*: 1152
 *KU204034. **Paraboea doitungensis**, *Paraboea doitungensis* Triboun & 1153
 D.J.Middleton, Thailand, Chiang Rai, Mae Fa Luang, Doi Tung, 23 ix 2008, *D.J.* 1154
Middleton & al., 4576, (BK, BKF, E). ITS: *KU203846; *trnL-trnF*: *KU203941; 1155
ndhF-trnL^{UAG}: *KU204020. **Paraboea eburnea**, *Paraboea eburnea* Triboun, Thailand, 1156
 Ranong, Tham Pha Kayang, 31 vii 2009, *P. Triboun, s.n. (EDNA12_27741)*, (BK). 1157
 ITS: *KU203869; *trnL-trnF*: *KU203964. **Paraboea effusa**, *Paraboea effusa*

1158 B.L.Burt, Malaysia, Sarawak, Mulu, 14 viii 2010, *C. Puglisi, CP 32*, (E). ITS:
 1159 JN934760; *trnL-trnF*: JN934718. **Paraboea evrardii**, *Middletonia evrardii* (Pellegr.)
 1160 C.Puglisi, Vietnam, Ninh Thuận PRO., Ninh Hải, 11 xi 2010, *Lý Ngọc Sâm & Phạm Vũ*
 1161 *Điệp, Lý 497*, (E). ITS: *KU203790; *trnL-trnF*: *KU203885; *ndhF-trnL*^{UAG}:
 1162 *KU203984. **Paraboea ferruginea**, *Paraboea ferruginea* (Ridl.) Ridl., Malaysia,
 1163 Kedah, Pulau Langkawi, *A. Weber, 860806*, (WU). ITS: *KU203862; *trnL-trnF*:
 1164 *KU203957. **Paraboea glabra**, *Paraboea glabra* (Ridl.) B.L.Burt, Thailand, Krabi or
 1165 Phangnga, *P. Triboun, s.n. (EDNA09_01765)*, (BK). ITS: JN934761; *trnL-trnF*:
 1166 JN934719; *ndhF-trnL*^{UAG}: *KU204035. **Paraboea glabrescens**, *Paraboea glabrescens*
 1167 (Barnett) C.Puglisi, Thailand, Kanchanaburi, Thong Pha Phum, 5 viii 2012, *D.J.*
 1168 *Middleton & al., 5254*, (BK, BKF, E). ITS: *KU203852; *trnL-trnF*: *KU203947.
 1169 **Paraboea glabrisepala**, *Paraboea glabrisepala* B.L.Burt, Thailand, Chiang Mai, Doi
 1170 Chiang Dao Wildlife Sanctuary, 20 ix 2008, *D.J. Middleton & al., 4533*, (BK, BKF, E).
 1171 ITS: JN934762; *trnL-trnF*: JN934720. **Paraboea glanduliflora**, *Paraboea*
 1172 *glanduliflora* Barnett, Thailand, Chiang Rai, Fang, Doi Ang Khang, 21 ix 2008, *D.J.*
 1173 *Middleton & al., 4545*, (BK, BKF, E). ITS: JN934763; *trnL-trnF*: JN934721.
 1174 **Paraboea glandulosa**, *Paraboea glandulosa* (B.L.Burt) C.Puglisi, Thailand,
 1175 Kanchanaburi, Thong Pha Phum, 28 x 2009, *D.J. Middleton & P. Triboun, 5202G*,
 1176 (BK, E). ITS: JN934784; *trnL-trnF*: JN934742; *ndhF-trnL*^{UAG}: *KU204032. **Paraboea**
 1177 **glutinosa**, *Paraboea glutinosa* (Hand.-Mazz.) K.Y.Pan, China, Guangxi, Xin Cheng,
 1178 23 viii 2006, *M. Möller & Y.G. Wei, MMO 06-786a*, (E). ITS: JN934764; *trnL-trnF*:
 1179 JN934722; *ndhF-trnL*^{UAG}: *KU204025. **Paraboea harroviana var. ovata**, *Paraboea*
 1180 *harroviana* (Craib) Z.R.Xu var. *ovata* Z.R.Xu, Thailand, Prachuap Khiri Khan, Khao
 1181 Loom Muak, 5 ix 2008, *D.J. Middleton & al., 4273*, (BK, BKF, E). ITS: JN934765;
 1182 *trnL-trnF*: JN934723; *ndhF-trnL*^{UAG}: *KU204021. **Paraboea havilandii**, *Paraboea*
 1183 *havilandii* (Ridl.) B.L.Burt, Malaysia, Sarawak, Bau, Tai Ton, 21 vii 2010, *C. Puglisi,*
 1184 *CP18*, (E). ITS: JN934766; *trnL-trnF*: JN934724. **Paraboea hekouensis**, *Paraboea*
 1185 *hekouensis* Y.M. Shui & W.H. Chen, China, Yunnan, Hekou, ix 2012, *Shui & al.,*
 1186 *94842*, (KUN). ITS: *KU203843; *trnL-trnF*: *KU203938. **Paraboea incudicarpa**,
 1187 *Paraboea incudicarpa* B.L.Burt, Thailand, Tak, Mae Sot, 11 ix 2009, *D.J. Middleton*
 1188 *& P. Triboun, 4857G*, (BK, E). ITS: JN934767; *trnL-trnF*: JN934725. **Paraboea**
 1189 **insularis**, *Paraboea insularis* Triboun, Thailand, Krabi, Ao Luk, *P. Triboun, 3673*,

1190 (BK). ITS: *KU203857; *trnL-trnF*: *KU203952. **Paraboea leuserensis**, *Paraboea*
 1191 *leuserensis* B.L.Burt, Indonesia, Sumatra, North Sumatra, 9 vii 2011, C. Puglisi & al.,
 1192 CP 231, (BO, E). ITS: *KU203863; *trnL-trnF*: *KU203958. **Paraboea longipetiolata**,
 1193 *Paraboea longipetiolata* (B.L.Burt) C.Puglisi, Thailand, Kanchanaburi, Thong Pha
 1194 Phum, 6 viii 2012, D.J. Middleton & al., 5257, (BK, BKF, E). ITS: *KU203851; *trnL-*
 1195 *trnF*: *KU203946. **Paraboea manhaoensis**, *Paraboea manhaoensis* Y.M. Shui &
 1196 W.H. Chen, China, Yunnan, Gejiu, 7 ix 2012, Shui & al., s.n. (EDNA13_30239),
 1197 (KUN). ITS: *KU203842; *trnL-trnF*: *KU203937. **Paraboea middletonii**, *Paraboea*
 1198 *middletonii* Triboun, Thailand, Nan, Doi Phu Kha National Park, 15 viii 2012, D.J.
 1199 Middleton & al., 5606, (BK, BKF, E). ITS: *KU203845; *trnL-trnF*: *KU203940;
 1200 *ndhF-trnL*^{UAG}: *KU204022. **Paraboea minor**, *Paraboea minor* (Barnett) B.L.Burt,
 1201 Thailand, Songkhla, Ton Nga Chang Wildlife Sanctuary, 7 ix 2010, D.J. Middleton &
 1202 al., 5225, (BKF, E). ITS: *KU203860; *trnL-trnF*: *KU203955. **Paraboea monticola**,
 1203 *Middletonia monticola* (Triboun & D.J.Middleton) C.Puglisi, Thailand, Surat Thani,
 1204 Khlong Phanom National Park, 7 ix 2008, D.J. Middleton & al., 4363, (BK, BKF, E).
 1205 ITS: *KU203789; *trnL-trnF*: KU203884; *ndhF-trnL*^{UAG}: *KU203982. **Paraboea**
 1206 **multiflora**, *Middletonia multiflora* (R.Br.) C.Puglisi, Thailand, Sukhothai, Khiri Mat,
 1207 12 viii 2012, D.J. Middleton & al., 5557, (BK, BKF, E). ITS: *KU203791; *trnL-trnF*:
 1208 *KU203886; *ndhF-trnL*^{UAG}: *KU203983. **Paraboea neurophylla**, *Paraboea*
 1209 *neurophylla* (Collett & Hemsl.) B.L.Burt, Thailand, Chiang Rai, Mae Fa Luang, 23 ix
 1210 2008, D.J. Middleton & al., 4557, (BK, BKF, E). ITS: JN934769; *trnL-trnF*:
 1211 JN934727; *ndhF-trnL*^{UAG}: *KU204015. **Paraboea paniculata**, *Paraboea paniculata*
 1212 (Ridl.) B.L.Burt, Malaysia, FRIM, FRI 65535, (KEP). ITS: JN934770; *trnL-trnF*:
 1213 JN934728; *ndhF-trnL*^{UAG}: *KU204039. **Paraboea paramartinii**, *Paraboea*
 1214 *paramartinii* Z.R.Xu & B.L.Burt, China, Guangxi, Napo, 1 ix 2006, M. Möller & Y.G.
 1215 Wei, MMO 06-852b, (E). ITS: JN934771; *trnL-trnF*: JN934729. **Paraboea patens**,
 1216 *Paraboea patens* (Ridl.) B.L.Burt, Thailand, Phangnga, Phangnga Town Park, 17 ix
 1217 2010, D.J. Middleton & al., 5456, (BKF, E). ITS: *KU203864; *trnL-trnF*: *KU203959.
 1218 **Paraboea peninsularis**, *Paraboea peninsularis* Triboun & D.J. Middleton, Thailand,
 1219 Krabi, Ko Phi Phi National Park, 11 ix 2008, D.J. Middleton & al., 4449, (BK, BKF,
 1220 E). ITS: JN934788; *trnL-trnF*: JN934746. **Paraboea phanomensis**, *Paraboea*
 1221 *phanomensis* Triboun & D.J. Middleton, Thailand, Surat Thani, Khlong Phanom

1222 National Park, 7 ix 2008, *D.J. Middleton & al.*, 4365, (BK, BKF, E). ITS: *KU203855;
1223 *trnL-trnF*: *KU203950. **Paraboea rabilii**, *Paraboea rabilii* Z.R.Xu & B.L.Burttt,
1224 Thailand, Trang, Huai Yot, *P. Triboun*, s.n. (EDNA11_02030), (BK). ITS:
1225 *KU203856; *trnL-trnF*: *KU203951. **Paraboea rosea**, *Paraboea rosea* Triboun,
1226 Thailand, Krabi, Talabeng Is., *P. Triboun*, s.n. (EDNA09_02286), (BK). ITS:
1227 *KU203866; *trnL-trnF*: *KU203961; *ndhF-trnL^{UAG}*: *KU204037. **Paraboea**
1228 **rufescens**, *Paraboea rufescens* (Franch.) B.L.Burttt, China, Yunnan, 19 x 2001, *M.*
1229 *Möller & Y.D. Qi*, MMO 01-108/3, (E). ITS: JN934772; *trnL-trnF*: JN934730.
1230 **Paraboea rufescens var. tomentosa**, *Paraboea rufescens* var. *tomentosa* (Barnett)
1231 Z.R.Xu, ex cult RBGE 20091920, *C. Puglisi*, (E). ITS: *KU203971; *trnL-trnF*:
1232 *KU204043; *ndhF-trnL^{UAG}*: *KU204023. **Paraboea sangwaniae**, *Paraboea*
1233 *sangwaniae* Triboun, Thailand, Chiang Rai, Mae Fa Luang, 23 ix 2008, *D.J. Middleton*
1234 *& al.*, 4572, (BK, BKF, E). ITS: JN934787; *trnL-trnF*: JN934745. **Paraboea**
1235 **siamensis**, *Paraboea siamensis* Triboun, Thailand, Tak, Umphang, 7 ix 2010, *P.*
1236 *Triboun & al.*, 4565, (BK, BKF, E). ITS: *KU203853; *trnL-trnF*: *KU203948.
1237 **Paraboea sinensis**, *Paraboea sinensis* (Oliv.) B.L.Burttt, China, Yunnan, Hekou, 20 ix
1238 2006, *M. Möller & L.M. Gao*, MMO 06-949a, (E). ITS: *KU203844; *trnL-trnF*:
1239 *KU203939; *ndhF-trnL^{UAG}*: *KU204024. **Paraboea subplana**, *Paraboea subplana*
1240 (B.L.Burttt) *C. Puglisi*, Thailand, Krabi, Wat Tham Sua, 11 ix 2008, *D.J. Middleton*,
1241 4444, (BK, BKF, E). ITS: *KU203854; *trnL-trnF*: *KU203949; *ndhF-trnL^{UAG}*:
1242 *KU204031. **Paraboea suffruticosa**, *Paraboea suffruticosa* (Ridl.) B.L.Burttt,
1243 Thailand, Satun, Mu Ko Phetra National Park, 10 ix 2008, *D.J. Middleton & al.*, 4432,
1244 (BK, BKF, E). ITS: JN934774; *trnL-trnF*: JN934732. **Paraboea swinhoei**, *Paraboea*
1245 *swinhoei* (Hance) B.L.Burttt, China, Guangxi, Xin Cheng, 23 viii 2006, *M. Möller &*
1246 *Y.G. Wei*, MMO 06-783c, (E). ITS: JN934775; *trnL-trnF*: JN934733. **Paraboea**
1247 **tarutaoensis**, *Paraboea tarutaoensis* Z.R.Xu & B.L.Burttt, Thailand, Satun, ex cult.
1248 RBGE 20082069, *D.J. Middleton*, (E). ITS: JN934776; *trnL-trnF*: JN934734.
1249 **Paraboea trachyphylla**, *Paraboea trachyphylla* Z.R.Xu & B.L.Burttt, Thailand, Surat
1250 Thani, Ban Thakhun, 6 ix 2008, *D.J. Middleton & al.*, 4310, (E). ITS: JN934777; *trnL-*
1251 *trnF*: JN934735; *ndhF-trnL^{UAG}*: *KU204028. **Paraboea treubii**, *Paraboea treubii*
1252 (H.O.Forbes) B.L.Burttt, Indonesia, Sumatra, North Sumatra, 11 vii 2011, *C. Puglisi &*
1253 *al.*, CP 275, (BO, E). ITS: *KU203872; *trnL-trnF*: *KU203967. **Paraboea trisepala**,

1254 *Paraboea trisekala* W.H.Chen & Y.M.Shui, China, Guangxi Jing Xi, Y.M. Shui & al.,
1255 CH 153, (KIB). ITS: JN934778; *trnL-trnF*: JN934736. **Paraboea umbellata**,
1256 *Paraboea umbellata* (Drake) B.L.Burt, China, Guangxi, Napo, 22 x 2001, M. Möller
1257 & Y.D. Qi, MMO 01-147/2, (E). ITS: JN934779; *trnL-trnF*: JN934737; *ndhF-trnL*^{UAG}:
1258 *KU204019. **Paraboea variopila**, *Paraboea variopila* Z.R.Xu & B.L.Burt, Thailand,
1259 Nakhon Si Thammarat, Thung Song, 11 ix 2010, D.J. Middleton & al., 5392, (BK,
1260 BKF, E). ITS: *KU203868; *trnL-trnF*: *KU203963 (partial); *ndhF-trnL*^{UAG}:
1261 *KU204029. **Paraboea velutina**, *Paraboea velutina* (W.T.Wang & C.Z.Gao)
1262 B.L.Burt, China, Guangxi, Feng Shan, 4 vi 2007, M. Möller & Y.G. Wei, MMO 07-
1263 1105a, (E). ITS: JN934780; *trnL-trnF*: JN934738; *ndhF-trnL*^{UAG}: *KU204018.
1264 **Paraboea verticillata**, *Paraboea verticillata* (Ridl.) B.L.Burt, Malaysia, Selangor,
1265 FRIM, FRI 48225, (KEP). ITS: JN934781; *trnL-trnF*: JN934739; *ndhF-trnL*^{UAG}:
1266 *KU204038. **Paraboea vulpina**, *Paraboea vulpina* Ridl., Thailand, Krabi, Muang
1267 Krabi, 11 ix 2008, D.J. Middleton & al., 4442, (E). ITS: JN934782; *trnL-trnF*:
1268 JN934740. **Paraboea xylocaulis**, *Paraboea xylocaulis* Triboun, Thailand, Krabi, Ao
1269 Luk, P. Triboun, 3674, (BK). ITS: JN934789; *trnL-trnF*: JN934747.
1270 **Rhabdothamnopsis sinensis 1**, *Rhabdothamnopsis sinensis* Hemsl., China, Yunnan,
1271 Zhao Tong, 22 vii 2010, M. Möller & P. Zhou, MMO 10-1667A, (E). ITS: *KU203829;
1272 *trnL-trnF*: *KU203924. **Rhabdothamnopsis sinensis 2**, *Rhabdothamnopsis sinensis*
1273 Hemsl., China, Sichuan, Luding, 17 viii 2009, M. Möller & P. Zhou, MMO 09-1613,
1274 (E). ITS: *KU203828; *trnL-trnF*: *KU203923. **Rhabdothamnopsis sinensis 3**,
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1276 JN934794; *trnL-trnF*: AJ492302. **Senyumia minutiflora**, *Senyumia minutiflora* (Ridl.)
1277 Kiew, A. Weber & B.L.Burt, Malaysia, Pahang, A.R. Rafidah, 55722, (KEP). ITS:
1278 HQ632957; *trnL-trnF*: HQ632865; *ndhF-trnL*^{UAG}: *KU203999. **Somrania albiflora**,
1279 *Somrania albiflora* D.J.Middleton, Thailand, Ranong, Kra Buri, 16 viii 2006, K.
1280 Williams & al., 2123, (A, BKF). ITS: *KU203792; *trnL-trnF*: *KU203887; *ndhF-*
1281 *trnL*^{UAG}: *KU203987. **Somrania flavida**, *Somrania flavida* D.J.Middleton & Triboun,
1282 Thailand, Surat Thani, Khao Sok, D.J. Middleton & al., 4324, (E). ITS: *KU203794;
1283 *trnL-trnF*: *KU203889; *ndhF-trnL*^{UAG}: *KU203988. **Somrania lineata**, *Somrania*
1284 *lineata* D.J.Middleton & Triboun, Thailand, Phangnga, Muang Phangnga, Tham Pha
1285 Phueng, 15 ix 2010, D.J. Middleton & al., 5434, (BKF, E). ITS: *KU203793; *trnL-*

1286 *trnF*: *KU203888; *ndhF-trnL*^{UAG}: *KU203989. **Spelaeanthus chinii 1**, *Spelaeanthus*
 1287 *chinii* Kiew, A.Weber & B.L.Burt, Malaysia, Pahang, Jerantut distr., *A. Weber*,
 1288 860709-2/2, (WU). ITS: FJ501307; *trnL-trnF*: FJ501457;. **Spelaeanthus chinii 2**,
 1289 *Spelaeanthus chinii* Kiew, A.Weber & B.L.Burt, Malaysia, Peninsular Malaysia, 27
 1290 viii 2008, *R. Kiew, FRI 60061*, (KEP). ITS: *KU203807; *trnL-trnF*: *KU203902;
 1291 *ndhF-trnL*^{UAG}: *KU203998. **Streptocarpus glandulosissimus**, *Streptocarpus*
 1292 *glandulosissimus* Engl., Tanzania, ex cult. RBGE 19652118, *O.M. Hilliard, S10*, (E).
 1293 ITS: AF316918; *trnL-trnF*: *KU203874; *ndhF-trnL*^{UAG}: *KU203972. **Streptocarpus**
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 1295 12 viii 2012, *D.J. Middleton & al., 5561*, (BK, BKF, E). ITS: *KU203795; *trnL-trnF*:
 1296 *KU203890; *ndhF-trnL*^{UAG}: *KU203990. **Streptocarpus orientalis 2**, *Damrongia*
 1297 *orientalis* (Craib) C.Puglisi, Thailand, 22 vii 2002, *EDNA12_27733*, (E). ITS:
 1298 *KU203796; *trnL-trnF*: *KU203891. **Streptocarpus orientalis 3**, *Damrongia*
 1299 *orientalis* (Craib) C.Puglisi, Thailand, Chiang Mai, *P. Palee, s.n. (EDNA08_01210)*,
 1300 (E). ITS: *KU203797; *trnL-trnF*: *KU203892. **Streptocarpus rexii**, *Streptocarpus*
 1301 *rexii* (Bowie ex Hook.) Lindl., South Africa, Grahamstown, 'Faraway' estate, 29 x
 1302 1986, ex cult. RBGE 19870333, *K. Jong s.n.*, (E). ITS: AF316979; *trnL-trnF*:
 1303 AJ492305; *ndhF-trnL*^{UAG}: *KU203973. **Streptocarpus sumatranus**, *Damrongia*
 1304 *sumatrana* (B.L.Burt) C.Puglisi, Indonesia, Sumatra, West Sumatra, 24 vi 2011, *C.*
 1305 *Puglisi & al., CP 127*, (BO, E). ITS: *KU203800; *trnL-trnF*: *KU203895; *ndhF-*
 1306 *trnL*^{UAG}: *KU203992.