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ORIGINAL ARTICLE

Chayamaritia (Gesneriaceae: Didymocarpoideae), a new genus from Southeast Asia

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Abstract Based on a phylogenetic analysis of Asian Gesneriaceae with the most comprehensive coverage at the genus level to date, the new genus *Chayamaritia* is established and described in subfamily Didymocarpoideae, tribe Trichosporeae, subtribe Didymocarpinae. It contains two species, of which one, *Chayamaritia smitinandii* (B.L.Burtt) D.J.Middleton, was formerly placed in the genera *Chirita* and *Henckelia.* The other, *Chayamaritia banksiae* D.J.Middleton, is newly described. The exclusion of *Chayamaritia smitinandii* from *Henckelia* further clarifies the taxonomic and biogeographic limits of *Henckelia* following its considerable recircumscription during the recent remodelling and synonymisation of *Chirita*.

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Introduction

The genus *Chirita* Buch.-Ham. ex D.Don was remodelled and split into five genera by Weber et al. (2011a). *Chirita* included a heterogeneous assemblage of species that was united by the possession of the so-called 'chiritoid stigma'. The chiritoid stigma is where the upper lobe of the stigma is not developed and the lower lobe is enlarged and often bifid (see Wu and Raven 2000, p 326). Despite a very diverse range in other characters, the possession of a chiritoid stigma was considered diagnostic for *Chirita* until Möller et al. (2009, 2011) demonstrated that the included species did not form a monophyletic group. The species were divided between redefined genera by Weber et al. (2011a) who also noted that there was a number of species for which the correct generic placement in the new system was problematic. This was largely due to these species not having been included in the molecular phylogenetic analyses and because the available herbarium material was rather sparse and/or poor to properly study the morphology. One such highlighted species was *Chirita smitinandii* B.L.Burtt. This species was moved into *Henckelia* Spreng., even though its relationships were not well understood, largely because no species could be left behind in *Chirita* when this genus was synonymised under *Henckelia*. Since Weber et al. (2011a) we have had the opportunity to collect new material of *Henckelia smitinandii* (B.L.Burtt) D.J.Middleton & Mich.Möller and study it much more closely, morphologically and with DNA sequence data. This paper presents our conclusions on this species and a new species clearly related to it.

Materials and methods

Plant material

Herbarium material has been studied from the following herbaria: BKF, CMU, E, K, L, P, QBG [abbreviations from Thiers (continuously updated)].

For the phylogenetic analyses, the extensive Old World Gesneriaceae matrix of Middleton et al. (2014) with 225 samples of tribe Trichosporeae (Weber et al. 2013), covering 52 out of 67 genera recognized in the tribe at present (Möller et al. 2011, 2014; Weber et al. 2013; Middleton et al. 2014), was extended by two *Tribounia* D.J.Middleton samples, four *Didissandra* C.B.Clarke samples, two samples of *Henckelia smitinandii* and one sample of an undescribed but similar species (Table 1). Not included were the African genera sensu Weber et al. (2013), and the Asian *Deinostigma* W.T.Wang, *Championia* Gardner (for both of which no material was available) and *Beccarinda* Kuntze. *Beccarinda* and *Championia* likely belong to the basal lineages of tribe Trichosporeae, in subtribe Leptoboeinae (Weber et al. 2013). The trees were rooted on *Tetraphyllum* Griff. ex C.B.Clarke (Möller et al. 2009).

This wide sampling across tribe Trichosporeae was deemed prudent to correctly place the three samples under investigation within the tribe, since the morphological characteristics of the *Henckelia smitinandii* group do not suggest a placement near or in any existing Asian genus.

Phylogenetic analysis

The sequences of the nuclear ribosomal internal transcribed spacers (ITS) and plastid *trn*L-F intron-spacer (*trn*L-F) for the *Didissandra* and *Henckelia smitinandii* group samples were acquired as described in Weber et al. (2011a). The newly acquired sequences have been submitted to GenBank (Table 1) and sequence matrices and tree files to TreeBase (http://purl.org/phylo/treebase/phylows/study/TB2:S17032).

Combinability tests of the two datasets, *trn*L-F and ITS, for phylogenetic analyses, and calculation of branch support were carried out as in Weber et al. (2011a), with the difference in sampling frequency in the Bayesian inference (BI) analysis (every 1000th generation) and the burn-in (250,000 generations, 5 %).

Results

The combined ITS and *trn*L-F matrix was 2209 characters long (1000 for ITS, 1209 for *trn*L-F). Of these, 66 had to be removed from the beginning of the plastid matrix due to sequencing artefacts, and 145 characters had to be excluded from the ITS matrix because of alignment ambiguities in hypervariable regions. Of the remaining 1998 characters, 939 were constant, 292 autapomorphic and 767 (38.4 %) parsimony informative. The two matrices were analysed together because the partition homogeneity test (PHT, $P = 0.39$) indicated no incongruence in phylogenetic signal between the two data sets.

The parsimony analysis resulted in 35,844 parsimonious trees (length = 6712 steps, consistency index = 0.2869, retention index = 0.6763). The characteristics of the Bayesian inference analysis indicated a good convergence of the two independent runs (Online Resources 1–5). There were differences in topology between the parsimony tree and Bayesian inference tree (Online Resources 6–8). However, these concern areas which received little or no branch support.

The three *Henckelia smitinandii* group samples formed a strongly supported clade (PP = 1; BS = 100 %) (Fig. 1) that is quite distant from the rest of *Henckelia* and not nested within any other genera. We, therefore, recognise them here as the new genus *Chayamaritia*, and the samples are labelled as such in Fig. 1. The genus is placed in subtribe Didymocarpinae, as well supported sister to *Petrocosmea* Oliv. (PP = 1; BS = 82 %). The clades of these two genera have long stems, indicating that the genera represent distinct units (Online Resources 6, 8). The two genera together are sister to *Allostigma* W.T.Wang (PP = 1; BS = 69 %) and these together sister (PP = 96; BS $\leq$ 50 %) to a clade comprised of *Pseudochirita* W.T.Wang and *Loxostigma* C.B.Clarke (PP = 1; BS = 73 %). The latter clade relationship, however, was not retrieved in the MP analysis (Online Resource 7). However, the sister relationship of the clade that includes *Chayamaritia* (and *Petrocosmea*) to a clade including the six genera *Glabrella* Mich.Möller & W.H.Chen, *Briggsiopsis* K.Y.Pan, *Anna* Pellegr., *Raphiocarpus* Chun, *Lysionotus* D.Don and *Hemiboea* C.B.Clarke was identical between the two phylogenetic analyses, including almost all relationships amongst the six genera. All of these, except for the two *Glabrella* species, are caulescent.

Discussion

We have assembled the largest dataset at the genus level to date for the family Gesneriaceae to investigate the position of a morphologically distinct lineage that was suspected to represent a new evolutionary unit. Indeed, our results showed that the samples formed a separate lineage and we, therefore, establish a new genus: *Chayamaritia*. The phylogenetic position of *Chayamaritia* in the molecular phylogeny is interesting, since most members of this clade combine a caulescent habit with an opposite decussate leaf

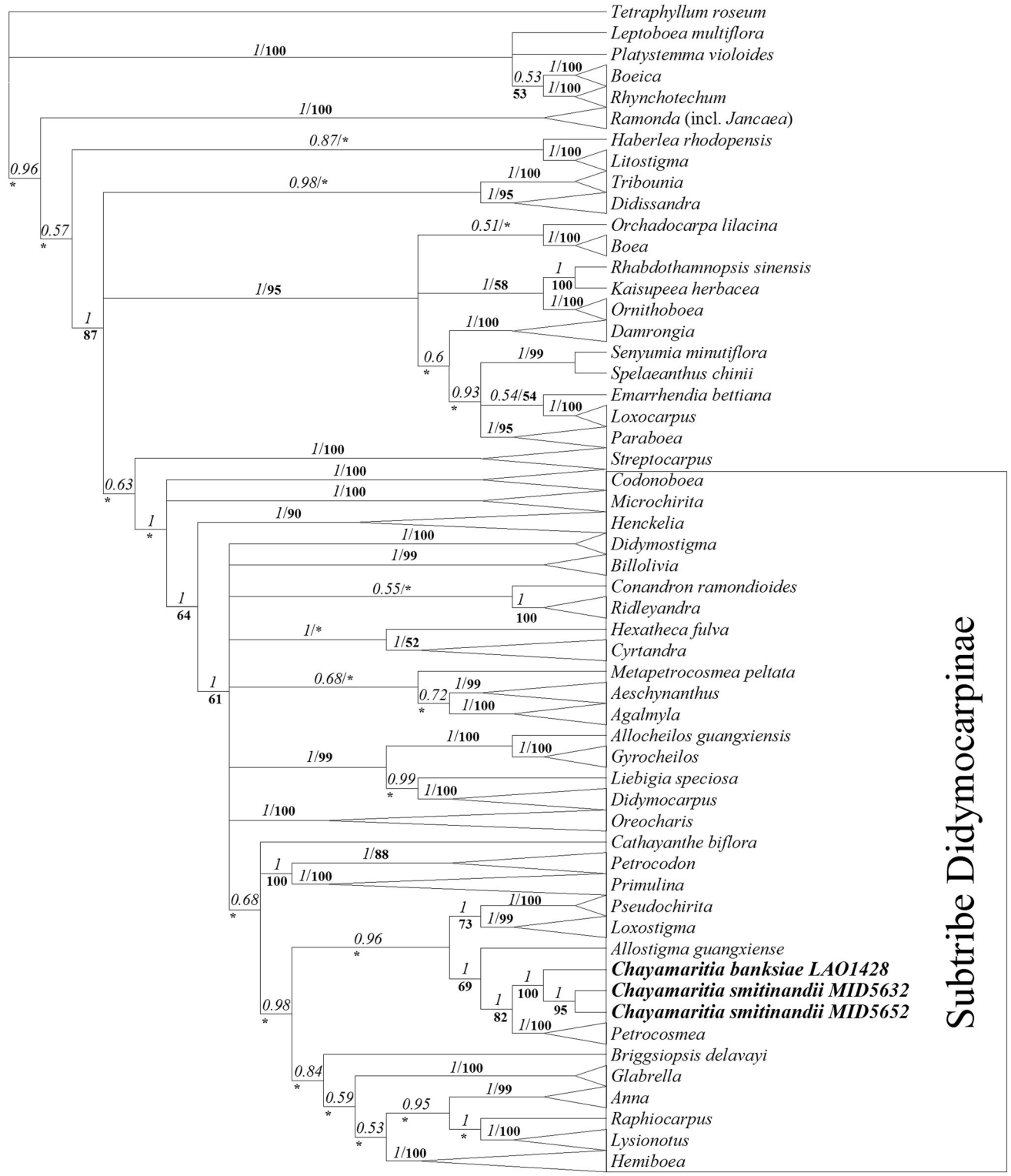

Fig. 1 Bayesian inference tree with genera collapsed (based on tree Online Resource 8), except *Chayamaritia*, based on combined analysis of ITS and *trn*L-F data. Numbers along branches are posterior probabilities (*italics*) and parsimony bootstrap values (**bold**). *Asterisk* indicates values <50 %

arrangement, except *Chayamaritia* and *Petrocosmea*. *Chayamaritia*, with its thick, short and prostrate stem and alternate leaf arrangement, could be seen as a transition from a caulescent habit to the rosette forms of *Petrocosmea*. Several species of *Petrocosmea* sect. *Deinanthera* W.T.Wang have long-petioled and pubescent leaves

Table 1 List of the 234 Gesneriaceae samples of tribe Trichosporeae included in the phylogenetic analysis, including voucher number and deposition, origin information and respective GenBank accession numbers

Taxon	Voucher number	Deposited in	Origin	*trn*L-F	ITS or ITS1/ITS2
Aeschynanthus bracteatus Wall. ex A.DC.	*Y.Z. Wang 991113*	PE	China, Yunnan, Xichou county	FJ501501	–
Aeschynanthus bracteatus Wall. ex A.DC.	*R. Cherry 123* [Cult. RBGE 19970165]	E	Vietnam; Lao Cai	–	AF349203/AF349284
Aeschynanthus lancilimbus W.T.Wang	*Y.Z. Wang S-10868*	PE	China, unknown locality	FJ501499	HQ632992
Aeschynanthus micranthus C.B.Clarke	*M. Möller* and *Y.D. Qi MMO 01-79*	E, PE, WU	China, Yunnan, Hekou county	FJ501500	–
Aeschynanthus micranthus C.B.Clarke	*A. Reid* and *J. Fernie 004* [Cult. RBGE 19951561]	E	China, Yunnan, Xishuangbanna Dai Aut. Pref.	–	AF349218/AF349299
Aeschynanthus rhododendron Ridl.	*P. Woods 600* [Cult. RBGE 19680624]	E	Peninsular Malaysia, Genting Highlands	HQ632895	FJ501333
Aeschynanthus roseoflorus Mendum	*G. Argent 87/14*	E	Indonesia, Seram	HQ632896	HQ632993
Agalmyla biflora (Elmer) Hilliard & B.L.Burtt	*RBGE-PNH1998 25435* [Cult. RBGE 19980287]	E	Philippines, Palawan, Near summit of Cleopatra Needle	FJ501541	–
Agalmyla biflora (Elmer) Hilliard & B.L.Burtt	*RBGE-PNH1998-25517* [Cult. RBGE 19980292]	E	Philippines, Palawan, near Thumb Peak	–	FJ501361
Agalmyla bilirana Hilliard & B.L.Burtt	*RBGE-PNHE 1999 12*	E	Philippines, Leyte Island	HQ632891	HQ632988
Agalmyla clarkei (Elmer) B.L.Burtt	*RBGE-PNH1999(P99) 13* [Cult. RBGE 19991911]	E	Philippines, Leyte Island, Mt. Lobi	FJ501540	–
Agalmyla clarkei (Elmer) B.L.Burtt	*RBGE-PNH1997 IS26* [Cult. RBGE 19972530A]	E	Philippines, Luzon, Barangay Penicuason	–	FJ501360
Agalmyla glabra (Merr.) Hilliard & B.L.Burtt	*RBGE-PNHE 1999 28*	E	Philippines, Camiguin Island	HQ632892	HQ632989
Agalmyla paucipilosa Hilliard & B.L.Burtt	*P. Smith* and *L. Galloway 261*	E	Indonesia, Sulawesi, Mt Rantemario	HQ632893	HQ632990
Agalmyla sojoliana Hilliard & B.L.Burtt	*P. Smith* and *L. Galloway 321*	E	Indonesia, Sulawesi, Mt Sojol	HQ632894	HQ632991
Allocheilos guangxiensis H.Q.Wen, Y.G.Wei & S.H.Zhong	*Y.G. Wei 06-02*	IBK	China, Guangxi, Yongfu county	HQ632897	HQ632994
Allostigma guangxiense W.T.Wang	*M. Möller* and *Y.G. Wei MMO 05-755*	E, IBK	China, Guangxi, Longzhou county	HQ632880	HQ632977
Anna mollifolia (W.T.Wang) W.T.Wang & K.Y.Pan	*M. Möller* and *Y.D. Qi MMO 01-146*	E, PE, WU	China, Guangxi, Napo county	FJ501543	AF055050/AF055051
Anna ophiorrhizoides (Hemsl.) B.L.Burtt & R.A.Davidson	*M. Möller* and *Y.G. Wei MMO 08-1280*	E, IBK	China, Sichuan, Emei Shan	HQ632937	HQ633034
Anna submontana Pellegr.	*M. Möller* and *Y.D. Qi MMO 01-85*	E, PE, WU	China, Yunnan, Maguan county	FJ501542	FJ501362
Billolivia longipetiolata D.J.Middleton & Luu	*L.H. Truong* and *P.H. Nhan BD624*	E	Vietnam, Lam Dong Province, Bidoup–Nui Ba National Park	Middleton et al. (2014)	Middleton et al. (2014) (ITS1 only)
Billolivia minutiflora D.J.Middleton & H.Atkins	*L.N. Sam LY498*	E	Vietnam, Lam Dong Province, Da Hoai District	Middleton et al. (2014)	Middleton et al. (2014) (ITS1 only)
Billolivia vietnamensis D.J.Middleton & Luu	*L.H. Truong* and *N.Q. Dat BGM1601*	E	Vietnam, Binh Phuoc, Bu Gia Map National Park	Middleton et al. (2014) (only *trn*L-F spacer)	Middleton et al. (2014) (ITS1 only)

Table 1 continued

Taxon	Voucher number	Deposited in	Origin	*trn*L-F	ITS or ITS1/ITS2
Billolivia violacea D.J.Middleton & H.Atkins	*D.J. Middleton 4210*	E	Vietnam, Lam Dong, Duc Trong District	Middleton et al. (2014)	Middleton et al. (2014)
Boea hygrometrica (Bunge) R.Br.	*Z.J. Gu 01-6184*	KUN	China, unknown locality	FJ501476	FJ501319
Boea philippensis C.B.Clarke	*S. Scott 02-142*	E	Indonesia, Sulawesi, Gunung Ali	HQ632862	HQ632953
Boeica ferruginea Drake	*M. Möller* and *Y.D. Qi MMO 01-182B ex Z.C. Qin 200012*	E, PE, WU	China, SE Yunnan	FJ501440	Wei et al. (2010)
Boeica multinervia K.Y.Pan	*Y.Z. Wang 015*	PE	China, Yunnan, Yingjiang	HQ632861	HQ632951
Briggsiopsis delavayi (Franch.) K.Y.Pan	*W. Fang 1*	IBK	China, Chongqing, Nanchuan county	HQ632879	HQ632976
Cathayanthe biflora Chun	*M. Möller* and *Y.G. Wei MMO 08-1327*	E, IBK	China, Hainan, Tongshi county	HQ632899	HQ632996
Codonoboea albomarginata (Hemsl.) Kiew	*A. Weber 840805-1/12*	WU	Peninsular Malaysia, Perak, Maxwell's Hill	AJ492297	HQ632961
Chayamaritia banksiae D.J.Middleton	*D.J. Middleton 5220* and *M. Newman* et al. *LAO1428*	E	Laos, Khammouan, Nakai Nam Theun	KP325433	KP325426
Chayamaritia smitinandii (B.L.Burtt) D.J.Middleton & Mich.Möller	*D.J. Middleton* et al. *5632*	E	Thailand, Nakhon Nayok, Khao Yai NP	KP325431	KP325424
Chayamaritia smitinandii (B.L.Burtt) D.J.Middleton & Mich.Möller	*D.J. Middleton* et al. *5652*	E	Thailand, Nakhon Nayok, Khao Yai NP	KP325432	KP325425
Codonoboea codonion (Kiew) C.L.Lim	*C.L. Lim FRI 65040*	KEP	Malaysia, Terengganu, Jerangau F.R.	JF912538	JF912565
Codonoboea corrugata (Mendum) D.J.Middleton	*RBGE-PNHE 1998s.n.*	E	Philippines, Palawan	FJ501484	HQ632962
Codonoboea elata (Ridl.) Rafidah	*A.R. Rafidah FRI 64321*	KEP	Malaysia, Perak, Maxwell's Hill	JF912523	JF912550
Codonoboea floribunda (M.R.Hend.) C.L.Lim	*C.L. Lim FRI 64971*	KEP	Malaysia, Terengganu, Sg. Nipah F.R.	JF912539	JF912566
Codonoboea leucocodon (Ridl.) Ridl.	*C.L. Lim FRI 64821*	KEP	Malaysia, Pahang, Gunung Tahan	JF912540	JF912567
Codonoboea malayana (Hook.f.) Kiew	*R. Kiew* and *D.J. Middleton FRI 57513*	KEP	Malaysia, Pahang, Fraser's Hill	JF912541	JF912568
Codonoboea pumila (Ridl.) C.L.Lim	*T.L. Yao FRI 55963*	KEP	Malaysia, Pahang, Fraser's Hill	JF912543	JF912570
Codonoboea racemosa (Jack) A.Weber	*P.S. Smith SMTSU 110/110*	E	Indonesia, Sumatra, Aceh	JF912544	JF912571
Codonoboea venusta (Ridl.) Kiew	*R. Kiew RK 5430*	KEP	Malaysia, Fraser's Hill	JF912545	JF912572
Conandron ramondioides Siebold and Zucc.	*Takeda Herbal Garden Kyoto* [Cult. RBGE 19691267]	E	Japan, unknown locality	FJ501515	FJ501340
Cyrtandra cumingii C.B.Clarke	*G. Kokubugata 11134*	TNS	Japan, Ruykyus, Iriomote Island	HQ632905	HQ633002
Cyrtandra cupulata Ridl.	*A. Weber 840806-2/4*	WU	Pensinsular Malaysia, Perak, Maxwell's Hill	FJ501532	AY818826/AY818861
Cyrtandra glabra Banks ex C.F.Gaertn.	*Q.C.B. Cronk* and *D. Percy T91*	E	French Polynesia: Society Is.: Tahiti: Mt. Tearoa Col	AY423136	FJ501353
Cyrtandra kusaimontana Hosok.	*NTBG 960873*	PTBG	Federated States of Micronesia, Caroline Islands	HQ632907	–
Cyrtandra kusaimontana Hosok.	*Flynn 5995*	PTBG	Federated States of Micronesia, Caroline Islands	–	EU919945

Table 1 continued

Taxon	Voucher number	Deposited in	Origin	*trn*L-F	ITS or ITS1/ITS2
Cyrtandra longifolia (Wawra) Hillebr. ex C.B.Clarke	*M. Kiehn 920825-2/1* [Cult. HBV]	WU	USA, Hawaii, Kauai	FJ501531	EU919939
Cyrtandra pendula Blume	*A. Weber* and *S. Anthonysamy 860730-1/2* [Cult. HBV]	WU	Peninsular Malaysia, Negeri Sembilan, Kuala Pilah distr., Jeram Toi	FJ501530	FJ501354
Cyrtandra pulchella O.Rich ex A.Gray	*Lorence 8525*	PTBG	Samoa Islands	HQ632906	EU919941
Damrongia fulva (Barnett) D.J.Middleton & A.Weber	*P. Triboun s.n.*	BK	Thailand, Khampaeng Phet	JF912536	JF912563
Damrongia lacunosa (Hook.f.) D.J.Middleton & A.Weber 1	*K. Imin* et al. *FRI 63238*	KEP	Peninsular Malaysia, Perak, Temengor F.R., Pulau Batu Putih	JF912530	JF912557
Damrongia lacunosa (Hook.f.) D.J.Middleton & A.Weber 2	*A. Weber 870510-1/8*	WU	Peninsular Malaysia, Pahang, Lipis distr., Gua Rusa	FJ501458	FJ501308
Damrongia purpureolineata Kerr ex Craib 1	*P. Triboun s.n.*	BK	Thailand, Lamphun, Li	JF912534	JF912561
Damrongia purpureolineata Kerr ex Craib 2	*D.J. Middleton* et al. *4812*	E	Thailand, Lamphun, Li	JF912535	JF912562
Didissandra elongata ssp. *minor* (Ridl.) A.Weber & B.L.Burtt	*C. Puglisi, M. Hughes, D. Girmansyah Suryadi 186*	E	Indonesia, Sumatra, Bengkulu, Gunung Kemumu	KP325427	KP325420
Didissandra frutescens (Jack) C.B.Clarke	*A. Weber 840805-1/2*	WU	Peninsular Malaysia, Perak, Maxwell's Hill	FJ501522	–
Didissandra frutescens (Jack) C.B.Clarke	*A.R. Rafidah FRI 64355*	KEP	Peninsular Malaysia, Perak, Kuala Kangsar	–	HQ632952
Didissandra sp.	*C. Puglisi, M. Hughes, D. Girmansyah Roki 69*	E	Indonesia, West Sumatra, road to Melampah	KP325428	KP325421
Didissandra sp.12	*C. Puglisi, M. Hughes, D. Girmansyah Roki 130*	E	Indonesia, West Sumatra, Solok Ambah, Sijunjung	KP325429	KP325422
Didissandra sp.16	*C.Puglisi, M. Hughes, D.Girmansyah Roki 101*	E	Indonesia, West Sumatra, Bukit Gagoan	KP325430	KP325423
Didymocarpus antirrhinoides A.Weber	*K. Jong 9009* [Cult. RBGE 19650167]	E	Peninsular Malaysia, Perak, Bujong Melaka, Ipoh.	FJ501513	DQ912671
Didymocarpus citrinus Ridl.	*P. Davis 69437* [Cult. RBGE 19830510]	E	Peninsular Malaysia, Perlis, Kedah Peak	AJ492293	DQ912669
Didymocarpus cordatus Wall. ex A.DC.	*A. Weber 860816-2/1*	WU	Peninsular Malaysia, Perak, Maxwell's Hill	AJ492294	DQ912673
Didymocarpus podocarpus C.B.Clarke	*H. Noltie, Pradhan, Sherub* and *Wangdi 193*	E	Bhutan, Deothang District	FJ501514	DQ912688
Didymocarpus purpureobracteatus W.W.Sm.	*Y.Z. Wang 991106*	PE	China, Yunnan, Pingbian county	FJ501510	–
Didymocarpus purpureobracteatus W.W.Sm.	*M. Möller* and *Y.D. Qi MMO 01-70*	E, PE, WU	China: Yunnan, Pingbian county	–	DQ912676
Didymocarpus stenanthos C.B.Clarke	*M. Möller* and *Y.D. Qi MMO 01-156*	E, PE, WU	China, Yunnan, Binchuan county	FJ501512	DQ912687
Didymocarpus villosus D.Don	*B. Adhikari SB 9*	E	Nepal, Sundarijal	HQ632904	HQ633001

Table 1 continued

Taxon	Voucher number	Deposited in	Origin	*trn*L-F	ITS or ITS1/ITS2
Didymostigma obtusum (C.B.Clarke) W.T.Wang	*M. Möller* and *Y.G. Wei MMO 08-1310*	E, IBK	China, Guangdong, Fengkai county	HQ632875	HQ632971
Didymostigma trichanthera C.X.Ye & X.G.Shi	*M. Möller* and *Y.G. Wei MMO 08-1335*	E, IBK	China, Guangdong, Longmen county	HQ632876	HQ632972
Emarhendia bettiana (M.R.Hend.) Kiew, A.Weber & B.L.Burtt	*R. Kiew FRI 55716*	KEP	Peninsular Malaysia	HQ632864	HQ632955
Glabrella longipes (Hemsl. ex Oliv.) Mich.Möller & W.H.Chen	*M. Möller* and *Y.D. Qi MMO 01-122*	E, PE, WU	China, Yunnan, Xichou county	FJ501545	AF055052/AF055053
Glabrella mihieri (Franch.) Mich.Möller & W.H.Chen	*Y.Z. Wang 11315B*	PE	China, Chongqing, Nanchuan county	FJ501544	FJ501363
Gyrocheilos chorisepalus W.T.Wang var. *synsepalus* W.T.Wang	*Y.G. Wei 07-708*	IBK	China, Guangdong, Xinyi county	HQ632900	HQ632997
Gyrocheilos lasiocalyx W.T.Wang	*M. Möller* and *Y.G. Wei MMO 06-881*	E	China, Guangxi, Guiping county	HQ632901	HQ632998
Gyrocheilos retrotrichus W.T.Wang	*M. Möller* and *Y.G. Wei MMO 07-1136*	E, IBK	China, Guangxi, Wuming county	HQ632902	HQ632999
Gyrocheilos retrotrichus W.T.Wang var. *oligolobus* W.T.Wang	*Y.G. Wei 06-208*	IBK	China, Guangxi, Rongshui county, Sirong town	HQ632903	HQ633000
Haberlea rhodopensis Friv.	Voucher from Cult. RBGE 19754106	E	(Greece)	AJ492296	Möller and Cronk (2001)
Hemiboea bicornuta (Hayata) Ohwi	Voucher from Cult. RBGE 19951207	E	unknown origin	FJ501534	FJ501356
Hemiboea cavaleriei H.Lév.	*Z.J. Gu G3*	KUN	China, unknown locality	FJ501533	FJ501355
Hemiboea fangii Chun ex Z.Yu Li	*M. Möller* and *Y.G. Wei MMO 08-1284*	E, IBK	China, Sichuan, Emei Shan	HQ632882	HQ632979
Hemiboea follicularis C.B.Clarke	*Y.G. Wei G03*	IBK	China, Guangxi, Huanjiang county	HQ632885	HQ632982
Hemiboea gracilis Franch.	*Y.Z. Wang 11317*	PE	China, Chongqing, Nanchuan county	FJ501536	Wei et al. (2010)
Hemiboea longgangensis Z.Yu Li	*Y.G. Wei 07-550*	IBK	China, Guangxi Longzhou county	HQ632889	HQ632986
Hemiboea longzhouensis W.T.Wang	*M. Möller* and *Y.G. Wei MMO 07-1127*	E, IBK	China, Guangxi, Longan county	HQ632888	HQ632985
Hemiboea magnibracteata Y.G.Wei & H.Q.Wen	*M. Möller* and *Y.G. Wei MMO 08-1347*	E, IBK	China, Guangxi, introduced from Huanjiang county to Guilin city	HQ632887	HQ632984
Hemiboea omeiensis W.T.Wang	*M. Möller* and *Y.G. Wei MMO 08-1271*	E, IBK	China, Sichuan, Emei Shan	HQ632886	HQ632983
Hemiboea ovalifolia (W.T.Wang) A.Weber & Mich.Möller	*B.M. Nong 06-1*	IBK	China, Guangxi, Napo county, Nonghua	HQ632883	HQ632980
Hemiboea purpureotincta (W.T.Wang) A.Weber & Mich.Möller	*M. Möller* and *Y.G. Wei MMO 06-813*	E, IBK	China, Guangxi, Tian Ling county	HQ632884	HQ632981
Hemiboea rubribracteata Z.Yu Li & Yan Liu	*M. Möller* and *Y.G. Wei MMO 07-1093*	E, IBK	China, Guangxi, introduced from Jingxi to Guilin city	HQ632890	HQ632987
Hemiboea subcapitata C.B.Clarke	*Y.Z. Wang 11306*	PE	China, Chongqing, Chengkou county	FJ501535	FJ501357
Henckelia anachoreta (Hance) D.J.Middleton & Mich.Möller	*D.J. Middleton* et al. *4480*	E	Thailand, Chiang Mai, Doi Suthep	HQ632870	HQ632966

Table 1 continued

Taxon	Voucher number	Deposited in	Origin	*trn*L-F	ITS or ITS1/ITS2
Henckelia bifolia (D.Don) A.Dietr.	*B. Adhikari L2B6*	E	Nepal, Chyalding, near Sybrubesi	JF912522	JF912549
Henckelia dielsii (Borza) D.J.Middleton & Mich.Möller	*M. Möller* et al. *MMO 08-1211*	E, KUN	China, Yunnan, Jingdong county	HQ632871	HQ632967
Henckelia floccosa (Thwaites) A.Weber & B.L.Burtt	*C.G. Jang s.n.* [G 157]	WU	Sri Lanka	FJ501486	HQ632964
Henckelia grandifolia A.Dietr.	*M. Möller* et al. *MMO 08-1222*	E, KUN	China, Yunnan, Jingdong county	JF912527	JF912554
Henckelia incana (Vahl) Spreng.	*S. Vogel SVG s.n.*	E	India, Nilghiri mts	HQ632869	HQ632965
Henckelia longisepala (H.W.Li) D.J.Middleton & Mich.Möller	*Y.M. Shui 73170*	KUN	China, Yunnan, Jinping county	HQ632890	HQ632963
Henckelia pumila (D.Don) A.Dietr. 1	*D.J. Middleton* et al. *4505*	E	Thailand, Chiang Mai, Doi Inthanon	JF912529	JF912556
Henckelia pumila (D.Don) A.Dietr. 2	*Gaoligong Shan Expedition 1996 7938* [Cult. RBGE 19962271]	E	China, Yunnan, Nujiang Lisu Aut. Pref., Fugong county	FJ501491	FJ501327
Henckelia urticifolia (D.Don) A.Dietr. 1	*J.M. Li 05851*	PE	China, Yunnan	DQ872821	DQ872835
Henckelia urticifolia (D.Don) A.Dietr. 2	*NPSW 110*	E	Bhutan, Tashigang distr.	JF912532	JF912559
Henckelia urticifolia (D.Don) A.Dietr. 3	*EMAK 109 H (Edinburgh-Makalu Expedition 1991)*	E	Nepal, Sankhuwasabha distr., Arun valley	FJ501492	FJ501328
Henckelia walkerae (Gardner) D.J.Middleton & Mich.Möller	*L. Skog 7736* (US 590934) [Cult. Smithsonian 94-250]	US	Sri Lanka; leg. in US 11.03.1996	FJ501490	FJ501326
Hexatheca fulva C.B.Clarke	*J. Sang* and *C. Geri S99358*	E	Sarawak, Bau, Fairy Cave	HQ632873	HQ632969
Jancaea heldreichii Boiss.	*E.G. Cairns s.n.* [Cult. RBGE 19771605]	photo E	Greece, Mt Olympus	FJ501439	Möller et al. (1999)
Kaisupeea herbacea (C.B.Clarke) B.L.Burtt	*K. Larsen 44272* [Cult. RBGE 19972918]	E	Thailand, Chachoengsao, Khao Tak Groep	FJ501459	FJ501309
Leptoboea multiflora (C.B.Clarke) Gamble subsp. *grandifolia* B.L.Burtt	*K. Larsen* et al. *32065*	E	Thailand, Chanthaburi, Khaso Phra Bat	FJ501442	Wei et al. (2010)
Liebigia barbata (Jack) D.J.Middleton	*P. Woods 1071 (C6570)*	E	Indonesia, Java, forest above Cibodas Garden	FJ501538	JF501359
Litostigma coriaceifolium Y.G.Wei, F.Wen & M.Möller	*Y.G. Wei MMO 07-1162B*	E, IBK	China, Guizhou, Xingyi county	Wei et al. (2010)	Wei et al. (2010)
Litostigma crystallinum Y.M.Shui & W.H.Chen	*Y.M. Shui 43865*	KUN	China, Yunnan, Malipo county	Wei et al. (2010)	Wei et al. (2010)
Loxocarpus argenteus B.L.Burtt	*T.L. Yao FRI 57975*	KEP	Malaysia, Sarawak, Bako National Park	JF912537	JF912564
Loxocarpus violoides (C.B.Clarke) T.L.Yao	*T.L. Yao FRI 65458*	KEP	Malaysia, Sayap, Kinabalu Park	JF912546	JF912573
Loxostigma fimbrisepalum K.Y.Pan	*Y.Z. Wang 991005*	PE	China, Yunnan, Jinping county	FJ501507	Wei et al. (2010)
Loxostigma glabrifolium D.Fang & K.Y.Pan	*Y.G. Wei 709*	IBK	China, Guangxi, Napo county	HQ632910	HQ633006
Loxostigma griffithii (Wight) C.B.Clarke	*Kew/Edinburgh Kanchenjunga Expedition (1989) 940* [Cult. RBGE 19892473A]	E	Nepal, Yamphudin	FJ501508	FJ501338

Table 1 continued

Taxon	Voucher number	Deposited in	Origin	*trn*L-F	ITS or ITS1/ITS2
Loxostigma sp.	*Gaoligong Shan Expedition 1996 7668*	E	China, Yunnan	AY423137	HQ633005
Lysionotus chingii Chun ex W.T.Wang	*Y.Z. Wang S-10669*	PE	China, unknown locality	FJ501498	FJ501332
Lysionotus forrestii W.W.Sm.	*Gaoligong Shan Expedition 1996 7925* [Cult. RBGE 19962269A]	E	China, Yunnan, Nujiang Lisu Aut. Pref.,	FJ501495	AF349152/AF349233
Lysionotus pauciflorus Maxim.	*M. Möller* and *Y.D. Qi MMO 01-101*	E, PE, WU	China, Yunnan, Xichou county, Cheng Jia Po	FJ501497	FJ501331
Lysionotus petelotii Pellegr.	*M. Möller* and *Y.D. Qi MMO 01-100/4*	E, PE	China, Yunnan, road to Xichou	FJ501496	HQ632974
Metapetrocosmea peltata (Merr. & Chun) W.T.Wang	*Y.G. Wei 07-702*	IBK	China, Hainan,Wuzhi Shan	HQ632872	HQ632968
Microchirita caliginosa (C.B.Clarke) Yin Z. Wang	ex HB München-Nymphenburg; *M. Kiehn* and *M. Pfosser 2000-1* [Cult. HBV GS-96-02]	WU	Peninsular Malaysia	FJ501488	FJ501325
Microchirita hamosa (R.Br.) Yin Z. Wang 1	*M. Möller* and *Y.G. Wei MMO 05-753*	E, IBK	China, Guangxi, Longzhou county	JF912524	JF912551
Microchirita hamosa (R.Br.) Yin Z. Wang 2	*J.M. Li LJM1181*	PE	China, unknown locality	DQ872822	DQ872822
Microchirita involucrata (Craib) Yin Z. Wang 1	*A.R. Rafidah FRI 64447*	KEP	Malaysia, Kelantan, Gunung Reng	JF912525	JF912552
Microchirita involucrata (Craib) Yin Z. Wang 2	*K. Imin* et al. *FRI 63180*	KEP	Peninsular Malaysia, Kedah, Baling	JF912526	JF912553
Microchirita lavandulacea (Stapf) Yin Z. Wang	Voucher from Cult. RBGE 20000897	E	China, unknown locality	FJ501487	FJ501324
Microchirita mollissima (Ridl.) A.Weber & D.J.Middleton	*D.J. Middleton* et al. *4361*	E	Thailand, Surat Thani, Khlong Phanom	JF912528	JF912555
Microchirita sericea (Ridl.) A.Weber & Rafidah	*A.R. Rafidah FRI 64328*	KEP	Malaysia, Kelantan, Gunung Reng	JF912548	JF912521
Microchirita sp. nov. 1	*D.J. Middleton* et al. *4849*	E	Thailand, Tak, Mae Sot	JF912520	JF912547
Microchirita tubulosa (Craib) A.Weber & D.J.Middleton	*D.J. Middleton* et al. *4809*	E	Thailand, Nakhon Sawan, Wat Thep Satha Phon	JF912531	JF912558
Microchirita viola (Ridl.) A.Weber & Rafidah	*A.R. Rafidah FRI 64388*	KEP	Malaysia, Kedah, P. Langkawi	JF912533	JF912560
Orchadocarpa lilacina Ridl.	*R. Kiew RK 5410*	KEP	Peninsular Malaysia, Pahang, Fraser's Hill	HQ632863	HQ632954
Oreocharis acaulis (Merr.) Mich.Möller & A.Weber	*M. Möller* and *Y.G. Wei MMO 08-1328*	E, IBK	China, Guangdong, Zhaoqin county	HQ632916	HQ633012
Oreocharis argyreia Chun ex K.Y.Pan	*M. Möller* and *Y.G. Wei MMO 07-1131*	E, IBK	China, Guangxi, Wuming county	HQ632919	HQ633015
Oreocharis aurea Dunn	*M. Möller* and *L.M. Gao MMO 06-980*	E, IBK	China, Yunnan, Jinping county	HQ632920	HQ633016

Table 1 continued

Taxon	Voucher number	Deposited in	Origin	*trn*L-F	ITS or ITS1/ITS2
Oreocharis auricula (S.Moore) C.B.Clarke	*M. Möller* and *L.M. Gao MMO 03-304*	E, KUN	China; Guizhou, Jiangkou county	FJ5011481	FJ501323
Oreocharis begoniifolia (H.W.Li) Mich.Möller & A.Weber	*M. Möller* et al. *MMO 08-1221*	E, KUN	China, Yunnan, Jing Dong county	HQ632929	HQ633025
Oreocharis concava (Craib) Mich.Möller & A.Weber	*M. Möller* and *Y.D. Qi MMO 01-153*	E, PE, WU	China, Yunnan, Binchuan county	FJ501505	FJ501336
Oreocharis convexa (Craib) Mich.Möller & A.Weber	*M. Möller* and *Y.D. Qi MMO 01-176*	E, PE, WU	China, Yunnan, Dali county	FJ501506	FJ501337
Oreocharis cotinifolia (W.T.Wang) Mich.Möller & A.Weber	*Q.M. Chuan 01*	IBK	China, Guangxi, Dayaoshan, Jinxiu conuty	HQ632914	HQ633010
Oreocharis craibii Mich.Möller & A.Weber	*M. Möller* and *L.M. Gao MMO 07-1072*	E, KUN	China, Sichuan, Pan Zhi Hua county	HQ632921	HQ633017
Oreocharis dasyantha Chun var. *ferruginosa* K.Y.Pan	*Y.G. Wei 07-700*	IBK	China, Hainan, Delong	HQ632918	HQ633014
Oreocharis esquirolii H.Lév.	*D.W. Zhang 723*	IBK	China, Guizhou, An Long county, Longtoushan	HQ632915	HQ633011
Oreocharis jiangxiensis (W.T.Wang) Mich.Möller & A.Weber	*M. Möller* et al. *MMO 09-1451*	E	China, Fujian, Jiangle county	HQ632914	HQ633029
Oreocharis lancifolia (Franch.) Mich.Möller & A.Weber	*M. Möller* and *P. Zhou MMO 09-1624*	E	China, Sichuan, Mianning county	HQ632924	HQ633020
Oreocharis longifolia (Craib) Mich.Möller & A.Weber	*M. Möller* et al. *MMO 08-1239*	E, KUN	China, Yunnan, Jingdong county	HQ632934	HQ633030
Oreocharis lungshengensis (W.T.Wang) Mich.Möller & A.Weber	*M. Möller* and *Y.G. Wei MMO 06-916*	E, IBK	China, Guangxi, Longsheng county	HQ632917	HQ633013
Oreocharis magnidens Chun ex K.Y.Pan	*M. Möller* and *Y.G. Wei MMO 06-896*	E, IBK	China, Guangxi, Jinxiu county	HQ632930	HQ633026
Oreocharis mileensis (W.T.Wang) Mich.Möller & A.Weber	*Y.M. Shui 65214*	KUN	China, Yunnan, Shilin county	HQ632928	HQ633024
Oreocharis muscicola (Diels) Mich.Möller & A.Weber	Kew (1995-2229)	K	unknown origin	FJ501548	FJ501366
Oreocharis pankaiyuae Mich.Möller & A.Weber	Voucher from Cult. RBGE 20060865	E	China, unknown locality	HQ632925	HQ633021
Oreocharis primuliflora (Batalin) Mich.Möller & A.Weber	*M. Möller* and *P. Zhou MMO 09-1605*	E	China, Sichuan, Danba county	HQ632923	HQ633019
Oreocharis primuloides (Miq.) Benth. & Hook.f. ex C.B.Clarke	*T. Tsuzuki s.n.* [Cult. RBGE 19842178A]	E	Japan, unknown locality	FJ501546	FJ501364
Oreocharis ronganensis (K.Y.Pan) Mich.Möller & A.Weber	*M. Möller* and *Y.G. Wei MMO 06-776*	E, IBK	China, Guangxi, Rong An county	HQ632927	HQ633023
Oreocharis rosthornii (Diels) Mich.Möller & A.Weber	*Sino-American Bryological Expedition, no. 398* (US 229325)	US	China, Guizhou, Jiangkou Xian	FJ501547	FJ501365
Oreocharis sinensis (Oliv.) Mich.Möller & A.Weber	*M. Möller* and *Y.G. Wei MMO 08-1329*	E, IBK	China, Guangdong, Bolou county	HQ632912	HQ633008

Table 1 continued

Taxon	Voucher number	Deposited in	Origin	*trn*L-F	ITS or ITS1/ITS2
Oreocharis sinohenryi (Chun) Mich.Möller & A.Weber	*M. Möller* and *Y.G. Wei MMO 07-1150*	E, IBK	China, Guangxi, Fangcheng county	HQ632913	HQ633009
Oreocharis stewardii (Chun) Mich.Möller & A.Weber	*M. Möller* and *Y.G. Wei MMO 06-917*	E, IBK	China, Guangxi,Shanjiang county	HQ632926	HQ633022
Oreocharis urceolata (K.Y.Pan) Mich.Möller & A.Weber	*M. Möller* and *P. Zhou MMO 09-1633*	E	China, Sichuan, Liangshan Yizu county	HQ632922	HQ633018
Oreocharis xiangguiensis W.T.Wang & K.Y.Pan 1	*M. Möller* and *Y.G. Wei MMO 05-741*	E, IBK	China, Guangxi, Lin Gui county	HQ632932	HQ633028
Oreocharis xiangguiensis W.T.Wang & K.Y.Pan 2	*M. Möller* and *Y.G. Wei MMO 06-915*	E, IBK	China, Guangxi, Longsheng county	HQ632931	HQ633027
Ornithoboea arachnoidea (Diels) Craib	Voucher from Cult. RBGE 19972903	E	Thailand, Chiang Mai, Doi Chiang Dao	FJ501461	FJ501312
Ornithoboea wildeana Craib	*Y.Z. Wang 00401*	PE	China, Yunnan, Xichou county	FJ501462	FJ501313
Paraboea acutifolia (Ridl.) B.L.Burtt	*A. Weber 86805-2/1*	WU	Peninsular Malaysia, Kedah, Pulau Langkawi, Bukit Terbak	FJ501464	FJ501314
Paraboea birmanica (Craib) C.Puglisi	*M. Möller* and *Y.G. Wei MMO 06-862*	E, IBK	China, Guangxi, Jingxi county	HQ632866	HQ632958
Paraboea capitata Ridl.	*A. Weber 870522-5/2* [Cult. HBV]	WU	Peninsular Malaysia, Perak, Kinta district	AJ492298	FJ501315
Paraboea crassifolia (Hemsl.) B.L.Burtt	*M. Möller* and *Y.D. Qi MMO 01-83*	E, PE, WU	China, Yunnan, Maguan county	FJ501472	FJ501318
Paraboea glandulosa (B.L.Burtt) C.Puglisi	*D.J. Middleton* and *P.Triboun 5202*	BK, E	Thailand, Kanchanaburi, Thong Pha Phum, Ti Pugae	HQ632867	HQ632959
Paraboea umbellata (Drake) B.L.Burtt	*M. Möller* and *Y.D. Qi MMO 01-147*	E, PE, WU	China, Guangxi, Napo county	FJ501470	FJ501317
Petrocodon ainsliifolius W.H.Chen & Y.M.Shui	*Y.M. Shui* et al. *44071*	KUN	China, Yunnan, Maguan county	HQ632941	HQ633038
Petrocodon coccinea (C.Y.Wu ex H.W.Li) Yin Z.Wang	*M. Möller* and *Y.D. Qi MMO 01-141*	E, PE, WU	China, Guangxi, Napo county	FJ501516	FJ501365
Petrocodon coriaceifolius (Y.G.Wei) Y.G.Wei & Mich.Möller	*M. Möller* and *Y.G. Wei MMO 06-913*	E, IBK	China, Guangxi, Yangshuo county	HQ632943	HQ633040
Petrocodon dealbatus Hance	*Q.J. Xie J-042 (US 422841)*	US	China, Guangdong, Lianxian county	FJ501537	FJ501358
Petrocodon fangianus (Y.G.Wei) J.M.Li & Yin Z.Wang	*Y.G. Wei MMO 07-1168*	IBK	China, Guangxi, Napo county	Wei et al. (2010)	Wei et al. (2010)
Petrocodon ferrugineus Y.G.Wei	*M. Möller* and *Y.G. Wei MMO 06-784*	E, IBK	China, Guangxi, Xincheng county	HQ632946	HQ633043
Petrocodon hancei (Hemsl.) A.Weber & Mich.Möller	*M. Möller* and *Y.G. Wei MMO 08-1342*	E, IBK	China, Guangxi, He Zhou city	HQ632944	HQ633041
Petrocodon hechiensis (Y.G.Wei, Yan Liu & F.Wen) Y.G.Wei & Mich.Möller	*M. Möller* and *Y.G. Wei MMO 07-1077*	E, IBK	China, Guangxi, Hechi city	HQ632942	HQ633039
Petrocodon integrifolius (D.Fang & L.Zeng) A.Weber & Mich.Möller	*M. Möller* and *Y.G. Wei MMO 06-865*	E, IBK	China, Guangxi, Longzhou county	HQ632940	HQ633037

Table 1 continued

Taxon	Voucher number	Deposited in	Origin	*trn*L-F	ITS or ITS1/ITS2
Petrocodon jasminiflorus (D.Fang & W.T.Wang) A.Weber & Mich.Möller	*M. Möller* and *Y.G. Wei MMO 06-851*	E, IBK	China, Guangxi, Napo county	Wei et al. (2010)	Wei et al. (2010)
Petrocodon lui (Yan Liu & W.B.Xu) A.Weber & Mich.Möller	*Y.G. Wei 8012*	IBK	China, Guangxi, Jingxi county, Wuping town, Xunma village	HQ632938	HQ633035
Petrocodon scopulorum (Chun) Yin Z.Wang	*W. Fang 2010-02*	IBK	China, Guizhou, Xiuwen county, Maochong village	HQ632947	HQ633044
Petrocodon tiandengensis (Yan Liu & B. Pan) A.Weber & Mich.Möller	*Y.G. Wei MMO 07-1164*	E, IBK	China, Guangxi, Tiandeng county,	HQ632945	HQ633042
Petrocodon viridescens W.H.Chen, Mich.Möller & Y.M.Shui	*Y.M. Shui* et al. *82661*	E	China, Yunnan, Maguan county	HQ632939	HQ633036
Petrocosmea kerrii Craib	*Voucher from* Cult. RBGE 19715592	E	unknown origin	FJ501502	FJ501334
Petrocosmea minor Hemsl.	*Sino-Amer. Bot. Expedition, no. 1574* (US 56119)	US	China, Yunnan, Lunan Xian	FJ501504	Wei et al. (2010)
Petrocosmea nervosa Craib	*Smithsonian Institute 78-057* [Cult. RBGE 19933232]	E, US	China, N Yunnan	AJ492299	FJ501335
Petrocosmea sericea C.Y.Wu ex H.W.Li	*Z.J. Gu 99-1104*	KUN	China, unknown locality	FJ501503	Wei et al. (2010)
Platystemma violoides Wall.	*Projektteam 197-241*	WU	Nepal, SE Kathmandu, Pulchoki	FJ501443	Wei et al. (2010)
Primulina weii Mich.Möller & A.Weber	*J.M. Li Ljm-04-42*	PE	China, Guangxi	DQ872811	DQ872832
Primulina bipinnatifida (W.T.Wang) Yin Z.Wang	–	PE	China, Guangxi	DQ872806	DQ872842
Primulina cordifolia (D.Fang & W.T.Wang) Yin Z.Wang	*J.M. Li 05561*	PE	China, Guangxi	DQ872803	DQ872845
Primulina dryas (Dunn) Mich.Möller & A.Weber	*T.C. Godfrey 369* [Cult. RBGE 19791050]	E	China, Hong Kong	FJ501524	FJ501348
Primulina gemella (D.Wood) Yin Z.Wang	*L. Averyanov 1987* [Cult. RBGE 19941913]	E	Vietnam, Hong Quang Special Region, Cat Hai	FJ501523	FJ501345
Primulina glandulosa (D.Fang et al.) Yin Z.Wang var. *yangshuoensis* (F.Wen, Q.X.Zhang & Yue Wang) Mich.Möller & A.Weber	*M. Möller* and *Y.G. Wei MMO 06-912*	E, IBK	China, Guangxi, Yang Shuo county	HQ632948	HQ633045
Primulina glandulosa (D.Fang et al.) Yin Z.Wang	*J.M. Li 054291*	PE	China, Guangxi	DQ872804	DQ872841
Primulina heterotricha (Merr.) Yin Z.Wang	*Y.Z. Wang 067311*	PE	China, Guangxi	DQ872816	DQ872826
Primulina linearifolia (W.T.Wang) Yin Z.Wang	*J.M. Li 11121*	PE	China, Guangxi	DQ872810	DQ872834
Primulina longgangensis (W.T.Wang) Yin Z.Wang	*A. Takhtajan* and *N. Aruzytov 1975* [Cult. RBGE 19941915]	E	Vietnam, unknown locality	AJ492290	FJ501347
Primulina luochengensis (Yan Liu & W.B.Xu) Mich.Möller & A.Weber	*Y.G. Wei MMO 07-1163*	IBK	China, Guangxi, Luocheng county, Xiaochangan town	HQ632949	HQ633046

Table 1 continued

Taxon	Voucher number	Deposited in	Origin	*trn*L-F	ITS or ITS1/ITS2
Primulina minutimaculata (D.Fang et W.T.Wang) Yin Z.Wang	*J.M. Li 067134*	PE	China, Guangxi	DQ872815	DQ872828
Primulina mollifolia (D.Fang et W.T.Wang) Yin Z.Wang	*J.M. Li 054281*	PE	China, Guangxi	DQ872802	DQ872847
Primulina ophiopogoides (D.Fang et W.T.Wang) Yin Z.Wang	*Y.Z. Wang 067134*	PE	China, Guangxi	DQ872814	DQ872829
Primulina pinnata (W.T.Wang) Yin Z.Wang	*Expedition Beijing 896526* (US 294374)	US	China, Guangxi, Rongshui Xian	FJ501526	FJ501349
Primulina pinnatifida (Hand.-Mazz.) Yin Z.Wang	*Q.J. Xie J-037* (US 422838)	US	China, Guangdong, Lianxian county	FJ501527	FJ501350
Primulina pteropoda (W.T.Wang) Yin Z.Wang	*Y.Z. Wang 067312*	PE	China, Guangxi	DQ872817	DQ872827
Primulina renifolia (D.Fang & D.H.Qin) Yin Z.Wang	*M. Möller* and *Y.G. Wei MMO 06-791*	E, IBK	China, Guangxi, Duan county	Wei et al. (2010)	Wei et al. (2010)
Primulina repanda (W.T.Wang) Yin Z.Wang var. *guilinensis* (W.T.Wang) Mich.Möller & A.Weber	*ex Smithsonian Institute 94-083* [Cult. RBGE 19951206]	E	China, Guangxi	AJ492292	FJ501351
Primulina spadiciformis (W.T.Wang) Mich.Möller & A.Weber	*ex Smithsonian Institute 94-087* [Cult. RBGE 19951205]	E	China, unknown locality	AJ492291	FJ501346
Primulina spinulosa (D.Fang et W.T.Wang) Yin Z.Wang	*Y.Z. Wang 067133*	PE	China, Guangxi	DQ872813	DQ872830
Primulina tabacum Hance	*Q.J. Xie* and *C.X. Ye s.n.* [Cult. RBGE 19951540]	E	China, Guangdong, Lian River	AJ492300	FJ501352
Primulina wentsaii (D.Fang et L.Zeng) Yin Z.Wang	*J.M. Li 11630*	PE	China, Guangxi	DQ872812	DQ872831
Pseudochirita guangxiensis (S.Z.Huang) W.T.Wang	*M. Möller* and *Y.G. Wei MMO 06-798*	E, IBK	China, Guangxi, Mashan county	HQ632908	HQ633003
Pseudochirita guangxiensis (S.Z.Huang) W.T.Wang var. *glauca* Y.G.Wei & Yan Liu	*M. Möller* and *Y.G. Wei MMO 05-751*	E, IBK	China, Guangxi, Jingxi county	HQ632909	HQ633004
Ramonda myconi (L.) Rchb.	Voucher from Cult. RBGE 19711477	E	Spain, Pyrenees	AJ492301	Möller et al. (1999)
Ramonda nathaliae Pančić & Petrovič	Voucher from Cult. RBGE 19784020	E	Macedonia, unknown locality	AJ501438	Möller et al. (1999)
Raphiocarpus sinicus Chun	*M. Möller* and *Y.G. Wei MMO 07-1141*	E, IBK	China, Guangxi, Shangsi county	HQ632877	HQ632973
Rhabdothamnopsis sinensis Hemsl.	Voucher from Cult. Kew 1988 4866	K	China, unknown locality	AJ492302	–
Rhabdothamnopsis sinensis Hemsl.	*M. Möller* and *L.M. Gao MMO 08-1059*	E, KUN	China, Sichuan, Mianning county	–	HQ632960
Rhynchotechum discolor (Maxim.) B.L.Burtt	*RBGE-PNH Expedition 1997/SM8* [Cult. RBGE 19972562]	E	Philippines, Luzon, Isabela	FJ501436	Wei et al. (2010)

Table 1 continued

Taxon	Voucher number	Deposited in	Origin	*trn*L-F	ITS or ITS1/ITS2
Rhynchotechum parviflorum Blume	*M. Mendum, G. Argent* and *Hendrian 00148*	E	Central Sulawesi, Mt. Sojol	FJ501437	Wei et al. (2010)
Ridleyandra petiolata (Ridl.) A.Weber	*M.A. Mohd.Hairul FRI 60092*	KEP	Peninsular Malaysia, G. Inas	HQ632935	HQ633032
Ridleyandra porphyrantha (A.Weber & Kiew) A.Weber	*A. Weber 870420-2/4*	WU	Malaysia, Pahang, side ridge of Gunung Bunga Buah	FJ501520	HQ633031
Ridleyandra quercifolia (Ridl.) A.Weber	*T.L. Yao FRI 65405*	KEP	Peninsular Malaysia, Perak, Maxwell Hill	HQ632936	HQ633033
Senyumia minutiflora (Ridl.) Kiew, A.Weber & B.L.Burtt	*A.R. Rafidah, R. Kiew* and *M.A. Mohd.Hairul FRI 55722*	KEP	Peninsular Malaysia, Pahang, Gunung Senyum	HQ632865	HQ632957
Spelaeanthus chinii Kiew, A.Weber & B.L.Burtt	*A. Weber 860709-2/2*	WU	Peninsular Malaysia, Pahang, Jerantut distr., Taman Negara	FJ501457	FJ501307
Streptocarpus andohahelensis Humbert	*M. Möller* and *G. Rafamatanantsoa MM 9717*	E, TAN	Madagascar, Tuléar, Ranomafana	FJ501449	AF316903
Streptocarpus beampingaratrensis Humbert	*M. Möller* and *G. Rafamatanantsoa MM 9715*	E, TAN	Madagascar, Tuléar, Ranomafana	FJ501448	AF316905
Streptocarpus dunnii Hook.f.	*I. LaCroix s.n.* [Cult. RBGE 19941745]	E	Swaziland, Mbabane	FJ501456	AF316951
Streptocarpus hilsenbergii R.Br.	*B.L. Burtt s.n.* [Cult. RBGE 19631505]	E	Madagascar, Mandrake valley	FJ501450	AF316907
Streptocarpus holstii Engl.	*Cornell University (Bail. Hort)* [Cult. RBGE 19592272]	E	Tanzania, unknown locality	AJ492304	AF316917
Streptocarpus ibityensis Humbert	*E. Fischer 250/93* [Cult. RBGE 19932867]	E	Madagascar, Antananarivo	FJ501455	AF316926
Streptocarpus papangae Humbert	*M. Möller* and *G. Rafamatanantsoa MM 9718*	E, TAN	Madagascar, Tuléar, Ranomafana	FJ501444	AF316929
Streptocarpus rexii (Hook.) Lindl.	*K. Jong s.n.* [Cult. RBGE 19870333]	E	South Africa, NE Cape, Grahamstown	AJ492305	AF316979
Streptocarpus saxorum Engl.	*A. Chautems* and *M. Perret 01-023*	G	cult. CJBG	FJ501447	–
Streptocarpus saxorum Engl.	*I.C. Mather 4* [Cult. RBGE 19721499]	E	Tanzania, Tanga region	–	AF316914
Tetraphyllum roseum Stapf	*H.K. Kurzweil 798*	WU	Thailand, Krabi Province	FJ501434	HQ632950
Tribounia grandiflora D.J.Middleton	*D.J. Middleton* and *P. Triboun 5205*	E	Thailand, Kanchanaburi, Muang, Wat Tham Khao Pun	JX839281	JX839280
Tribounia venosa (Barnett) D.J.Middleton	*D.J. Middleton* and *P. Triboun 4589*	E	Thailand, Lampang, Mae Prik, Tham Nam Pha Phangam	JX839282	JX839283

somewhat resembling those of *Chayamaritia*. However, the flowers of the two genera are very different, clearly forming a long corolla tube in *Chayamaritia* and often flat-faced or with only a short tube in *Petrocosmea*. In fact, the corolla of the former is rather similar in shape and size to those found among most other genera in the clade, such as *Pseudochirita* and *Allostigma*. In addition, the imbricate sepals of *Chayamaritia* are rather characteristic and apparently uncommon in Asian Gesneriaceae. Although we have not done an extensive survey, we are aware of imbricate sepals only in some species of *Petrocosmea* (e.g. *P. bicolor* D.J.Middleton & Triboun) and *Paraboea* (e.g. *P. sinensis* (Oliv.) B.L.Burtt).

An alternate leaf arrangement occurs in genera across the family Gesneriaceae and, amongst those from the Old World, can be found in tribe Trichosporeae, subtribe Leptoboeinae, in most species of *Boeica* C.B.Clarke and some species of *Rhynchotechum* Blume, and in subtribe Didymocarpinae in the recently described *Billolivia* D.J.Middleton (Middleton et al. 2014) and in *Cathayanthe* W.Y.Chun from Hainan. None of these have been shown to be closely related to *Chayamaritia* (Fig. 1).

Henckelia is likely to remain a confusing concept for some time to come due to its very radical realignment following its treatment by Weber et al. (2011a). It was a large genus both before and after being redefined by Weber et al. (2011a), but only a minority of the species is common to both circumscriptions. The other result of the new genus concept for *Henckelia* is that it shifted from being a genus with two centres of diversity in South India/Sri Lanka and Malesia to being a genus of India, Sri Lanka and the Himalayas with extensions into northern Thailand, northern Laos and northern Vietnam. In the old concept, most of its species were found in the aseasonal wet tropics of Malesia south of 9°N, and in the new concept all species bar one in Southeast Asia are only found north of 18°N. Indeed, if it were not for the extremely widespread *Henckelia anachoreta* (Hance) D.J.Middleton & Mich.Möller, which is found from around 30°N in China to around 13°N in Thailand, there would be no overlap with *Chayamaritia* which occupies a zone between the old and most of the new concepts of *Henckelia* at 14–18°N. There is a similar biogeographic split with its sister genus *Petrocosmea*, all species of which are only found north of 18°N except for the poorly known *Petrocosmea condorensis* Pellegr., which occurs on Con Son Island off the south coast of Vietnam. This species is almost certainly misplaced in *Petrocosmea* but requires further study.

Chayamaritia is the fifth new genus of Gesneriaceae described from Southeast Asia since 2012, the others being *Somrania* D.J.Middleton (Middleton and Triboun 2012) and *Tribounia* (Middleton and Möller 2012), both from Thailand, *Billolivia* (Middleton et al. 2014), from Vietnam, and *Glabrella* from South China (Möller et al. 2014). *Somrania* and *Billolivia* were described from species that were also previously unknown. The situation with *Chayamaritia* is more akin to *Tribounia* and *Glabrella* in that the type species of each of them were previously described in other genera. In the cases of *Chayamaritia* and *Tribounia*, the discovery of a new but clearly related species to these original two species was the spur to investigate their relationships that then resulted in new genera. All of these new genera, each supported by molecular phylogenetic studies (Möller et al. 2009, 2011; Middleton and Möller 2012; Middleton et al. 2014; Puglisi 2014), present a contrast to the other recent trend in Gesneriaceae systematics where large numbers of genera have been synonymised (Möller et al. 2011; Weber et al. 2011b, 2011c) or radically realigned (Weber et al. 2011a; Middleton et al. 2013). Although there are unlikely to be more large realignments of genera, there are still a number of genera where the limits are in need of clarification, including other species assemblages formerly placed in *Chirita* (see Weber et al. 2011a).

Conservation assessments using IUCN (2012) guidelines are calculated for one species. For the other species, *Chayamaritia banksiae*, it is concluded that there are insufficient data to give an assessment.

Taxonomic treatment

Chayamaritia D.J.Middleton & Mich.Möller, **gen. nov.**—TYPE: *Chayamaritia smitinandii* (B.L.Burtt) D.J.Middleton.

Description: Herb with thick, short, somewhat fleshy stem firmly attached to rock. Leaves simple, congested, alternately arranged around thick stem, petiolate, pubescent above and beneath, venation pinnate, eucamptodromous, tertiary venation alternate percurrent. Inflorescences axillary, scapose, 2–12-flowered, pubescent throughout, flowers somewhat pendent. Calyx of five lobes divided to base, strongly imbricate, upper lobe generally larger, margins minutely to coarsely dentate. Corolla with a long broad tube and 2-lipped limb with slightly spreading lobes; tube dorsally with 2 furrows with a ridge inbetween; upper lip 2-lobed, lobes rounded; lower lip 3-lobed, lobes rounded. Fertile stamens 2, the anterior ones; filaments inserted around or slightly below middle of corolla tube, bent around the middle, widest in middle; anther with 2 thecae, thecae parallel, glabrous, adnate tip to tip, touching face to face; lateral staminodes 2, large; medial staminode small. Disc a small 5-lobed or 5-crenate ring. Pistil with short stipe, ovary and style, held in a wide groove in the dorsal side of the corolla tube; ovary cylindrical, bicarpellate, unilocular with two parietal placentae, ovules numerous; stigma chiritoid, with a spathulate lower lobe, this bifid

with blunt lobes. Fruit a fusiform capsule, shortly stipitate, not twisted, dehiscence loculicidal along upper side. Seeds small, numerous, unappendaged.

Diagnosis: Similar to both *Henckelia* and *Primulina* in the tubular corollas, two fertile stamens and chiritoid stigma but differing from both in the combination of thickened rhizomatous prostrate stem, the alternately arranged leaves and the imbricate sepals.

Distribution: Central and eastern Thailand, Laos.

Etymology: The genus is named in honour of Dr Kongkanda Chayamarit of the Forest Herbarium in Bangkok. She has been a tireless advocate of research on the Thai flora and has been instrumental in the increase in publication rate of the *Flora of Thailand* series in recent years. She has done this through finding sources of funding for field work and family accounts and through ensuring that authors of accounts do not forget their promises!

Currently only known from two species, one of them newly described here.

Key to the species in *Chayamaritia*

1. Calyx lobes 7–15 mm wide; corolla tube whitish ventrally, lobe margins dentate; leaves 1.5–1.9 times as long as wide, base rounded to subcordate…***C. banksiae.***

1. Calyx lobes 0.9–4.2 mm wide; corolla tube purple ventrally, lobe margins more or less entire; leaves 1.8–5.6 times as long as wide, base cuneate to attenuate or rarely rounded…***C. smitinandii.***

Chayamaritia banksiae D.J.Middleton, **sp. nov.**—TYPE: Laos, Khammouan, Nam On catchment, Phou Ak escarpment, Nakai Nam Theun NBCA, 936 m a. s. l., 22 May 2006, collected only as a living collection *Newman* et al. LAO1428, grown on at the Royal Botanic Garden Edinburgh as accession number 20060845*A and vouchered for the herbarium and as the holotype as *Middleton 5220* (Holotype E) (Figs. 2, 3a–c, 4).

Description: Basal parts, petioles and leaf blades above and below densely covered with short white appressed hairs, these somewhat reddish when young. Leaves congested; petioles 6–16 cm long; blade ovate, 8.8–18 × 5.7–10.7 cm, 1.5–1.9 times as long as wide, base rounded to subcordate, sometimes slightly asymmetrical, apex shortly acuminate, margin minutely dentate, midrib impressed above, strongly prominent beneath, 8–9 veins on each side of midrib, these impressed above, very prominent beneath, tertiary venation obscure above, prominent beneath. Inflorescence 4–6-flowered, all axes and bracts pale green with red appressed hairs; peduncle to 15.5 cm long; bracts ovate, apex acuminate, margin dentate, c. 2 × 1.9 cm; pedicels 1.2–1.5 mm. Calyx lobes ovate, 15–21 × 7–15 mm, apex acuminate, pale green with red and green appressed hairs, inside with white appressed hairs in upper half, margin coarsely dentate but obscured by ciliate hairs. Corolla 4.8–6.2 cm long, tube white ventrally and purple dorsally outside, white to pale purple with 2 parallel yellow lines ventrally inside, lobes purple outside and inside, paler at base; tube 3.5–4.5 cm long; upper lip with each lobe orbicular, apex rounded, margins minutely dentate and ciliate, 10–14 × 12.5–16 mm; lower lip with each lobe orbicular, apex rounded, margins minutely dentate and ciliate, lateral lobes 12.5–13 × 11–16 mm, middle lobe 11–12 × 12–14 mm; outside of corolla short glandular pubescent throughout except at very base, glandular heads of hairs very small, inside glabrous except for short glandular hairs at sinus of upper lobes and sessile glands on ventral throat. Fertile stamens inserted at 15–21 mm from corolla base; filaments white, 11.5–15 mm long, geniculate and widening at 6–8 mm, minutely and sparsely glandular puberulent; anthers cream-coloured, 3 × 2.2–3 mm; lateral staminodes 5.5–11 mm long, middle staminode 0.5–1.2 mm long. Disc 5-lobed, c. 1.5 mm high, with sparse minute glandular hairs. Ovary and style green, densely covered with long eglandular hairs; ovary shortly stipitate, 20–28 mm long; style 8 mm long; stigma only of lower lobe, c. 5 mm long, this bifid with blunt lobes. Fruit unknown.

Diagnosis: Most similar to *Chayamaritia smitinandii* but differing in the outside of the corolla being white ventrally (purple in *C. smitinandii*), the leaf blade index mostly being lower (1.5–1.9 vs. 1.8–5.6 times as long as wide in *C. smitinandii*), the blade base being rounded to subcordate (cuneate to attenuate or only rarely rounded in *C. smitinandii*), the calyx lobes being broader and more dentate (7–15 mm vs. 0.9–4.2 mm wide in *C. smitinandii*) and the corolla lobes being minutely dentate along margin (entire in *C. smitinandii*).

Distribution: Endemic to Laos (Khammouan Province).

Habitat: Growing on sides of boulders in evergreen forest.

Etymology: Named after the botanical illustrator Claire Banks.

Proposed IUCN conservation assessment: Data Deficient. *Chayamaritia banksiae* is only known from one collection, and its complete distribution is unknown. The type specimen was collected from a cultivated plant with known provenance in Nakai Nam Theun National Biodiversity Conservation Area in Khammouan Province in Laos. Although the collection locality is not particularly far from the populations of *Chayamaritia smitinandii* in northeastern Thailand, the two species are easily distinguished, most obviously in leaf and sepal shapes as noted in the key and diagnosis.

Chayamaritia smitinandii (B.L.Burtt) D.J.Middleton, **comb. nov.**—TYPE: Thailand, Nakhon Ratchasima, Khao Yai National Park, 6 Oct 1962, *T. Smitinand 7491* (Holotype BKF) (Figs. 3c, d, 4)

≡ *Chirita smitinandii* B.L.Burtt in Thai Forest Bull., Bot. 29: 89. 2001

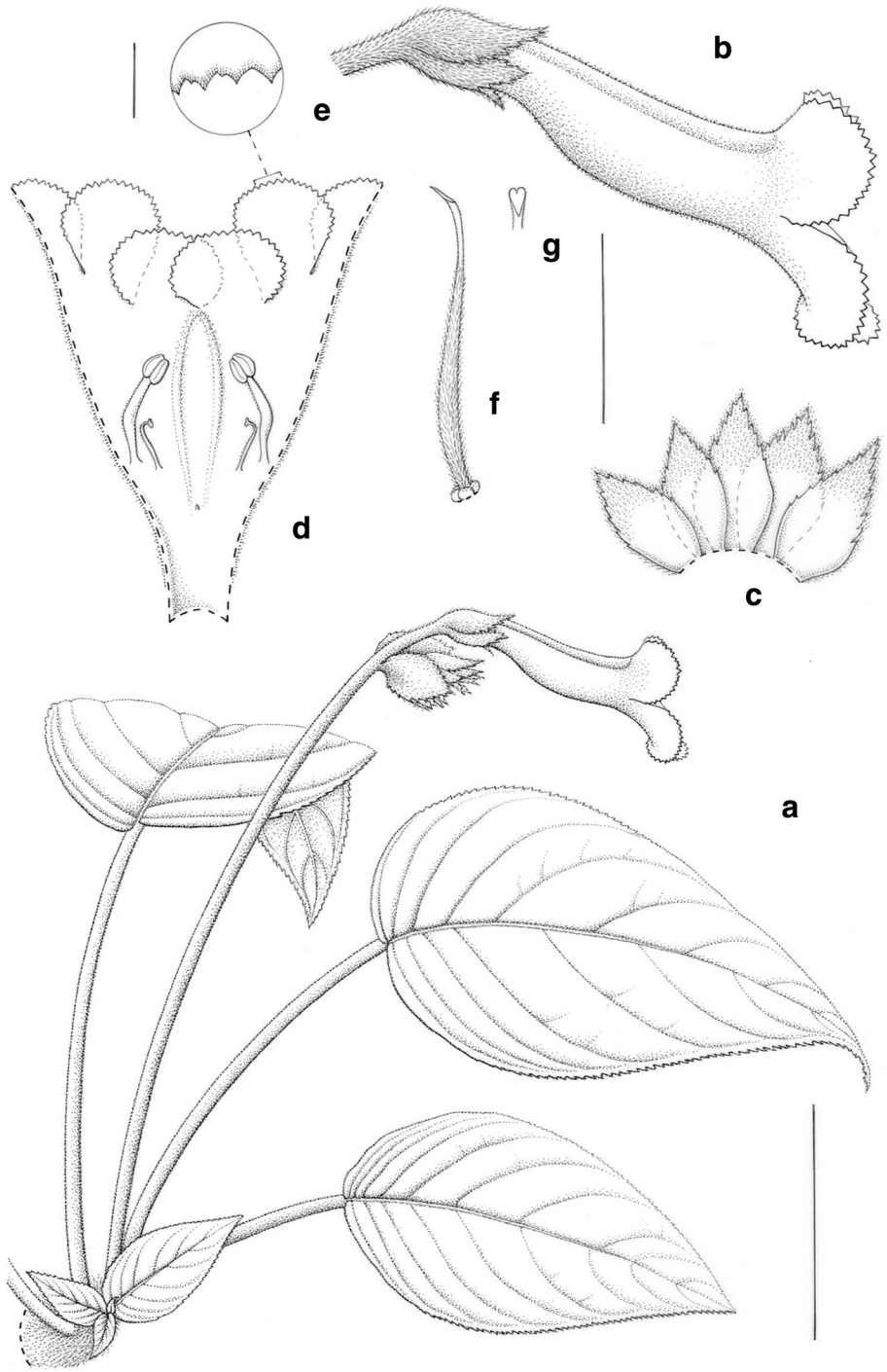

Fig. 2 *Chayamaritia banksiae* D.J.Middleton. **a** Habit; **b** flower, lateral view; **c** calyx opened out showing imbricate lobes; **d** corolla dissection; **e** close-up of corolla lobe margin; **f** pistil; **g** close-up of stigma showing enlarged and slightly bifid lower lobe. Drawn from *Middleton* 5220 (**e**) by Claire Banks. *Scale bars* **a** = 5 cm; **b–d**, **f**, **g** = 2 cm; **e** = 2 mm

≡ *Henckelia smitinandii* (B.L.Burtt) D.J.Middleton & Mich.Möller, Taxon 60: 776. 2011.

Description: Leaves congested; petioles (1.1–)4–13 cm long, densely pubescent; blades (3.2–)13–21 × (0.8–) 2.5–10.5 cm, 1.8–5.6 times as long as wide, base attenuate to cuneate or rarely rounded, apex acuminate, margin minutely dentate, secondary veins 6–9, pale pubescent all over above and beneath, more densely so beneath. Inflorescences 2–12-flowered, all axes densely pubescent; peduncles 11.5–26 cm long; bracts narrowly elliptic to lanceolate, somewhat falcate, 7.7–34 × 1.8–8 mm, apex acuminate, densely pubescent; pedicels 6.5–11 mm long.

Fig. 3 *Chayamaritia banksiae* D.J.Middleton. **a** Whole plant in cultivation at the Royal Botanic Garden Edinburgh; **b** Close-up of flower showing strongly imbricate sepals; **c** Close-up of corolla throat and stigma. *Chayamaritia smitinandii* (B.L.Burtt) D.J.Middleton. **d** Fruiting population of *Middleton* et al. 5632. **e** Flowering plant of *Middleton* et al. 5652. *Scale bars* in **c**, **d** = 1 cm

Calyx slightly zygomorphic with upper lobe longer than others, lobes lanceolate or narrowly elliptic, 5.3–15 × 0.9–4.2 mm, apex acute or acuminate, margin slightly toothed or appearing as large sessile glands on margin, densely pubescent. Corolla 3.8–6 cm long, outside deep purple throughout, paler proximally, inside with 2 ventral yellow lines in line with sinuses on lower lip and down into tube; tube 3.5–4.5 cm long; upper lip with each

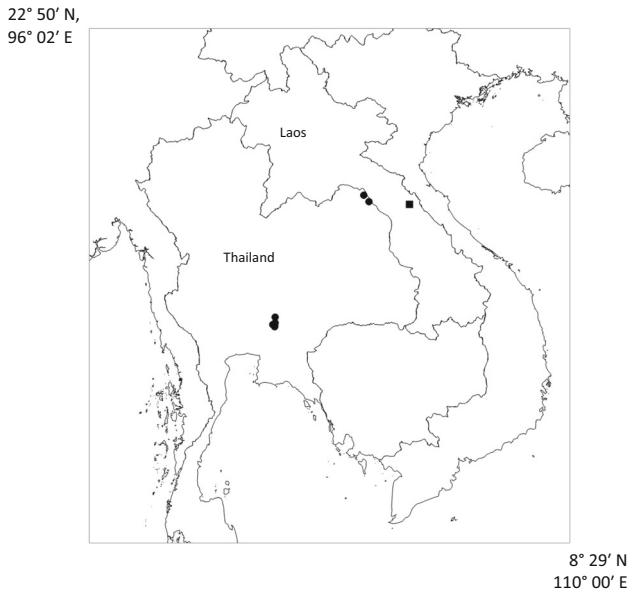

Fig. 4 Distribution of *Chayamaritia banksiae* D.J.Middleton (*filled square*) and *Chayamaritia smitinandii* (B.L.Burtt) D.J.Middleton (*filled circle*)

lobe squarish, apex rounded, margins ± entire, 8–11.5 × 9–11.5 mm; lower lip with each lobe orbicular to obovate, apices rounded, margins ± entire, lateral lobes 5.5–8 × 10 mm, middle lobe 7–10 × 7–10 mm; outside of corolla densely covered in gland-tipped purple hairs, inside glabrous except for gland-tipped hairs along inside of each furrow dorsally. Stamens inserted at 16–26 mm from corolla base; filaments 9.5–13 mm long, white, widest in middle, glabrous; anthers 2.1–2.7 × 2.1–3.1 mm; lateral staminodes 4–5 mm long, medial staminode 0.7 mm long. Disc 0.9–1.4 mm, 5-crenate at margin. Pistil 40–47 mm long; ovary shortly stipitate, 26.5–30 mm long, green, densely eglandular pubescent and with few subsessile glands; style 13.5–17 mm long, white, densely eglandular pubescent intermixed with fewer and shorter gland-tipped hairs; stigma with upper lip absent and an enlarged spathulate entire lower lip, 2–3 mm long, weakly bifid at apex. Fruit 3–5 cm long, 2.2–2.7 mm wide.

Distribution: Thailand (Nakhon Ratchasima, Nakhon Nayok, Buengkan and Nakhon Phanom Provinces).

Habitat: In evergreen and submontane forest in deep shade at 150–1200 m altitude.

Etymology: Named after the Thai botanist Tem Smitinand (1920–1995) who was also a maternal uncle of Kongkanda Chayamarit after whom the genus is named.

Proposed IUCN conservation assessment: Vulnerable VU B1 ab(iii). This species has an Extent of Occurrence of less than 20,000 km^2, and the northeastern populations are widely separated from the central populations by the predominant agricultural landscape of northeastern Thailand. In addition, the known populations can be subject to disturbance by the high visitor numbers found in the areas where this species is found in Khao Yai National Park.

Additional specimens studied: Thailand: **Nakhon Nayok:** Muang Nakhon Nayok, Hin Tang subdistrict, Pah Dah Baek Falls, 12 Sep 2002, *J.F. Maxwell 02-353* (BKF, CMU, L); ibid, 19 Oct 2003, *P. Palee 643* (CMU); Muang Nakhon Nayok, Khao Yai National Park, Near Pha Ta-Baeg Waterfall, 14 Oct 1984, *G. Murata* et al. *T-52442* (BKF); Muang Nakhon Nayok, Khao Yai National Park, Pah Da Bek trail to river, 20 Aug 2012, *D.J. Middleton* et al. *5632* (E); Muang Nakhon Nayok, Khao Yai National Park, Pha Diao Dai Nature Trail, 23 Aug 2012, *D.J. Middleton* et al. *5652* (E). **Nakhon Ratchasima:** Khao Yai National Park, Khao Khiew, Pha Tom Chai, 14 Sep 1999, *S. Watthana 695* (QBG); Khao Yai National Park, Khao Laem, 19 Oct 1969, *C.F.v. Beusekom* and *C. Charoenphol 1758* (BKF, E, K, L, P). **Nakhon Phanom:** Phu Langka National Park, Tadkham Falls, 30 Oct 1998, *T. Wongprasert s.n.* (BKF). **Buengkan:** Seka district, Phu Wua Wildlife Sanctuary, Bang Bart stream, 10 Oct 2013, *S. Suddee* et al. *4595* (BKF).

Until fairly recently, this species was only known from 600–1200 m altitude in Khao Yai National Park in Nakhon Ratchasima and Nakhon Nayok Provinces. Recent collections from some distance to the northeast in Buengkan and Nakhon Phanom Provinces were collected at much lower altitudes.

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