doi:10.1038/nature09919

Contents:

1. Computed Tomographic Methods

The fossil specimen was scanned at the Helmholtz Centre Berlin for Materials and Energy using a micro focus x-ray tube (Hamamatsu, L8121-03) at 60 kV, 166 µA in small spot mode (focus: 7µm). A 1 mm aluminium window served as beam filter in order to suppress the beam hardening effects. The installed detector was a flat panel sensor (Hamamatsu, C7942SK-05) with 2316x2316 pixels and a resolution of 50 µm. Exposure time was 1.3 sec. For each scan 1300 projections were measured over an angular range from 360°. The magnification ratio was 1.9x, corresponding to an effective voxel size of 0.02625 mm for the specimen. Cone beam reconstruction using filtered back-projection algorithm was performed in the software package Octopus (Xraylab, Institute for Nuclear Sciences, Proeftuinstraat 86, 9000 Ghent (Belgium)). The data were visualized and processed by volume rendering software VG Studio Max 2.1. The reconstruction of the skull was performed using a 3D wax model built on the basis the CT data.

Other squamate taxa scanned at the above facility and reconstructed in Octopus include *Eremias* sp. and *Tetradactylus seps*. The remaining squamate taxa *Spathorhynchus fossorium*, *Loveridgea ionidesii*, *Blanus cinereus*, *Gallotia caesaris*, *Dibamus novaeguineae*, *Typhlops vermicularis* and *Varanus acanthurus* were scanned at the Museum für Naturkunde Berlin using a phoenix|x-ray nanotom (GE Sensing & Inspection Technologies GmbH, Wunstorf, Germany) equipped with a 180 kV high-power nanofocus tube with a tungsten target. Reconstructions were performed in datos|x-reconstruction software (GE Sensing & Inspection Technologies GmbH phoenix|x-ray), and data were visualized in VGStudio Max 2.0. See sections 2 and 3 for images and collection numbers.

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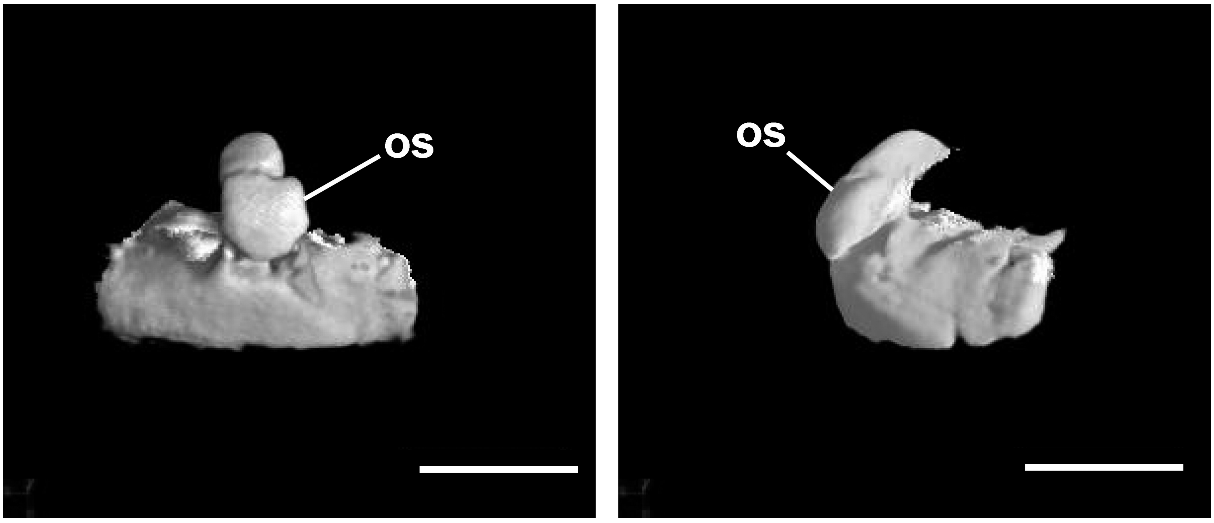
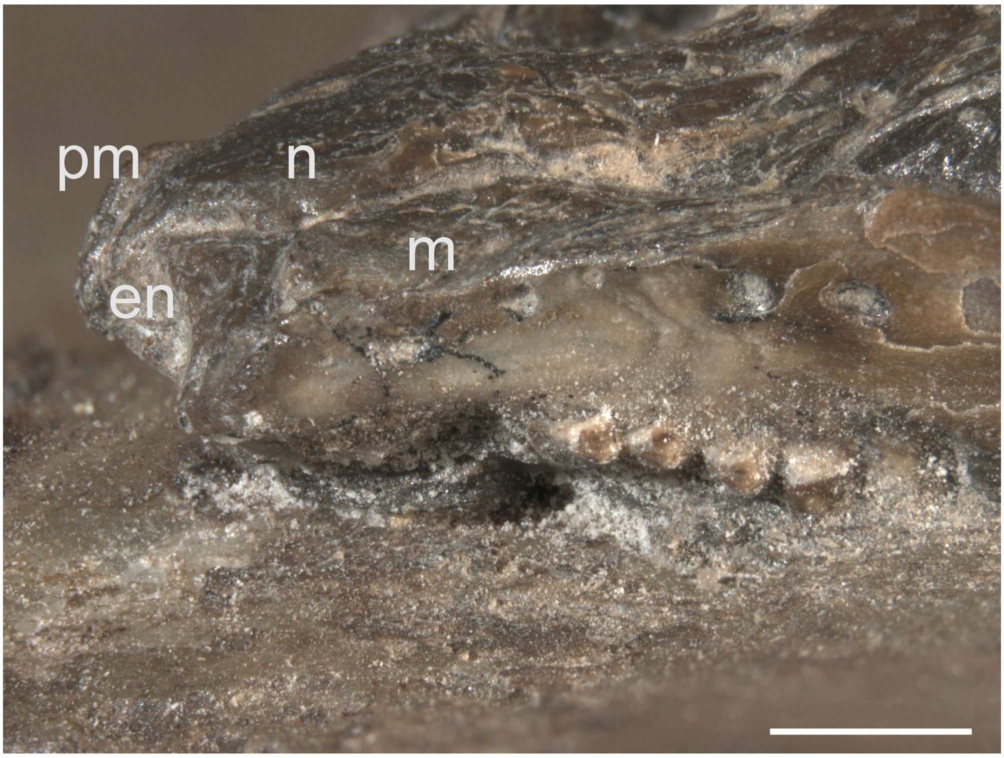
2. Additional Imagery



Premaxilla of *Cryptolacerta hassiaca* in anterior (left) and left lateral (right) view. Note the osteoderm (os) on the base of the dorsal process, indicating that the anteriormost part of the snout was protected, possibly in relation to digging behaviour. As can be seen, the bone is not distorted and the snout was therefore slightly downturned. Scale bars equal 1 mm.



Photograph showing the snout of *Crypolacerta hassiaca* in left lateral view. Note the anteromedial flange of the maxilla covering most of the posterodorsal part of the external naris (en). m, maxilla; n, nasal; pm, premaxilla. Scale bar equals 1 mm. Photograph taken by Henrik Stöhr.

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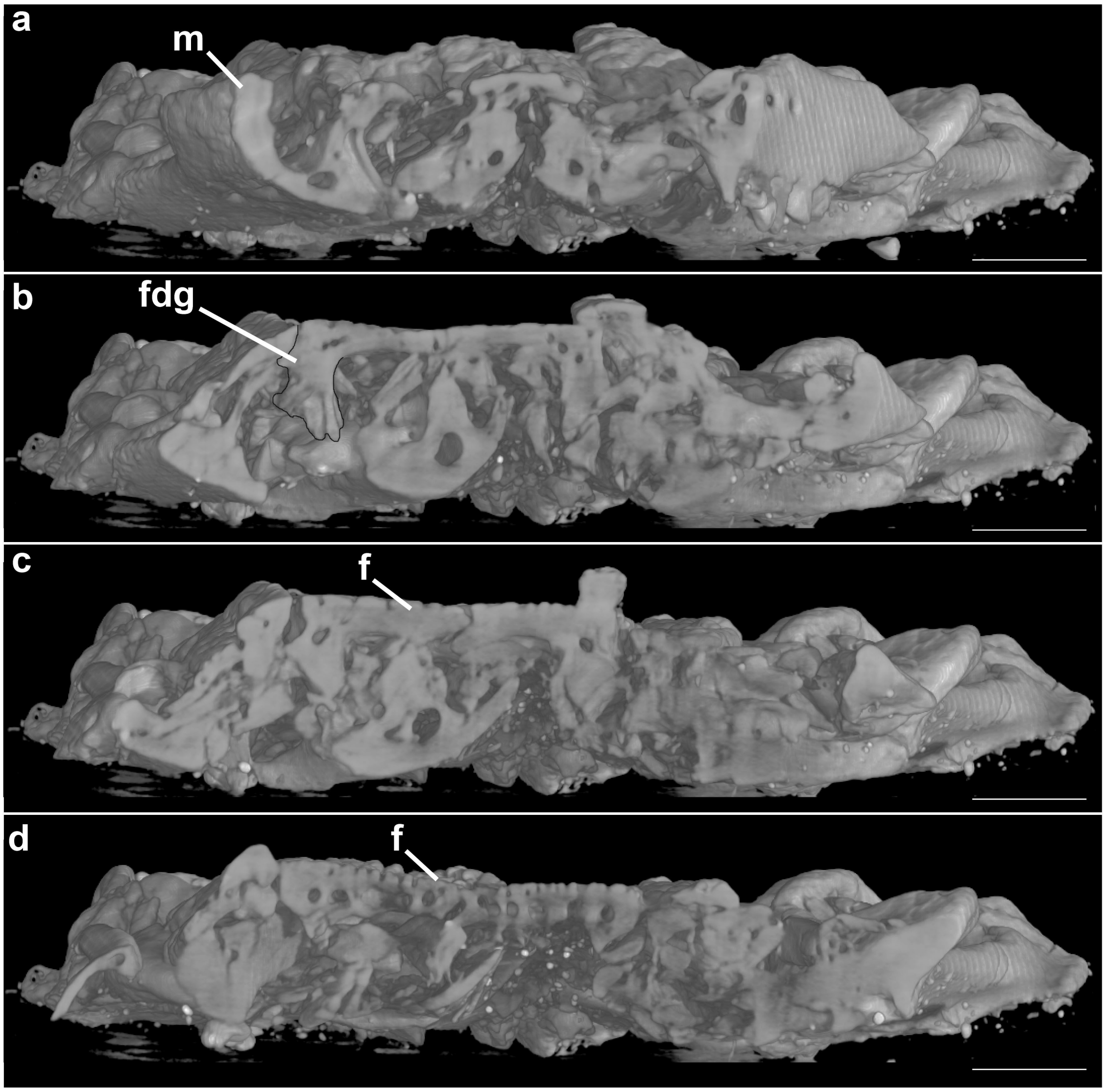
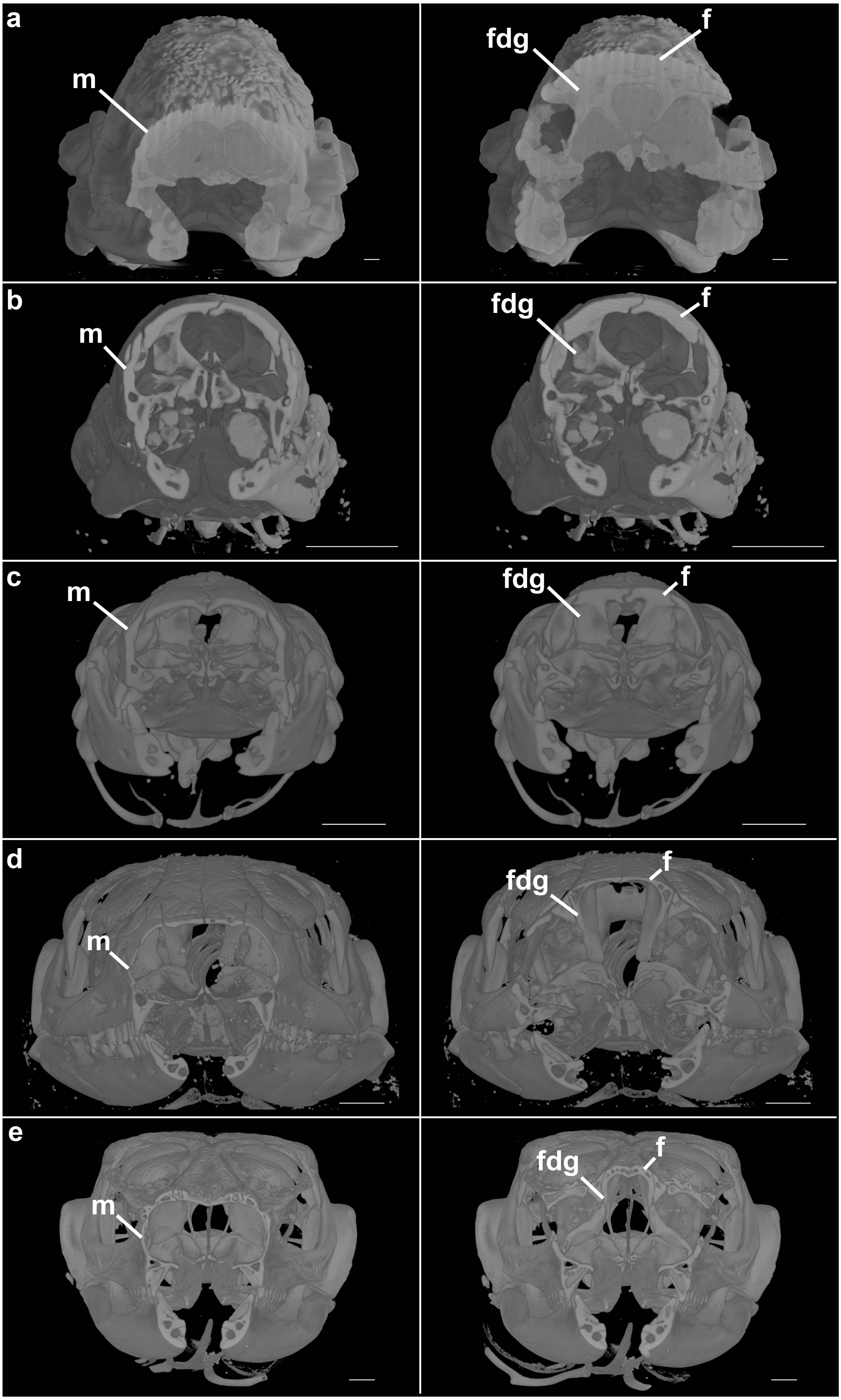
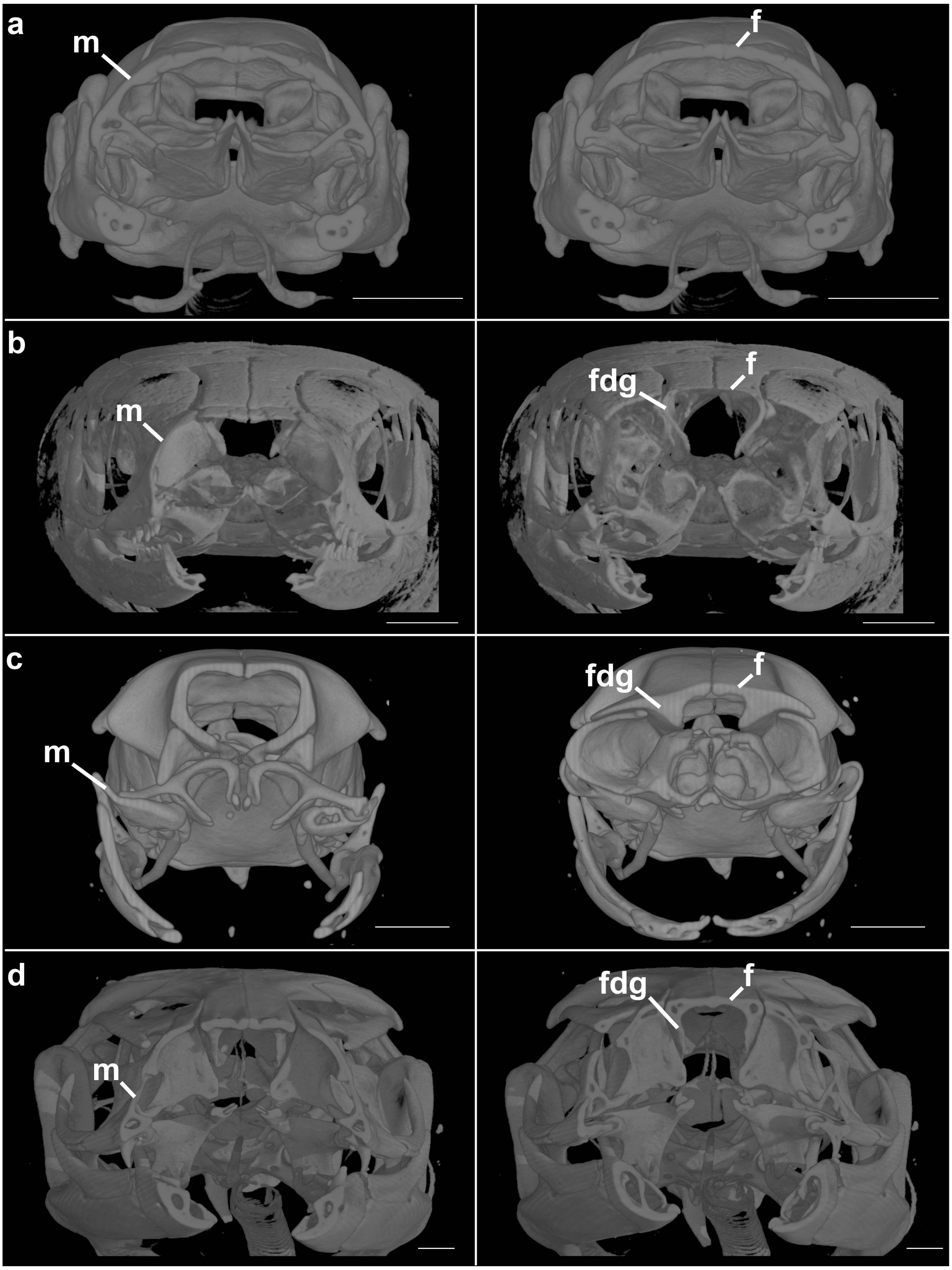


Cryptolacerta hassiaca, 3D transverse CT cross sections through the anterior half of the skull, from anterior to posterior a) at the mid level of the maxilla (m), note the thickness of the bone and the lack of vascularization; b) at the level of the frontal downgrowth (fdg), note the transverse width of the process and the overall 'short and broad' appearance (the black line denotes the outline of the downgrowth); c) at the level slightly posterior to the anterior edge of the frontals (f), note the thickness of the bone and the lack of vascularization; d) at the posterior level of the frontals, note the decrease in bone density resulting in a well-vascuralized bone. Scale bars equal 1 mm.


a
m
fdg
f
b
m
fdg
f
c
m
fdg
f
d
m
fdg
f
e
m
fdg
f

Previous page: 3D transverse CT cross sections through the mid level of the snout (left) and the anterior parts of the frontals at the level of the frontal downgrowths (right) of selected amphisbaenians and lacertids. a) the Eocene amphisbaenian *Spathorhynchus fossorium*; b) the amphisbaenid amphisbaenian *Loveridgea ionidesii*; c) the blanid amphisbaenian *Blanus cinereus*; d) the lacertid *Gallotia caesaris*; e) the lacertid *Eremias* sp. Note the difference in the shape of the frontal downgrowths between amphisbaenians and lacertids, as well as the difference in thickness and bone density of maxilla and frontal. Scale bars equal 1 mm. For collection numbers see section 3.



3D transverse CT cross sections through the mid level of the snout (left) and the anterior parts of the frontals at the level of the frontal downgrowths (right) of selected squamate outgroup taxa. a) the dibamid *Dibamus novaeguineae*; b) the cordylid *Tetradactylus seps*; c) the blind snake *Typhlops vermicularis* (note the change in ordering: the right section showing the frontal downgrowth is further anterior than the left section showin the maxilla); d) the varanid *Varanus acanthurus.* Scale bars equal 1 mm. For collection numbers see section 3.

3. Phylogenetic analysis

Phylogenetic analyses were performed using both morphological and molecular data since the two data sets result in divergent hypotheses of squamate relationships, especially the relationships of amphisbaenians. We used two genetic markers (*rag-1* and *c-mos*) in combination with the morphological characters. Analyses were performed on the dataset below using Mesquite 2.6[31] to combine morphological and molecular data. The total number of taxa was 65.

Parsimony analysis was carried out with the software package TNT 1.1. [32] using the “new technology“ search option, with the implementation of all 4 search algorithms (sectorial search, ratchet, drift, and tree fusing), level 10 for most aggressive searches and 50 replications. Bayesian analysis was performed using MrBayes 3.2 [33]. The data set was partitioned into morphological and molecular components; for the molecular data the GTR+gamma+I model was implemented, and for the morphological data the Mk model + gamma was used (4 rate categories for the gamma shape parameter). A previous run without implementing a gamma shape parameter for the morphological characters was not supported according to Bayes factor comparison. All uninformative morphological characters were deleted prior to the analysis, as they may affect the result if the data are to be analyzed in a likelihood framework [34,35]. Two runs with 4 chains each were performed for 20,000,000 generations to ensure the runs reached stationarity, with a sampling every 100 generations, and a burnin set to 5000 sampled generations.

Morphological data

The morphological data set is based on a previously published analysis of squamate relationships [9]; however, multiple non-germane terminal taxa were collapsed into higher-order clades to facilitate runs (in fact, [9] used the “ratchet“ option in TNT 1.1 to obtain a hypothesis of phylogenetic relationships due to the great amount of ambiguity introduced by fossils). *Cryptolacerta* was added to the data set, and Lacertidae were broken down into 3 individual taxa: *Gallotia* as a representative of Gallotiinae, one of the two major clades of crown lacertids [24], *Eremias* as a representative of Lacertinae, the sister group to gallotiines, and the Oligocene lacertid *Dracaenosaurus.* Scorings were based on personal observations (see below for the list of examined specimens) and on the literature [1, 15, 36-38].In addition, the following recodings were performed for amphisbaenians and *Eolacerta*: *Eolacerta*: #166-0 (mandible, fusion of articular, prearticular, and surangular: *Eolacerta* recoded as (0) based on personal observations); Amphisbaenia: #76-1 (parietal, descensus parietalis: recoded as (1) because we consider the parietal ventral extension to be a synapomorphy with the condition in Lacertidae); Amphisbaenidae, Blanidae, Trogonophidae: #37-(-) (prefrontal, contact with postorbitofrontal: recoded as (-) because the derived condition of extant amphisbaenids, blanids, and trogonophids makes the coding of this characer impossible); Bipedidae: #55-1 (frontals, unfused or fused in adults: recoded as (1) based on observations on a CT-scanned specimen of *Bipes* on www.digimorph.org), Rhineuridae: #33-01 (maxilla, posterior extent of tooth row long or short: recoded as (01) due to variation in extant and fossil rhineurids), #92-0 (postfrontal shape, elongate or irregular: recoded as (0) based on fossil rhineurids [13,14]), #93-1 (postfrontal, contact with parietal absent or present: recoded as (1) based on fossil rhineurids [13,14]), #94-1 (postorbitofrontal, fusion absent or present: recoded as (1) based on fossil rhineurids [13,14]), #95-? (postorbital, present or absent: recoded as (?) based on fossil and extant rhineurids), #105-1 (ectopterygoid, direction mediolateral or anterolateral: recoded as (1) as we interpret the direction to be anterolateral in rhineurids), #121-0 (pyriform recess, absent or present: recoded as (0) as we consider the pyriform recess to be absent in rhineurids), #130-01(orbitosphenoid, not azygous or azygous: recoded as (01) because a paired orbitosphenoid is present in the fossil *Rhineura hatcherii* [15]), #165-1 (extracolumella tissue, not calcified or calcified: recoded as (1) because we consider the tissue to be calcified in rhineurids), #202-01 (angular, present or absent: recoded as (01) due its variation in extant and fossil rhineurids). Furthermore, the following characters were modifed or replaced:

#1 (skull, percentage of total length made up by antorbital snout): modified into a simpler version as the previous definition largely applied to mosaurs only: Postorbital skull table length: (0) less than one half of skull; (1) one half of skull or more.

#7 (dermal sculpturing): modified into: surface of facial bones: (0) smooth; (1) rugose (based on #33 [1]).

#18, (premaxilla, contact with nasals): this character was uninformative and was replaced by: Premaxilla, nasal process: (0) short, not intersecting between nasals; (1) long, intersecting between nasals (modified from #32 [1]).

#37 (contact between prefrontal and postorbitofronal): modified into: (0) absent; (1) present, pointy contact; (2) present, sutural contact.

#162 (quadrate, tympanic crest): modified into a simpler version, as the previous definition largely applied to mosasaurs only: (0) tympanic crest on quadrate present; (1) tympanic crest absent.

#355 (M. intermandibularis anterior superficialis): this character was uninformative and was replaced by: Snout, orientation: (0) straight anteriorly (0); (1) sloping anteroventrally ('downturned') (modified from #24 [1]).

#356 (M. intermandibularis anterior profundus apneurosis): this character was uninformative and was replaced by a new character for squamate relationships: Frontal subolfactory processes: (0) narrow and slender, more than double as deep as wide; (1) transversely widened and of stout appearance, less then double as deep as wide [n.a. when frontal downgrowths are absent].

#358 (M. mandibulohyoideus II): this character was uninformative and was replaced by a new character for squamate relationships: Frontal in transverse cross section :(0) thin sheet of bone; (1) notably thickened and with increased bone density, vascularization not visible (1).

#359 (M. mandibulohyoideus III): this character was uninformative and was replaced by a new character for squamate relationships: Maxilla in transverse cross section :(0) thin sheet of bone; (1) notably thickened and with increased bone density, vascularization not visible (1).
#362 (Muscle "X"): this character was uninformative and was replaced by: Position of external nares: (0) lateral-anterolateral; (1) anterior-anteroventral (modified from #37, [1]).
#363 (M. sternohyoideus): this character was uninformative and was replaced by: Orbit height: more than one half of the skull height at the orbit level (0); one half of skull height or less [this character is independent of the completeness of the orbital rim] (modified from #10 [1]):
#364 (biogeographic distribution): we consider it doubtful to use biogeographic occurrence as a phylogenetic character, which is why we replaced this character with a new one for squamate relationships: Suture between frontals: (0) vertically straight; (1) strongly interdigitating tongue-and-groove articulation (1).

Specimens examined:

Institutional Abbreviations: ROMV-R, Royal Ontario Museum; UCMP, University of California Museum of Paleontology; USNM, Smithsonian Institution, National Museum of Natural History; ZFMK, Zoologisches Forschungsinstitut und Museum Alexander Koenig Bonn; ZMB, Museum für Naturkunde Berlin.
Gallotia caesaris, ZMB 29489 (CT scan); *Gallotia goliath* ZFMK58250; *Gallotia stehlini* ZFMK 7881; *Eremias sp.* ZMB uncatalogued (CT scan); *Podarcis pityusensis* private collection M. Kroniger (CT scan); *Loveridgea ionidesii* ZMB uncatalogued (CT scan); *Blanus cinereus* ZMB 10974 (CT scan); *Spathorhynchus fossorium* USNM V 26317 (CT scan); *Amphisbaena alba,* ROMV-R 0357*; Bipes biporus* UCMP 1198020, UCMP 137630, UCMP 137868; *Dibamus novaeguineae* ZMB 50450 (CT scan); *Cyclura cornuta* ZFMK 5223; *Cordylus tropidosternum* ZFMK 7810; *Gerrhosaurus major* ZFMK 56403; *Tetradactylus*

seps private collection M. Cunningham (CT scan); *Echinosaura horrida* ZFMK 7274; *Chalcides ocellatus* ZFMK 7850; *Ameiva ameiva* ZFMK 59020; *Xantusia henshawi* ZFMK; *Varanus acanthurus* ZMB 37676 (CT scan); *Varanus salvator* ZFMK 14862; *Typhlops vermicularis* ZMB 4409 (CT scan).

In addition, CT scans of the entire range of squamate diversity, as present on www.digmorph.org as of January 17, 2011, were investigated. We also considered the following references for scoring the new characters for non-lacertibaenian taxa: [10, 11, 28], Bellairs 1950[39], Evans & Barbadillo 1997[40], Evans & Manabe 1999[41], Gao & Norell 2000[42], Rieppel 1981[43], 1984[44], Rieppel et al. 2007[45], Wu et al. 1996[46].

Molecular data

The *rag-1* and *c-mos* data for 39 extant squamate taxa were mostly taken from [3], with some additional taxa retrieved from GenBank. The data set was re-aligned in SeaView 2.3[47] using the Clustal algorithm. In total 2842 sites of *rag-1* and 374 sites of *c-mos* were considered.

The following taxa were used (if no Genbank accession number is given, then the taxon is from the [3] data set):

rag-1:

RHYNCHOCEPHALIA:	*Sphenodon punctatus*
DIPLODACTYLINAE:	*Pseudothecadactylus lindneri*
GYMNOPHTHALMIDAE:	*Leposoma parietale*
TEIIDAE:	*Cnemidophorus tigris*
CORDYLOIDEA:	*Cordylus polyzonus*
Xenosaurus:	*Xenosaurus grandis*
Shinisaurus:	*Shinisaurus crocodilurus*

Lanthanotus:	*Lanthanotus borneensis*
Anniella:	*Anniella pulchra*
ANILIOIDEA :	*Cylindrophis rufus*
NeoMACROSTOMATA:	*Agkistrodon piscivorus*
Xenopeltis:	*Xenopeltis unicolor* EU402870.1
Xantusia:	*Xantusia vigilis*
Lepidophyma:	*Lepidophyma flavimaculatum* DQ249134.1
Gallotia	*Gallotia galloti* EF632215.1.
Eremias	*Eremias sp.*
Bipes:	*Bipes biporus*
Blanus:	*Blanus strauchi* AY444050.1
AMPHISBAENIDAE:	*Amphisbaena sp.*
TROGONOPHIDAE:	*Trogonophis wiegmanni*
RHINEURIDAE:	*Rhineura floridana*
CHAMAELEONIDAE:	*Chamaeleo rudis*
Physignathus:	*Physignathus cocincinus*
Agama :	*Agama agama* AY487356.1
CROTAPHYTIDAE:	*Crotaphytus collaris* AY988014.1
IGUANIDAE:	*Sauromalus obesus*
TROPIDURIDAE:	*Tropidurus hispidus* AY988013.1
SCELOTINAE:	*Proscelotes eggeli*
ACONTINAE :	*Acontias meleagris*
SCINCINAE:	*Manuya aurata*
FEYLININAE:	*Feylinia polylepis*
DIBAMIDAE:	*Dibamus sp.*
HELODERMATIDAE:	*Heloderma suspectum*

Gekko:	*Gekko gecko*
Teratoscincus:	*Teratoscincus przewalskii*
VARANIDAE:	*Varanus griseus*
Typhlops:	*Typhlops jamaicensis* EU402866.1/AY487387.1
Leptotyphlops :	*Leptotyphlops columbi* EU402851.1/AY487383.1
PYGOPODIDAE:	*Lialis jicari*

c-mos:

RHYNCHOCEPHALIA:	*Sphenodon punctatus*
DIPLODACTYLINAE:	*Pseudothecadactylus lindneri*
GYMNOPHTHALMIDAE:	*Bachia dorbignyi*
TEIIDAE:	*Tupinambis quadrilineatus*
CORDYLOIDEA:	*Cordylus cordylus*
Xenosaurus:	*Xenosaurus grandis*
Shinisaurus:	*Shinisaurus crocodilurus*
Lanthanotus:	*Lanthanotus borneensis*
Anniella:	*Anniella pulchra* AY487350.1
ANILIOIDEA :	*Cylindrophis rufus*
NeoMACROSTOMATA:	*Agkistrodon piscivorus*
Xenopeltis:	*Xenopeltis unicolor* AF544689.1
Xantusia:	*Xantusia vigilis*
Lepidophyma:	*Lepidophyma sylvaticum* AY217891.1
Gallotia:	*Gallotia galloti*
Eremias:	*Eremias arguta* EF632258.1
Bipes:	*Bipes biporus*
Blanus:	*Blanus strauchi* AY444024.1

AMPHISBAENIDAE:	*Amphisbaena xera*
TROGONOPHIDAE:	*Diplometophon zarudnyi*
RHINEURIDAE:	*Rhineura floridana* AY444022.1
CHAMAELEONIDAE:	*Chamaeleo jacksonii*
Physignathus:	*Physignathus cocincinus*
Agama :	*Agama agama* AF137530.1
CROTAPHYTIDAE:	*Crotaphytus collaris* AY987985.1
IGUANIDAE:	*Sauromalus obesus*
TROPIDURIDAE:	*Tropidurus hispidus* AY987984.1
SCELOTINAE:	*Proscelotes eggeli*
ACONTINAE :	*Acontias meleagris*
SCINCINAE:	*Eumeces skiltonianus*
FEYLININAE:	*Feylinia polylepis*
DIBAMIDAE:	*Dibamus sp.*
HELODERMATIDAE:	*Heloderma suspectum*
Gekko:	*Gekko gecko* AY444028.1
Teratoscincus:	*Teratoscincus przewalskii*
VARANIDAE:	*Varanus salvator*
Typhlops:	*Typhlops jamaicensis* AF544733.1
Leptotyphlops :	*Leptotyphlops columbi* AF544718.1
PYGOPODIDAE:	*Lialis burtonis*

Results: parsimony analysis

The parsimony analysis resulted in 6 most parsimonious trees (7944 steps). In all trees, *Cryptolacerta* falls as sister taxon to amphisbaenians (see below for the strict consensus). It requires 15 additional steps to group *Cryptolacerta* with Lacertidae, 19 steps to place

Cryptolacerta outside Lacertibaenia, and 8 steps to collapse Lacertibaenia. A bootstrap analysis (1000 replications) showed a support of 74% for the grouping *Cryptolacerta*/Amphisbaenia, whereas Lacertibaenia as a whole received support below 50%. (see below).

Apart from the position of *Cryptolacerta*, other noteworthy results of the parsimony analysis are: 1) the phylogenetic position of the Eocene *Dracaenosaurus* within crown Lacertidae, thus supporting the hypothesis of a deep Paleogene origin of modern lacertids, as recently proposed [24]; 2) the grouping of mosasaurs with snakes instead of anguimorphs; 3) the sistergroup relationship between xantusiids and *Eolacerta*.

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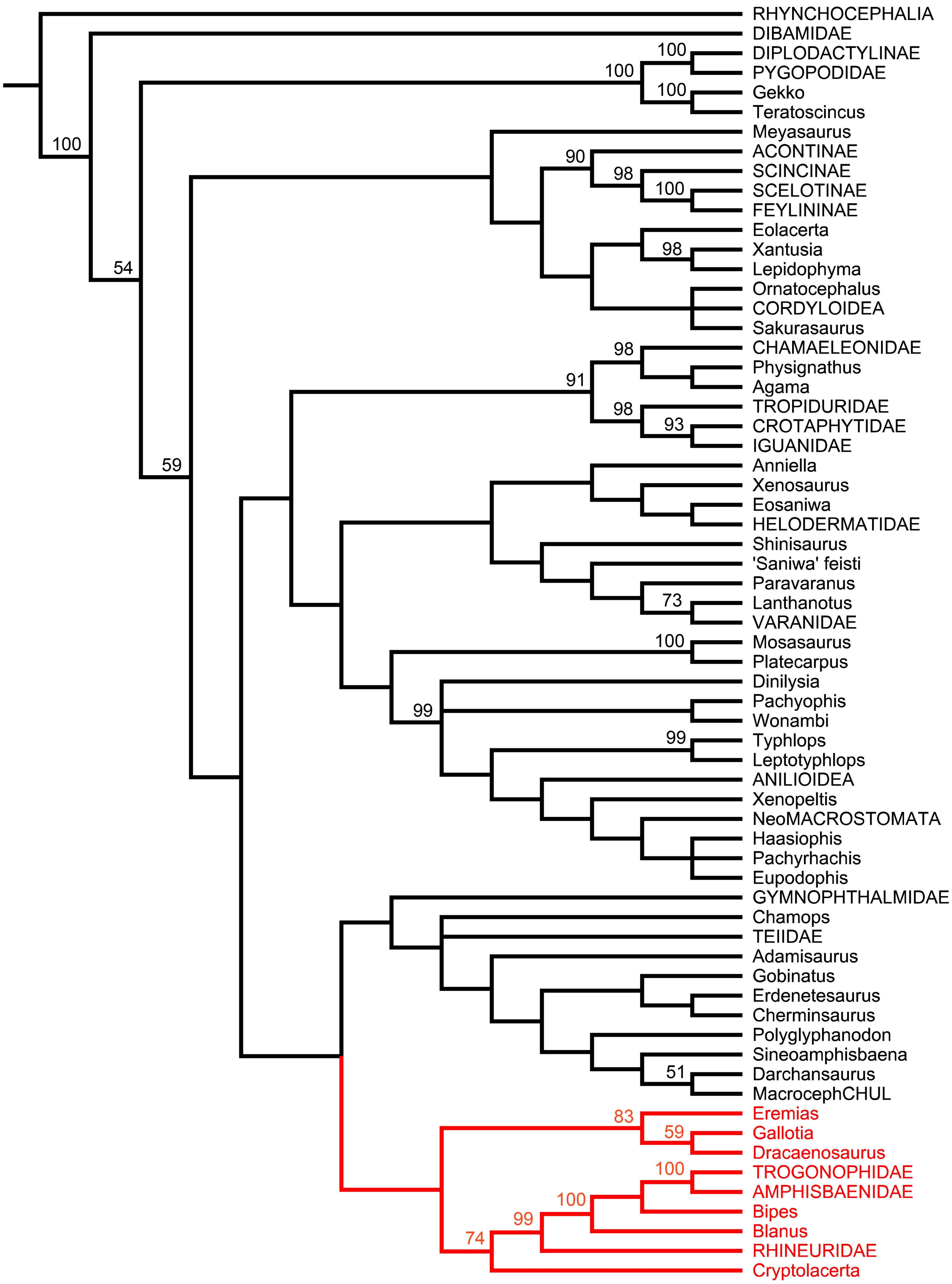
Strict consensus of 6 trees; bootstrap values >50% are indicated:



Results: Bayesian analysis

In the Bayesian runs, *Cryptolacerta* again groups as sister taxon to Amphisbaenia (see below), with a fairly high support of 0.9. Lacertibaenia as a whole receives very strong support of 1. While the position of *Dracaenosaurus* within crown lacertids remains the same as in the parsimony analysis, mosasaurs cluster with anguimorphs and *Eolacerta* groups with the Mesozoic *Meyasaurus*. *Blanus* und *Bipes* cluster as sister taxa, although support for this grouping is low.

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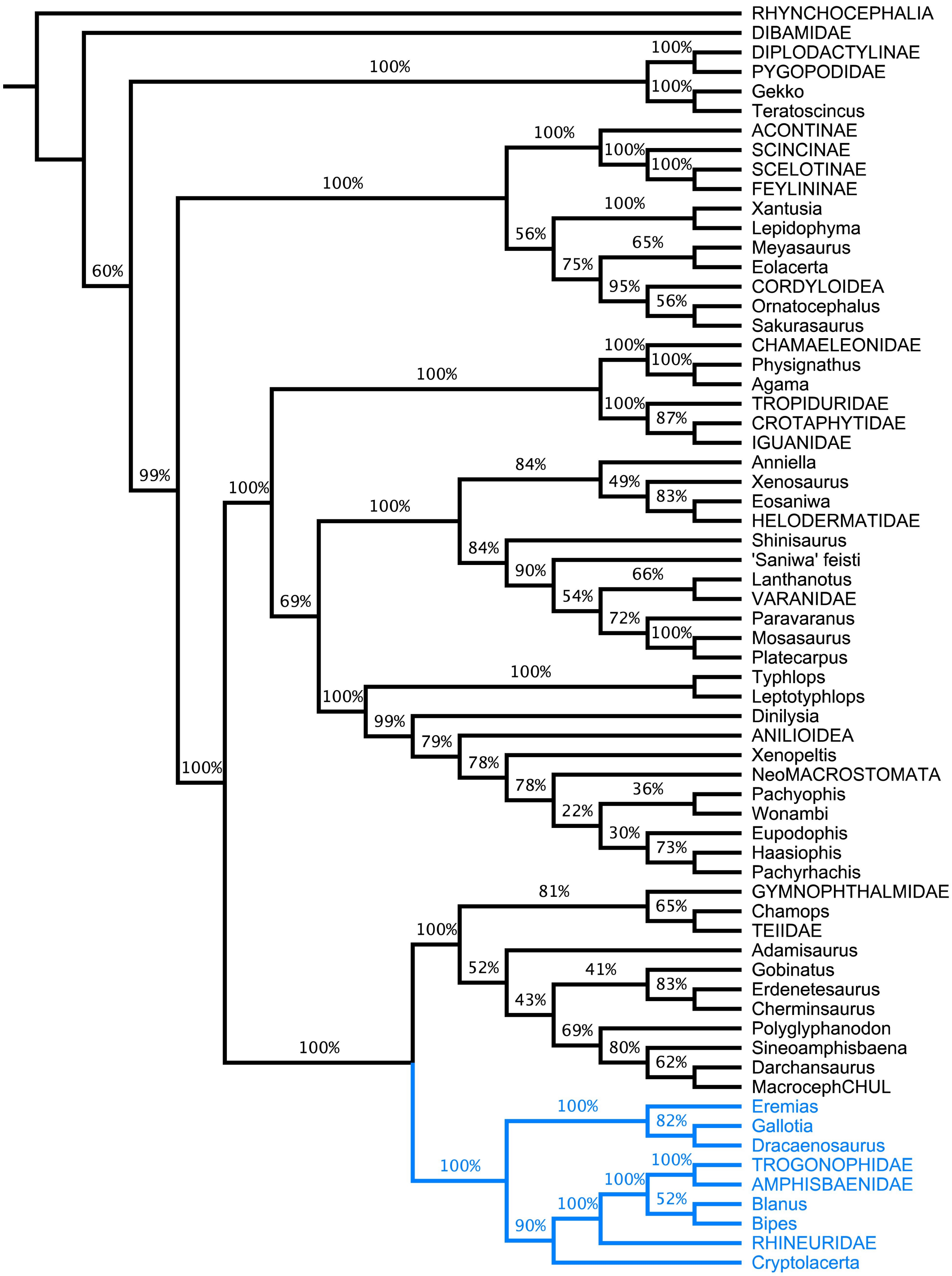
Allcompat consensus tree with percentages indicating posterior probabilities:



4. Data Matrix

#NEXUS

BEGIN TAXA;
DIMENSIONS NTAX=65;
TAXLABELS RHYNCHOCEPHALIA DIPLODACTYLINAE Gekko Teratoscincus PYGOPODIDAE Xenosaurus Eosaniwa Shinisaurus '"Saniwa" feisti' HELODERMATIDAE Lanthanotus VARANIDAE Mosasaurus Platecarpus Anniella Typhlops Leptotyphlops ANILIOIDEA NeoMACROSTOMATA Xenopeltis Dinilysia Haasiophis Pachyrhachis Eupodophis Pachyophis Wonambi Xantusia Lepidophyma GYMNOPHTHALMIDAE Chamops TEIIDAE Polyglyphanodon Erdenetesaurus Adamisaurus Cherminsaurus Gobinatus Darchansaurus MacrocephCHUL Sineoamphisbaena CHAMAELEONIDAE Physignathus Agama CROTAPHYTIDAE IGUANIDAE TROPIDURIDAE Ornatocephalus CORDYLOIDEA SCELOTINAE ACONTINAE SCINCINAE FEYLININAE DIBAMIDAE Meyasaurus Paravaranus Sakurasaurus Eolacerta Bipes Blanus AMPHISBAENIDAE TROGONOPHIDAE RHINEURIDAE Gallotia Eremias Dracaenosaurus Cryptolacerta ;

END;

BEGIN CHARACTERS;
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END;

5. Morphological Diagnoses and Synapomorphies

In the following we present diagnoses for the nodes Lacertibaenia, *Cryptolacerta*/Amphisbaenia, Amphisbaenia, and Lacertidae. All synapomorphies are unequivocal (i.e. present under either type of character optimization) and were derived from PAUP*[48] after importing the trees generated in the phylogenetic analyses.

Lacertibaenia Vidal and Hedges, 2005

Definition: the most recent common ancestor of *Gallotia* and *Amphisbaena*, and all descendants.

Diagnosis: 1) short supratemporal parietal processes (#80-1), which are 2) dorsally flat (#81-1); extensive contact between parietal and supratemporal (#84-1); 3) broad articulation between vomer and palatine (#108-0); 4) lateral exposure of the ectopterygoid (#126-1); 5) presence of spheno-occipital epiphyses (#128-1); 6) reduced crista prootica (#138-1); 7) posterodorsally inclined crista tuberalis (#151-1); 8) ventral exposure of the occipital recess (#155-1); 9) flat ventral margin of the coronoid (#195-0); 10) cervical intercentra being fused to the posterior part of the preceding centrum (#243-2); 11) absence of epicoracoid cartilage (#264-1).

Cryptolacerta + Amphisbaenia

Definition: the most recent common ancestor of *Cryptolacerta* and Amphisbaenia, and all descendants.

Diagnosis: 1) postorbital skull at least half as long as remaining skull (#1-1); 2) blunt and rounded snout #3-1); 3) sutural contact between prefrontal and postorbitofrontal (#37-2); 4) contact between prefrontal and jugal (#39-1); 5) absence of a lacrimal (#41-3); 6) little angulated, curved jugal (#47-1); 7) subequal width of the anterior and posterior borders of the frontal (#57-0); 8) lack of frontal constriction between the orbits (#58-0); lack of a tympanic crest (#162-1); 9) absence of well developed neural spines (#232-2); 10) presence of 7 or fewer cervical vertebrae (#242-1); 11) rod-like clavicles (#260-0); 12) absence of an anterior coracoid emargination (#262-0); 13) absence of interclavicle (#268-1); 14) fusion of cephalic scales (#302-1; although this is a soft part character, the scute impressions on the skull roof of *Cryptolacerta* indicate scale fusion); 15) frontal subolfactory processes transversely widened (#356-1); 16) increased thickness and density of frontal bone (#358-1); 17) increased thickeness and density of maxillary bone (#359-1); 18) orbits reduced in size (#363-1); 19) vertical tongue-and-groove articulation between the frontals (#364-1).

Amphisbaenia Gray, 1844

Definition: the most recent common ancestor of *Amphisbaena* and *Rhineura*, and all descendants.

Diagnosis: 1) partial surrounding of the olfactory tracts by the frontal subolfactory processes (#61-1); 2) absence of a pineal foramen (#77-3); 3) absence of parietal supratemporal processes (#80-2); 4) bony contact between parietal and supraoccipital (#85-1); 5) absence of a supratemporal (#87-1); 6) absence of a forking of the medial surface of the postorbital/postfrontal (#89-0); 7) absence of a complete suptratemporal arch (#99-1); 8) absence of a crista prootica (#132-2); 9) absence of the epipterygoid (#134-1); 10) otooccipital suspension of the quadrate (#159-3); 11) absence of a mandibular adductor fossa expansion (#169-0); 12) absence of a posterior mylohyoid foramen (#175-1); 13) posterior extension of the dentary beyond the midpoint of the mandible (#180-1); 14) closure of Meckel's canal (#181-2); 15) absence of a dentary subdental shelf (#182-1); 16) absence of an anterior inferior alveolar foramen (#183-3); 17) absence of a dorsal fossa on the retroarticular process (#208-1); 18) presence of a torsion of the retroarticular process (#210-1); 19) straight and pointed middle and posterior marginal teeth (#212-0); 20) presence of an enlarged median premaxillary tooth (#222-1); 21) absence of functional sacral vertebrae (#247-1); 22) presence of lympapophyses in the cloacal vertebrae (#248-1); 23) ribs with an anteroventral pseudotuberculum (#255-1).

Lacertidae Bonaparte, 1831

Definition: the most recent common ancestor of *Gallotia* and *Eremias*, and all descendants. Diagnosis: 1) bilobed premaxillary incisive process (#14-1); 2) presence of a palpebral bone (#101-1); 3) presence of a secondary palate around the choanal groove (#114-1); 4) presence of a midline contact between the vomers (#120-0); 5) long splenial (#189-0); 6) presence of 26 presacral vertebrae (#236-1); 7) presence of a sternal fontanelle (#273-1); 8) presence of an ilium anterior process (#287-0); 9) division of the foretongue by more than 40% of its length (#317-3); 10) presence of an expanded anterior head of the M. pseudotemporalis profundus (#340-2).

6. Principal Components Analysis of Ecomorphology

We inferred the habits of *Cryptolacerta* based on PCA of seven measured variables in extant squamates from [19], Table **1**, using PAST ver. 1.98[49]. We excluded a single measured variable (tail length) from [19] because it was not preserved in *Cryptolacerta*, and excluded elongate, limbless taxa from the analysis since that body plan disproportionately drove most of the variation seen in the original study. Squamate taxa possessing ecological habits consistent with the paleoenvironments of the Grube Messel locality were projected into the resulting morphospace, along with *Cryptolacerta* for comparison (although we included sand and grass swimmers in the PCA, we did not compare them to *Cryptolacerta*).

Table 1. Taxa, variables, and ecology used in PCA analysis. SVL= Snout Vent Length; HW= Head Width; SE= Snout –Eye distance; FLL=Forelimb Length; HLL= Hindlimb Length. Measurements are in mm.

Species	SVL	HW	SE	FLL	HLL	Fingers	Toes	Ecology
Abronia graminea	96.2	13.2	13.1	22.9	30.5	5.0	5.0	arboreal
Gecko gekko	146.2	28.2	25.7	37.1	44.3	5.0	5.0	arboreal
Gonatodes albogularis	39.2	5.7	6.8	12.1	17.0	5.0	5.0	arboreal
Calotes versicolor	83.5	13.7	14.1	39.6	61.9	5.0	5.0	arboreal
Polychrus marmoratus	129.3	18.2	19.4	42.2	54.0	5.0	5.0	arboreal
Takydromus smaragdinus	48.2	5.5	7.7	17.2	23.8	5.0	5.0	arboreal, grass-swimming
Basiliscus basiliscus	163.9	25.8	30.2	64.9	138.9	5.0	5.0	arboreal, semi-aquatic
Enyalioides laticeps	112.1	21.9	22.0	53.3	89.4	5.0	5.0	arboreal, terrestrial
Placosoma glabellum	53.1	5.8	7.4	14.7	19.9	5.0	5.0	arboreal, terrestrial leaf-litter
Eumeces laticeps	109.7	10.9	15.7	33.9	46.5	5.0	5.0	arboreal?
Gerrhonotus liocephalus	131.7	14.8	15.4	24.0	28.4	5.0	5.0	arboreal, terrestrial
Cercosaura argulus	42.1	5.6	7.2	14.1	18.7	5.0	5.0	arboreal, terrestrial
Cercosaura ocellata	48.7	6.2	7.3	16.6	23.9	5.0	5.0	arboreal, terrestrial
Eumeces fasciatus	66.7	6.9	9.0	19.5	27.1	5.0	5.0	arboreal, terrestrial
Eumeces inexpectatus	71.6	6.9	9.6	20.8	29.3	5.0	5.0	arboreal, terrestrial

Diplodactylus damaeus	50.4	7.4	8.6	14.2	20.6	5.0	5.0	arboreal, terrestrial
Amphiglossus macrocercus	68.7	6.2	7.7	15.1	22.7	5.0	5.0	arboreal, terrestrial?
Alopoglossus carinicaudatus	54.9	7.2	7.8	14.3	22.2	5.0	5.0	as per congeners
Colobodactylus tanuayi	51.8	5.6	5.9	9.7	17.5	4.8	5.0	as per congeners
Bipes biporus	167.2	4.3	3.6	6.1	0.0	5.0	0.0	burrowing
Bipes canaliculatus	182.5	5.4	4.5	6.5	0.0	4.0	0.0	burrowing
Bipes tridactyluls	127.5	5.1	3.7	6.0	0.0	3.0	0.0	burrowing
Dibamus novaeguineae	128.3	2.9	2.6	0.0	1.1	0.0	0.4	burrowing
Calyptommatus leiolepis	53.3	3.1	3.3	0.0	3.3	0.0	1.0	BURROWING
Calyptommatus nicterus	60.7	3.5	3.4	0.0	3.2	0.0	1.0	BURROWING
Calyptommatus sinebrachiatus	57.5	3.3	3.4	0.0	2.8	0.0	1.0	BURROWING
Notobachia ablephara	52.4	2.7	3.3	1.1	5.5	1.0	2.0	burrowing
Procellosaurinus erythrocercus	27.5	3.2	3.3	5.8	9.8	4.0	5.0	burrowing
Procellosaurinus tetradactylus	26.0	2.8	3.1	5.3	9.4	4.0	5.0	burrowing
Psilophthalmus paeminosus	32.0	2.9	3.2	4.0	7.5	4.0	5.0	burrowing
Brachymeles gracilis	75.0	5.5	6.2	8.3	13.8	5.0	5.0	burrowing
Brachymeles talinis	108.4	7.7	8.5	12.5	20.9	5.0	5.0	burrowing
Proscelotes eggeli	87.0	5.9	6.3	8.4	12.5	5.0	5.0	burrowing
Pygomeles braconnieri	139.1	5.6	7.4	0.0	3.5	0.0	1.0	burrowing
Scelotes bipes	47.9	2.5	3.0	0.0	3.1	0.0	2.0	burrowing
Scelotes gronovi	67.4	2.6	3.8	0.0	3.1	0.0	1.0	burrowing
Scelotes sexlineatus	75.7	3.2	4.5	0.0	8.9	0.0	2.0	burrowing
Voeltzkowia fierinensis	57.4	2.1	3.0	0.0	3.6	0.0	2.0	burrowing
Neoseps reynoldsi	54.0	2.6	4.2	2.0	6.6	1.1	2.0	burrowing
Bachia bresslaui	98.6	5.7	6.1	2.7	3.0	1.0	1.0	BURROWING (for genus)
Bachia dorbignyi	63.2	3.4	3.4	2.2	0.8	3.0	1.0	BURROWING (for genus)
Bachia flavescens	65.8	3.4	3.9	1.9	1.8	1.0	1.0	BURROWING (for genus)
Scincopus fasciatus	150.5	18.6	21.9	43.9	47.7	5.0	5.0	burrowing in sand
Scincus scincus	117.2	9.8	16.6	31.6	37.7	5.0	5.0	burrowing in sand
Sphenops boulengeri	83.9	4.3	6.3	7.5	17.7	4.8	5.0	burrowing in sand
Sphenops	98.3	3.9	6.9	4.4	15.8	2.0	4.0	burrowing in sand

sphenopsiformis								
Chalcides mionecton	86.8	4.8	6.5	6.5	15.1	4.0	4.0	burrowing, cryptic
Sepsina angolensis	71.1	3.7	4.1	2.4	7.4	3.0	3.0	leaf litter, burrowing
Cordylus cataphractus	89.0	17.3	15.1	29.8	39.4	5.0	5.0	saxicolous
Cordylus cordylus	82.4	14.0	13.1	26.8	39.1	5.0	5.0	saxicolous
Cordylus jordani	93.6	16.7	14.7	32.9	46.0	5.0	5.0	saxicolous
Cordylus warreni	108.6	19.0	17.5	34.1	50.3	5.0	5.0	saxicolous
Platysaurus rhodesianus	97.3	13.6	14.7	37.3	51.4	5.0	5.0	saxicolous
Pseudocordylus microlepidotus	122.4	20.9	20.3	40.3	57.2	5.0	5.0	saxicolous
Oedura coggeri	71.3	12.3	11.9	17.1	21.1	5.0	5.0	saxicolous, arboreal
Urosaurus ornatus	48.9	7.9	7.7	17.2	26.5	5.0	5.0	saxicolous, arboreal
Amphiglossus astrolabi	190.5	14.0	17.9	32.6	44.7	5.0	5.0	semi-aquatic
Neusticurus ecpleopus	59.7	7.7	8.4	17.2	27.1	5.0	5.0	semi-aquatic
Neusticurus rudis	72.5	9.0	11.5	22.6	34.7	5.0	5.0	semi-aquatic (for genus)
Lanthanotus borneensis	169.0	14.6	13.3	26.1	33.0	5.0	5.0	semi-aquatic, burrowing
Barisia imbricata	110.3	14.4	13.8	22.0	28.0	5.0	5.0	terrestrial
Celestus enneagrammus	72.6	7.1	7.3	11.0	16.1	5.0	5.0	terrestrial
Diploglossus pleei	87.2	8.4	7.8	9.6	15.3	5.0	5.0	terrestrial
Elgaria coerulea	86.5	10.9	11.4	19.8	27.3	5.0	5.0	terrestrial
Elgaria kingii	79.6	8.6	9.3	14.2	19.1	5.0	5.0	terrestrial
Elgaria multicarinata	110.4	12.4	13.5	25.5	32.0	5.0	5.0	terrestrial
Elgaria panamintina	109.9	12.5	13.2	24.6	31.1	5.0	5.0	terrestrial
Elgaria paucicarinata	87.6	10.2	11.0	16.2	23.3	5.0	5.0	terrestrial
Mesaspis moreleti	66.8	8.2	8.2	15.1	19.0	5.0	5.0	terrestrial
Sauresia agasepsoides	60.0	4.3	4.0	3.4	6.8	4.0	4.0	terrestrial
Wetmorena haetiana	68.7	6.4	6.2	6.9	11.1	4.0	4.0	terrestrial
Coleonyx elegans	76.9	11.1	12.9	24.7	31.0	5.0	5.0	terrestrial
Gerrhosaurus major	210.3	28.8	27.5	51.1	71.0	5.0	5.0	terrestrial
Gerrhosaurus nigrolineatus	96.8	12.1	14.2	22.9	43.5	5.0	5.0	terrestrial
Cercosaura eigenmanni	40.8	5.4	6.7	13.1	17.9	5.0	5.0	terrestrial
Pholidobolus montium	50.9	5.8	6.4	14.3	22.2	5.0	5.0	terrestrial

Ptychoglossus brevifrontalis	51.9	6.1	6.4	10.4	18.5	5.0	5.0	terrestrial
Vanzosaura rubricauda	29.6	3.0	3.4	5.4	9.9	4.0	5.0	terrestrial
Dipsosaurus dorsalis	123.1	17.8	16.2	41.6	79.7	5.0	5.0	terrestrial
Gambelia wislizenii	100.2	16.5	17.0	36.6	69.6	5.0	5.0	terrestrial
Leiocephalus carinatus	108.1	17.6	17.1	38.3	65.2	5.0	5.0	terrestrial
Meroles cuneirostris	50.9	9.1	10.2	17.9	38.1	5.0	5.0	terrestrial
Psammodromus hispanicus	37.5	5.5	6.5	12.8	21.4	5.0	5.0	terrestrial
Amphiglossus igneocaudatus	52.8	3.6	5.3	7.0	16.4	5.0	5.0	terrestrial
Gongylomorphus bojeri	47.0	4.8	6.6	12.2	19.9	5.0	5.0	terrestrial
Ameiva ameiva	191.3	27.5	36.4	61.4	123.2	5.0	5.0	terrestrial
Dicrodon guttulatum	120.1	17.3	21.4	40.1	82.5	5.0	5.0	terrestrial
Teius teyou	115.6	14.2	19.2	34.4	72.4	5.0	4.0	terrestrial
Varanus griseus	303.5	32.9	37.1	73.9	90.4	5.0	5.0	terrestrial
Xantusia vigilis	39.7	5.1	5.0	10.1	14.0	5.0	5.0	terrestrial
Cnemidophorus sexlineatus	63.9	8.7	11.0	20.7	41.8	5.0	5.0	terrestrial
Eumeces longirostris	66.1	6.7	10.0	21.8	31.8	5.0	5.0	terrestrial
Eumeces schwartzei	108.1	8.9	12.4	27.1	37.0	5.0	5.0	terrestrial
Tracheloptychus madagascariensis	55.4	8.3	9.2	17.8	38.6	5.0	5.0	terrestrial
Zonosaurus ornatus	121.5	16.3	16.6	25.9	47.9	5.0	5.0	terrestrial
Cercosaura quadrilineatus	39.9	4.7	5.1	10.6	13.9	5.0	5.0	terrestrial as per congeners
Proctoporus bolivianus	57.0	6.5	6.7	13.3	19.4	5.0	5.0	terrestrial as per congeners
Proctoporus simoterus	64.5	6.5	6.8	12.0	15.5	5.0	5.0	terrestrial as per congeners
Amphiglossus melanopleura	43.7	4.0	4.5	7.4	13.3	5.0	5.0	terrestrial (leaf-litter)
Amphiglossus melanurus	65.2	4.7	5.7	9.0	14.9	5.0	5.0	terrestrial (leaf-litter)
Amphiglossus ornaticeps	55.0	3.6	4.1	4.3	7.8	5.0	5.0	terrestrial (leaf-litter)
Amphiglossus punctatus	60.7	5.1	6.6	13.2	19.4	5.0	5.0	terrestrial (leaf-litter); arboreal?
Amphiglossus intermedius	68.0	4.7	5.3	9.3	18.3	5.0	5.0	terrestrial (leaf-litter); for genus
Amphiglossus stumpffi	86.9	5.5	6.3	12.7	21.6	5.0	5.0	terrestrial (leaf-litter); for genus
Amphiglossus	84.1	6.8	7.5	11.9	17.8	5.0	5.0	terrestrial (leaf-

tsaratananensis								litter); for genus
Amphiglossus waterlotti	121.0	9.4	13.1	23.7	31.4	5.0	5.0	terrestrial (leaf-litter); for genus
Scelotes mirus	75.3	4.0	4.7	5.9	11.5	5.0	5.0	terrestrial, among grass
Diploglossus bilobatus	70.3	7.9	7.5	10.7	16.2	5.0	5.0	terrestrial "semi-fossorial"
Teratoscincus scincus	96.7	19.5	17.4	32.8	44.5	5.0	5.0	terrestrial, burrowing
Angolossaurus skoogi	132.4	15.2	17.1	38.0	53.8	5.0	5.0	terrestrial, BURROWING
Leiolepis belliana	120.9	16.8	16.8	38.7	72.6	5.0	5.0	terrestrial, burrowing
Phrynocephalus versicolor	52.4	10.7	8.3	22.0	36.6	5.0	5.0	terrestrial, burrowing
Chalcides ocellatus	119.5	8.7	11.4	22.2	30.3	5.0	5.0	terrestrial, burrowing
Sphenodon punctatus	216.7	35.5	36.4	62.9	87.0	5.0	5.0	terrestrial, burrowing
Heloderma suspectum	300.3	39.6	29.3	75.2	82.1	5.0	5.0	terrestrial, climbing, digging
Chalcides polylepis	109.3	7.6	10.3	21.2	29.0	5.0	5.0	terrestrial, cryptic
Eumeces schneideri	126.5	10.4	14.2	33.0	46.9	5.0	5.0	terrestrial, cryptic
Scelotes caffer	46.7	2.8	2.8	2.8	8.5	3.0	3.0	terrestrial, cryptic
Lepidophyma flavimaculatum	85.7	9.5	10.8	26.3	34.7	5.0	5.0	terrestrial, cryptic
Eumeces obsoletus	105.7	9.4	12.7	27.7	34.8	5.0	5.0	terrestrial, cryptic
Chalcides chalcides	136.0	5.7	7.5	5.6	8.3	3.0	3.0	terrestrial, cryptic, "grass-swimming"?
Eumeces egregius	47.0	3.5	4.9	8.8	13.3	5.0	5.0	terrestrial, cryptic, burrowing
Scelotes kasneri	64.8	2.9	4.4	0.0	6.6	0.0	2.0	terrestrial, cryptic, burrowing?
Alopoglossus atriventrils	45.4	6.3	7.2	13.8	21.1	5.0	5.0	terrestrial, leaf litter
Alopoglossus copii	51.6	7.2	7.6	14.9	25.5	5.0	5.0	terrestrial, leaf litter
Iphisa elegans	54.7	6.0	6.3	9.6	16.6	5.0	5.0	terrestrial, leaf litter
Gymnophthalmus leucomystax	36.4	3.7	4.0	8.1	9.6	4.0	5.0	terrestrial, leaf litter (for G. speciosus)
Leposooma percarinatum	34.7	4.3	4.9	10.0	12.6	5.0	5.0	terrestrial, leaf litter (for L. southi)
Heterodactylus imbricatus	87.6	7.5	7.9	11.5	22.6	4.8	5.0	terrestrial, leaf-litter (burrows?)
Cercosaura schreibersi	39.8	4.7	5.3	10.7	13.9	5.0	5.0	terrestrial, leaf-litter, grass clumps

Micrablepharus maximiliani	39.2	4.5	5.0	9.8	15.0	4.0	5.0	terrestrial, grass clumps, leaf litter
Chaemasaura anguina	121.6	6.8	9.3	3.9	7.2	1.0	1.0	terrestrial, grass-swimming
Tetradactylus africanus	86.3	6.3	7.7	1.3	3.9	1.0	1.0	terrestrial, grass-swimming
Tetradactylus seps	51.6	5.3	6.0	9.3	17.0	5.0	5.0	terrestrial, grass-swimming
Tetradactylus tetradactylus	66.2	4.9	5.8	6.1	7.5	4.0	4.0	terrestrial, grass-swimming
Cordylosaurus trivittata	41.0	4.5	5.0	9.4	14.8	5.0	5.0	terrestrial, saxicolous
Xenosaurus grandis	100.5	16.3	14.9	30.7	37.8	5.0	5.0	terrestrial, saxicolous
Podarcis sicula	71.4	8.6	9.9	19.5	32.1	5.0	5.0	terrestrial, saxicolous, arboreal
Shinisaurus crocodilurus	135.5	18.2	18.5	40.7	48.9	5.0	5.0	terrestrial, semi-aquatic
Arthrosaura reticulata	59.1	7.1	7.8	15.1	25.3	5.0	5.0	terrestrial, semi-aquatic, leaf litter
Amphiglossus mouroundavae	57.9	4.9	6.1	13.2	19.4	5.0	5.0	terrestrial, under cover
Colobodactylus dalcyanus	38.5	4.2	4.4	7.6	11.1	4.0	5.0	under rocks (terrestrial)
Talpalactera hassicaa	71.7	8.4	9.4	14.2	18.4	5.0	5.0	

Table SX. Taxa and PCA scores.

Species	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7
Abronia graminea	-11.40	-0.38	3.50	-1.59	-0.69	0.18	0.05
Gecko gekko	-67.39	2.36	11.04	-10.26	-1.73	0.02	0.47
Gonatodes albogularis	48.22	-9.65	2.96	-0.02	-0.26	-0.42	0.25
Calotes versicolor	-15.49	-37.28	0.53	3.71	2.74	0.73	0.07
Polychrus marmoratus	-55.16	-12.73	5.77	1.12	1.36	-0.93	0.05
Takydromus smaragdinus	36.50	-12.96	2.49	2.12	0.46	-0.97	0.18
Basiliscus basiliscus	-123.42	-74.35	-19.39	-0.03	0.76	0.93	0.18
Enyalioides laticeps	-55.81	-53.18	-1.32	0.68	2.75	1.04	0.27
Placosoma glabellum	34.14	-6.73	2.41	1.25	-0.11	-0.60	0.13
Eumeces laticeps	-31.77	-11.11	1.66	3.71	0.75	-2.59	0.04
Gerrhonotus liocephalus	-42.89	16.37	3.73	-1.89	-1.68	-0.41	-0.13
Cercosaura argulus	44.52	-10.49	3.33	0.81	0.06	-0.77	0.24
Cercosaura ocellata	36.13	-12.61	2.17	1.60	0.39	-0.18	0.14
Eumeces fasciatus	18.03	-8.41	1.81	2.19	0.22	-0.80	0.06
Eumeces inexpectatus	12.52	-8.50	1.35	2.61	0.23	-1.12	0.05
Diplodactylus damaeus	36.09	-8.66	2.77	-0.80	-0.54	-0.51	0.26
Amphiglossus macrocercus	19.14	-2.09	0.27	1.56	-0.52	-0.18	-0.04
Alopoglossus carinicaudatus	31.63	-7.77	1.43	-0.07	-0.45	0.17	0.13

Colobodactylus tanuayi	37.59	-3.24	-0.21	-0.11	-0.83	0.60	-0.09
Bipes biporus	-57.33	64.67	-4.16	4.73	-0.20	1.77	2.54
Bipes canaliculatus	-71.23	71.21	-4.56	4.07	0.05	1.71	1.82
Bipes tridactyluls	-22.18	46.71	-1.11	2.00	2.01	1.22	1.75
Dibamus novaeguineae	-21.36	49.09	-7.41	0.74	2.46	0.80	-0.48
Calyptommatus leiolepis	44.29	13.30	-2.50	-2.73	3.45	-0.44	-0.06
Calyptommatus nicterus	37.71	16.66	-2.84	-2.75	3.26	-0.18	-0.13
Calyptommatus sinebrachiatus	40.71	15.55	-2.47	-2.73	3.35	-0.38	-0.09
Notobachia ablephara	44.09	10.72	-2.69	-1.67	2.39	-0.33	-0.22
Procellosaurinus erythrocercus	63.41	-6.04	1.28	0.12	0.17	0.37	-0.49
Procellosaurinus tetradactylus	65.08	-6.14	1.05	0.23	0.13	0.27	-0.48
Psilophthalmus paeminosus	60.72	-1.46	0.71	-0.18	-0.31	0.29	-0.53
Brachymeles gracilis	18.63	10.64	-1.03	0.25	-1.80	0.48	-0.17
Brachymeles talinis	-15.07	18.00	-2.95	0.62	-2.24	0.72	-0.39
Proscelotes eggeli	8.35	16.98	-1.03	0.48	-2.00	0.69	-0.29
Pygomeles braconnieri	-32.67	51.09	-7.37	-3.07	0.50	-0.90	-0.64
Scelotes bipes	49.26	11.08	-2.15	-2.24	3.06	-0.59	-0.80
Scelotes gronovi	31.86	19.83	-3.57	-2.06	3.02	-0.94	-0.16
Scelotes sexlineatus	22.31	18.86	-6.70	-2.49	1.84	-0.46	-1.00
Voeltzkowia fierinensis	40.70	15.04	-3.30	-1.59	2.83	-0.66	-0.91
Neoseps reynoldsi	41.96	10.12	-2.58	-1.59	2.25	-1.03	-0.10
Bachia bresslaui	2.89	32.22	-2.19	-2.66	1.78	-0.47	0.29
Bachia dorbignyi	35.77	18.69	0.11	-0.81	1.79	0.01	1.69
Bachia flavescens	33.14	19.21	-0.97	-1.61	2.89	-0.64	0.47
Scincopus fasciatus	-72.53	0.68	9.27	1.32	0.94	-2.99	0.07
Scincus scincus	-34.75	0.03	3.75	3.49	0.05	-4.37	0.09
Sphenops boulengeri	9.70	12.10	-4.76	0.89	-2.25	0.18	-0.39
Sphenops sphenopsiformis	-1.64	21.42	-7.60	-0.71	-0.93	-0.84	-1.41
Chalcides mionecton	8.21	15.81	-4.34	-0.15	-1.38	0.00	-0.10
Sepsina angolensis	26.28	16.84	-3.25	-0.84	0.06	0.42	0.07
Cordylus cataphractus	-10.57	-14.04	6.36	-2.85	0.50	1.13	0.23
Cordylus cordylus	-3.24	-14.93	3.20	-1.16	0.36	0.85	0.15
Cordylus jordani	-17.62	-18.18	4.49	-0.84	1.12	1.43	0.10
Cordylus warreni	-33.34	-15.87	3.44	-2.79	0.21	1.11	0.16
Platysaurus rhodesianus	-23.54	-22.05	3.34	3.25	2.05	-0.28	0.03
Pseudocordylus microlepidotus	-50.10	-18.04	4.54	-2.37	0.62	0.32	0.20
Oedura coggeri	15.68	-1.79	5.55	-3.71	-1.08	-0.06	0.29
Urosaurus ornatus	34.65	-15.04	1.98	0.44	0.34	0.69	0.15
Amphiglossus astrolabi	-103.12	26.68	-2.88	3.18	-1.86	-1.36	-0.66
Neusticurus ecpleopus	24.80	-10.69	0.91	0.65	-0.10	0.23	0.09
Neusticurus rudis	8.91	-13.51	0.98	0.92	0.00	-1.03	0.18
Lanthanotus borneensis	-77.85	29.17	-0.52	1.62	-1.51	1.81	-0.77
Barisia imbricata	-23.03	8.05	3.68	-2.54	-1.34	0.42	-0.03
Celestus enneagrammus	18.96	6.36	0.73	-0.36	-1.38	0.51	-0.07
Diploglossus pleei	6.42	13.91	-0.36	-1.51	-2.18	1.16	-0.19
Elgaria coerulea	-0.43	-0.55	2.45	-0.84	-0.77	-0.01	0.05
Elgaria kingii	10.48	5.48	1.91	-0.77	-1.29	-0.06	0.00
Elgaria multicarinata	-25.13	3.90	3.25	0.44	-0.44	-0.50	-0.08
Elgaria panamintina	-24.12	4.76	3.09	0.12	-0.57	-0.21	-0.10

Elgaria paucicarinata	1.03	4.62	1.52	-1.61	-1.53	-0.13	0.03
Mesaspis moreleti	21.83	-0.39	3.20	-0.05	-0.47	0.28	0.04
Sauresia agasepsoides	36.02	11.75	-0.92	-0.81	-0.68	0.82	0.02
Wetmorena haetiana	25.41	10.41	-0.05	-1.56	-0.65	0.56	0.08
Coleonyx elegans	5.36	-9.93	5.14	-0.04	0.25	-1.29	0.25
Gerrhosaurus major	-137.39	4.80	2.89	-3.44	-0.73	0.92	-0.26
Gerrhosaurus nigrolineatus	-16.49	-10.22	-3.45	-1.65	-1.50	-0.21	0.11
Cercosaura eigenmanni	46.28	-9.97	2.95	0.72	-0.02	-0.51	0.22
Pholidobolus montium	35.51	-9.21	0.90	1.44	0.01	0.36	0.05
Ptychoglossus brevifrontalis	36.85	-4.39	0.08	-0.36	-0.95	0.58	0.07
Vanzosaura rubricauda	61.62	-5.00	0.73	0.12	-0.02	0.24	-0.50
Dipsosaurus dorsalis	-58.08	-34.75	-8.25	1.92	1.20	3.42	-0.27
Gambelia wislizenii	-32.92	-35.26	-5.17	-0.49	0.48	1.30	0.13
Leiocephalus carinatus	-38.95	-29.09	-1.85	-0.13	0.92	1.47	0.05
Meroles cuneirostris	28.20	-23.90	-2.68	-1.51	-0.62	0.42	0.31
Psammodromus hispanicus	48.07	-14.04	1.18	0.41	-0.12	-0.02	0.22
Amphiglossus igneocaudatus	38.07	-0.55	-2.51	0.49	-1.54	0.07	0.00
Gongylomorphus bojeri	40.39	-8.27	0.55	0.99	-0.46	-0.45	0.14
Ameiva ameiva	-142.29	-49.45	-13.94	-4.41	-1.86	-3.46	0.53
Dicrodon guttulatum	-56.58	-38.36	-9.65	-1.20	-0.66	-0.55	0.25
Teius teyou	-46.99	-29.58	-9.92	-0.57	-0.57	-1.18	0.96
Varanus griseus	-234.19	21.10	5.48	2.26	0.27	-3.07	-0.62
Xantusia vigilis	49.61	-5.98	2.45	0.51	-0.23	0.54	0.10
Cnemidophorus sexlineatus	14.62	-22.06	-3.59	0.04	-0.48	-0.18	0.21
Eumeces longirostris	16.25	-13.35	1.20	2.71	0.43	-1.50	0.14
Eumeces schwartzei	-24.70	-1.07	0.40	3.89	0.15	-1.48	-0.17
Tracheloptychus madagascariensis	24.27	-21.98	-3.87	-0.33	-0.50	0.83	0.17
Zonosaurus ornatus	-41.46	-4.48	-3.36	-3.53	-2.01	0.88	0.00
Cercosaura quadrilineatus	49.38	-5.98	2.71	0.96	-0.12	0.18	0.11
Proctoporus bolivianus	31.21	-4.01	1.50	0.67	-0.37	0.48	0.02
Proctoporus simoterus	26.23	2.91	2.04	0.44	-0.77	0.29	-0.03
Amphiglossus melanopleura	47.17	-2.36	0.06	0.50	-0.90	0.50	0.03
Amphiglossus melanurus	26.91	5.24	-0.76	0.94	-1.30	0.29	-0.11
Amphiglossus ornaticeps	39.94	8.35	-0.41	0.18	-1.68	0.53	-0.09
Amphiglossus punctatus	28.13	-2.11	0.58	1.79	-0.45	-0.21	-0.02
Amphiglossus intermedius	23.21	3.81	-2.60	1.31	-1.30	0.89	-0.20
Amphiglossus stumpffi	4.23	8.22	-2.82	2.44	-1.16	0.85	-0.35
Amphiglossus tsaratananensis	7.95	9.90	-0.46	0.57	-1.50	0.41	-0.19
Amphiglossus waterlotti	-33.47	10.29	0.23	2.34	-1.04	-1.72	-0.21
Scelotes mirus	20.12	13.90	-2.46	1.04	-1.98	0.77	-0.29
Diploglossus bilobatus	20.92	5.23	0.99	-1.23	-1.47	0.84	-0.03
Teratoscincus scincus	-20.47	-16.28	6.60	-4.00	0.36	0.94	0.31
Angolossaurus skoogi	-56.16	-8.83	1.02	2.61	0.75	-0.55	-0.16
Leiolepis belliana	-52.87	-29.06	-6.74	1.09	0.55	1.99	-0.14
Phrynocephalus versicolor	26.41	-23.61	1.12	0.25	1.05	2.37	0.09
Chalcides ocellatus	-31.10	11.38	-0.78	2.98	-0.93	-0.81	-0.34
Sphenodon punctatus	-153.46	-11.42	6.95	-7.41	-0.60	-1.53	0.34
Heloderma suspectum	-228.63	25.85	11.92	2.23	3.12	6.04	-1.33

Chalcides polylepis	-21.08	8.45	-0.69	3.47	-0.64	-0.78	-0.31
Eumeces schneideri	-46.35	-3.19	-0.98	5.07	0.53	-1.39	-0.28
Scelotes caffer	47.70	5.08	-2.28	-0.39	1.00	0.60	0.22
Lepidophyma flavimaculatum	-3.70	-8.96	2.64	3.09	0.93	-0.33	-0.06
Eumeces obsoletus	-22.04	-0.79	2.40	3.62	0.37	-1.68	-0.11
Chalcides chalcides	-33.05	43.53	-4.94	0.07	-1.40	-0.30	-0.36
Eumeces egregius	43.90	-1.41	0.69	1.39	-0.69	-0.18	0.03
Scelotes kasneri	32.83	15.77	-4.81	-2.62	2.19	-0.90	-0.87
Alopoglossus atriventrils	40.74	-10.82	1.89	0.28	-0.19	-0.08	0.19
Alopoglossus copii	33.27	-12.03	0.36	0.09	-0.29	0.50	0.13
Iphisa elegans	35.26	-1.30	0.22	-0.44	-1.13	0.54	0.04
Gymnophthalmus leucomystax	54.87	-2.93	2.68	0.80	0.43	0.03	-0.54
Leposooma percarinatum	54.67	-7.01	3.15	0.89	-0.07	-0.04	0.16
Heterodactylus imbricatus	3.13	7.78	-3.16	-0.31	-1.83	0.96	-0.34
Cercosaura schreibersi	49.42	-6.09	2.83	0.90	-0.14	0.01	0.13
Micrablepharus maximiliani	49.86	-6.76	1.40	0.49	0.37	0.08	-0.51
Chaemasaura anguina	-19.79	38.32	-4.18	-3.66	0.60	-1.71	0.31
Tetradactylus africanus	13.58	26.22	-2.14	-5.00	1.19	-1.32	0.58
Tetradactylus seps	38.06	-2.77	-0.29	-0.08	-1.09	0.38	0.05
Tetradactylus tetradactylus	29.32	12.63	0.77	-0.70	-0.57	-0.29	0.10
Cordylosaurus trivittata	48.42	-5.66	1.21	0.64	-0.48	0.33	0.09
Xenosaurus grandis	-20.30	-7.80	6.51	-1.17	0.62	0.64	0.09
Podarcis sicula	11.81	-10.50	-0.28	0.65	-0.31	0.00	0.07
Shinisaurus crocodilurus	-58.39	-5.25	6.68	1.27	1.25	-0.45	-0.07
Arthrosaura reticulata	26.63	-8.58	0.03	0.45	-0.44	0.36	0.07
Amphiglossus mouroundavae	30.69	-3.29	0.62	2.06	-0.26	0.01	-0.03
Colobodactylus dalcyanus	52.50	-3.06	1.66	0.09	0.08	0.22	-0.53
Cryptolacerta hassiaca	17.75	2.45	2.82	-0.98	-1.12	-0.42	0.10

Table SX. PCA eigenvalues and % variance

PC	Eigenvalue	% Variance
1	2657.75	86.014
2	406.371	13.152
3	17.5981	0.56953
4	4.86283	0.15738
5	1.74012	0.056316
6	1.36413	0.044148
7	0.226085	0.0073169

Table SX PCA loadings

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	Axis 7
SVL	-0.8871	0.4525	-0.07671	0.04006	-0.02144	0.01392	-0.01117
HW	-0.1172	-0.1215	0.3882	-0.6855	0.00118	0.5923	-0.00546

					8		
SE	-0.1183	-0.1392	0.2059	-0.5032	-0.2691	-0.7679	0.09427
FLL	-0.2505	-0.3942	0.7096	0.4405	0.2771	-0.08619	-0.00548
HLL	-0.35	-0.7762	-0.5158	-0.02228	-0.03828	0.08385	-0.00394
Fingers	-0.00593	-0.03635	0.1286	0.2488	-0.7067	0.2022	0.6163
Toes	-0.00192	-0.04439	0.1222	0.1367	-0.5911	0.06266	-0.7817

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