Supplementary document I. Codes of gene bank DNA sequences used in this study.

Species	DYNLL	CMOS	ND2	PDC	RAG1
Aprasia aurita		AY134536	NC_035150		
Aprasia inaurita		FJ571646	AY134574		FJ571632
Aprasia parapulchella		AY134539	KJ004564	HQ426172	GU459539
Aprasia picturata		AY134540	AY134576		
Aprasia pseudopulchella		AY134541	AY134577		
Aprasia pulchella		AY134542	AY134578		
Aprasia repens	KR697862	AY134543	AY134579		KR697784
Aprasia rostrata		AY134537	AY134573		
Aprasia smithi		AY134544	AY134580		
Aprasia striolata		AY134545	AY134581		
Carphodactylus laevis		EF534905	AY369017	GU459744	
Delma australis	KR697863	KR697824	KP851417		KR697785
Delma borea	KR697865	KR697827	KT803491		KR697787
Delma butleri	KR697867	KP851210	AY134584	GU459740	KR697789
Delma concinna	KR697870	KR697829			KR697791
Delma desmosa	KR697872	KR697830	KT803492		KR697793
Delma elegans	KR697874	KR697833	KT803494		KR697794
Delma fraseri	KR697876	KR697834	KT803496		KR697797
Delma grayii	KR697878	KR697836	KT803550		KR697798
Delma haroldi	KR697869	KR697828	AY13485		KR697790
Delma hebesa	KR697880	KR697838	KP851414		KR697786
Delma impar	KR697882	KR697840	KT803562		KR697800
Delma inornata	KR697884	KR697842	KT803564		KR697802
Delma labialis	KR697886	KR697845	KT803565		KR697805
Delma mitella	KR697888	KR697846			KR697806
Delma molleri	KR697889	KR697847	KT803567		KR697807
Delma nasuta	KR697891	KR697849	KT803568		KR697809
Delma pax	KR697894	KR697851	KT803570		KR697811
Delma petersoni	KR697896	KR697853	KT803572		KR697813
Delma plebeia	KR697897	KR697855	KT803574		KR697815
Delma tealei	KR697900	KR697858	KT803577		KR697817
Delma tincta	KR697903	KR697859	KT803579	HQ426188	KR697819
Delma torquata	KR697905	KP851226	MN999500		KR697822
Pletholax gracilis	KR697909	AY134566	JX041418	HQ426227	HQ426315
Diplodactylus barraganae			FJ665515		
Lialis burtonis	KR697906	EF534906	AY134599	GU459742	GU457991
Lialis jicari		AY134564	AY134600		AY662628
Aristelliger lar		EF534931	MN694931	EF534847	EF534805
Eublepharis macularius		EU366458	NC033383	EF534816	GU457987
Euleptes europea		KC191042	JN393941	EF534848	EF534806
Naultinus gemmeus		JQ945592		GU459560	GU459358
Sphaerodactylus nicholsi		MN415319	MN415701	HQ426240	MN415897
Sphaerodactylus torrei		EF534913	KU158022	EF534829	EF534788
Ramphotyphlops braminus		AY099980	NC010196	HQ426256	
Lucasium alboguttatum			JQ517747		
Naultinus elegans			GU459757	GU459556	GU459354
Oedodera marmorata		JQ945594	KU158073	KU157837	KU157988
Oedura castelnaui			JQ173633	JQ173679	JQ173727
Ophidiocephalus taeniatus	KR697907	FJ571645	KU158027	KU157750	HQ426303

Supplementary document I continued

Species	DYNLL	CMOS	ND2	PDC	RAG1
Orraya occultus			JX041389	JQ945388	JQ945320
Paradelma orientalis	KR697908	FJ571642	MN999513	HQ426215	HQ426304
Pygopus lepidopodus	KR697910	FJ571643	AY134603	KU680104	HQ426319
Pygopus nigriceps	FJ571644	EF534907	JX440518	KU157749	FJ571628
Pygopus robertsi			MN999531		
Pygopus schraderi			FJ403393		FJ571629
Pygopus steelescotti			MN999532		
Python molurus		GQ225667	NC015812		
Saltuarius cornutus			JF807328		
Sphaerodactylus glaucus		HQ426579	JX041437	HQ426237	HQ426325
Strophurus assimilis			KU680174		KU679968
Teratoscincus scincus		KC191039	MT977329		
Underwoodisaurus milii		EF534904	JF807369	GU459756	MT977248

Supplementary document II. Ecological characterization of pygopodid species.

Species	Habits	Habitat and observations
Aprasia aurita	Fossorial	Sandy and loamy soils, sheltering under leaf litter, rotting logs and mallee roots
Aprasia clairae	Fossorial	Sandy soil in coastal dunes, sheltering beneath limestone slabs
Aprasia fusca	Fossorial	Sandy soil in coastal dunes, sheltering under leaf litter, at the bases of shrubs and tree stumps
Aprasia haroldi	Fossorial	Sandy soil in coastal dunes
Aprasia inaurita	Fossorial	Sandy soil sheltering beneath tree stumps or surface debris
Aprasia litorea	Fossorial	Sandy soil in coastal hillocks, sheltering under logs and leaf litter
Aprasia parapulchella	Fossorial	Soil, sheltering in ant tunnels and under rocks
Aprasia picturata	Fossorial	Sandy loam
Aprasia pseudopulchella	Fossorial	Stony and clay soils, sheltering under rocks and tree stumps
Aprasia pulchella	Fossorial	Granite and lateritic soils, sheltering under rocks
Aprasia repens	Fossorial	Loose sands and soils
Aprasia rostrata	Fossorial	Sandy soil in coastal dunes
Aprasia smithi	Fossorial	Sandy loams and yellow sands, sheltering under leaf litter and other cover
Aprasia striolata	Fossorial	Sandy and loamy soils
Aprasia wicherina	Fossorial	Deep sands in plains
Delma australis	Ground	Spinifex and leaf litter in mallee and grasslands, sheltering beneath leaf litter and spinifex
Delma borea	Ground	Spinifex grasslands, sheltering in leaf litter, dense grass and other cover
Delma butleri	Ground	Spinifex grasslands, sheltering in grasses
Delma concinna	Shrub	Inside hummock grass clumps in sandy plains and coastal heaths
Delma desmosa	Ground	Spinifex deserts
Delma elegans	Ground	Stony hillsides sheltering in spinifex
Delma fraseri	Ground	Coastal sands and heaths, sheltering in spinifex tussocks
Delma grayii	Ground	Low *Banksia*, heath and low shrub
Delma haroldi	Ground	Spinifex and shrublands
Delma hebesa	Ground	Scrub, mallee heath along coastal sandy plains, sheltering under rocks, roots and logs
Delma impar	Ground	Grassy plains and woodlands, sheltering beneath loose rocks, in soil cracks and grass tussocks
Delma inornata	Shrub	Grasslands and open woodlands with grasses
Delma labialis	Ground	Understoreys of low vegetation, grasses and leaf litter in open forests, sheltering under objects incl. artificial debris
Delma mitella	Ground	Open forest and forest margins, sheltering in tussock of grass and other thick ground cover
Delma molleri	Ground	Grasslands and shrublands, sheltering under flat stones, timber and rubbish
Delma nasuta	Shrub	Sandy and rocky deserts, sheltering in small shrubs and spinifex
Delma pax	Ground	Spinifex grassland, sheltering beneath leaf litter and dead vegetation
Delma petersoni	Ground	Coastal sands and heath, sheltering in spinifex tussocks
Delma plebeia	Ground	Grasslands and open forests with grassy understorey
Delma tealei	Ground	Grasslands and coastal stony hills, sheltering under limestones and hummock grass
Delma tincta	Ground	Spinifex deserts, rocky outcrops, coastal forests, sheltering in grass, under rocks and debris; occasionally burrowing in soil
Delma torquata	Ground	Brigalow acacia and open woodlands with an understorey of grass and shrubs, sheltering beneath rocks, logs and leaf litter
Lialis burtonis	Ground	Wide variety of habitats, active on the surface
Lialis jicari	Ground	Wetter grasslands and savannas, sheltering in ground vegetation
Ophidiocephalus taeniatus	Fossorial	Sandy loams in arid shrublands, sheltering in leaf litter and deep cracks
Paradelma orientalis	Ground	Sandy soils in stone ridges, brigalow acacia and woodlands, sheltering beneath sandstone slabs, stones, leaf litter and in grassy tussocks
Pletholax edelensis	Shrub	Sandy soil in banksia and coastal heath, basking on dense and low vegetation
Pletholax gracilis	Shrub	Sandy soil in banksia and coastal heath, basking on dense and low vegetation
Pygopus lepidopodus	Ground	Mallee, heaths, woodlands and dunes, sheltering beneath low or/and dense vegetation
Pygopus nigriceps	Ground	Sandy deserts, heaths, dunes, woodlands and mallee, sheltering in soil cracks and under debris
Pygopus robertsi	Ground	Sandy soils in woodlands and heaths
Pygopus schraderi	Ground	Stony plains, mallee, scrublands, woodlands and spinifex deserts, sheltering in soil cracks and under debris
Pygopus steelescotti	Ground	Tropical woodlands, sheltering under debris

Supplementary document III. Kluge (1974) defined the linear morphometric variables used in this study as:

SVL: distance between the anterior extreme of the snout and the posterior margin of the middle preanal scale.Head length: distance between the anterior extreme of the snout of the rear extreme of the mouth.
Snout length: horizontal distance between the anterior extreme of the snout and the anterior margin of the ocular orbit.
Eye width: horizontal distance between the anterior and posterior extremes of the cornea, and excluding the ocular scale ring.
Postorbital length: distance between the rear extreme of the ocular orbit and the rear angle of the mouth.
Head width: across long body axis distance between the widest extremes of head.
Head depth: vertical distance between the dorsal side of the head and the ventral side of the throat at level of the mouth.
Rostral width: horizontal distance between the widest extremes of the rostral scale.
Tail length: horizontal distance between the posterior extreme of the middle preanal scale and the tip of the tail.

Kluge (1974) also used several meristic traits. One of them, the number of hindlimb scales along the ventralmost margin of the limb excluding those overlapping with the body scalation, was also used in the analysis.

I used data from all the species examined by Kluge with the exception of *Delma torquata* for which the only specimen with an unbroken tail had an extremely short tail length, thus indicating its being regenerated. The only specimen of *Ophidiocephalus taeniatus* examined by Kluge (1974) had a broken tail. Used here were published morphometric data on this species (McDonald & Fyfe 2008) to build an ordinary least squares regression and predict the tail length of this specimen. Although in this study authors indicated whether lizards had regenerated tails or not, close examinations of the bivariate relationships SVL/tail length revealed anomalous individuals. This suggests that they failed to truly distinguish between unbroken and regenerated tails. For this reason, I combined visual inspection of the bivariate plot and Cook's distance to delete outliers and perform OLS regression with the remaining data (R^2 = 0.553, P = 0.003) and estimated the complete tail length using the following equation:

$$(1.477 \pm 0.400)SVL + (74.464 \pm 37.944) = \text{Tail length}$$

Morphometric data used in morphologic analysis.

Species	SVL	Head length	Snout length	Eye width	Postorbital length	Head width
Aprasia aurita	91.7	3.6	1.9	0.7	0.8	3.0
Aprasia inaurita	105.0	3.6	1.8	0.8	0.7	2.8
Aprasia parapulchella	107.0	3.4	1.5	0.8	0.8	2.9
Aprasia pseudopulchella	115.4	3.6	1.6	0.8	0.8	3.0
Aprasia striolata	91.4	3.4	1.8	0.8	0.8	2.7
Aprasia pulchella	83.5	3.5	1.5	0.8	0.9	2.6
Aprasia repens	87.0	3.2	1.6	0.7	0.7	2.5
Aprasia smithi	101.0	4.2	2.2	0.9	0.8	3.2
Paradelma orientalis	167.5	8.4	4.2	1.9	1.9	7.6
Pygopus lepidopodus	172.4	11.1	5.9	1.9	2.8	8.8
Pygopus nigriceps	136.2	8.8	4.8	1.8	2.4	7.8
Ophidiocephalus taeniatus	102.0	5.6	3.4	0.7	1.5	4.3
Pletholax gracilis	67.3	5.0	2.7	0.8	1.3	3.0
Delma australis	59.6	4.7	2.2	1.1	1.2	4.3
Delma borea	59.9	6.4	2.7	1.2	1.8	4.3
Delma pax	73.2	6.4	3.1	1.3	2.0	4.8
Delma tincta	61.0	5.3	2.6	1.0	1.5	4.0
Delma elegans	86.2	7.6	3.8	1.5	1.9	5.8
Delma impar	71.4	6.4	3.1	1.2	2.1	4.9
Delma molleri	77.1	6.7	3.3	1.3	2.0	5.3
Delma plebeia	84.5	7.3	3.7	1.3	2.2	5.4
Delma fraseri	87.1	8.3	4.1	1.5	2.5	6.3
Delma grayii	83.0	7.8	3.7	1.3	2.0	5.5
Delma inornata	90.7	7.6	3.7	1.4	2.2	5.8
Delma nasuta	73.6	8.1	3.8	1.5	2.1	5.1
Delma concinna	74.3	8.4	4.5	1.2	1.9	5.3
Lialis burtonis	182.5	16.9	9.0	1.8	5.6	8.3
Lialis jicari	212.5	17.3	10.3	2.1	4.4	6.3

Supplementary document III continued

Species	Head depth	Rostral width	Trunk length	Tail length	Number of hindlimb scales
Aprasia aurita	2.3	1.2	88.1	54.6	1.0
Aprasia inaurita	2.2	1.0	101.4	60.1	1.5
Aprasia parapulchella	2.4	0.9	103.5	68.9	1.5
Aprasia pseudopulchella	2.2	0.6	111.8	72.5	1.0
Aprasia striolata	2.1	0.9	87.9	51.0	1.1
Aprasia pulchella	2.0	0.9	80.0	52.6	1.5
Aprasia repens	1.8	0.9	83.8	46.6	1.0
Aprasia smithi	2.6	1.2	96.7	66.0	1.0
Paradelma orientalis	5.6	2.8	159.0	221.8	2.5
Pygopus lepidopodus	7.2	3.8	161.2	341.3	7.0
Pygopus nigriceps	5.9	3.4	127.3	164.2	5.0
Ophidiocephalus taeniatus	3.3	2.3	96.4	225.0	3.0
Pletholax gracilis	2.5	1.5	62.3	192.7	2.5
Delma australis	3.0	1.6	54.9	100.2	3.5
Delma borea	3.3	1.8	53.4	180.1	2.5
Delma pax	4.0	2.1	66.8	181.9	3.5
Delma tincta	3.2	1.7	55.7	178.2	2.5
Delma elegans	4.2	2.1	78.6	323.8	4.0
Delma impar	4.2	2.3	65.0	126.7	3.0
Delma molleri	3.9	2.4	70.4	173.0	3.5
Delma plebeia	4.2	2.4	77.2	190.4	3.0
Delma fraseri	4.6	2.4	78.7	253.0	3.5
Delma grayii	4.5	2.4	75.2	266.3	5.0
Delma inornata	4.7	2.5	83.1	216.5	4.0
Delma nasuta	4.2	2.0	65.5	228.8	4.0
Delma concinna	4.5	1.8	65.9	319.4	5.0
Lialis burtonis	6.4	2.3	165.5	198.4	1.5
Lialis jicari	6.3	2.0	195.2	296.0	2.0

Estimated slopes and intercepts of OLS regression of head length against the nine morphologic variables.

Variable	Slope ± SE	T	P	Intercept ± SE	R^2
Snout length	1.074 ± 0.033	32.429	<0.0001	-0.359 ± 0.027	0.975
Eye width	0.666 ± 0.060	10.944	<0.0001	-0.457 ± 0.049	0.821
Postorbital length	1.121 ± 0.054	20.749	<0.0001	-0.674 ± 0.044	0.943
Head width	0.746 ± 0.063	11.727	<0.0001	0.066 ± 0.051	0.841
Head depth	0.803 ± 0.052	15.406	<0.0001	-0.081 ± 0.042	0.901
Rostral width	0.695 ± 0.102	6.778	<0.0001	-0.095 ± 0.055	0.638
Trunk length	1.184 ± 0.149	7.907	<0.0001	1.223 ± 0.122	0.706
Tail length	0.312 ± 0.135	2.309	0.0295	1.694 ± 0.110	0.169
Hindlimb scales number	0.732 ± 0.197	3.704	0.0010	-0.187 ± 0.161	0.345

Supplementary document IV. Results of the test for phylogenetic signal on morphological variables.

Variable	K	P	Lambda	P
SVL	2.310	0.0010	1.095	<0.00001
Head length	2.750	0.0010	1.117	<0.00001
Snout length	2.873	0.0010	1.116	<0.00001
Eye width	1.746	0.0010	1.109	<0.00001
Postorbital length	2.544	0.0010	1.106	<0.00001
Head width	1.771	0.0010	1.116	<0.00001
Head depth	1.898	0.0010	1.107	<0.00001
Rostral width	1.706	0.0010	1.076	<0.00001
Trunk length	1.289	0.0010	1.094	<0.00001
Number of hindlimb scales	1.350	0.0010	1.070	0.00001
Tail length	1.400	0.0010	1.117	<0.00001
Size-free 1st PC	2.068	0.0010	0.997	<0.00001
Size-free 2nd PC	1.104	0.0010	0.989	0.0005
Mean annual temperature	0.690	0.0100	0.849	0.0106
Annual accumulated precipitation	0.619	0.0430	0.001	1.0000

Supplementary document V. Corrected Akaiké values of the examined models of morphological evolution for body size and shape, and climate. Models with the largest weight are marked in bold and for comparison the second in order of importance, in italics. Early-burst models of SVL evolution have a rate of -0.209, Delta models of shape evolution have an estimated parameter value of 0.126, and in the case of bioclimatic variables, the Kappa model for mean annual temperature has an estimated parameter of 0.138. Models evaluated were: BM – Brownian motion; OU – Ornstein-Uhlenbeck; EB – early-burst; Lamba; Kappa; Delta; MTrend – mean trend; RTrend – rate trend; Wnoise – white noise.

Variable	BM	OU	EB	Lambda	Kappa	Delta	MTrend	RTrend	WNoise	Weight
SVL	262.9	265.4	**251.1**	265.4	*254.2*	265.4	265.4	255.2	288.4	0.742/0.157
Size-corrected 1st PC	-16.2	-13.6	*-19.3*	-13.6	-13.6	**-23.3**	-13.6	-17.1	9.9	0.806/0.109
Mean annual temperature	-92.7	-94.2	-90.7	-93.3	**-94.7**	*-97.3*	-90.4	-93.7	-89.0	0.508/0.140
Annual precipitation	12.2	*9.9*	14.5	10.6	10.9	14.5	14.5	12.0	**8.3**	0.404/0.183

Supplementary document VI. Models examined in QuaSSE analysis of effects of SVL and body shape, and mean annual temperature on speciation rates and values of corrected Akaiké values and relative weights for each one.

Trait	Model	k	AICc	AICc Weight
SVL	Constant	3	416.7	0.010
	Linear	4	417.9	0.006
	Sigmoid	6	424.6	0.001
	Hump-shaped	6	425.0	0.001
	Linear with drift	5	407.7	0.974
	Sigmoid with drift	7	417.9	0.005
	Hump-shaped with drift	7	419.7	0.002
1st size-free PC	Constant	3	157.6	0.192
	Linear	4	160.0	0.059
	Sigmoid	6	165.6	0.003
	Hump-shaped	6	165.3	0.004
	Linear with drift	5	158.6	0.118
	Sigmoid with drift	7	155.5	0.566
	Hump-shaped with drift	7	160.1	0.054
Annual mean temperature	Constant	3	206.4	<0.00001
	Linear	4	209.1	<0.00001
	Sigmoid	6	215.4	<0.00001
	Hump-shaped	6	215.3	<0.00001
	Linear with drift	5	182.6	0.999
	Sigmoid with drift	7	207.6	<0.00001
	Hump-shaped with drift	7	211.7	<0.00001