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LITOSTIGMA, A NEW GENUS FROM CHINA: A MORPHOLOGICAL LINK BETWEEN BASAL AND DERIVED DIDYMOCARPOID GESNERIACEAE

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Litostigma, a new Chinese genus of Gesneriaceae, is described and illustrated. It is characterised by its large flowers in comparison to its small leaves; slightly revolute leaf margins; 1-flowered cymes; crateriform or disciform stigma; and long ovoid capsule. Rather surprisingly, *Litostigma* falls among the basal didymocarpoid Gesneriaceae. Two new species, *Litostigma coriaceifolium* Y.G.Wei, F.Wen & M.Möller and *Litostigma crystallinum* Y.M.Shui & W.H.Chen, are described.

Keywords. Flora of China, Gesneriaceae, *Litostigma*, *Petrocosmea*, phylogeny.

INTRODUCTION

In the most recent classification of the Gesneriaceae (Weber, 2004) four informal major groups were recognised. Of these the palaeotropical didymocarpoids include 85 genera, 58 of which are found in China. During an expedition to Guizhou province, China, in 2007, specimens of a new species were collected (Fig. 1) which also proved to belong to a new genus. In reference to its simple stigma the genus is named *Litostigma* Y.G.Wei, F.Wen & M.Möller. The species is named *Litostigma coriaceifolium* Y.G.Wei, F.Wen & M.Möller. Subsequently, it was discovered that material of a species morphologically very similar to *Litostigma coriaceifolium* had been collected in 2002 in Malipo, Yunnan (Fig. 1), and cited as '*Petrocosmea crystallina*' Y.M.Shui & W.H.Chen in Shui & Chen (2006). This name was not validly published under the International Code of Botanical Nomenclature (McNeill *et al.*, 2006) as there was no Latin diagnosis or description. This plant was placed in *Petrocosmea* Oliv. due to the form of the peduncle and its anther indumentum. In some species of *Petrocosmea* and in '*Petrocosmea crystallina*' the peduncles bend back in order to place the capsule into rock crevices and thus the seeds into a suitable position for seedling establishment (Shui Yu-Min, pers. obs.).

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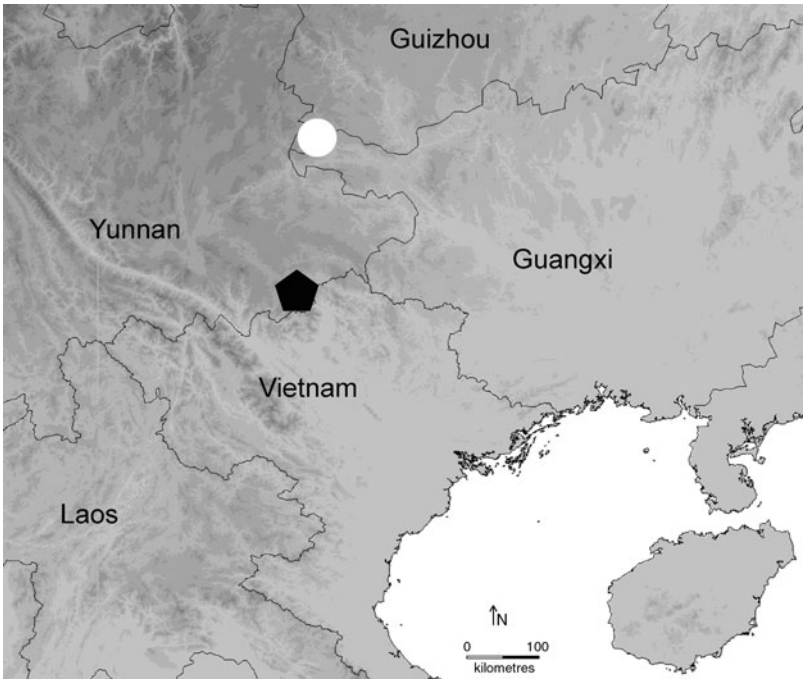

FIG. 1. Map showing the collection localities of *Litostigma coriaceifolium* Y.G.Wei, F.Wen & M.Möller (○) and *L. crystallinum* Y.M.Shui & W.H.Chen (⬟). Drawn with DIVA GIS 5.2 (http://www.diva-gis.org).

Generic delimitations in Gesneriaceae are often difficult due to large overlaps in characters between genera (Burtt, 1963, 1977). For this reason we undertook a combined phylogenetic–morphological approach. We attempted to determine the phylogenetic position of *Litostigma* among the Old World didymocarpoid Gesneriaceae, specifically in relation to *Petrocosmea* and other morphologically similar genera. In addition to the molecular analysis a detailed morphological comparison was made.

MATERIALS AND METHODS

Phylogenetic analysis

A data matrix was assembled consisting of 1952 molecular sequence characters (*trn*LF = 1054 characters, and ITS = 898 characters) that included 90 taxa across the Old World didymocarpoids. Sequence data were either taken from Möller *et al.* (2009) or acquired using methods explained therein. Twenty-one sequences (16 ITS and 5 *trn*LF) were newly acquired here, two were included from previous publications (*Jancaea heldreichii* Boiss., *Ramonda myconi* (L.) Rchb., Möller *et al.*, 1999), and one retrieved from GenBank (*Haberlea rhodopensis* Friv., Möller & Cronk, 2001a). The ingroup samples included *Litostigma coriaceifolium*, '*Petrocosmea crystallina*' and four species of *Petrocosmea* proper (Table 1). A partition

TABLE 1. Details of 92 didymocarpoid taxa included in the phylogenetic analysis, including voucher number (information in square brackets refers to the accession number of living material grown on from the specimen cited – where there is only a living accession number given it has been vouchered into the herbarium with the same number), deposition of voucher, origin and GenBank sequence information. RBGE = living collection at the Royal Botanic Garden Edinburgh, Scotland, UK; HBV = living collection at the Botanic Garden, Vienna, Austria

Taxon	Voucher number	Deposited in	Origin	*trn*LF	ITS1/ITS2
Aeschynanthus bracteatus Wall. ex DC.	*Wang* 991113	PE	China, Yunnan, Xichou county	FJ501501	–
Aeschynanthus bracteatus Wall. ex DC.	*R. Cherry* 123 [cult. RBGE 19970165]	E	Vietnam, Lao Cai	–	AF349203/ AF349284
Aeschynanthus micranthus C.B.Clarke	*M. Moeller* MMO 01-79	E, WU	China, Yunnan, Hekou county	FJ501500	–
Aeschynanthus micranthus C.B.Clarke	*A. Reid & J. Fernie* 004 [cult. RBGE 19951561]	E	China, Yunnan, Xishuangbanna Dai Aut. Pref.	–	AF349218/ AF349299
Agalmyla biflora (Elmer) O.M.Hilliard & B.L.Burtt	RBGE-PNH1998-25435 [cult. RBGE 19980287]	E	Philippines, Palawan, near summit of Cleopatra Needle	FJ501541	–
Agalmyla biflora (Elmer) O.M.Hilliard & B.L.Burtt	RBGE-PNH1998-25517 [cult. RBGE 19980292]	E	Philippines, Palawan, near Thumb Peak	–	FJ501361
Agalmyla clarkei (Elmer) B.L.Burtt	RBGE-PNH1999(P99) 13 [cult. RBGE 19991911]	E	Philippines, Leyte, Leyte Island, Mt. Lobi	FJ501540	–
Agalmyla clarkei (Elmer) B.L.Burtt	RBGE-PNH1997 IS26 [cult. RBGE 19972530A]	E	Philippines, Luzon, Barangay Penicuason	–	FJ501360
Anclystemon aureus (Franch.) B.L.Burtt	*M. Möller* MMO 01-153	E, WU	China, Yunnan, Binchuan county	FJ501505	FJ501336
Ancylostemon convexus Craib	*M. Möller* MMO 01-176	E, WU	China, Yunnan, Dali county, Yu Dai Lu, Cang Shan	FJ501506	FJ501337
Anna mollifolia (W.T.Wang) W.T.Wang & K.Y.Pan	*M. Möller* MMO 01-146	E, WU	China, Guangxi, Napo county	FJ501543	AF055050/ AF055051

TABLE 1. (*Cont'd*)

Taxon	Voucher number	Deposited in	Origin	*trn*LF	ITS1/ITS2
Anna submontana Pellegr.	*M. Möller* MMO 01-85	E, WU	China, Yunnan, Maguan county	FJ501542	FJ501362
Boea hygrometrica (Bunge) R.Br.	*Gu* 01-6184	KUN	China, unknown locality	FJ501476	FJ501319
Boea magellanica Lam.	*Lambinon* 87/830	L	Papua New Guinea, Morobe province	FJ501478	FJ501321
Boeica ferruginea Drake	*M. Möller* MMO 01-182B ex *Zhang Chang Qin* 200012	E, WU	China, SE Yunnan	FJ501440	This study
Boeica porosa C.B.Clarke	*Gu* 99-705	KUN	China, unknown locality	FJ501441	This study
Briggsia longipes (Hemsl. ex Oliv.) Craib	*M. Möller* MMO 01-122	E, WU	China, Yunnan, Xichou county	FJ501545	AF055052/ AF055053
Briggsia mihieri Craib	*Wang* 11315B	PE	China, Chongqing, Nanchuan county	FJ501544	FJ501363
Briggsia muscicola (Diels) Craib	Kew (1995-2229)	K	Unknown origin	FJ501548	FJ501366
Briggsia rosthornii (Diels) B.L.Burtt	Sino-American Bryological Expedition 1991, no. 398 (US 229325)	US	China, Guizhou, Jiangkou Xian	FJ501547	FJ501365
Calcareoboea coccinea C.Y.Wu ex H.W.Li	*M. Möller* MMO 01-141	E, WU	China, Guangxi, Napo county	FJ501516	FJ501365
Chirita asperifolia (Blume) B.L.Burtt	*P. Woods* 1071 (C6570)	E	Indonesia, Java, forest above Tjibodas Garden	FJ501538	JF501359
Chirita caliginosa C.B.Clarke	Ex HB München-Nymphenburg; *Kiehn & Pfosser* 2000-1 [cult. HBV GS-96-02]	WU	Peninsular Malaysia	FJ501488	FJ501325
Chirita lavandulacea Stapf	Cult. RBGE 20000897	E	China	FJ501487	FJ501324
Chirita pinnata W.T.Wang	Expedition Beijing 896526 (US 294374)	US	China, Guangxi, Rongshui Xian	FJ501526	FJ501349
Chirita pinnatifida (Hand.-Mazz.) B.L.Burtt	*Xie Qingjian* J-037 (US 422838)	US	China, Guangdong, Lianxian county	FJ501527	FJ501350

TABLE 1. (*Cont'd*)

Taxon	Voucher number	Deposited in	Origin	*trn*LF	ITS1/ITS2
Chirita pumila D.Don	Gaoligong Shan Expedition 1996 7938 [cult. RBGE 19962271]	E	China, Yunnan, Nujiang Lisu Aut. Pref., Fugong county	FJ501491	FJ501327
Chirita sinensis Lindl.	*T.C. Godfrey* 369 [cult. RBGE 19791050]	E	China, Hong Kong	FJ501524	FJ501348
Chirita urticifolia Buch.-Ham. ex D.Don	EMAK 109 H (Edinburgh-Makalu Expedition 1991)	E	Nepal, Sankhuwasabha district, Arun valley	FJ501492	FJ501328
Chirita walkeri Gardner	*Skog* 7736 (US 590934) [cult. Smithsonian 94-250]	US	Sri Lanka; leg. in US 11.03.1996	FJ501490	FJ501326
Chiritopsis repanda W.T.Wang var. *guilinensis* W.T.Wang	Ex Smithsonian Institute 94-083 [cult. RBGE 19951206]	E	China, Guangxi, Zhuang Aut. Reg.	AJ492292	FJ501351
Conandron ramondioides Sieb. & Zucc.	Takeda Herbal Garden Kyoto [cult. RBGE 19691267]	E	Japan	FJ501515	FJ501340
Corallodiscus lanuginosus (Wall. ex R.Br.) B.L.Burtt	*M. Möller* MMO 01-138	E, WU	China, Yunnan, Xichou county	FJ501432	This study
Cyrtandra cupulata Ridl.	*Weber* 840806-2/4	WU	Peninsular Malaysia, Perak, Maxwell's Hill	FJ501532	AY818826/ AY818861
Cyrtandra glabra Banks ex Gaertn.	*Cronk & Percy* T91	E	French Polynesia: Society Is.: Tahiti: Mt. Tearoa Col	AY423136	FJ501353
Cyrtandra longifolia (Wawra) Hillebr. ex C.B.Clarke	*Kiehn* 920825-2/1 [cult. HBV]	WU	USA, Hawaii, Kauai	FJ501531	AY818846/ AY818881
Cyrtandra pendula Blume	*Weber & Anthonysamy* 860730-1/2 [cult. HBV]	WU	Peninsular Malaysia	FJ501530	FJ501354
Didymocarpus antirrhinoides A.Weber	*Jong* 9009 [cult. RBGE 19650167]	E	Peninsular Malaysia, Perak, Bujong Melakah, Ipoh	FJ501513	DQ912671
Didymocarpus citrinus Ridl.	*P. Davis* 69437 [cult. RBGE 19830510]	E	Peninsular Malaysia, Perlis, Kedat Peak	AJ492293	DQ912669
Didymocarpus cordatus Wall. ex DC.	*Weber* 860816-2/1	WU	Peninsular Malaysia, Perak, Maxwell's Hill	AJ492294	DQ912673

TABLE 1. (*Cont'd*)

Taxon	Voucher number	Deposited in	Origin	*trn*LF	ITS1/ITS2
Didymocarpus podocarpus C.B.Clarke	*Noltie, Pradhan, Sherub & Wangdi* 193	E	Bhutan, Deothang district	FJ501514	DQ912688
Didymocarpus purpureobracteatus W.W.Sm.	*Wang* 991106	PE	China, Yunnan, Pingbian county	FJ501510	–
Didymocarpus purpureobracteatus W.W.Sm.	*M. Möller* MMO 01-70	E, WU	China, Yunnan, Pingbian county	–	DQ912676
Didymocarpus stenanthos C.B.Clarke	*M. Möller* MMO 01-156	E, WU	China, Yunnan, Binchuan county	FJ501512	DQ912687
Dolicholoma jasminiflorum D.Fang & W.T.Wang	*M. Möller* MMO 09-06851	E	China, Guangxi, Napo county	This study	This study
Haberlea rhodopensis Friv.	Cult. RBGE 19754106	E	(Greece)	AJ492296	Möller & Cronk, 2001a
Hemiboea bicornuta (Hayata) Ohwi	Smithsonian Institute [cult. RBGE 19951207]	E	Unknown origin	FJ501534	FJ501356
Hemiboea cavaleriei H.Lév.	*Gu* G3	KUN	China, unknown locality	FJ501533	FJ501355
Hemiboea gracilis Franch.	*Wang* 11317	PE	China, Chongqing, Nanchuan county	FJ501536	This study
Hemiboea subcapitata C.B.Clarke	*Wang* 11306	PE	China, Chongqing, Chengkou county	FJ501535	FJ501357
Jancaea heldreichii Boiss.	*E.G. Cairns* [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 province, Khao Tak Groep	FJ501459	FJ501309
Leptoboea multiflora (C.B.Clarke) Gamble subsp. *grandifolia* B.L.Burtt	*Larsen et al.* 32065	E	Thailand, SE, Khaso Phra Bat, N of Chanthaburi	FJ501442	This study

TABLE 1. (*Cont'd*)

Taxon	Voucher number	Deposited in	Origin	*trn*LF	ITS1/ITS2
Litostigma coriaceifolium Y.G.Wei, F.Wen & M. Möller, sp. nov.	*M. Möller* MMO 07-1162	E, IBK	China, Guizhou, Xingyi county	This study	This study
Litostigma crystallinum Y.M.Shui & W.H.Chen, sp. nov.	*Y.M. Shui* 43865	KUN	China, Yunnan, Malipo county	This study	This study
Loxostigma fimbrisepalum K.Y.Pan	*Wang* 991005	PE	China, Yunnan, Jinping county	FJ501507	This study
Loxostigma griffithii (Wight) C.B.Clarke	Kew/Edinburgh Kanchenjunga Expedition (1989) 940 [cult. RBGE 19892473A]	E	Nepal, Yamphudin	FJ501508	FJ501338
Lysionotus chingii Chun ex W.T.Wang	*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* MMO 01-101	E, WU	China, Yunnan, Xichou county, Cheng Jia Po	FJ501497	FJ501331
Opithandra primuloides (Miq.) B.L.Burtt	*T. Tsuzuki* [cult. RBGE 19842178A]	E	Japan, unknown locality	FJ501546	FJ501364
Oreocharis auricula (S.Moore) C.B.Clarke	Sino-American Bryological Expedition 1991, no. 1832	WU	China, Guizhou, Yinjiang county	FJ501481	–
Oreocharis auricula (S.Moore) C.B.Clarke	*M. Möller* MMO 03-304	E	China, Guizhou, Jiangkou county	–	FJ501323
Ornithoboea arachnoidea (Diels) Craib	Ex HBV [cult. RBGE 19972903]	E	Thailand, Chiang Mai, Doi Chiang Dao	FJ501461	FJ501312
Ornithoboea wildeana Craib	*Wang* 00401	PE	China, Yunnan, Xichou county	FJ501462	FJ501313

TABLE 1. (*Cont'd*)

Taxon	Voucher number	Deposited in	Origin	*trn*LF	ITS1/ITS2
Paraboea acutifolia (Ridl.) B.L.Burtt	*Weber* 86805-2/1	WU	Peninsular Malaysia, Kedah, Pulau Langkawi, Bukit Terbak	FJ501464	FJ501314
Paraboea capitata Ridl.	*Weber* 870522-5/2 [cult. HBV]	WU	Peninsular Malaysia, Perak, Kinta district	AJ492298	FJ501315
Paraboea crassifolia (Hemsl.) B.L.Burtt	*M. Möller* MMO 01-83	E, WU	China, Yunnan, Maguan county	FJ501472	FJ501318
Paraboea rufescens (Franch.) B.L.Burtt var. *umbellata* (Drake) K.Y.Pan	*M. Möller* MMO 01-147	E, WU	China, Guangxi, Napo county, Nong Bu	FJ501470	FJ501317
Paralagarosolen fangianum Y.G.Wei	*M. Möller* MMO 07-1168	E	China, Guangxi, Napo county	This study	This study
Petrocodon dealbatus Hance	*Xie Qingjian* J-042 (US 422841)	US	China, Guangdong, Lianxian county	FJ501537	FJ501358
Petrocosmea kerrii Craib	Cult. RBGE 19715592	E	Unknown origin	FJ501502	FJ501334
Petrocosmea minor Hemsl.	Sino-American Bot. Exped. 1984, no. 1574 (US 56119)	US	China, Yunnan, Lunan Xian	FJ501504	This study
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	*Gu* 99-1104	KUN	China, unknown locality	FJ501503	This study
Platystemma violoides Wall.	Projektteam 197-241	WU	Nepal, SE Kathmandu Pulchoki	FJ501443	This study
Primulina tabacum Hance	*Q.J. Xie & C.X. Ye* [cult. RBGE 19951540]	E	China, Guangdong, Lian River	AJ492300	FJ501352
Ramonda myconi (L.) Rchb.	Lausanne Botanic Garden [cult. RBGE 19711477]	E	Spain, Pyrenees	AJ492301	Möller *et al.*, 1999

TABLE 1. (*Cont'd*)

Taxon	Voucher number	Deposited in	Origin	*trn*LF	ITS1/ITS2
Raphiocarpus begoniifolius (H.Lév.) B.L.Burtt	*Wang* 991108	PE	China, Yunnan, Yuanyang county	FJ501517	FJ501342
Raphiocarpus petelotii (Pellegr.) B.L.Burtt	*S. Goodwin & R. Cherry* 92/208 [cult. RBGE 19982405]	E	Vietnam, Lao Cai province	FJ501518	FJ501343
Rhabdothamnopsis sinensis Hemsl.	[Ex cult. Kew 1988 4866]	K	China, unknown locality	AJ492302	FJ501310
Rhynchotechum discolor (Maxim.) B.L.Burtt	RBGE-PNH Expedition 1997/SM8 [cult. RBGE 19972562]	E	Philippines, Luzon, Isabela	FJ501436	This study
Rhynchotechum parviflorum Blume	*M. Mendum, G. Argent & Hendrian* 00148	E	Central Sulawesi, Mt. Sojol	FJ501437	This study
Saintpaulia tongwensis B.L.Burtt	*I.C. Mather* 2 [cult. RBGE 19850668]	E	Tanzania, Tanga region	FJ501446	FJ501303
Saintpaulia velutina B.L.Burtt	Munich University [cult. RBGE 19872179]	E	Tanzania, unknown locality	AJ492303	FJ501304
Spelaeanthus chinii Kiew, A.Weber & B.L.Burtt	*Weber* 860709-2/2	WU	Peninsular Malaysia, Pahang, Jerantut district, Taman Negara	FJ501457	FJ501307
Streptocarpus andohahelensis Humbert	*M. Möller* MM 9717	E	Madagascar, Tuléar, Ranomafana	FJ501449	AF316903
Streptocarpus beampingaratrensis Humbert	*M. Möller* MM 9715	E	Madagascar, Tuléar, Ranomafana	FJ501448	AF316905
Streptocarpus dunnii Hook.f.	*Isobel La Croix* [cult. RBGE 19941745]	E	Swaziland, Mbabane	FJ501456	AF316951
Streptocarpus hilsenbergii R.Br.	*B.L. Burtt* [cult. RBGE 19631505]	E	Madagascar, Mandrake valley	FJ501450	AF316907

TABLE 1. (*Cont'd*)

Taxon	Voucher number	Deposited in	Origin	*trn*LF	ITS1/ITS2
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* MM 9718	E	Madagascar, Tuléar, Ranomafana	FJ501444	AF316929
Streptocarpus rexii Lindl.	*K. Jong* [cult. RBGE 19870333]	E	South Africa, NE Cape, Grahamstown	AJ492305	AF316979
Streptocarpus saxorum Engl.	*Chautems & Perret* 01-023	G	Cult. CJBG	FJ501447	–
Streptocarpus saxorum Engl.	*I.C. Mather* 4 [cult. RBGE 19721499]	E	Tanzania, Tanga region	–	AF316914
Wentsaiboea renifolia D.Fang & D.H.Qin	*M. Möller* MMO 06-791	E	China, Guangxi, DuAn county	This study	This study

homogeneity test and the parsimony and branch support analyses were conducted following Möller *et al.* (2009). The phylogenetic tree was rooted on *Corallodiscus* Batalin as one of the most basal lineages in Old World didymocarpoids, as suggested in Möller *et al.* (2009).

Scanning electron microscopy

Materials for SEM were fixed in FAA (5% acetic acid, 5% formaldehyde, and in 50% ethanol). The fixed material was dehydrated in an ethanol series and acetone, critical point dried in CO_2 with an Emitech K850 critical point dryer (Ashford, UK), coated with platinum in a peltier cooled Emitech K575X sputter coater (Ashford, UK) and then examined with a LEO Supra 55VP scanning electron microscope at a working distance of 11 mm and 4.8 to 5 kV.

Results and Discussion

Comparison with morphologically similar genera

Litostigma has the characteristic morphological features of relatively large diandrous flowers in comparison to the small leaves and stature of the plant, with petiolate, slightly revolute leaf margins, uniflowered cymes, undivided stigma and untwisted narrowly ovoid capsules, dehiscing loculicidally and septicidally.

Among Weber's (2004) Old World advanced Asiatic and Malesian didymocarpoid genera there are some morphological similarities between *Litostigma* and straight-fruited advanced genera such as *Didymocarpus* Wall., *Dolicholoma* D.Fang & W.T.Wang, *Paralagarosolen* Y.G.Wei, *Petrocodon* Hance and *Wentsaiboea* D.Fang & D.H.Qin. The similarities are often in individual characters that are, however, shared with several other genera, such as a ± capitate stigma (*Didymocarpus*, *Dolicholoma*, *Petrocodon*, *Wentsaiboea*), small elliptic leaves, ovoid ovary and capsule (*Dolicholoma*, *Paralagarosolen*, *Wentsaiboea*), and 1-flowered cymes (*Dolicholoma*, *Paralagarosolen*). However, these genera differ from *Litostigma* in other characters (Table 2). For example, most of them have verruculose and/or ornamented seed testa cells (Table 2; Beaufort-Murphy, 1983), very unlike *Litostigma* (Fig. 3A–B).

Litostigma differs from *Petrocosmea* most notably through the latter's short tube and flat-faced corollas, and its strongly ornamented seeds (Table 2). *Petrocosmea* flowers are also distinctly bilabiate, with the lobes of the upper lip often nearly completely fused.

Phylogenetic position of Litostigma

The partition homogeneity test suggested that the two sequence matrices were highly congruent ($P = 0.74$). Analysing the two genes individually did not alter the position of *Litostigma* and *Petrocosmea* proper in the phylogenetic trees (data not shown).

TABLE 2. Morphology of selected Gesneriaceae genera superficially resembling *Litostigma* or implicated in molecular studies (compiled from Beaufort-Murphy, 1983; Wang *et al.*, 1990, 1998; Wei, 2004; Weber, 2004; and Weber & Skog, 2007 onwards)

	Character						
Genus	Number of flowers per inflorescence	Flower	Stamens	Stigma	Ovary	Capsule	Seeds
Litostigma	1-flowered	Infundibuliform	2, anterior, coherent adaxially	Crateriform or disciform	Ovoid, 1-loculed, placentae 2, parietal, slightly protruding inwards, 2-cleft	Straight in relation to pedicel, slightly longer than calyx, long narrowly ovoid, dehiscing to base, 4 valves	Reticulate
Petrocosmea	Few- to several-flowered	Short-tubed, flat-faced	2, anterior, basifixed, coherent at apices	Capitate or globose	Ovoid or conical	Straight in relation to pedicel, ovoid or oblong, dehiscing loculicidally, straight	Ornamented
Dolicholoma	1- to 4-flowered	Near hypocrateriform	2, anterior, coherent adaxially	Terminal, disc-like, undivided	Narrowly ovoid, 1-loculed, placentae 2, parietal, slightly protruding inwards, 2-cleft	Straight in relation to pedicel, nearly as long as calyx, narrowly ellipsoid, dehiscing to base, 4 valves, straight	Verruculose, complex ornamented
Paralagarosolen	1-flowered	Hypocrateriform	2, anterior, coherent adaxially	Bilobed, equal, lobes broadly ovoid (unclear whether split horizontally)	Ovoid to near ellipsoid, 1-loculed, placentae 2, parietal, projecting slightly inwards, 2-cleft	Straight in relation to pedicel, slightly longer than calyx, ovoid-ellipsoid, dehiscing to base, 4 valves, straight	Densely verrucose

TABLE 2. (*Cont'd*)

Genus	Character						
	Number of flowers per inflorescence	Flower	Stamens	Stigma	Ovary	Capsule	Seeds
Petrocodon	Few- to many-flowered	Suburceolate-tubular, campanulate	2, anterior, anthers dorsifixed, coherent apically, dehiscing longitudinally	Terminal, nearly globose, undivided	Linear, 1-loculed, placentae 2, parietal, projecting inwards, 2-cleft	Straight in relation to pedicel, much surpassing calyx, linear, dehiscing loculicidally to base, 2 valves, straight	Verruculose, smooth
Wentsaiboea	Few- to many-flowered	Obliquely campanulate, swollen abaxially	2, anterior, anthers dorsifixed, coherent adaxially, dehiscing longitudinally	Obliquely hippocrepiform	Narrowly ovoid, 1-loculed, placentae 2, parietal, projecting inwards, 2-cleft	Straight in relation to pedicel, slightly longer than calyx, narrowly ellipsoid, straight	Verruculose, ornamented
Didymocarpus	1- to many-flowered	Cylindric to infundibuliform-tubular, wide to narrow, long, rarely saccate at base	2, anterior, anthers dorsifixed, coherent adaxially, dehiscing longitudinally	Terminal, depressed-globose to disc-like or truncate	Linear, 1-loculed, placentae 2, parietal, slightly projecting inwards, 2-cleft	Straight in relation to pedicel, much longer than calyx, usually linear, dehiscing loculicidally to base, 2 or 4 valves, straight	Striate, tuberculate, verrucate, or smooth

TABLE 2. (*Cont'd*)

Genus	Character						
	Number of flowers per inflorescence	Flower	Stamens	Stigma	Ovary	Capsule	Seeds
Corallodiscus	1- to many-flowered	Short tubular	4, anthers dorsifixed, coherent in pairs, dehiscing longitudinally	Terminal, capitate, emarginate	Oblong, 1-loculed, placentae 2, parietal, projecting inwards, 2-cleft	Straight in relation to pedicel, much longer than calyx, narrowly oblong to linear, rarely ovoid, dehiscing loculicidally and sometimes septicidally to base, 2 valves, straight	Reticulate
Haberlea	Few-flowered	Short cylindric, broad	4, didynamous	Capitate	Ovoid, 1-loculed, placentae 2, parietal, projecting inwards, 2-cleft	Ovoid, dehiscing septicidally, 2 valves	Reticulate
Ramonda	2- to 4-flowered	Absent, actinomorphic corolla	4–5, equalling the number of corolla lobes	Capitate	Ovoid, 1-loculed, placentae 2, parietal, projecting inwards, 2-cleft	Ovoid, dehiscing septicidally, 2 valves	Reticulate

The maximum parsimony (MP) analysis on the combined sequences resulted in 156 most parsimonious trees of 3957 steps (CI = 0.4079, RI = 0.6363). The topology recovered here is congruent with that in Möller *et al.* (2009). Here we focus on the positions of *Litostigma* and '*Petrocosmea crystallina*' in particular.

The MP strict consensus tree shows the new genus *Litostigma* and '*Petrocosmea crystallina*' (in Fig. 2 as *L. crystallinum*) in a strongly supported sister relationship

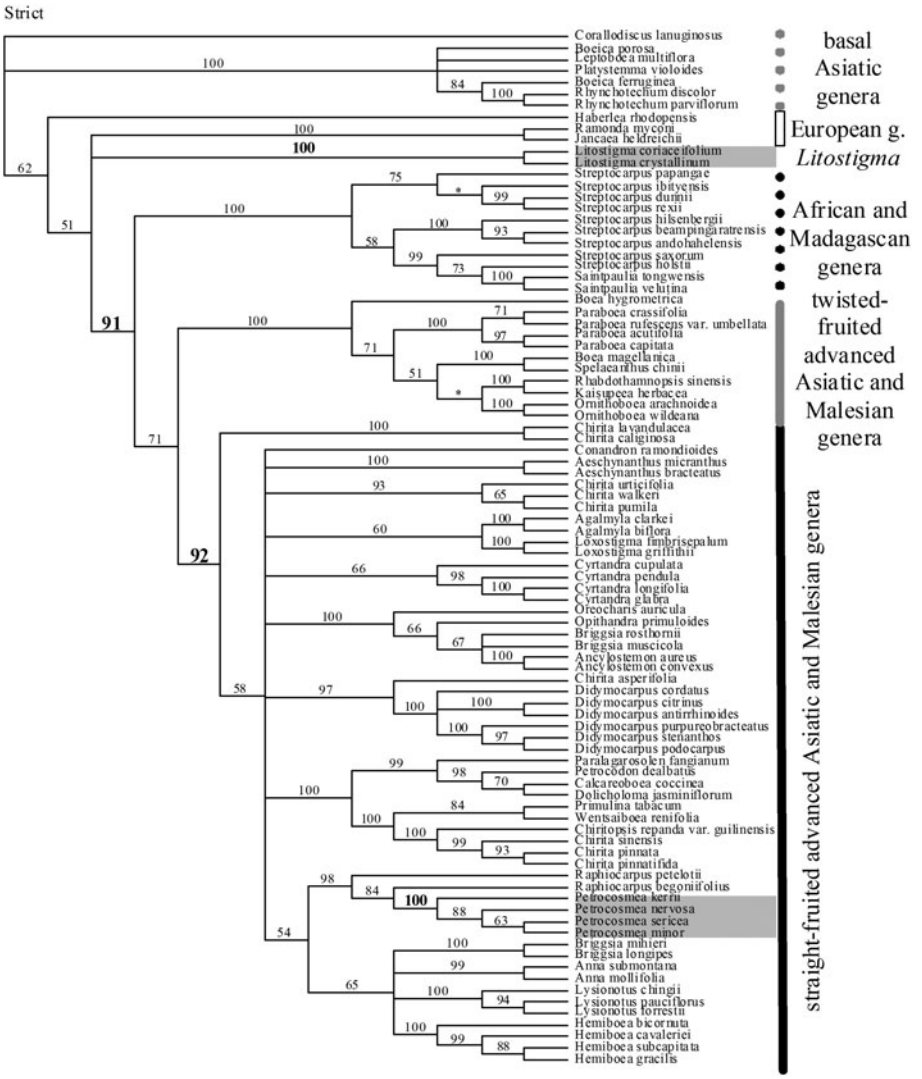

FIG. 2. Strict consensus tree of 156 most parsimonious trees based on *trn*LF and ITS sequences, highlighting the position of *Litostigma coriaceifolium*, *L. crystallinum* and *Petrocosmea*, falling in two very distantly related clades. Numbers along branches are bootstrap values. Asterisks denote branches that received less than 50% branch support.

(BS = 100%). Their genetic distance is 0.36% in the *trn*LF and 3.7% in the ITS data, indicating their close relatedness. Intrageneric ITS distance levels in other Gesneriaceae genera are much higher than those observed between *Litostigma* and '*Petrocosmea crystallina*' (e.g. *Aeschynanthus* Jack: 16.9%, Denduangboripant *et al.*, 2001; *Agalmyla* Blume: 14.1%, Chapman, 2003; *Streptocarpus* Lindl.: 23.5%, Möller & Cronk, 2001a, 2001b) and thus support a treatment of '*Petrocosmea crystallina*' as a species of the new genus *Litostigma* (described as *L. crystallinum* below).

In the present phylogeny the clade with *Petrocosmea* proper (with 4 out of c.27 species included in the analysis – representing all three sections recognised in the genus) was highly supported (BS = 100%) and is sister to a grade of *Raphiocarpus begoniifolius* (H.Lév.) B.L.Burtt and *R. petelotii* (Pellegr.) B.L.Burtt with high branch support (BS = 98%). The *Litostigma* clade is far from *Petrocosmea* proper, near the base of the didymocarpoids, on a polytomy with the European *Ramonda* Rich./*Jancaea* Boiss. clade. This suggests that the true affinities of *Litostigma* do not necessarily lie directly with the European genera.

Though some branches in the phylogenetic tree between *Petrocosmea* proper and *Litostigma* are not well supported, two were highly supported – one leading to the straight-fruited advanced Asiatic and Malesian clade (BS = 92%), the other supporting the monophyly of the former clade plus the two twisted-fruited clades, the African/Madagascan and the twisted-fruited advanced Asiatic and Malesian clade (BS = 91%). This makes a closer relationship between *Petrocosmea* proper and *Litostigma* highly unlikely.

The genera with some morphological similarities to *Litostigma*, namely *Dolicholoma*, *Paralagarosolen*, *Petrocodon*, *Wentsaiboea* and *Didymocarpus*, are all distant from the new genus in a mixed clade (BS = 100%) (first four genera), or in a separate clade with *Chirita asperifolia* (Blume) B.L.Burtt (BS = 97%) (*Didymocarpus*), among the straight-fruited advanced Asiatic and Malesian genera (BS = 95%), and on a polytomy with the clade containing *Petrocosmea*.

Litostigma *as a morphological link*

Litostigma is a new genus, currently with just two species. A relationship to the basal Asiatic and European genera of Old World Gesneriaceae is suggested by molecular data. A loose association with *Ramonda* and *Jancaea* is indicated, but there is no obvious similarity in gross morphology. Apart from its overall smaller size, *Litostigma* has strongly petiolate and glabrous leaves, very unlike *Ramonda* and *Jancaea*. Furthermore, the corolla of *Litostigma* is strongly tubular and bilabiate, with two fertile stamens, while *Ramonda* has a 5-merous, actinomorphic and flat-faced flower with five stamens, and *Jancaea* has a 4-(rarely 5-)merous, subactinomorphic and campanulate flower with 4 (rarely 5) stamens.

Among the basal didymocarpoid lineages Weber (2004) does not list any genera with morphological similarities to *Litostigma*; in fact it is the only genus with two

fertile stamens in this group, all others having four or five (an exception is *Tetraphyllum* which includes species with both four and two stamens; Weber, 2004). Apart from tetrandry, the basal didymocarpoids are characterised by the possession of seeds without testa cell ornamentation, straight fruits (Weber, 2004; Möller *et al.*, 2009) and septicidal (*Haberlea* Friv., *Jancaea* and *Ramonda*) or septicidally and loculicidally (*Boeica* C.B.Clarke, *Corallodiscus* and *Leptoboea* Benth.) dehiscing capsules. These seed, fruit shape, and capsule dehiscence (septicidally and loculicidally) characters are also found in *Litostigma* (Fig. 3, Table 2).

A major morphological progression has taken place between basal didymocarpoid lineages and the African, Madagascan and advanced Asian and Malesian lineages: the evolution of twisted fruits (found in a major clade of the advanced Asian and Malesian clade) and a change to diandry (Weber, 2004; Möller *et al.*, 2009). The diandrous infundibuliform corolla of *Litostigma* is remarkably similar to those of some species in the African genus *Streptocarpus* and the only difference of this genus to *Litostigma* is the ovoid ovary and straight fruit of the latter. Such fruits are found in some African genera, such as *Saintpaulia* Wendl. and *Acanthonema* Hook.f., and represent cases of parallel convergent evolution within the genus *Streptocarpus* (Möller *et al.*, 2009). Several other advanced Asiatic and Malesian genera possess an infundibuliform diandrous corolla (some *Chirita* Buch.-Ham. ex D.Don,

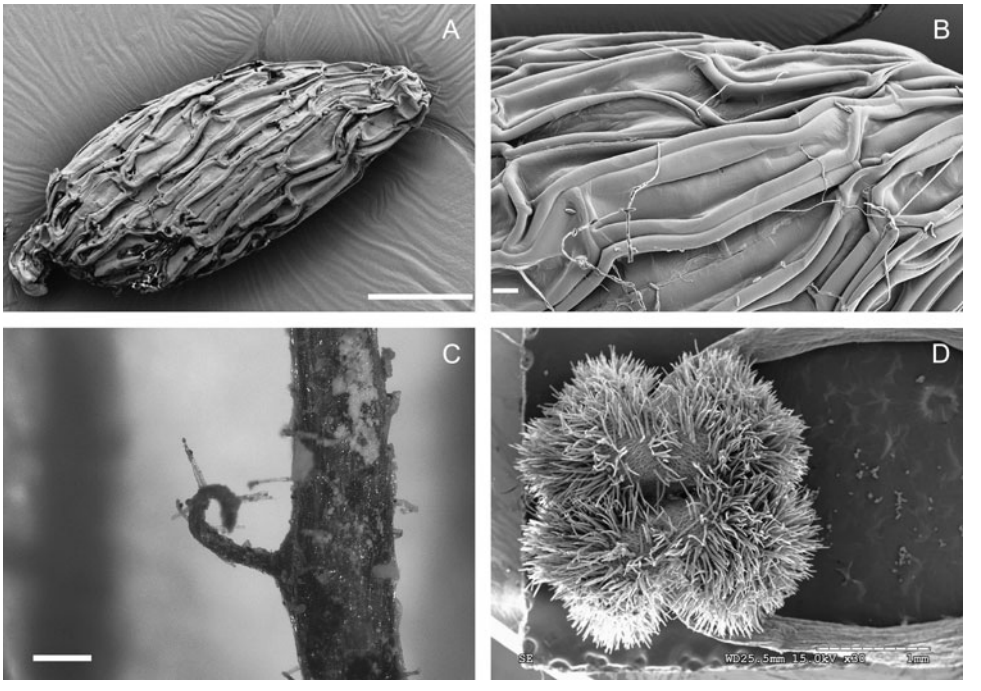

FIG. 3. *Litostigma*. A–C: *Litostigma coriaceifolium*. A, SEM micrograph of seed (scale bar = 100 μm). Magnified in B (scale bar = 10 μm). C, single bract subtending the single flower (scale bar = 200 μm). D: *Litostigma crystallinum*, SEM micrograph of anthers (scale bar = 1 mm).

Didymostigma W.T.Wang, some *Lysionotus* D.Don species, *Pseudochirita* W.T.Wang, some *Raphiocarpus* Chun species and the twisted-fruited *Rhabdothamnopsis* Hemsl.), suggesting some convergence for this character in the evolution of didymocarpoid Gesneriaceae.

In the present study the molecular data are the strongest support for the new genus status of *Litostigma*. The morphological characters describing the species would individually not make such a strong case, due to many overlaps with other genera. Only the combination of a range of floral (infundibuliform flowers, diandry, uniflowered inflorescence, undivided stigma, not twisted loculicidally and septicidally dehiscing fruit) and vegetative (petiolate leaves with revolute leaf margin) characters provides a unique definition of the genus.

The phylogenetic placement of *Litostigma* and the combination of ancestral and derived characters within the didymocarpoid Gesneriaceae makes this genus a very important morphological link between the ancestral basal Asiatic and European and derived African, Asian and Malesian genera. The addition of further, as yet possibly undiscovered, genera, particularly those in basal lineages, may help place *Litostigma* more precisely. Further additions may also help stabilise phylogenetic relationships among the basal and derived didymocarpoid lineages and help form a better understanding of the morphological transitions involved in the evolution of the majority of the Old World Gesneriaceae.

Taxonomic Treatment

Litostigma Y.G.Wei, F.Wen & M.Möller, **gen. nov.** (subfam. Didymocarpoideae Endl., tribe Didymocarpeae Endl.).

Petrocosmea Oliv. affinis a qua cyma 1-flora, stigmate crateriformi vel disciformi, differt. A *Dolicholomate* D.Fang & W.T.Wang forma floris et seminibus reticulatis (in *Dolicholomate* verruculosis et ornamentatis) differt.

Herbae perennes acaules rhizomatosae. Folia basalia petiolata. Cymae axillares uniflorae, unibracteatae et bibracteate. Calyx actinomorphus. Sepala 5. Corollae tubus infundibularis, abaxialiter paulo ventricosus, limbus bilabiatus, labio adaxiali 2-partito eo abaxiali 3-lobo omnibus cum lobis orbiculari-ovatis. Stamina 2 ad laterem abaxialem corollae tubi adnata; filamenta linearia; antherae cohaerentes ellipticae, subtilis puberulae (ampliare c.40×). Staminodia 3 ad laterem adaxialem corollae tubi adnata, linearia. Discus annularis. Pistillum inclusum; ovarium anguste ovoideum, uniloculare, placentis duabus parietalibus intrinsecus projectis bifidis; stylus elongatus ovario fere 4-plo longior; stigma simplex, crateriforme vel disciforme. Capsula ovoidea valvis quatuor dehiscens. – Typus generis: *Litostigma coriaceifolium* Y.G.Wei, F.Wen & M.Möller.

Perennial, stemless, rhizomatous herbs. *Leaves* basal, distinctly petiolate. *Cymes* 1-flowered, 1-bracteate. *Sepals* 5. *Corolla* zygomorphic, infundibuliform, adaxial lip

2-parted, abaxial lip 3-parted, all lobes divided nearly to the base, orbicular-ovate. *Stamens* 2, staminodes 3. *Disc* annular, ovary ovoid-ellipsoid, 1-loculed; placentae 2, parietal, intrusive, bifid. *Stigma* crateriform or disciform. *Fruit* narrowly ovoid, glabrous, dehiscing into 4 valves. *Seeds* reticulate, with raised testa cell walls.

Distribution. Southern China.

Etymology. The generic name is derived from Greek *litos*, meaning plain or simple, and *stigma* in allusion to the uncomplicated structure of the stigma.

Litostigma coriaceifolium Y.G.Wei, F.Wen & M.Möller, **sp. nov. Figs 1, 3A–C, 4.**

Haec species *Litostigmati crystallino* Y.M.Shui & W.H.Chen similis, sed foliis majoribus 1–2.1 cm longis (in illa minoribus 4.5–6 cm longis), sepalis 3–4 mm (nec 7 mm) longis, antheris glabris (nec dense pilosis) et stigmate crateriformi (nec disciformi) differt. – Type: China, Guizhou province, Xingyi county, Maling gorge, 1186 m, 24 iv 2007, *Y.G. Wei & F. Wen* 0701 (holo IBK!; iso PE!).

Small perennial, stemless herb. *Rhizome* subterete, 1–1.5 cm long, 1–2 mm in diameter. *Leaves* 10–15, basal; leaf blade coriaceous, elliptic, 1–2.1 cm long, 0.6–1.1 cm wide, apex rounded, base obtuse to acute, margin entire, slightly revolute, glabrous, 3–4-nerved on each side, lateral nerves not distinct when dried; petiole 0.4–2.5 cm long, sparsely pubescent. *Cymes* 1–4, 1-flowered; peduncle 1.5–2 cm long, together with pedicel pubescent; 1-bracteate, lanceolate-linear, 1.5–2 mm long, margin entire, pubescent on each side; pedicel 1–4 cm long. *Sepals* 5, lanceolate to narrowly ovate, 3–4 mm long, 1–1.5 mm wide, pubescent outside, glabrous inside. *Corolla* light bluish-purple to pink, 1.2–2.1 cm long, pubescent outside, glabrous inside, tube infundibuliform, with undilated proximal part 0.8–0.9 cm long and dilated distal part 0.5–0.6 cm long, 1.5–1.7 cm in diameter at the orifice, 4–6 mm in diameter near the base; adaxial lip 4–5 mm long, 2-parted nearly to the base, abaxial lip 4–5 mm long, 3-parted nearly to the base, with lobes all orbicular-ovate. *Stamens* 2 (in anterior position), inserted at 5–7 mm from corolla tube base; filaments linear, slightly arcuate, 3–4 mm long; anthers elliptic, 1–1.5 mm long, finely pubescent (at 40×), coherent adaxially. *Staminodes* 3, glabrous, inserted at 4–6 mm from corolla tube base, lateral 2 c.2 mm long, median c.1 mm long. *Disc* annular, c.1 mm high. *Pistil* c.1.5 cm long; ovary ovoid-ellipsoid, c.2 mm long, c.1 mm in diameter, narrowly ovoid with style pubescent, style c.1.3 cm long. *Ovary* 1-loculed; placentae 2, parietal, intrusive, bifid. *Stigma* crateriform, c.2 mm in diameter. *Fruit* 5–6 mm long, narrowly ovoid, glabrous, dehiscing into 4 valves. *Seeds* reticulate with raised testa cell walls, 0.43 × 0.16 mm.

Distribution and habitat. As far as known endemic to Guizhou (Fig. 1). Found in the Maling gorge, Xingyi county, Guizhou province, China, growing on rocky slopes. Because of the wet limestone habitat, chalk grains cover the surface of the leaves.

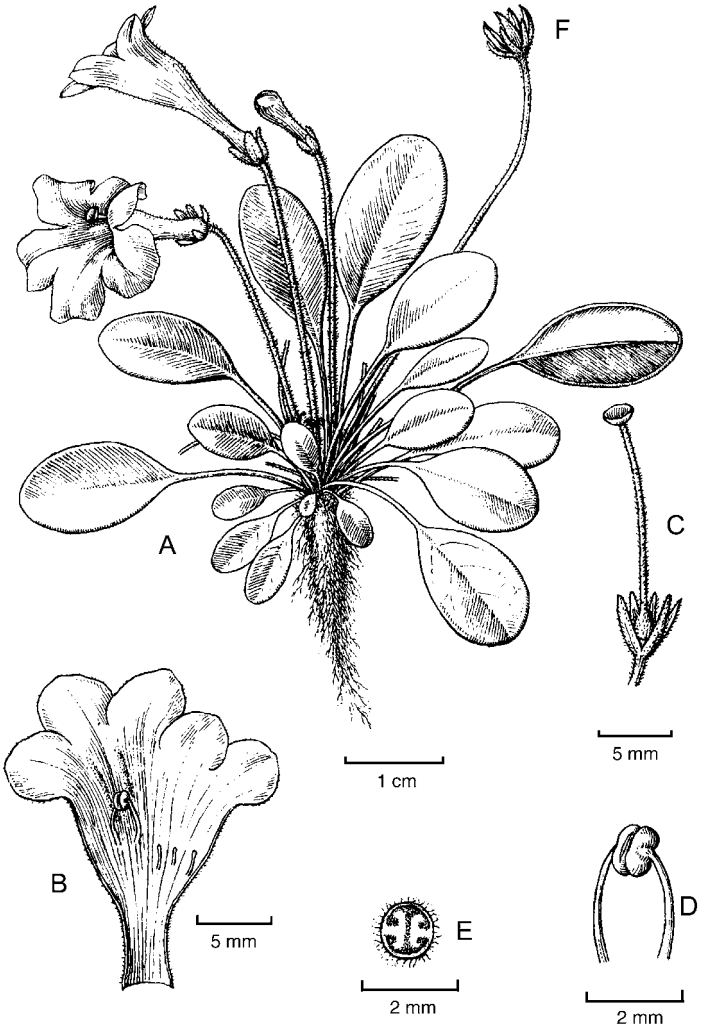

FIG. 4. *Litostigma coriaceifolium* Y.G.Wei, F.Wen & M.Möller. A, habit; B, corolla open with stamens and staminodes; C, stamens, calyx and pistil; D, capsule; E, ovary; F, capsule and calyx. Drawn by Shun-Qing He.

Etymology. The epithet is derived from the coriaceous leaf blades in living material.

Conservation assessment. In 2006, the species was collected for the first time. In 2007 this locality was destroyed by a landslide. In 2008, a new locality was found about 38 km distant from the first, with about 3000 plants.

Proposed IUCN status. Critically Endangered, CR B1ac(iii).

Litostigma crystallinum Y.M.Shui & W.H.Chen, **sp. nov. Figs 1, 3D, 5.**

Haec species *Litostigmati coriaceifolio* Y.G.Wei, F.Wen & M.Möller similis, sed foliis majoribus 4.5–6 cm longis (in illa minoribus 1–2.1 cm longis), sepalis 7 mm (nec 3–4 mm) longis, antheris dense pilosis (nec glabris) et stigmate disciformi (nec crateriformi) differt. – Type: China, Yunnan province, Malipo county, Tianbao village, 850 m, 4 v 2005, *Y.M. Shui, W.H. Chen & M.D. Zhang* 53856 (holo KUN!).

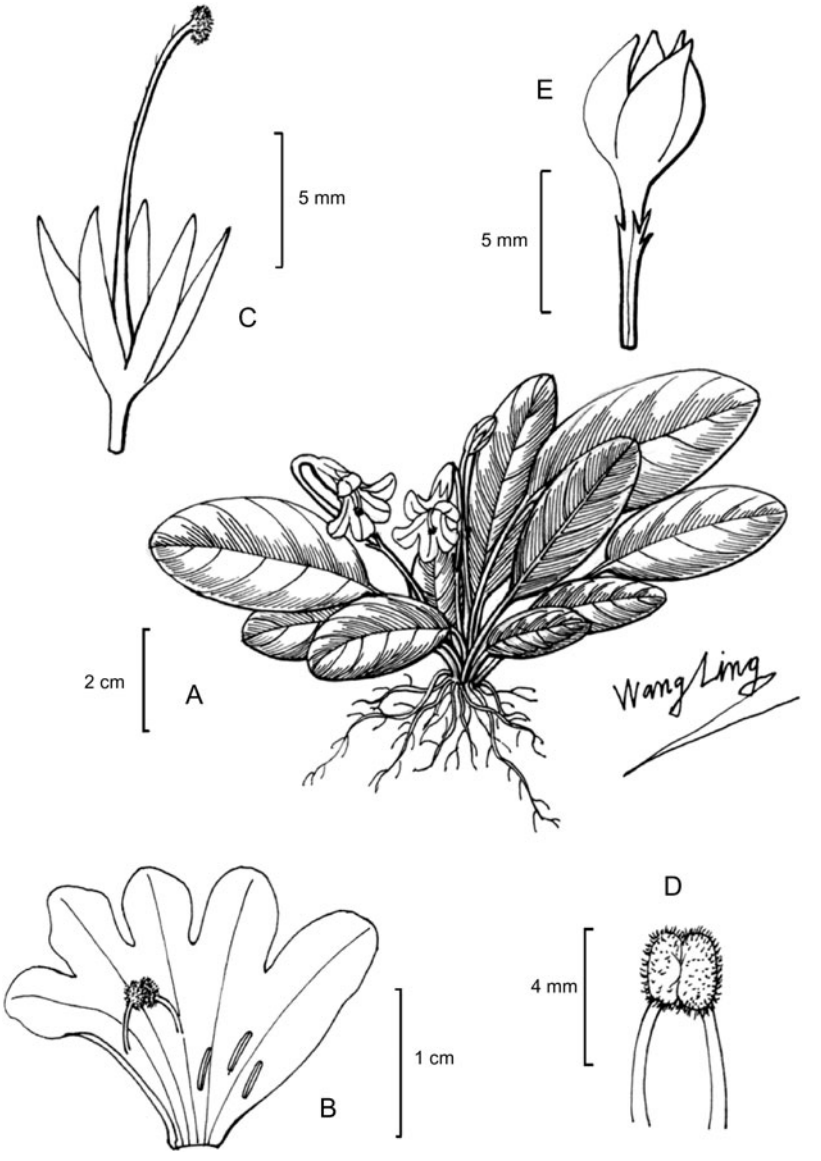

FIG. 5. *Litostigma crystallinum* Y.M.Shui & W.H.Chen. A, habit; B, corolla open with stamens and staminodes; C, calyx and pistil; D, stamens; E, capsule. Drawn by Wang Ling.

Perennial herb, stemless. *Rhizome* subterete, 3–5 mm long, 2–3 mm in diameter. *Leaves* 11–13, basal; leaf blade thickly papery, elliptic, 4.5–6 cm long, 3–4 cm wide, apex rounded, base broadly cuneiform, margin entire, slightly revolute, glabrous, green above, greyish green beneath; lateral nerves distinct, 5–6 on each side, concave above, convex beneath; petiole 4–11 cm long, glabrous. *Cymes* 1–2, 1-flowered; peduncle 3–9 cm long, pubescent; 2-bracteate, small, lanceolate, 3 × 0.8 mm; pedicel 2.5 cm long, pubescent. *Sepals* 5, lanceolate, c.0.7 × 0.2 cm, pubescent outside, glabrous inside. *Corolla* purple, infundibuliform, 1.5–1.7 mm long, slightly pubescent outside, glabrous inside; corolla tube 0.7–1 cm long with short proximal undilated part; adaxial lobes 2, rather oblong, 0.7 × 0.6 cm, abaxial lobes 3, oblong or obovate, 0.7 × 0.6 cm. *Stamens* 2 in anterior position, adnate to 3 mm above base of corolla tube; filaments linear, slightly erect, c.4 mm long; anthers elliptic, c.2 mm long, pilosous, coherent adaxially. *Staminodes* 2, 1–2.5 mm long, glabrous, adnate to c.2–3 mm above corolla base. *Disc* annular. *Pistil* c.1.2 mm long; ovary ovoid-ellipsoid, c.1.5 mm long, c.1 mm in diameter, 1-loculed with 2 parietal and intrusive placentae; style c.9.5 mm long, pubescent. *Stigma* disciform, c.0.5 mm in diameter. *Fruit* 4–5 mm long, narrowly ovoid, glabrous, dehiscing into 4 valves. *Seeds* ovoid, obliquely reticulate with raised testa cell walls, 0.3 × 0.1 mm.

Paratypes. CHINA. **Yunnan**: Malipo county, Tianbao village, 850 m, 19 ix 2002, dry fruit, *Y.M. Shui & D.G. Wang* 21814 (KUN); ibid., 1 ii 2005, *Y.M. Shui & W.H. Chen* 43865 (KUN).

Distribution and habitat. The new species is endemic to SE Yunnan, China (Fig. 1). It grows on a cliff at the entrance of a limestone cave at c.850 m elevation. Because of its close proximity to Vietnam, the species may occur there as well.

Etymology. The epithet *crystallinum* alludes to its habit (i.e. growing on crystalline limestone).

Conservation assessment. The species was first found in November 2002, growing on moist rock surfaces at the mouth of a limestone cave near a waterfall. The cave occupied an area of c.2.5 × 2 m. Only 18 mature individuals and about 180 juvenile plants were observed. In February 2005, only 16 mature and about 160 young plants were found. In 2008, the status of the population was 14 mature and 130 immature individuals, showing a slow but steady decline.

Proposed IUCN status. Critically Endangered, CR B1ab(v)+C2a(i)+D.

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