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Tribounia, a new genus of Gesneriaceae from Thailand

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Abstract The new genus *Tribounia* is described with two species, *Tribounia venosa* (Barnett) D.J. Middleton, a new combination, and *Tribounia grandiflora* D.J. Middleton, a new species. A key to the species and conservation assessments are provided.

Keywords Gesneriaceae; new genus; Thailand; *Tribounia*

Supplementary Material The Electronic Supplement and the alignment are available in the Supplementary Data section of the online version of this article. (<http://ingentaconnect.com/content/iapt/tax>).

■ INTRODUCTION

In recent years there have been several studies on the phylogenetic relationships of the Asian Gesneriaceae (Mayer & al., 2003; Möller & al., 2009, 2011a) which have led to the synonymisation of many small and monotypic genera (Möller & al., 2011a, b; Puglisi & al., 2011; Weber & al., 2011b, c). These studies have also led to the erection or reinstatement of new or previously synonymised genera (Wei & al., 2010; Weber & al., 2011a) as the investigation of heteromorphic lineages clarifies the relationships within them. This paper is the result of a morphological and molecular investigation into *Didymocarpus venosus* Barnett which has long been recognised as misplaced in *Didymocarpus* Wall. (Weber & Burt, 1998; Weber & al., 2000; Burt, 2001).

Didymocarpus venosus was first described in 1961 (Barnett, 1961a, b) and listed in Barnett (1962) without any comment on its unusual morphology within the genus. Weber & Burt (1998) and Weber & al. (2000) explicitly stated that *Didymocarpus venosus* did not belong in *Didymocarpus* Wall. and noted that Burt would reclassify it later. In a later work, however, Burt (2001) included it without change but noted that it was “almost certainly not a *Didymocarpus*”. Palee & al. (2006) did not include this species in their molecular phylogeny of *Didymocarpus* in Thailand.

In October 2009 a plant was found in the Thai province of Kanchanaburi which was similar to, but quite clearly not the same as, *Didymocarpus venosus*. At this stage it became more pressing to deal with the generic status of *Didymocarpus venosus* in order to have a proper taxonomic framework in which to describe the new species. The description of the genus *Tribounia* with two species is the result.

The morphological characters which separate *Tribounia* from the other genera of Asian Gesneriaceae are the prominent boss, a large swelling on the dorsal surface of the corolla into which the fertile stamens protrude by strongly bent or curved filaments, combined with an exceedingly long stipe in the fruit.

This description of *Tribounia* with its two species is part of ongoing taxonomic work on Gesneriaceae for the *Flora of Thailand* which has already revealed many species new to

science (Middleton & Triboun, 2010, 2012; Triboun & Middleton, 2010, in press). Both *Tribounia* species are found on karst limestone, a habitat that is quite extensive in Thailand and other parts of Southeast Asia and contains large numbers of locally endemic Gesneriaceae species. The high level of local endemism and the threats to karst limestone, particularly from the cement industry (Clements & al., 2006), mean that many species of Gesneriaceae, including *Tribounia grandiflora*, are under severe threat.

■ MATERIALS AND METHODS

Specimens were studied from the following herbaria: ABD, BK, BKF, E, K, QBG. These studies were supplemented by field work in Thailand.

The sequence matrix of Weber & al. (2011a) comprising 232 samples of didymocarpoid Gesneriaceae was reduced to 97 samples by removing mainly taxa of the straight-fruited Asian and Malesian didymocarps which are in distant and derived positions to *Tribounia* (Appendix). The straight-fruited Asian and Malesian didymocarps were represented here by clades of *Codonoboea* Ridl. (10 samples, 10 species in all), *Microchirita* (C.B. Clarke) Yin Z. Wang (11 samples, 9 species), *Henckelia* Spreng. (13 samples, 10 species) and a clade including *Allocheilos quangxiensis* H.Q. Wen, Y.G. Wei & S.H. Zhong, *Cathayanthe biflora* Chun, *Liebigia speciosa* (Blume) Endl., four taxa of *Gyrocheilos* W.T. Wang, and samples of seven species of *Didymocarpus*, these nesting deeply in this clade in Weber & al. (2011a).

Using the methodology of Weber & al. (2011a), chloroplast *trnL-F* and nuclear ribosomal ITS sequences were acquired for *Tribounia grandiflora* D.J. Middleton and *Tribounia venosa* (Barnett) D.J. Middleton (see Appendix for voucher details).

Combinability of the two datasets, *trnL-F* and ITS, phylogenetic and branch support analyses were carried out largely as in Weber & al. (2011a). The only differences concerned the sampling frequency in the Bayesian inference (BI) analysis (every 500th generation) and the burn-in (200,000 generations, 5%; Electronic Supplement: E–F).

■ RESULTS AND DISCUSSION

The aligned matrix was 1804 characters long after the exclusion of 136 (7.5%) ambiguous *trnL-F* sites at the beginning and end of the cpDNA matrix, and 96 (5.3%) ITS characters in hypervariable regions that showed ambiguous alignments. Of the 885 variable positions 589 were parsimony-informative, equivalent to 32.6% of all included characters. The partition homogeneity test showed no incongruence between the two datasets ($P = 0.98$), therefore the data is suitable for a combined phylogenetic analysis.

The parsimony analysis yielded 272 parsimonious trees of 3748 steps length with a consistency index of 0.3981 and retention index of 0.6501. The average number of steps per character (3748/1804) was 2.08 indicating a relatively high saturation of substitutions. The diagnostic features of the BI analysis demonstrated that convergence of the two runs had occurred (Electronic Supplement: A–D) and the posterior probability (PP) branch support values showed a high correlation between the two parallel Bayesian inference runs (Electronic Supplement: G). Indeed only minor differences in topology were observed between the parsimony majority-rule consensus tree (Fig. 1) and the Bayesian inference tree (Fig. 2). However, these differences concerned branches that reciprocally collapsed in the two analyses and/or received low branch support.

The two *Tribounia* samples were sister with high branch support (bootstrap, BS = 100%; PP = 1.00; Figs. 1–2). They were resolved as sister to *Didissandra frutescens* (Jack) C.B. Clarke in the MP analysis (though with no branch support; Fig. 1), and fell on a polytomy with *Didissandra frutescens* and three other clades in the BI analysis (Fig. 2).

Tribounia differs from *Didissandra* in the large boss on the corolla (absent in *Didissandra*), 2 stamens (4 in *Didissandra*, except for *D. triflora* C.B. Clarke with 2 stamens), and the pendulous fruit with a long stipe (erect or horizontal and without a long stipe in *Didissandra*). *Tribounia* differs from the genera of the two clades containing *Streptocarpus* and *Boea* respectively by the large boss on the corolla and the non-twisted stipitate fruits, and from the remaining clade by the combination of the large boss on the corolla and the pendulous fruit with a long stipe. It differs from individual genera within each of these clades by many additional characters.

Weber & Burt (1998) and Weber & al. (2000) were correct with their statements that *Tribounia venosus* (which they referred to as *Didymocarpus venosus*) does not belong to *Didymocarpus*. *Tribounia* appears to belong to more basal lineages among the advanced Asian and Malesian didymocarpoideae (Figs. 1–2), while *Didymocarpus* is sister to the Chinese *Gyrocheilos* and *Allocheilos* in a well-supported (BS = 100%; PP = 1.00), more derived position. The position of *Tribounia* in the trees does not differ when the two species are included in the complete 232 didymocarpoideae dataset of Weber & al. (2011a; data not shown).

The two *Tribounia* species have quite different corolla shapes: *Tribounia grandiflora* has an open corolla tube with a short dilated distal end and long undilated basal part, while *T. venosus* has a laterally compressed corolla similar to some

species in *Streptocarpus* (e.g., *S. saxorum* Engler, *S. johannis* L.L. Britten) and a short undilated basal part. The corolla morphologies are suggestive of moth or butterfly pollination for *T. venosus* and long-tongued bee pollination for *T. grandiflora*.

The simplest morphological character found to separate *Tribounia* from *Didymocarpus*, the prominent boss on the dorsal surface of the corolla, is not unique in Gesneriaceae. In a rather less prominent form it also occurs in some species in other genera such as *Hemiboea* (*H. cavaleriei* H. Lév., *H. magnibracteata* Y.G. Wei & H.Q. Wen, *H. subcaulis* Hand.-Mazz.), *Primulina* (*P. heterotricha* (Merr.) Yin Z. Wang, *P. pteropoda* (W.T. Wang) Yin Z. Wang) or *Oreocharis* (*O. mileensis* (W.T. Wang) Mich. Möller & A. Weber). In none of these other species is the boss on the corolla as large as in *Tribounia*. These structures may act to accommodate the cohering anthers upon an insect entering the corolla in the species of *Tribounia*, *Hemiboea* or *Primulina*, or even the insect itself in *Oreocharis mileensis* since the anthers are presented at the bottom of the corolla tube. These differences, and the isolated positions of these genera in phylogenetic trees (Weber & al., 2011a), suggest that this structure has evolved several times independently. The same has been found for other characters associated with pollination syndromes in Gesneriaceae (e.g., Harrison & al., 1999; Hughes & al., 2006; Möller & al., 2011b). None of these other species has the pendulous fruit with the long stipe found in *Tribounia*. Long fruit stipes are known in *Aeschynanthus* Jack but this genus differs in very many other morphological characters and was shown in Möller & al. (2011a) to be only distantly related to *Didissandra* and thereby to *Tribounia*.

■ TAXONOMIC TREATMENT

Tribounia D.J. Middleton, gen. nov. – Type: *Tribounia venosa* (Barnett) D.J. Middleton.

Differs from other genera of Asian Gesneriaceae by the combination of caulescent habit, the prominent boss on the dorsal surface of the corolla into which the fertile stamens protrude, fertile stamens 2, stigma capitate, and the capsule long stipitate, pendulous and non-twisted.

Caulescent herbs growing in crevices in karst limestone, probably annuals. Leaves opposite, equal, petiolate; venation pinnate, eucamptodromous, tertiary venation alternate percurrent. Inflorescence dichasial, axillary but often with the appearance of a terminal panicle. Calyx equally 5-partite almost to base, lobes narrowly ovate to elliptic; persistent in fruit. Corolla zygomorphic, of a narrow lower tube which widens into an infundibuliform upper tube which has a prominent boss on the dorsal surface, lobes 5, slightly to markedly spreading. Fertile stamens 2, filaments curved or bent in middle, the bend in the filaments having the effect of pushing the anthers into the boss (or pouch from the inside) on dorsal surface; anthers adnate at their tips, locules slightly divergent or not, partially held inside the boss on dorsal corolla surface; lateral staminodes 2, large; medial staminode extremely small or absent. Pistil with short stipe, ovary and short style; ovary cylindrical, bicarpellate, unilocular with two parietal placentae, ovules

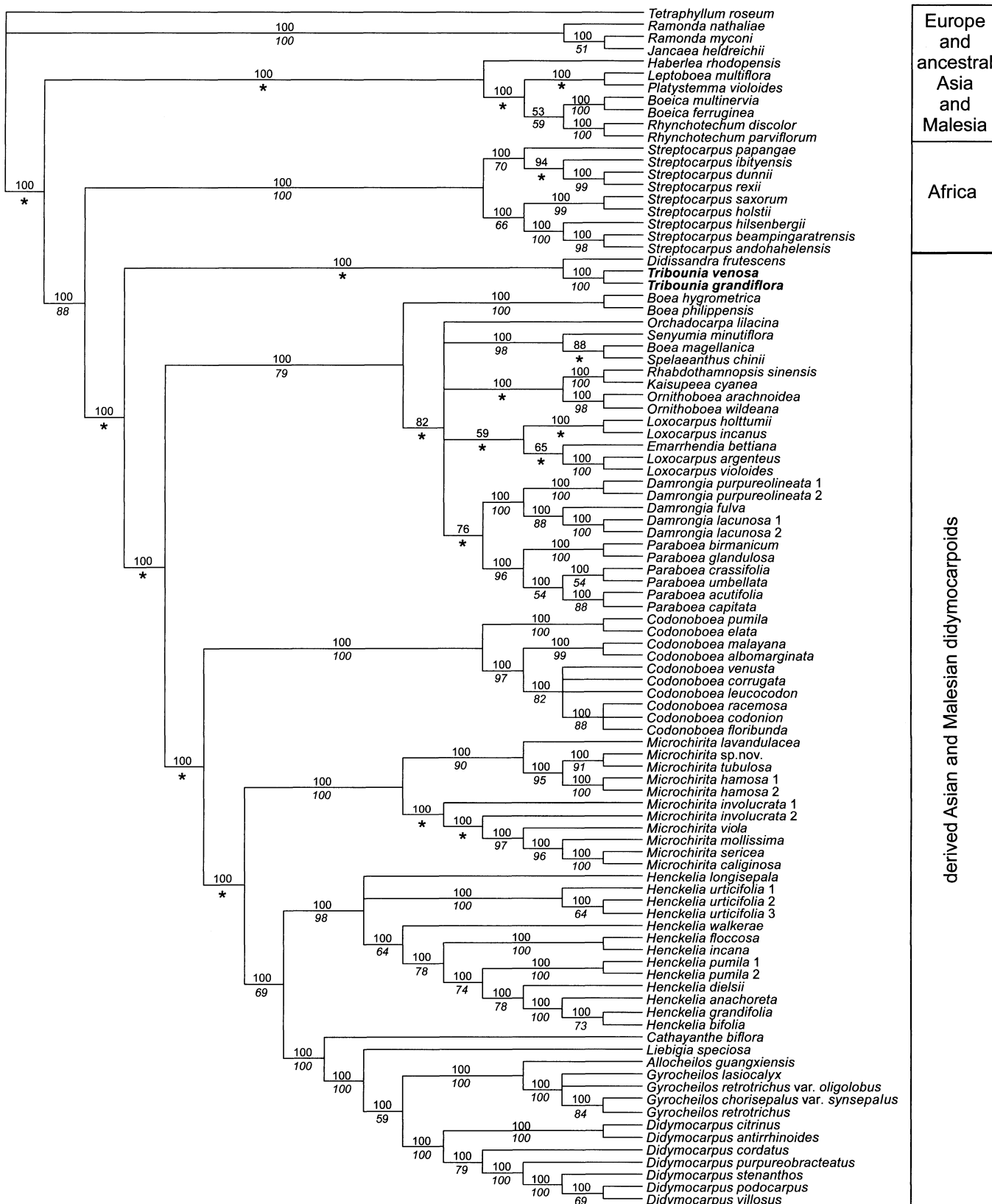


Fig. 1. Maximum parsimony 50% majority-rule consensus tree of 3748 steps length based on combined chloroplast *trnL-F* and nuclear ribosomal internal transcribed spacer DNA sequences (CI = 0.3981, RI = 0.6501). Numbers above branches are majority-rule frequencies, numbers below branches are bootstrap values (* denotes values <50%).

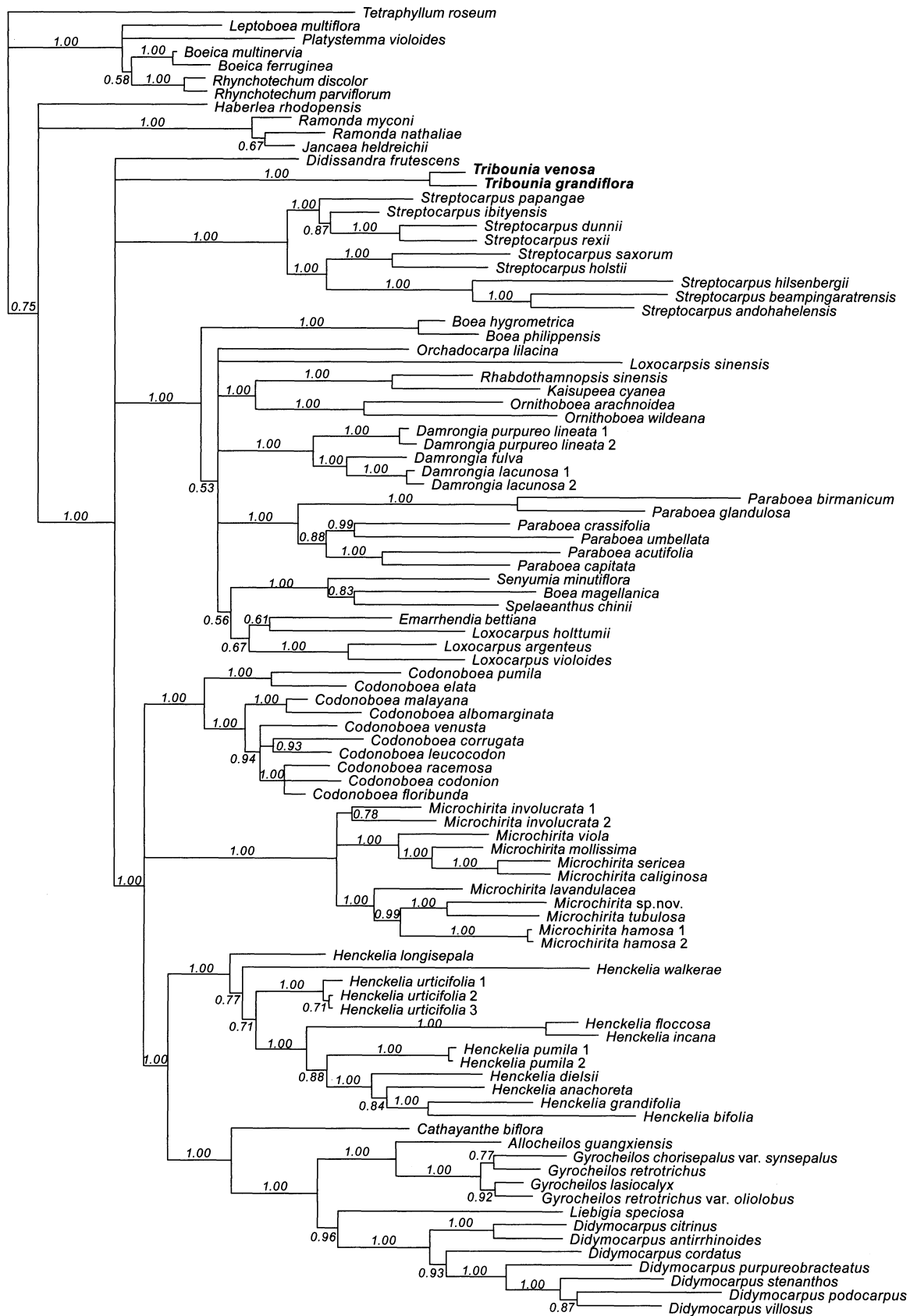


Fig. 2. Bayesian inference tree with average branch lengths based on combined *trnL-F* and ITS sequences of 97 didymocarpid Gesneriaceae samples. Posterior probabilities are displayed along the branches.

numerous; stigma capitate. Fruit a fusiform pendulous capsule, not twisted, long stipitate, dehiscence loculicidal. Seeds numerous, subglobose, longitudinally ridged and radially more minutely ridged and pitted.

Distribution. – Two species, both of which are endemic to Thailand.

Etymology. – The genus is named in honour of Dr. Pramote Triboun of the Bangkok Herbarium (BK) for his contribution to our understanding of Gesneriaceae in Thailand.

Key to the species

1. Indumentum mostly of eglandular hairs with occasional glandular hair, vegetative parts of plant not sticky; corolla <2.5 cm long, mouth of corolla strongly oblique with ventral part of corolla tube much longer than dorsal; fruit <3 cm long *T. venosa*
1. Indumentum a mixture of eglandular and glandular hairs, vegetative parts sticky; corolla >3 cm long, mouth of corolla only weakly oblique with ventral part of corolla tube not much longer than dorsal; fruit >4 cm long *T. grandiflora*

Tribounia venosa (Barnett) D.J. Middleton, **comb. nov.** ≡ *Didymocarpus venosus* Barnett in Nat. Hist. Bull. Siam Soc. 20: 13. 1961; Barnett in Kew Bull. 15: 251. 1961; Barnett, Fl. Siam. 3: 218. 1962 – Lectotype (designated by Barnett, 1961b: 252): Thailand, Ratchaburi, young plants collected on limestone rocks and cultivated in Bangkok, 25 Oct 1924, *A.F.G. Kerr 9341* (K; isotype BK). — Figure 3.

Lithophytic herb on limestone rocks to 30 cm tall, probably annuals; stems with multicellular uniseriate hairs, mostly eglandular and often hooked at the tip, fewer hairs with glandular tip. Leaves: petiole 3.0–10.5 cm long, eglandular pubescent, hairs mostly with a hooked tip, occasional glandular hair present; blade ovate, 3.0–9.2 × 2.0–7.3 cm, apex short acuminate, base cordate, margin dentate to crenate, dark green above, paler beneath, 5–9 pairs of secondary veins, densely pubescent above and beneath, mostly with eglandular hairs, occasional glandular hair present. Inflorescence axillary but often with the appearance of a terminal panicle, 9–17 cm long, all parts with a mixture of shorter eglandular hairs with a hooked tip and longer glandular hairs; peduncle 4.0–9.5 cm long; pedicels 10–14 mm long. Calyx green, lobes elliptic, 3.5–4.5 × 1.1–1.7 mm, apex acute to acuminate, pubescent outside and inside with multicellular uniseriate hairs of varying lengths to 0.6 mm long, the hairs a mixture of shorter eglandular hairs, mostly with hooked tips, and longer glandular hairs. Corolla 22–25 mm long, narrowly tubular and curved downward in lower part, widening into infundibuliform upper part, with a prominent boss on dorsal side just below upper lobes, lobes spreading, mouth of corolla strongly oblique, tube pale green at very base, dark red higher to red suffused with very pale green outside and inside, boss pale green suffused with red, lobes pale purple to bluish-purple inside, each with a darker stripe down lobe, pale purple outside; tube 9–11 mm long, narrow in lower part, widening at 6–8 mm; upper lobes ±

orbicular, ca. 7 × 9 mm, apex rounded; lateral lobes ± orbicular, 6.8–7.5 × 6.0–7.5 mm, apex rounded; lower lobe ± orbicular, 6.0–6.8 × 7.0 mm, apex rounded; glabrous inside except for subsessile glands at margin of the boss (pouch from the inside), glandular pubescent outside, becoming more sparsely so distally. Fertile stamens inserted ca. 6 mm from corolla base; filaments curved, ca. 2.5 mm long, glabrous; anthers 1.3 × 1.5 mm, glabrous; lateral staminodes with a winged filament and the filament strongly curved so the vestigial anthers point towards corolla base, ca. 2.5 mm long in total; medial staminode absent. Disc an annular ring, ca. 0.6 mm high. Pistil ca. 9 mm long, densely glandular pubescent; stipe ca. 2 mm long; ovary ca. 6 mm long; style ca. 1 mm long. Fruit 19–30 × 2–3 mm of which stipe 3–6 mm long, densely pubescent. Seeds ca. 3 mm long, ca. 2 mm diameter.

Specimens studied. – THAILAND. Lampang, Mae Prik District, Tham Nam Pha Phangam, 200 m altitude, 25 Sep 2008, *D.J. Middleton, P. Karaket, P. Triboun, U. Kawatkul & R. Meeboonya 4589* (BK, BKF, E, QBG); Nakhon Sawan, Ban Den, Khao Sang, 8 Nov 1920, *A.F.G. Kerr 4539* (BKF, K); Nakhon Sawan, Khao Sung, near Paknampo, 9 Dec 1913, *A.F.G. Kerr 3018* (K); Nakhon Ratchasima, Lat Bua Kao, Oct 1916, *C. Boden Kloss s.n.* (K); Kanchanaburi, Ban Kao, 9 Nov 1961, *K. Larsen 8083* (ABD, K); Kanchanaburi, Khao Salop, 19 Nov 1970, *T. Smitinand 11372* (BKF, E); Kanchanaburi, Ta Sakae (cultivated Bangkok), 6 Oct 1930, *A.F.G. Kerr 19736* (K); Khao Koh Ai Wao, 15 Nov 1969, *B. Sangkhachand 1575* (BKF); Prachuap Khiri Khan, Khao Chong Krachok, *T. Sindhiphong 22* (BKF).

Distribution. – Endemic to Thailand.

Habitat. – In crevices of karst limestone in deciduous forest.

IUCN conservation assessment. – Least Concern (LC).

This species is fairly widespread. Most of the collection localities are in non-protected areas so the status of this species should be checked regularly, particularly as karst limestone habitats are frequently affected by mining and fire.

Tribounia grandiflora D.J. Middleton, **sp. nov.** – Holotype: Thailand, Kanchanaburi, Muang Kanchanaburi, Wat Tham Khao Pun, 70 m altitude, 14°00'00"N, 99°30'15"E, small karst limestone mountain with disturbed vegetation of small trees and bamboo, 29 Oct 2009, *D.J. Middleton & P. Triboun 5205* (BKF; isotypes BK, E, QBG). – Figures 4–5.

Differs from *Tribounia venosa* in the more glandular vegetative parts, the larger corolla, the much less oblique corolla mouth and the longer fruits.

Herb to 60 cm tall in fissures in limestone rocks, probably annuals, sticky throughout, caulescent; stems reddish-brown, densely pubescent with a mixture of shorter eglandular, occasionally hooked at the tip, and longer glandular multicellular uniseriate hairs. Leaves: petiole 2.5–11.0 cm long, densely pubescent with a mixture of shorter eglandular and longer glandular multicellular uniseriate hairs; blade ovate, 5.5–17.0 × 2.7–9.0 cm, apex acute to short acuminate, base equal or slightly unequal, rounded to cordate, margin dentate, pale green above, very pale green beneath, 8–15 pairs of lateral

veins, densely pubescent above and beneath with hairs as on petiole. Inflorescence axillary but often with the appearance of a terminal panicle, 6–16 cm long; peduncle 3–7 cm long; pedicels 8–12 mm long. Calyx green, lobes narrowly ovate, 6.5–12.0 × 1.7–2.4 mm, apex acuminate, pubescent outside and inside with multicellular uniseriate hairs of varying length to 0.8 mm long, mostly with glandular tips, the few eglandular

hairs generally shorter. Corolla 33–38 mm long, narrowly tubular and straight in lower half, widening into infundibuliform upper half, with a prominent boss just below upper lobes, lobes only slightly spreading, mouth of corolla weakly oblique, tube green at very base, then reddish-purple and then upper wider tube purple but paler on ventral surface outside and paler on ventral surface inside with darker purple and white lines, lobes



Fig. 3. *Tribounia venosa* (Barnett) D.J. Middleton. **A**, habit. **B**, close up of strongly oblique corolla mouth; **C**, side view of corolla showing boss; **D**, pendulous fruit. — All photos by D.J. Middleton.

purple; tube 26.5–34.0 mm long, narrow in lower part, widening at 15–17 mm; upper lobes ± orbicular, 6.0–6.5 × 6.5–7.0 mm, apex rounded, sinus between them ca. 4 mm deep; lateral lobes ± orbicular, apex rounded, 7–8 × 7–8 mm; lower lobe ± orbicular, apex rounded, 5.5–6.5 × 7.0–7.5 mm; glabrous inside except for sessile glands at raised base and margin of the boss (pouch from the inside), glandular pubescent outside,

becoming more sparsely so distally. Fertile stamens inserted at ca. 17 mm from base of corolla; filaments geniculate and widened in middle, ca. 9 mm long, glabrous; anthers ca. 2 × 3 mm, glabrous; lateral staminodes with a winged filament and the filament strongly curved so the vestigial anthers point towards corolla base, ca. 5 mm long in total; medial staminode ca. 0.2 mm long. Disc a rather uneven ring, ca. 1 mm high. Pistil

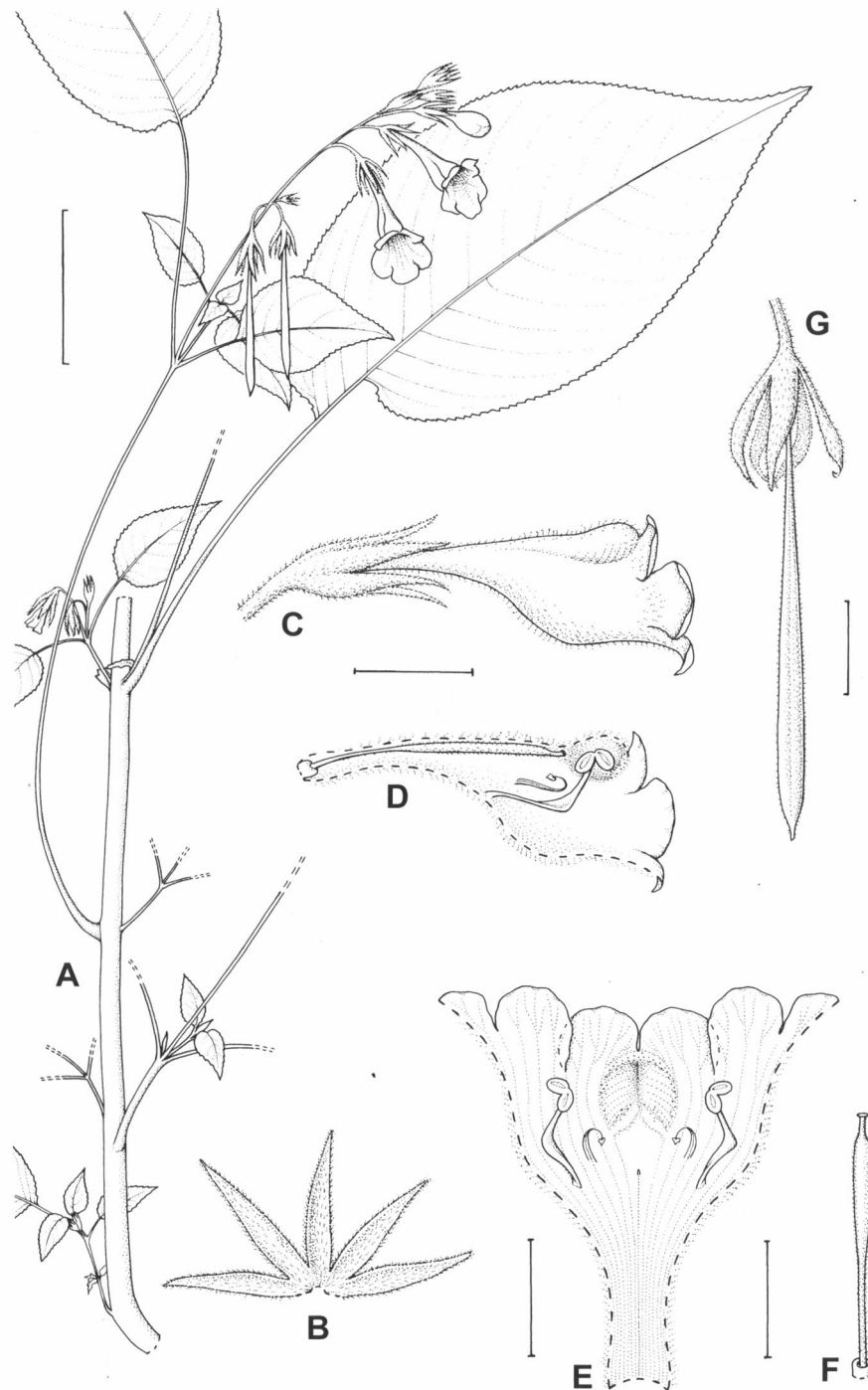


Fig. 4. *Tribounia grandiflora* D.J. Middleton. **A**, habit; **B**, calyx opened out; **C**, corolla, lateral view; **D**, corolla, longitudinal dissection showing position of stamens and pistil; **E**, corolla opened out; **F**, pistil; **G**, fruit and persistent calyx. — Scale bars: A, 5 cm; B–G, 1 cm. — Drawn by Claire Banks from D.J. Middleton & P. Triboun 5205 (E).

17–23 mm long, densely glandular pubescent; stipe 7.0–9.5 mm long; ovary 7.5–11.0 mm long; ca. style ca. 2.5 mm long. Fruit 44–54 × 2.5–4.0 mm of which stipe 13–15 mm long, densely pubescent. Seeds ca. 4 mm long, ca. 3 mm diameter.

Specimens studied. – THAILAND. Kanchanaburi, Sai Yok, Suea Dao Cave, Tham Suea Dao Temple, R. Pooma, C.C. Berg & K. Phattarahirankanok 5830 (BKF, E); Kanchanaburi, Wang Po, 26 Oct 1969, Kasem 640 (BK).

Distribution. – Endemic to Thailand.

Habitat. – In crevices of karst limestone in deciduous forest.

IUCN conservation assessment. – Endangered (EN ab(iii)). The known Extent of Occurrence of this species is less than 300 km² and the known localities are all outside of protected areas and are subject to degradation from surrounding agriculture and forest clearance, thereby changing the microclimate of the limestone habitat.

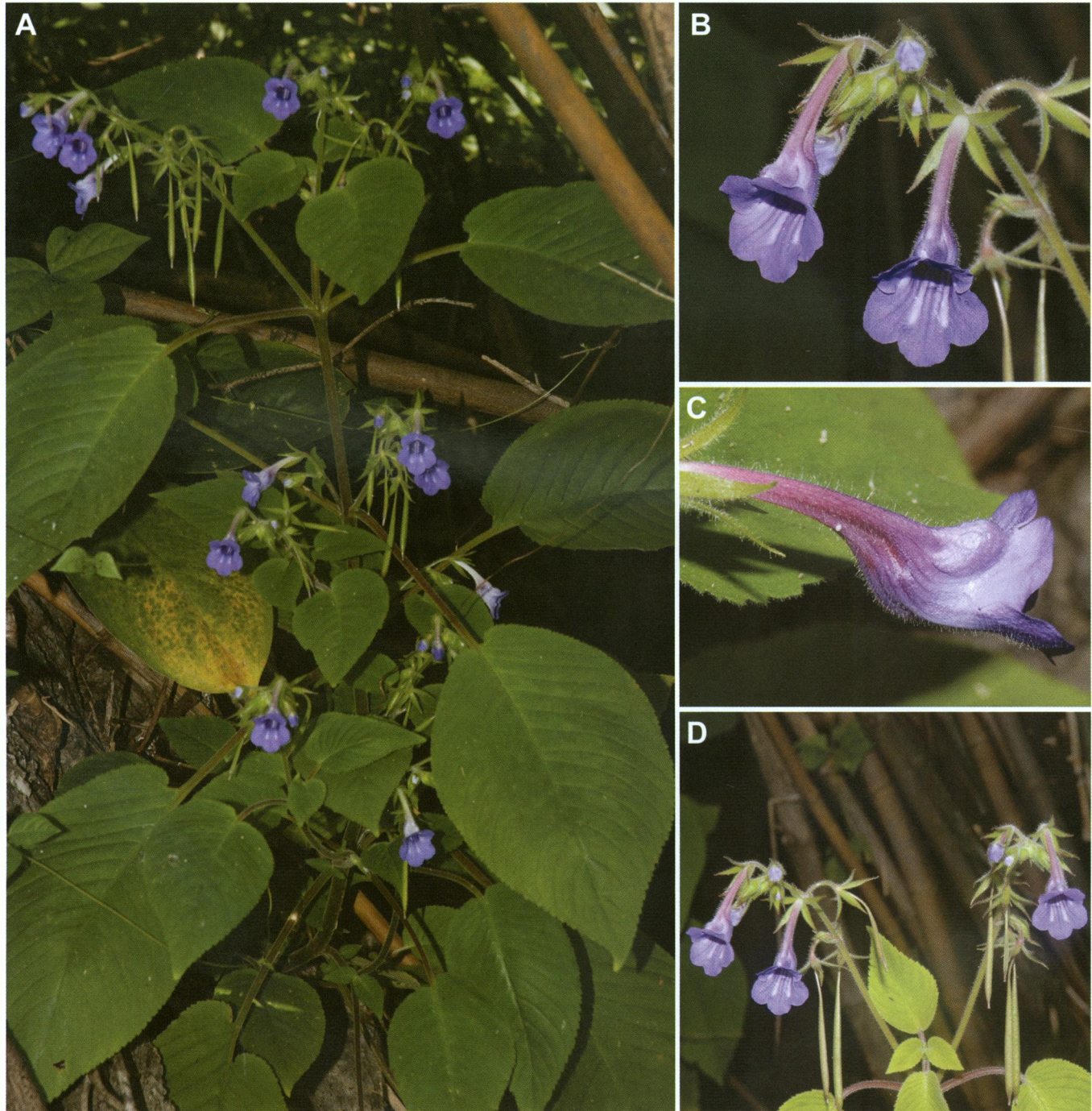


Fig. 5. *Tribounia grandiflora* D.J. Middleton. **A**, habit; **B**, flowers; **C**, side view of corolla showing boss; **D**, flowers and pendulous fruit. — All photos by D.J. Middleton.

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Appendix. List of the 97 didymocarpoid Gesneriaceae samples included in the phylogenetic analysis, including voucher information and GenBank accession numbers (*trnL-F*, ITS or ITS1 / ITS2).

Allocheilos guangxiensis H.Q. Wen, Y.G. Wei & S.H. Zhong, China, Guangxi, Yongfu county, *Y.G. Wei 06-02* (IBK), HQ632897, HQ632994; *Boea hygrometrica* (Bunge) R. Br., China, unknown locality, *Z.J. Gu 01-6184* (KUN), FJ501476, FJ501319; *Boea magellanica* Lam., Papua New Guinea, Morobe Province, *Lambinon 87/830* (L), FJ501478, FJ501321; *Boea philippensis* C.B. Clarke, Indonesia, Sulawesi, Gunung Ali, *S. Scott 02-142* (E), HQ632862, HQ632953; *Boeica ferruginea* Drake, China, SE Yunnan, *M. Möller MMO 01-182B ex Zhang Chang Qin 200012* (E, WU), FJ501440; *Boeica multinervia* K.Y. Pan, China, Yunnan, Yingjiang, *Y.Z. Wang 015* (PE), HQ632861, HQ632951; *Cathayanthe biflora* Chun, China, Hainan, Tongshi county, *M. Möller MMO 08-1327* (E), HQ632899, HQ632996; *Codonoboea albomarginata* (Hemsl.) Kiew, Peninsular Malaysia, Perak, Maxwell’s Hill, *A. Weber 840805-1/12* (WU), AJ492297, HQ632961; *Codonoboea codonion* (Kiew) C.L. Lim, Malaysia, Terengganu, Jerangau F.R., *C.L. Lim FRI 65040* (KEP), JF912538, JF912565; *Codonoboea corrugata* (Mendum) D.J. Middleton, Philippines, Palawan, *RBGE-PNHE 1998 s.n.* (E), FJ501484, HQ632962; *Codonoboea elata* (Ridl.) Rafidah, Malaysia, Perak, Maxwell’s Hill, *A.R. Rafidah FRI 64321* (KEP), JF912523, JF912550; *Codonoboea floribunda* (M.R. Hend.) C.L. Lim, Malaysia, Terengganu, Sg. Nipah F.R., *C.L. Lim FRI 64971* (KEP), JF912539, JF912566; *Codonoboea leucocodon* (Ridl.) Ridl., Malaysia, Pahang, Gunung Tahan, *C.L. Lim FRI 64821* (KEP), JF912540, JF912567; *Codonoboea malayana* (Hook. f.) Kiew, Malaysia, Pahang, Fraser’s Hill, *R. Kiew & D.J. Middleton FRI 57513* (KEP), JF912541, JF912568; *Codonoboea pumila* (Ridl.) C.L. Lim, Malaysia, Pahang, Fraser’s Hill, *T.L. Yao FRI 55963* (KEP), JF912543, JF912570; *Codonoboea racemosa* Spreng. (Jack) A. Weber, Indonesia, Sumatra, Aceh, *P.S. Smith, SMTSU 110/110* (E), JF912544, JF912571; *Codonoboea venusta* (Ridl.) Kiew, Malaysia, Fraser’s Hill, *R. Kiew, RK 5430* (KEP), JF912545, JF912572; *Damrongia fulva* (Barnett) D.J. Middleton & A. Weber, Thailand, Khampaeng Phet, *P. Triboun s.n.* (BK), JF912536, JF912563; *Damrongia lacunosa* (Hook. f.) D.J. Middleton & A. Weber 1, Peninsular Malaysia, Perak, Temengor F.R., Pulau Batu Putih, *K. Imin & al. FRI 63238* (KEP), JF912530, JF912557; *Damrongia lacunosa* (Hook. f.) D.J. Middleton & A. Weber 2, Peninsular Malaysia, Pahang, Lipis distr., Gua Rusa, *A. Weber 870510-1/8* (WU), FJ501458, FJ501308; *Damrongia purpureolineata* Kerr ex Craib 1, Thailand, Lamphun, Li, *P. Triboun s.n.* (BK), JF912534, JF912561;

Appendix. Continued.

Damrongia purpureolineata Kerr ex Craib 2, Thailand, Lamphun, Li, *D.J. Middleton & al.* 4812 (E), JF912535, JF912562; *Didissandra frutescens* (Jack) C.B. Clarke, Peninsular Malaysia, Perak, Maxwell's Hill, *A. Weber* 840805-1/2 (WU), FJ501522, –; *Didissandra frutescens* (Jack) C.B. Clarke, Peninsular Malaysia, Perak, Kuala Kangsar, *A.R. Rafidah FRI 64355* (KEP), –, HQ632952; *Didymocarpus antirrhinoides* A. Weber, Peninsular Malaysia, Perak, Bujong Melaka, Ipoh., *K. Jong 9009* [Cult. RBGE 19650167] (E), FJ501513, DQ912671; *Didymocarpus citrinus* Ridl., Peninsular Malaysia, Perlis, Kedah Peak, *P. Davis 69437* [Cult. RBGE 19830510] (E), AJ492293, DQ912669; *Didymocarpus cordatus* Wall. ex A. DC., Peninsular Malaysia, Perak, Maxwell's Hill, *A. Weber* 860816-2/1 (WU), AJ492294, DQ912673; *Didymocarpus podocarpus* C.B. Clarke, Bhutan, Deothang District, *H. Noltie & al.* 193 (E), FJ501514, DQ912688; *Didymocarpus purpureobracteatus* W.W. Sm., China, Yunnan, Pingbian county, *Y.Z. Wang 991106* (PE), FJ501510, –; *Didymocarpus purpureobracteatus* W.W. Sm., China: Yunnan, Pingbian county, *M. Möller MMO 01-70* (E, WU), –, DQ912676; *Didymocarpus stenanthos* C.B. Clarke, China, Yunnan, Binchuan county, *M. Möller MMO 01-156* (E, WU), FJ501512, DQ912687; *Didymocarpus villosus* D. Don, Nepal, Sundarjal, *B. Adhikari SB 9* (E), HQ632904, HQ633001; *Emarthenidia bettiana* (M.R. Hend.) Kiew, A. Weber & B.L. Burt, Peninsular Malaysia, *R. Kiew FRI 55716* (KEP), HQ632864, HQ632955; *Gyrocheilos chorisepalus* W.T. Wang var. *synsepalus* W.T. Wang, China, Guangdong, Xinyi county, *Y.G. Wei 07-708* (IBK), HQ632900, HQ632997; *Gyrocheilos lasiocalyx* W.T. Wang, China, Guangxi, Guiping county, *M. Möller MMO 06-881* (E), HQ632901, HQ632998; *Gyrocheilos retrotrichus* W.T. Wang, China, Guangxi, Wuming county, *M. Möller MMO 07-1136* (E), HQ632902, HQ632999; *Gyrocheilos retrotrichus* W.T. Wang var. *oligolobus* W.T. Wang, China, Guangxi, Rongshui county, Sirong town, *Y.G. Wei 06-208* (E), HQ632903, HQ633000; *Haberlea leucodensis* Friv., (Greece), Voucher from Cult. RBGE 19754106 (E), AJ492296^b; *Henckelia anachoreta* (Hance) D.J. Middleton & Mich. Möller, Thailand, Chiang Mai, Doi Suthep, *D.J. Middleton & al.* 4480 (E), HQ632870, HQ632966; *Henckelia bifolia* (D. Don) A. Dietr., Nepal, Chyalding, near Sybrubesi, *B. Adhikari L2B6* (E), JF912522, JF912549; *Henckelia dielsii* (Borza) D.J. Middleton & Mich. Möller, China, Yunnan, Jingdong county, *M. Möller MMO 08-1211* (E), HQ632871, HQ632967; *Henckelia floccosa* (Thwaites) A. Weber & B.L. Burt, Sri Lanka, *C.G. Jang s.n.* [G 157] (WU), FJ501486, HQ632964; *Henckelia grandifolia* A. Dietr., China, Yunnan, Jingdong county, *M. Möller MMO 08-1222* (E), JF912527, JF912554; *Henckelia incana* (Vahl) Spreng., India, Nilgiri mts., *S. Vogel SVG s.n.* (E), HQ632869, HQ632965; *Henckelia longisepala* (H.W. Li) D.J. Middleton & Mich. Möller, China, Yunnan, Jinping county, *Y.M. Shui 73170* (KUN), HQ632890, HQ632963; *Henckelia pumila* (D. Don) A. Dietr. 2, China, Yunnan, Nujiang Lisu Aut. Pref., Fugong county, *Gaoligong Shan Expedition 1996 7938* [Cult. RBGE 19962271] (E), FJ501491, FJ501327; *Henckelia urticifolia* (D. Don.) A. Dietr. 1, China, Yunnan, *J.M. Li 05851* (PE), DQ872821, DQ872835; *Henckelia urticifolia* (D. Don.) A. Dietr. 2, Bhutan, Tashigang distr., *NPSW 110* (E), JF912532, JF912559; *Henckelia urticifolia* (D. Don.) A. Dietr. 3, Nepal, Sankhuwasabha distr., Arun valley, *EMAK 109 H* (Edinburgh-Makalu Expedition 1991) (E), FJ501492, FJ501328; *Henckelia walkerae* (Gardner) D.J. Middleton & Mich. Möller, Sri Lanka; leg. in US 11.03.1996, *L. Skog 7736* (US 590934) [Cult. Smithsonian 94-250] (US), FJ501490, FJ501326; *Jancaea heldreichii* Boiss., Greece, Mt Olympus, *E.G. Cairns s.n.* [Cult. RBGE 19771605] (photo E), FJ501439^a; *Kaisupeeia cyanea* B.L. Burt, Thailand, Chachoengsao, Khao Tak Groep, *K. Larsen 44272* [Cult. RBGE 19972918] (E), FJ501459, FJ501309; *Leptoboea multiflora* (C.B. Clarke) Gamble subsp. *grandifolia* B.L. Burt, Thailand, Chanthaburi, Khaso Phra Bat, *Larsen & al.* 32065 (E), FJ501442^c; *Liebigia speciosa* (Blume) Endl., Indonesia, Java, forest above Cibodas Garden, *P. Woods 1071* (C6570) (E), FJ501538, JF501359; *Loxocarpus argenteus* B.L. Burt, Malaysia, Sarawak, Bako National Park, *T.L. Yao FRI 57975* (KEP), JF912537, JF912564; *Loxocarpus holtumii* M.R. Hend., Peninsular Malaysia, Johor, Gunung Pantai, *A. Weber 840723-1/2* (WU), FJ501479, HQ632956; *Loxocarpus incanus* R. Br., Malaysia, Ulu Bendul, Negeri Sembilan, *T.L. Yao FRI 65362* (KEP), JF912542, JF912569; *Loxocarpus violoides* (C.B. Clarke) B.L. Burt, T.L. Yao, Malaysia, Sayap, Kinabalu Park, *T.L. Yao FRI 65458* (KEP), JF912546, JF912573; *Microchirita caliginosa* (C.B. Clarke) Yin Z. Wang, Peninsular Malaysia, ex HB München-Nymphenburg; *M. Kiehn & M. Pfoser 2000-1* [Cult. HBV GS-96-02] (WU), FJ501488, FJ501325; *Microchirita hamosa* (R. Br.) Yin Z. Wang 1, China, Guangxi, Longzhou county, *M. Möller MMO 05-753* (E), JF912524, JF912551; *Microchirita hamosa* (R. Br.) Yin Z. Wang 2, China, unknown locality, *J.M. Li LJM1181* (PE), DQ872822, DQ872839; *Microchirita involucrata* (Craib) Yin Z. Wang 1, Malaysia, Kelantan, Gunung Reng, *A.R. Rafidah FRI 64447* (KEP), JF912525, JF912552; *Microchirita involucrata* (Craib) Yin Z. Wang 2, Peninsular Malaysia, Kedah, Baling, *K. Imin & al. FRI 63180* (KEP), JF912526, JF912553; *Microchirita lavandulacea* (Stapf) Yin Z. Wang, China, unknown locality, Voucher from Cult. RBGE 20000897 (E), FJ501487, FJ501324; *Microchirita mollissima* (Ridl.) A. Weber & D.J. Middleton, Thailand, Surat Thani, Khlong Phanom, *D.J. Middleton & al.* 4361 (E), JF912528, JF912555; *Microchirita sericea* (Ridl.) A. Weber & Rafidah, Malaysia, Kelantan, Gunung Reng, *A.R. Rafidah FRI 64328* (KEP), JF912548, JF912521; *Microchirita sp. nov.*, Thailand, Tak, Mae Sot, *D.J. Middleton & al.* 4849 (E), JF912520, JF912547; *Microchirita tubulosa* (Craib) A. Weber & D.J. Middleton, Thailand, Nakhon Sawan, Wat Thap Satha Phon, *D. Middleton & al.* 4809 (E), JF912531, JF912558; *Microchirita viola* (Ridl.) A. Weber & Rafidah, Malaysia, Kedah, P. Langkawi, *A.R. Rafidah FRI 64388* (KEP), JF912533, JF912560; *Orchadocarpus lilacina* Ridl., Peninsular Malaysia, Pahang, Fraser's Hill, *R. Kiew, RK 5410* (KEP), HQ632863, HQ632954; *Ornithoboea arachnoidea* (Diels) Craib, Thailand, Chiang Mai, Doi Chiang Dao, Voucher from Cult. RBGE 19972903 (E), FJ501461, FJ501312; *Ornithoboea wildeana* Craib, China, Yunnan, Xichou county, *Y.Z. Wang 00401* (PE), FJ501462, FJ501313; *Paraboea acutifolia* (Ridl.) B.L. Burt, Peninsular Malaysia, Kedah, Pulau Langkawi, Bukit Terbak, *A. Weber 86805-2/1* (WU), FJ501464, FJ501314; *Paraboea birmanica* (Craib) C. Puglisi, China, Guangxi, Jingxi county, *M. Möller MMO 06-862* (E), HQ632866, HQ632958; *Paraboea capitata* Ridl., Peninsular Malaysia, Perak, Kinta district, *A. Weber 870522-5/2* [Cult. HBV] (WU), AJ492298, FJ501315; *Paraboea crassifolia* (Hemsl.) B.L. Burt, China, Yunnan, Maguan county, *M. Möller MMO 01-83* (E, WU), FJ501472, FJ501318; *Paraboea glandulosa* (B.L. Burt) C. Puglisi, Thailand, Kanchanaburi, Thong Pha Phum, Ti Pugae, *D.J. Middleton & P. Triboun 5202*, BK, E, HQ632867, HQ632959; *Paraboea umbellata* (Drake) B.L. Burt, China, Guangxi, Napo county, *M. Möller MMO 01-147* (E, WU), FJ501470, FJ501317; *Platystemma violoides* Wall., Nepal, SE Kathmandu, Pulchoki, *Projektteam 197-241* (WU), FJ501443^c; *Ramonda myconi* (L.) Rchb., Spain, Pyrenees, Voucher from Cult. RBGE 19711477 (E), AJ492301^a; *Ramonda nathaliae* Pančić & Petrov., Macedonia, unknown locality, Voucher from Cult. RBGE 19784020 (E), AJ501438^a; *Rhabdothamnopsis sinensis* Hemsl., China, unknown locality, Voucher from Cult. Kew 1988 4866, K, AJ492302, –; *Rhabdothamnopsis sinensis* Hemsl., China, Sichuan, Mianning county, *M. Möller MMO 08-1059* (E), –, HQ632960; *Rhynchotechum discolor* (Maxim.) B.L. Burt, Philippines, Luzon, Isabela, *RBGE-PNH Expedition 1997/SM8* [Cult. RBGE 19972562] (E), FJ501436^c; *Rhynchotechum parviflorum* Blume, Central Sulawesi, Mt. Sojol, *M. Mendum & al.* 00148 (E), FJ501437^c; *Senyumia minutiflora* (Ridl.) Kiew & al., Peninsular Malaysia, Pahang, Gunung Senyum, *A.R. Rafidah & al. FRI 55722* (KEP), HQ632865, HQ632957; *Spelaeanthus chinii* Kiew & al., Peninsular Malaysia, Pahang, Jerantut distr., Taman Negara, *A. Weber 860709-2/2* (WU), FJ501457, FJ501307; *Streptocarpus andohahelensis* Humbert, Madagascar, Tuléar, Ranomafana, *M. Möller MM 9717* (E), FJ501449, AF316903; *Streptocarpus beampingararensis* Humbert, Madagascar, Tuléar, Ranomafana, *M. Möller MM 9715* (E), FJ501448, AF316905; *Streptocarpus dunnii* Hook. f., Swaziland, Mbabane, *I. LaCroix s.n.* [Cult. RBGE 19941745] (E), FJ501456, AF316951; *Streptocarpus hilsenbergii* R. Br., Madagascar, Mandrake valley, *B.L. Burt s.n.* [Cult. RBGE 19631505] (E), FJ501450, AF316907; *Streptocarpus holstii* Engl., Tanzania, unknown locality, Cornell University (Bail. Hort) [Cult. RBGE 19592272] (E), AJ492304, AF316917; *Streptocarpus ibityensis* Humbert, Madagascar, Antananarivo, *E. Fischer 250/93* [Cult. RBGE 19932867] (E), FJ501455, AF316926; *Streptocarpus papangae* Humbert, Madagascar, Tuléar, Ranomafana, *M. Möller MM 9718* (E), FJ501444, AF316929; *Streptocarpus rexii* (Hook.) Lindl., South Africa, NE Cape, Grahamstown, *K. Jong s.n.* [Cult. RBGE 19870333] (E), AJ492305, AF316979; *Streptocarpus saxorum* Engl., cult. CJBG, *A. Chautems & M. Perret 01-023* (G), FJ501447, –; *Streptocarpus saxorum* Engl., Tanzania, Tanga region, *I.C. Mather 4* [Cult. RBGE 19721499] (E), –, AF316914; *Tetraphyllum roseum* Stapf, Thailand, Krabi Province, *H.K. Kurzweil 798* (WU), FJ501434, HQ632950; *Tribounia grandiflora* D.J. Middleton, Thailand, Kanchanaburi, Muang, Wat Tham Khao Pun, *D.J. Middleton & P. Triboun 5205* (E), JX839281, JX839280; *Tribounia venosa* (Barnett) D.J. Middleton, Thailand, Lampang, Mae Prik, Tham Nam Pha Phangam, *D.J. Middleton & al.* 4589 (E), JX839282, JX839283.

^aMöller & al., 1999; ^bMöller & Cronk, 2001; ^cWei & al., 2010.