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Supplementary material

Evolution of *Geosiris* (Iridaceae): historical biogeography and plastid-genome evolution in a genus of non-photosynthetic tropical rainforest herbs disjunct across the Indian Ocean

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Table S1. Accessions used for phylogenetic analyses and divergence dating, including species name, voucher information (if available), and GenBank numbers for the used markers (*mat*K, *rpl*4, *rps*16, *rbc*L, *tnr*L–F)

All accessions except *Geosiris australiensis* were previously used in Goldblatt *et al*. (2008) and partly originate from Chase *et al*. (1995), Souza-Chies *et al*. (1997), and Reeves *et al*. (2001)

Name	Voucher information	*mat*k	*rpl*4	*rps*16	*rbc*L	*trn*L–F
Alophia veracruzana	Goldblatt & Howard 9070 (MO)	AJ579931	Z68231	AJ578764	AJ309678	AJ409592
Amaryllis belladonna	Ronsted 448 (C)					JX464334
Amaryllis belladonna	Steele 1103 (MO)	JQ276394	JQ274292		JQ273899	
Aristea glauca	Goldblatt 9500 (MO)	AJ579933		AJ578766	Z77282	AJ290285
Aristea platycaulis	S 69-1198 (P)		Z68232			
Babiana ecklonii	Goldblatt & Manning 9958 (MO)				AJ309673	AJ409586
Babiana stricta	S 94-578 (MNHN)		Z68234			
Bobartia gladiata	Goldblatt 9490 (MO)	AJ580604	Z68268	AJ578769	AJ309699	AJ409615
Calydorea mexicanum	Goldblatt 9579 (MO)	AJ580606	AJ409033	AJ578770	AJ309682	AJ409596
Chasmanthe aethiopica	Chase I-3 (K)		AJ409022		AJ309660	AJ409572
Cipura campanulata	Henrich 143 (MO)	AJ579939	AJ409032	AJ578772	AJ309681	AJ409595
Cobana guatemalensis	Rodriguez et al. 2831 (IBUG)	AM940208	AM940196	AM940173	AM940185	AM940160
Crocosmia sp.	034 (Porto Alegre)		Z68236			
Crocus nudiflorus	EB 66-2483bis (P)		Z68237			
Crocus pulchellus	Chase I-19 (K)				AJ309668	AJ409580
Cypella aquatilis	Castillo s.n. (MO)	AJ580610		AJ578775	AJ309683	AJ409597
Dietes robinsoniana	Pickard 3377 (MO)	AJ580614	Z68239		AJ309695	AJ409611
Dietes robinsoniana	Snijman & Manning 1194 (K)			AJ578778		
Diplarrena latifolia	Chase I-220 (K)	AJ579946	AJ409036	AJ578779	AJ309686	AJ409600
Doryanthes excelsa	Chase 188 (NCU)		AJ409053		Z73697	AJ290281
Eleutherine latifolia	Goldblatt 9072 (MO)		AJ409031	AJ578782	Z77283	AJ409591
Ennealophus euryandrus	Solomon 9972 (MO)	AJ579950	AJ409034	AJ578783	AJ309684	AJ409598
Ferraria crispa	Goldblatt & Manning 9732 (MO)	AJ579951	AJ409040	AJ578784	AJ309690	AJ409606
Freesia laxa	Chase I-1 (K)		AJ409021		Z73703	AJ409575

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Name	Voucher information	*mat*k	*rpl*4	*rps*16	*rbc*L	*trn*L–F
Geissorhiza rosea	Goldblatt & Manning 9668 (MO)		AJ409029		AJ309676	AJ409589
Gelasine elongata	Goldblatt 5925 (MO)	AJ580618	AJ409027	AJ578787	AJ309674	AJ409587
Geosiris aphylla	Prance 30781 (K)	AJ579955	AJ409045	AJ578788		AJ409616
Geosiris australiensis	Gray 9763, Hawkes and de Groot (CNS)	MH142524	MH142524	MH142524	MH142524	MH142524
Gladiolus communis	EB (P)		Z68241			
Gladiolus gueinzii	Goldblatt 9052 (MO)				Z77286	AJ409574
Herbertia pulchella	Goldblatt s.n. (MO)	AJ580620	AJ409042	AJ578790	AJ309692	AJ409608
Hesperantha pseudopilosa	Goldblatt & Manning 9677 (MO)		AJ409019		AJ309656	AJ409579
Hesperoxiphion peruvianum	Goldblatt s.n. (MO)	AJ579959	AJ409030	AJ578792	AJ309677	AJ409590
Iris dichotoma	Chase I-155 (K)	AJ579962	AJ409043	AJ578795	AJ309696	AJ409612
Isophysis tasmanica	Bruhl s.n. (TAS)	AJ579963	Z68243	AJ578796	Z77287	AJ290283
Ixia latifolia	Goldblatt & Manning 9594 (MO)		AJ409025		Z77288	AJ409581
Ixiolirion tataricum	Chase 489 (K)	AJ579965	AJ409051	AJ578798	Z73704	AJ290280
Klattia flava	Goldblatt B656 (MO)	AJ579966	AJ409047	AJ578799	AJ309667	AJ409617
Larentia mexicana	Ortiz-Catedral 212 (IBUG)	AM940210	AM940198	AM940175	AM940187	AM940162
Libertia formosa	Souza-Chies et al. 1997 (Chile)		Z68245			
Libertia ixioides	Chase I-218 (K)	AJ579968		AJ578801	AJ309687	AJ409601
Micranthus junceus	Chase I-156 (K)		AJ409018		AJ309662	AJ409570
Molineria capitulata	Steele 1081 (UMO)	HQ180860	HQ183071		HQ182423	
Molineria capitulata	Z.J.Liu 6075					JX290049
Moraea namaquamontana	Folken & Vonter 627 (PRE)	AJ579971		AJ578804	AJ309697	AJ409613
Nemastylis tenuis	Rodriguez 2636 (IBUG)	AM940213	AM940201	AM940178	AM940190	AM940165
Neomarica northiana	Solomon 6950 (MO)	AJ579972		AJ578805	AJ309679	AJ409593
Neomarica sp.	010 (Porto Alegre)		Z68247			
Nivenia corymbosa	Goldblatt B656 (MO)	AJ580621.3	Z68266	AJ578806	Z77289	AJ290287
Olsynium filifolium	Chase I-243 (K)	AJ579974	AJ409037	AJ578807	AJ309688	AJ409602
Orthrosanthus chimboracensis	Chase I-231 (K)	AJ579976	AJ409039	AJ578809		AJ409605
Orthrosanthus polystachyus	Goldblatt 9297 (MO)				L10249	
Patersonia fragilis	S 92-20 (P)		Z68248			

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Name	Voucher information	*mat*k	*rpl*4	*rps*16	*rbc*L	*trn*L–F
Patersonia glabrata	UNSW 21494 (UNSW)	AJ580623		AJ578810	AJ277879	AJ290284
Pillansia templemannii	Bean s.n. (MO)		Z68260		AJ309671	AJ409585
Radinosiphon leptostachya	Boussard s.n. (MO)		AJ409020		AJ309661	AJ409573
Romulea monadelpha	Goldblatt 6230 (MO)				AJ309659	AJ409576
Romulea revelieri	Moret 93-88 (P)		Z68261			
Savannosiphon euryphyllus	Bolnick s.n. (MO)				AJ309664	AJ409568
Schizorhiza neglecta	Goldblatt & Manning 9489 (MO)		Z68244		AJ309665	AJ409567
Sisyrinchium micranthum	Henrich s.n. (MO)	AJ579982		AJ578815	Z77290	AJ409603
Sisyrinchium striatum	Souza-Chies et al. 1997 (Chile)		Z68263			
Solenomelus pedunculatus	Chase I-222 (K)	AJ579983	AJ409038	AJ578816	AJ309689	AJ409604
Sparaxis sp.	EB (P)		Z68249			
Sparaxis variegata	Goldblatt 2460 (MO)				AJ309669	AJ409582
Syringodea bifucata	Davidson 3108 (MO)		AJ409026			AJ409584
Syringodea unifolia	Manning 2342 (NBG)	AM941386	AM941384		AM941383	
Thereianthus racemosus	Goldblatt 10454 (K)		AJ409017		AJ309663	AJ409569
Tigridia orthantha	Rodriguez 2836 (IBUG)	AM940217	AM940205	AM940182	AM940194	AM940169
Trimezia martinicensis	Berry 3802 (MO)	AJ579988		AJ578821	AJ309672	AJ409583
Trimezia steyermarkii	Goldblatt 1345 (MO)		Z68264			
Tritonia disticha	Goldblatt & Manning 9545 (MO)		AJ409028		AJ309675	AJ409588
Tritoniopsis unguicularis	Goldblatt 9486 (MO)		AJ409023		AJ309658	AJ409577
Watsonia angusta	Goldblatt 6904 (MO)		Z68265		AJ309666	AJ409566
Witsenia maura	Orchand 35 (MO)	AJ580627	AJ409046	AJ578825	AJ277880	AJ290286
Xeronema callistemon	Steele et al. 2012 (worldplants.com)	JQ276431	JQ274329		JQ273936	
Zephyra elegans	Chase 1575 (K)	AJ579994	AJ409052	AJ578827	Y17340	AJ290277

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Results of ancestral area estimation using BioGeoBEARS

Table S2. Results from BioGeoBEARS model comparison

Bold formatting represents the two best fitting biogeographic models. AICc, Akaike information criterion for small sample sizes; AICc_wt, Akaike information criterion weights for small sample sizes; d, dispersal; e, extinction; j, jump dispersal; DEC, dispersal–extinction–cladogenesis; LnL, log-likelihood

Model	LnL	Number of parameters	d	e	j	AICc	AICc_wt
DEC	–85.59	2	0.0077	0.0013	0	175.40	0.0238
DEC+J	**–81.50**	**3**	**0.0069**	**0**	**0.011**	**169.46**	**0.4646**
DIVALIKE	–84.62	2	0.0089	0.0011	0	173.48	0.0624
DIVALIKE+J	**–81.53**	**3**	**0.0078**	**0**	**0.0089**	**169.53**	**0.4492**

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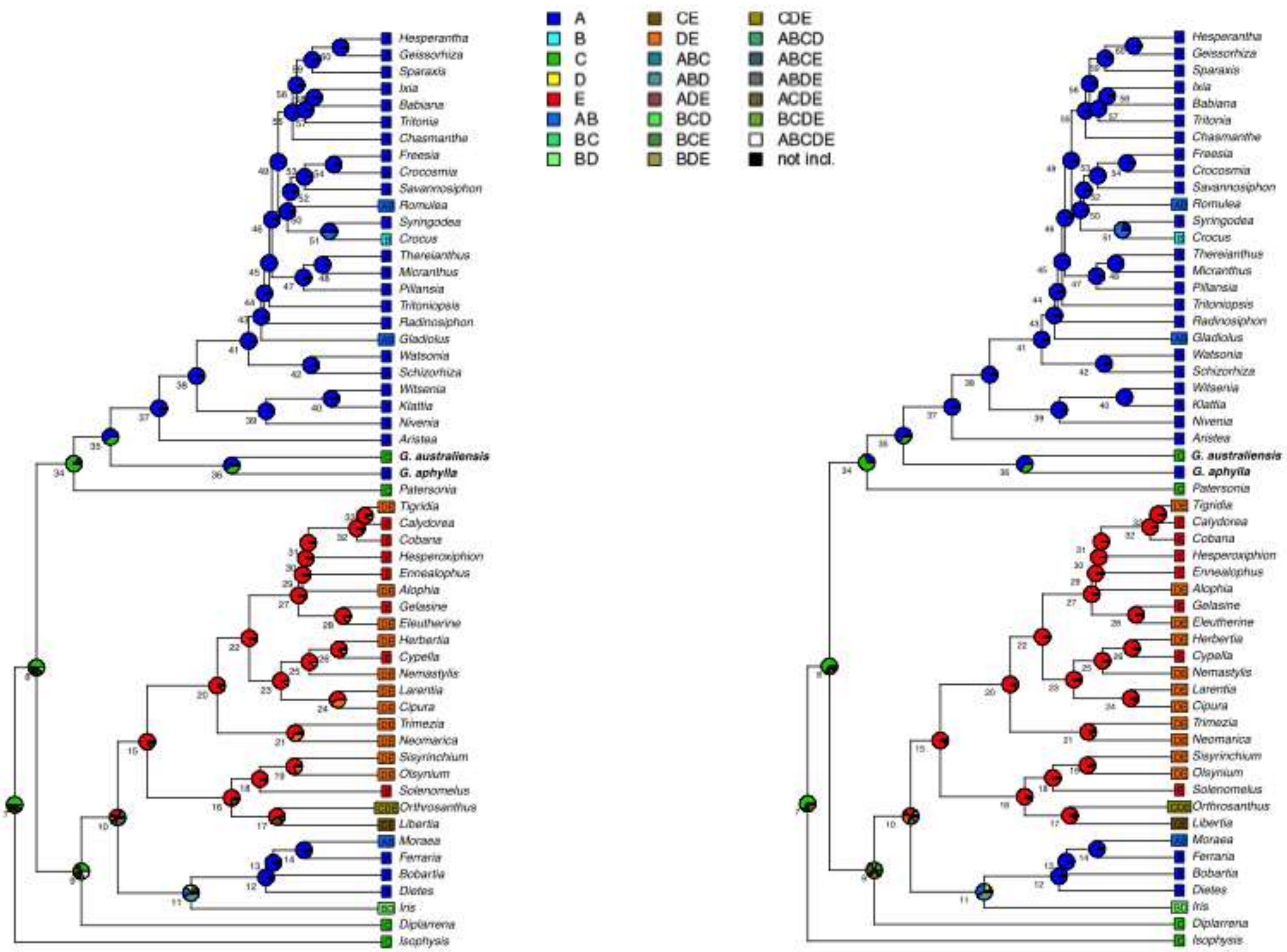

Fig. S1. Chronograms with ancestral area estimates for both models with the highest Akaike information criterion weights for small sample sizes (AICc). (*a*) Dispersal–extinction–cladogenesis with jump dispersal (DEC+J) and (*b*) Likelihood dispersal-vicariance analysis with jump dispersal DIVALIKE+J. Colours in legend apply to both reconstructions.

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Table S3. Probabilities of ancestral-range estimation using the dispersal–extinction–cladogenesis with jump dispersal (DEC+J) model

Node numbers refer to numbers shown in chronograms in Fig. S1

Node	A	B	C	D	E	AB	BC	BD	CE	DE	ABC	ABD	ADE	BCD	BCE	BDE	CDE	ABCD	ABCE	ABDE	ACDE	BCDE	ABCDE
7			**50**				3.3		8		3.2			2.9	1.7		5.6	4.9	3.1		8.2	3.3	5.8
8	0.1		**48.3**		0.1	0.2	3.1		8.5		2.5	0.4	0.7	2.2	1.2		4.9	4.6	2.7	0.8	7.2	3.6	8.9
9	0.1	0.2	**31.5**	0.1	0.5		6.2		17.1	0.1	1.3			1.7	0.8	0.1	7.2	3.2		0.1	3.8	7.3	18.5
10	4.9	8	4.1	3	23.8	1.4	1.4	0.7	1	10	0.5	1	1.2	0.1	2.9	7.4	1.1	0.2		**27.2**	0.2	0.2	
11	11.5	9.1		15.3		20.7		1.9				**41.4**											
12	**95.7**					4.3																	
13	**95.5**					4.5																	
14	**90.2**					9.7																	
15			1.1	1.1	**81.8**				10.2	5							0.9						
16			0.2	0.1	**77.4**				15.3	4.3							2.7						
17			2.4		**60**				26	5.1							6.5						
18				0.1	**95.1**					4.8													
19				1.9	**78.6**					19.6													
20				0.9	**90.1**					9.1													
21				3.4	**64**					32.5													
22				0.4	**96**					3.6													
23				0.8	**90.3**					8.8													
24				2.7	**56.1**					41.2													
25				1	**87.4**					11.6													
26				0.2	**86.8**					13													
27					**94.9**					5													
28					**84.2**					15.8													
29				0.1	**97**					2.9													
30					**100**																		
31					**99.9**					0.1													
32					**94.8**					5.2													
33					**89.4**					10.6													
34	14.8		**85.2**																				
35	**62**		38																				
36	**61.5**		38.5																				
37	**99.9**					0.1																	
38	**99.8**					0.2																	
39	**100**																						
40	**100**																						
41	**98.8**					1.2																	
42	**100**																						
43	**97.2**					2.8																	
44	**100**																						
45	**100**																						
46	**100**																						
47	**100**																						
48	**100**																						
49	**99.7**					0.3																	
50	**97.3**					2.6																	
51	**52.1**	0.8				47.2																	
52	**98.8**					1.1																	

Node	A	B	C	D	E	AB	BC	BD	CE	DE	ABC	ABD	ADE	BCD	BCE	BDE	CDE	ABCD	ABCE	ABDE	ACDE	BCDE	ABCDE
53	**100**																						
54	**100**																						
55	**100**																						
56	**100**																						
57	**100**																						
58	**100**																						
59	**100**																						
60	**100**																						

Table S4. Probabilities of ancestral-range estimation using the Likelihood dispersal-vicariance analysis with jump dispersal (DIVALIKE+J) model

Node numbers refer to numbers shown in chronograms in Fig. S1

Node	A	B	C	D	E	AB	BC	BD	CE	DE	ABC	ABD	ADE	BCD	BCE	BDE	CDE	ABCD	ABCE	ABDE	ACDE	BCDE	ABCDE
7			**66.7**				0.5		0.9		2.8	0.1	0.3	0.9			2.3	4		0.1	19.2	0.5	1.5
8	0.1	0.2	**65.4**		0.3	1.8	0.5	0.2	1.2	0.3	0.9	2.6	14	0.4		0.1	0.8	1.7		2.1	6.1	0.3	0.9
9	0.1	0.3	19.6		0.3	0.1	11.7	0.2	**27.8**	1.3	1.7	0.1	0.2	3.7		0.5	17.3	1.5		0.3	3.5	6.6	3.2
10	2.9	10.7	0.7	0.7	**26.4**	4.1	0.8	1	0.3	22.2	0.2	0.5	0.7		0.7	14.1	0.1		0.3	13.5		0.1	0.1
11	4.6	2.8		16.4		32.8		2.7				**40.6**											
12	**100**																						
13	**100**																						
14	**98**					1.9																	
15			0.5	0.2	**94.5**				2.8	1.8							0.1						
16			0.5	0.1	**92.9**				5.9	0.4							0.3						
17			6.4	0.1	**85.8**				4.9	1.5							1.4						
18				0.1	**97.5**					2.4													
19				3.2	**92.2**					4.6													
20				0.4	**93.8**					5.8													
21				6.4	**84.9**					8.7													
22					**99.7**					0.3													
23				0.3	**97.3**					2.4													
24				3.2	**89.9**					6.9													
25				0.3	**97.5**					2.2													
26				0.1	**97.7**					2.3													
27					**99.8**					0.2													
28					**96.9**					3.1													
29					**99.6**					0.3													
30					**100**																		
31					**100**																		
32					**100**																		
33					**99.3**					0.6													
34	28.1		**71.9**																				
35	**68.4**		31.6																				
36	**67.9**		32.1																				
37	**100**																						
38	**100**																						
39	**100**																						
40	**100**																						

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Node	A	B	C	D	E	AB	BC	BD	CE	DE	ABC	ABD	ADE	BCD	BCE	BDE	CDE	ABCD	ABCE	ABDE	ACDE	BCDE	ABCDE
41	**99.9**					0.1																	
42	**100**																						
43	**99.2**					0.8																	
44	**100**																						
45	**100**																						
46	**100**																						
47	**100**																						
48	**100**																						
49	**100**																						
50	**99.3**					0.7																	
51	22.8	0.3				**76.9**																	
52	**99.8**					0.2																	
53	**100**																						
54	**100**																						
55	**100**																						
56	**100**																						
57	**100**																						
58	**100**																						
59	**100**																						
60	**100**																						

Table S5. Difference from probabilities of ancestral-range estimation from dispersal–extinction–cladogenesis with jump dispersal (DEC+J) model to the estimates from the DIVALIKE + J model

Node numbers refer to numbers shown in chronograms in Fig. S1

Node	A	B	C	D	E	AB	BC	BD	CE	DE	ABC	ABD	ADE	BCD	BCE	BDE	CDE	ABCD	ABCE	ABDE	ACDE	BCDE	ABCDE
7			–16.7				2.8		7.1		0.4	–0.1	–0.3	2	1.7		3.3	0.9	3.1	–0.1	–11	2.8	4.3
8		–0.2	–17.1		–0.2	–1.6	2.6	–0.2	7.3	–0.3	1.6	–2.2	–13.3	1.8	1.2	–0.1	4.1	2.9	2.7	–1.3	1.1	3.3	8
9		–0.1	11.9	0.1	0.2	–0.1	–5.5	–0.2	–10.7	–1.2	–0.4	–0.1	–0.2	–2	0.8	–0.4	–10.1	1.7		–0.2	0.3	0.7	15.3
10	2	–2.7	3.4	2.3	–2.6	–2.7	0.6	–0.3	0.7	–12.2	0.3	0.5	0.5	0.1	2.2	–6.7	1	0.2	–0.3	13.7	0.2	0.1	–0.1
11	6.9	6.3		–1.1		–12.1		–0.8				0.8											
12	–4.3					4.3																	
13	–4.5					4.5																	
14	–7.8					7.8																	
15			0.6	0.9	–12.7				7.4	3.2							0.8						
16			–0.3		–15.5				9.4	3.9							2.4						
17			–4	–0.1	–25.8				21.1	3.6							5.1						
18					–2.4					2.4													
19				–1.3	–13.6					15													
20				0.5	–3.7					3.3													
21				–3	–20.9					23.8													
22				0.4	–3.7					3.3													
23				0.5	–7					6.4													
24				–0.5	–33.8					34.3													
25				0.7	–10.1					9.4													
26				0.1	–10.9					10.7													
27					–4.9					4.8													
28					–12.7					12.7													
29				0.1	–2.6					2.6													

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Node	A	B	C	D	E	AB	BC	BD	CE	DE	ABC	ABD	ADE	BCD	BCE	BDE	CDE	ABCD	ABCE	ABDE	ACDE	BCDE	ABCDE
30																							
31					–0.1					0.1													
32					–5.2					5.2													
33					–9.9					10													
34	–13.3		13.3																				
35	–6.4		6.4																				
36	–6.4		6.4																				
37	–0.1					0.1																	
38	–0.2					0.2																	
39																							
40																							
41	–1.1					1.1																	
42																							
43	–2					2																	
44																							
45																							
46																							
47																							
48																							
49	–0.3					0.3																	
50	–2					1.9																	
51	29.3	0.5				–29.7																	
52	–1					0.9																	
53																							
54																							
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60																							

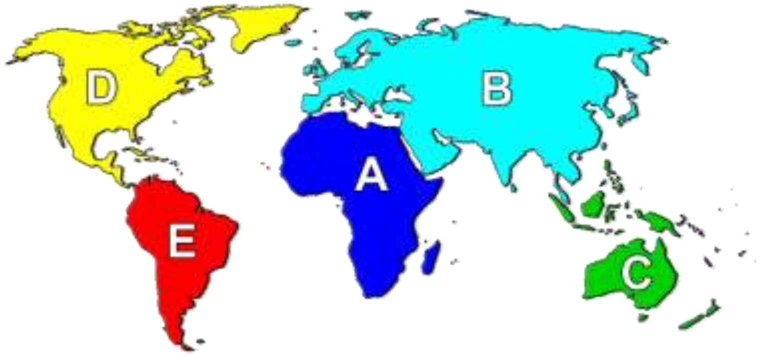

Fig. S2. Information about included and excluded areas in the biogeographic analysis. Areas: A, Africa; B, Eurasia; C, Australasia; D, North America; E, South America. Included area combinations: AB, BC, BD, CE, DE; ABC, ABD, ADE, BCD, BCE, BDE, CDE; and ABCD, ABCE, ABDE, ACDE, BCDE, ABCDE. Excluded are combinations (non-adjacent or not connected areas): AC, AD, AE, BE, CD; ABE, ACD, ACE. Australia and South America (CE) are considered as adjacent at they both have been connected through Antarctica in the Paleogene and before (Sher and Martin 2006; Scher *et al*. 2015). North America and Eurasia (BD) are considered as adjacent, as they connect at low sea levels through the Bering Strait.

Table S6. Summary of gene presence in selected taxa

Comparison of gene degradation in seven species of varying degrees of heterotrophy (+, intact; ψ, pseudogenised; –, absent). Gene function categories are as per the categorisation of Graham *et al*. (2017)

Gene function category	Gene	Taxon							
		Iris missouriensis	*Iris gatesii*	*Lilium longiflorum*	*Dendrobium candidum*	*Petrosavia stellaris*	*Geosiris aphylla*	*Geosiris australiensis*	*Thismia tentaculata*
NADH dehydrogenase genes									
	ndhA-1	+	+	+	+	+	ψ	ψ	–
	ndhA-2	+	+	+	+	+	ψ	–	–
	ndhB	+	+	+	+	+	ψ	ψ	–
	ndhC	+	+	+	–	+	–	–	–
	ndhD	+	+	+	+	+	ψ	ψ	–
	ndhE	+	+	+	+	+	ψ	ψ	–
	ndhF	+	+	+	+	+	–	–	–
	ndhG	+	+	+	+	+	ψ	+	–
	ndhH	+	+	+	+	+	ψ	ψ	–
	ndhI	+	+	+	–	–	–	–	–
	ndhJ	+	+	+	+	–	ψ	ψ	–
	ndhK	+	+	+	–	–	ψ	ψ	–
Main photosynthesis genes									
	ccsA	+	+	+	+	+	ψ	–	–
	cemA	+	+	+	+	–	–	–	–
	petA	+	+	+	+	–	–	–	–

Gene function category	Gene	*Iris missouriensis*	*Iris gatesii*	*Lilium longiflorum*	*Dendrobium candidum*	*Petrosavia stellaris*	*Geosiris aphylla*	*Geosiris australiensis*	*Thismia tentaculata*
	petB	+	+	+	+	+	ψ	ψ	–
	petD	+	+	+	+	+	ψ	ψ	–
	petG	+	+	+	+	+	ψ	–	–
	petL	+	+	+	+	–	–	–	–
	petN	+	+	+	+	–	–	–	–
	psaA	+	+	+	+	–	ψ	–	–
	psaB	+	+	+	+	+	–	–	–
	psaC	+	+	+	+	–	ψ	ψ	–
	psaI	+	+	+	+	–	ψ	+	–
	psaJ	+	+	+	+	–	–	–	–
	psbA	+	+	+	+	–	ψ	–	–
	psbB	+	–	+	+	–	ψ	–	–
	psbC	+	+	+	+	–	ψ	–	–
	psbD	+	+	+	+	–	ψ	–	–
	psbE	+	+	+	+	–	–	–	–
	psbF	+	+	+	+	–	–	–	–
	psbH	+	+	+	+	–	ψ	ψ	–
	psbI	+	+	+	+	+	–	ψ	–
	psbJ	+	+	+	+	–	–	–	–
	psbK	+	+	+	+	–	ψ	–	–
	psbL	+	+	+	+	–	–	–	–
	psbM	+	+	+	+	–	ψ	–	–
	psbN	+	+	+	+	–	ψ	ψ	–
	psbT	+	+	+	+	–	ψ	ψ	–
	IhbA	+	+	+	+	+	+	+	–
	rbcL	+	+	+	+	+	ψ	ψ	–
	ycf3-1	+	+	+	+	–	ψ	–	–
	ycf3-2	+	+	–	+	–	ψ	–	–
	ycf3-3	+	+	–	+	–	ψ	–	–
	ycf4	+	+	+	+	–	ψ	ψ	–
RNA polymerase (PEP) genes									
	rpoA	+	+	+	+	+	ψ	ψ	–
	rpoB	+	+	+	+	+	–	–	–
	rpoC1-1	+	+	+	+	+	ψ	–	–
	rpoC1-2	+	+	–	+	+	ψ	–	–
	rpoC2	+	+	+	+	+	ψ	–	–
ATP synthase genes									
	atpA	+	+	+	+	+	ψ	–	–
	atpB	+	+	+	+	+	ψ	ψ	–
	atpE	+	+	+	+	+	ψ	ψ	–
	atpF	+	+	+	+	+	ψ	–	–
	atpH	+	+	+	+	+	–	+	–
	atpI	+	+	+	+	+	–	–	–
Genes for plastid genetic apparatus and with other functions									
	accD	+	+	+	+	+	+	ψ	+
	clpP	+	+	+	+	+	+	+	–
	infA	+	+	+	+	+	+	+	–

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Gene function category	Gene	Taxon							
		Iris missouriensis	*Iris gatesii*	*Lilium longiflorum*	*Dendrobium candidum*	*Petrosavia stellaris*	*Geosiris aphylla*	*Geosiris australiensis*	*Thismia tentaculata*
	matK	+	+	+	+	+	+	+	–
	rpl14	+	+	+	+	+	+	+	–
	rpl16	+	+	+	+	+	+	+	–
	rpl2	+	+	+	+	+	+	+	+
	rpl20	+	+	+	+	+	+	+	–
	rpl22	+	+	+	+	+	+	+	–
	rpl23	+	+	+	+	+	+	+	–
	rpl32	+	+	+	+	+	+	ψ	–
	rpl33	+	+	+	+	+	+	+	–
	rpl36	+	+	+	+	+	+	+	–
	rps11	+	+	+	+	+	+	+	–
	rps12	+	+	+	+	+	+	+	+
	rps14	+	+	+	+	+	+	+	–
	rps15	+	+	+	+	+	+	+	–
	rps16	+	+	+	+	+	+	+	–
	rps18	+	+	+	+	+	+	+	+
	rps19	+	+	+	+	+	+	+	–
	rps2	+	+	+	+	+	+	+	+
	rps3	+	+	+	+	+	+	+	–
	rps4	+	+	+	+	+	+	+	+
	rps7	+	+	+	+	+	+	+	–
	rps8	+	+	+	+	+	+	+	+
	rrn16	+	+	+	+	+	+	+	+
	rrn23	+	+	+	+	+	+	+	+
	rrn4.5	+	+	+	+	+	+	+	–
	rrn5	+	+	+	+	+	+	+	+
	trnA-UGC	+	+	+	+	+	+	+	–
	trnC-GCA	+	+	+	+	+	+	+	–
	trnD-GUC	+	+	+	+	+	+	+	–
	trnE-UUC	+	+	+	+	+	+	+	+
	trnF-GAA	+	+	+	+	+	+	+	–
	trnfM-CAU	+	+	+	+	+	+	+	+
	trnG-GCC	+	–	–	+	+	+	+	–
	trnG-UCC	+	+	+	+	+	+	–	–
	trnH-GUG	+	+	+	+	+	+	+	–
	trnI-CAU	+	+	+	+	+	+	+	–
	trnI-GAU	+	+	+	+	+	+	+	–
	trnK-UUU	+	+	+	+	+	+	+	–
	trnL-CAA	+	+	+	+	+	+	+	–
	trnL-UAA	+	+	+	+	+	+	+	–
	trnL-UAG	+	+	+	+	+	+	+	–
	trnM-CAU	+	+	+	+	+	+	+	–
	trnN-GUU	+	+	+	+	+	+	+	–
	trnP-UGG	+	+	+	+	+	+	+	–
	trnQ-UUG	+	+	+	+	+	+	+	–
	trnR-ACG	+	+	+	+	+	+	+	–
	trnR-UCU	+	+	+	+	+	+	+	–

Gene function category	Gene	*Iris missouriensis*	*Iris gatesii*	*Lilium longiflorum*	*Dendrobium candidum*	*Petrosavia stellaris*	*Geosiris aphylla*	*Geosiris australiensis*	*Thismia tentaculata*
	trnS-GCU	+	+	+	+	+	+	ψ	–
	trnS-GGA	+	+	+	+	+	+	+	–
	trnS-UGA	+	+	+	+	+	+	+	–
	trnT-GGU	+	+	+	+	–	+	+	–
	trnT-UGU	+	+	+	+	+	+	+	–
	trnV-GAC	+	+	+	+	+	+	+	–
	trnV-UAC	+	+	+	+	+	+	+	–
	trnW-CCA	+	+	+	+	+	+	+	–
	trnY-GUA	+	+	+	+	+	+	+	–
	ycf1	+	+	+	+	+	+	ψ	–
	ycf2	+	+	+	+	+	+	+	–

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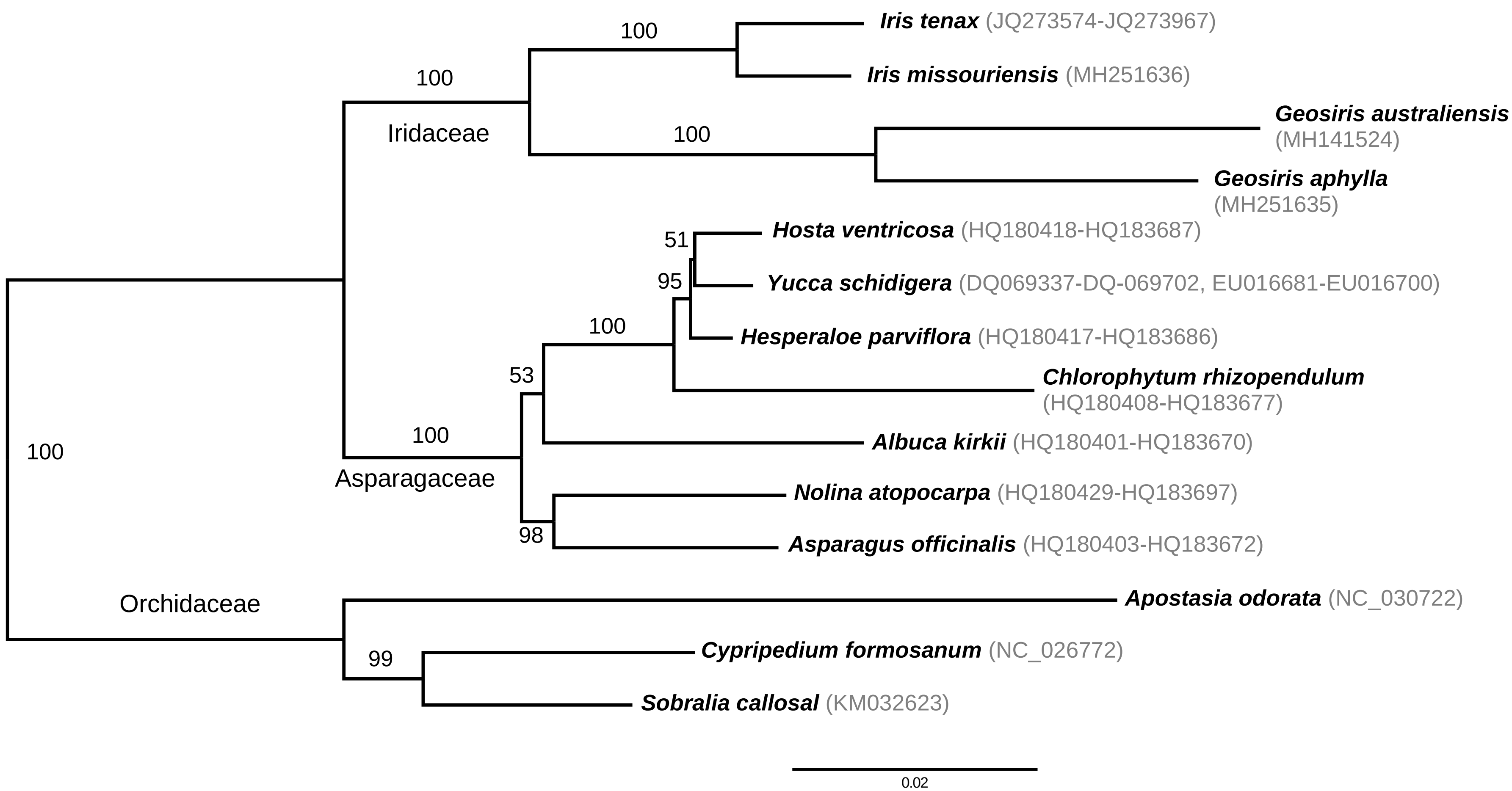

Fig. S3. Reference maximum-likelihood tree for branch tests generated from the 27 retained protein-coding genes in *Geosiris australiensis*.

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Results of divergence dating analysis using BEAST

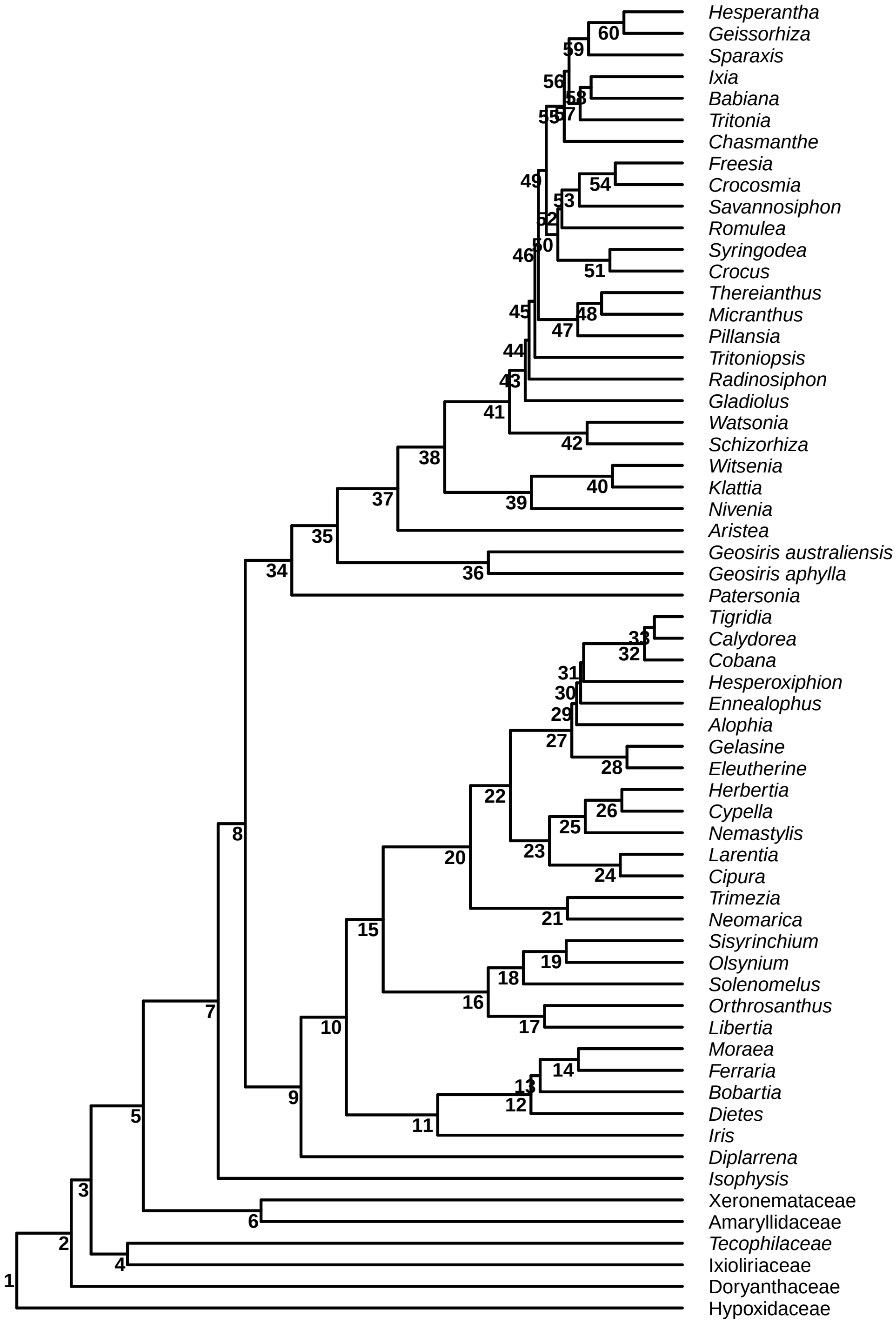

Fig. S4. Chronogram with node numbers that refer to Table S7 containing node ages and clade support.

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Table S7. Results of divergence-dating analysis using BEAST, displaying clade support with posterior probability values (PP), age estimates as common ancestor heights, and 95% highest probability distribution (HPD) interval of age estimates

Node numbers refer to Fig. S4

Node	PP	Age	95% HPD	Node	PP	Age	95% HPD
1	1	102.65	92.29–112.82	31	0.24	14.65	9.26–21.26
2	1	94.23	83.32–104.89	32	1	5.86	2.54–9.88
3	0.85	90.9	80.92–100.72	33	1	4.32	1.38–7.74
4	1	85.57	75.96–95.74	34	1	60.23	48.97–72.02
5	1	83.14	73.43–92.99	35	1	53.21	42.24–64.48
6	1	64.99	38.99–85.53	36	1	29.92	16.11–43.89
7	1	71.6	60.62–82.91	37	1	43.87	32.91–54.03
8	1	67.42	56.42–78.55	38	1	36.66	27.55–46.54
9	1	58.81	47.1–70.22	39	1	23.29	13.56–33.48
10	1	51.82	40.36–63.11	40	1	10.77	4.31–18.43
11	1	37.73	23.34–50.68	41	1	26.67	19.66–34.57
12	1	23.36	13.52–34.38	42	0.99	14.69	6.32–23.5
13	0.53	20.58	11.16–30.69	43	0.95	24.17	17.65–31.39
14	1	16.05	7.62–25.41	44	0.43	23.03	16.52–29.42
15	1	46.15	35.43–57.28	45	0.46	22.13	15.98–28.94
16	1	29.94	20.4–39.93	46	0.4	21.86	16.09–28.25
17	1	21.26	9.45–32.6	47	1	16.14	8.93–23.22
18	1	24.53	15.46–34	48	1	12.46	5.92–19.32
19	1	17.91	8.63–26.22	49	0.77	20.57	14.97–26.66
20	1	32.71	22.87–42.22	50	0.61	18.05	11.54–24.25
21	1	17.73	7.95–28.71	51	0.98	11.15	4.42–18.62
22	1	26.54	18.43–35.39	52	0.31	17.04	10.43–23.81
23	1	20.49	13.36–28.4	53	0.65	14.7	7.68–21.22
24	1	9.58	3.46–16.49	54	0.73	8.36	1.81–15.44
25	1	15	8.49–22.02	55	0.92	18.13	12.69–24.09
26	1	9.34	4.02–15.53	56	0.43	16.83	11.77–22.61
27	1	17.07	10.67–23.98	57	0.55	13.95	8.22–19.35
28	1	8.55	3.39–14.07	58	0.53	10.93	5.6–16.3
29	0.53	15.65	9.84–22.44	59	0.92	14.32	9.44–19.88
30	0.31	14.82	9.08–21.85	60	1	9.03	4.73–13.58

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