PNAS
www.pnas.org

Supplementary Information for

Ecomorphological diversification from conserved pattern of cranial integration in squamates

A Watanabe, A-C Fabre, RN Felice, JA Maisano, J Müller, A Herrel, A Goswami

Akinobu Watanabe
Email: awatanab@nyit.edu

This PDF file includes:

Supplementary text
Figs. S1 to S11
Tables S1 to S12
References for SI reference citations

Supplementary Information Text

Institutional and Fieldwork Abbreviations

AMNH (FARB)	American Museum of Natural History (Fossil Amphibians, Reptiles, Birds Collection), New York, NY, U.S.A.
CAS	California Academy of Sciences, San Francisco, CA, U.S.A.
CM	Carnegie Museum of Natural History, Pittsburgh, PA, U.S.A.
FLMNH	Florida Museum of Natural History, Gainesville, FL, U.S.A.
FMNH	Field Museum of Natural History, Chicago, IL, U.S.A.
FRIM	Forest Research Institute, Kepong, Malaysia
IGM	Geological Institute, Mongolian Academy of Sciences, Ulaan Bataar, Mongolia
LACM	Los Angeles County Museum, Los Angeles, CA, U.S.A.
MAE	Mongolia-AMNH Expedition
MCZ	Museum of Comparative Zoology, Cambridge, MA, U.S.A.
MNHN	Muséum national d'Histoire naturelle, Paris, France
NHMUK	Natural History Museum, London, U.K.
ROM	Royal Ontario Museum, Toronto, Canada
TNHC	Texas Memorial Museum, Austin, TX, U.S.A.
UCMP	University of California Museum of Paleontology, Berkeley, CA, U.S.A.
UMMZ	University of Michigan Museum of Zoology, Ann Arbor, MI, U.S.A.
USNM	National Museum of Natural History, Washington, DC, U.S.A.
UTA	University of Texas at Arlington, Arlington, TX, U.S.A.
YPM	Yale Peabody Museum, New Haven, CT, U.S.A.
ZFMK	Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany
ZMB	Zoological Museum of Berlin, Berlin, Germany
ZPAL	Institute of Paleobiology, Warsaw, Poland

Taxonomic Sampling

To sample the taxonomic and phylogenetic breadth of Squamata efficiently, we assessed the taxonomic coverage of existing scan data from DigiMorph (digimorph.org) representing 129 extant species and supplemented with scans of 45 additional extant taxa from Museum für Naturkunde (Berlin, Germany), Museum for Comparative Zoology (Cambridge, MA, USA), and Morphosource to fill gaps in sampling at our targeted level. When the taxonomic name specified on a specimen was absent or mismatched in the phylogenetic tree, the name was replaced with updated nomenclature in accordance with The Reptile Database (reptile-database.org) or with the closest relative sampled in the tree (*SI Appendix*, Table S2). We ensured that the sampled specimens exhibited sufficient somatic maturity and all regions of interest. Accordingly, specimens with cranial osteoderms inseparable from skull bones, even with CT data, were removed from sampling (e.g., *Anguis*, *Gerrhonotus*, *Gerrhosaurus*, *Ophiodes*, *Ophisaurus*, *Podarcis*). The sex of the specimens was not considered.

For extinct groups, we surveyed the existing literature and online databases (primarily DigiMorph) to identify fossil skulls of squamates that are complete, fully articulated, and minimally deformed. Three-dimensional (3-D) skull reconstructions were created from surface and CT data of fossil specimens that are potentially suitable for the study. Newly scanned specimens for this study included *Carusia intermedia* (IGM 3/17), *Ctenomastax parva* (IGM 3/62), *Dyticonastis rensbergeri* (UCMP 76881), *Eosaniwa koehni* (FMNH XXXVII/57), *Estesia mongoliensis* (AMNH FARB 29072), *Gambelia corona* (LACM 42880), *Globaura venusta* (IGM 3/164), *Helodermoides tuberculatus* (CMNH 51344), *Hymenosaurus clarki* (IGM 3/53), *Isodontosaurus gracilis* (IGM 3/84), *Listromycter leakeyi* (NHMUK R 8292), *Lophocranion rusingense* (NHMUK R 8293), *Peltosaurus granulosus* (AMNH FARB 42193), *Phrynosomimus asper* (IGM 3/181), *Platecarpus coryphaeus* (SMF R417), *Plotosaurus bennisoni*

(UCMP 32778), *Polyglyphanodon sternbergi* (USNM 16588), *Priscagama gobiensis* (MAE 98-154), *Pyramicephalosaurus cherminicus* (IGM 3/130), and *Slavoia darevskii* (ZPAL MgR-I.112). µCT data of *Hyporhina antiqua* (YPM 11390) and *Spathorhynchus fossorium* (USNM 26318) were taken from a previous study (1). Of the specimens scanned, only seven of the specimens exhibited adequate preservation and preparation to collect coordinate data for the study: *Estesia*, *Gambelia*, *Hyporhina*, *Plotosaurus*, *Polyglyphanodon*, *Slavoia*, and *Spathorhynchus*. The final dataset analyzed in this study comprises a total of 181 taxa, with 109 extant non-snake squamate species, 65 snake species, and seven fossil squamate taxa (Table S2).

Scan Data

To enable efficient sampling of skull reconstructions, the scan data were collected from multiple sources (see 'Source' in Table S2). Specimens from DigiMorph (digimorph.org) were scanned with an ACTIS scanner at the High-Resolution X-ray Computed Tomography Facility at the University of Texas at Austin, with the exception of *Anelytropsis papillosus* and *Liotyphlops albirostris* which were scanned at Amherst College using a Skyscan 1172 desktop µ-CT scanner (Bruker microCT, Kontich, Belgium). Author A.H. imaged specimens using the X-Tek scanner (X-tek Systems, Ltd., Amherst, NH, U.S.A.) at Harvard University. At Museum für Naturkunde, specimens were scanned using a Phoenix nanotom X-ray|s (General Electric, Boston, MA, U.S.A.). Some fossil specimens were scanned at the Microscopy and Imaging Facility at the American Museum of Natural History. Furthermore, a Go!SCAN surface scanner (Creaform, Lévis, Canada) was used to digitize a few of the fossil specimens. The scanning parameters differ across specimens from attempts to optimize the quality of the scans for individual specimens. Although variation in scan resolution (and contrast for CT imaging) could introduce slight differences in resulting reconstructions, and thereby coordinate data, we considered such differences to be inconsequential relative to the total variation in skull shape across squamates.

3-D Reconstructions

VGStudio MAX (Volume Graphics, Heidelberg, Germany) was used to segment and create skull reconstructions for specimens scanned at the High-Resolution X-ray CT Facility at The University of Texas at Austin, Amherst College, and Museum für Naturkunde. Data of specimens scanned at Muséum national d'Histoire naturelle and the American Museum of Natural History were segmented in Avizo (FEI Visualization Sciences, Burlington, MA, USA). VXElements (Creaform, Lévis, Canada) was used to process surface scan data recorded with Go!SCAN scanners and virtually stitch separate partial scans taken from multiple sides (e.g., dorsal, ventral). In all cases, the resulting skull reconstructions were exported as PLY files.

Next, we imported the PLY files into GeoMagic Wrap (3D Systems, Rock Hill, South Carolina, USA) and prepared the 3-D skull reconstructions for the landmarking procedure. First, small holes, such as foramina, were virtually filled by removing 1–2 polygon-wide rim of the hole and creating a surface across the rim with the 'Tangent mode' of the 'Fill Hole' tool. We employed this mode for filling holes because it does not modify the surrounding polygons ('Curvature' mode) while creating surfaces that conform to the configuration of surrounding polygons (*contra* 'Flat' mode). After all small holes were filled, small, isolated components were removed. Lastly, we used the 'QuickSmooth' function to make the polygons more uniform in size. The processed reconstructions were then centered at the centroid and exported as a PLY file.

Coordinate Data

The general protocol for collection of coordinate data follows Felice and Goswami (2). A.W. collected landmark data only from specimens in visually neutral poses, where the articular surfaces and their outlines are immediately adjacent to each other (see 'Within-Landmark Analyses'). Detailed guidelines for the procedure will be described in a future publication. Here, we describe aspects of the protocol that are particularly relevant to this study.

We used the program Landmark Editor (3) (http://graphics.idav.ucdavis.edu/research/EvoMorph) to virtually place landmarks and curve semi-landmarks that define and outline skull regions determined *a priori* (Table S1). Evolutionarily homologous (Type I) landmarks were sampled to the extent possible. However, due to the considerable phylogenetic and morphological breadth of the study, we adopted more functional definitions for many regions that are applicable across squamates. At this step, liberal sampling of curve semi-landmarks was collected in order to accurately follow the contours of regions (Fig. S1a). Although the program is equipped with tools to place surface semi-landmarks, we elected to perform a semi-automated procedure to place surface semi-landmarks on skull models, as described below. After the placement of landmarks and curve semi-landmarks, the x, y, z coordinate data were exported as PTS files.

We used available packages and code to subsample curve semi-landmarks and place surface semi-landmarks in R (4). Because curve semi-landmarks were liberally sampled in Landmark Editor, subsampling algorithm employed by Botton-Divet and colleagues (5) was used to sample far fewer numbers of semi-landmarks along each path defined by dozens of existing semi-landmarks (Fig. S1b). The amount of subsampled curve semi-landmarks for each curve was chosen to generally match the density of surface semi-landmarks for that region (Table S1).

For the placement of surface semi-landmarks, we used the `placePatch` function in the `Morpho` R package v2.5.1 (6). This function places surface (patch) semi-landmarks by fitting a template with surface semi-landmarks and the same configuration of landmarks and curve semi-landmarks onto the coordinate data of each specimen that consists of landmarks and curve semi-landmarks. The position of the surface semi-landmarks is determined through a thin-plate spline method. To prevent the surface semi-landmarks from being placed within a mesh (e.g., an internal anatomical structure, reverse side of external surface), the user specifies an ‘inflate’ value to temporarily shift each surface semi-landmark along its normal to the specified magnitude and subsequently ‘deflate’ until the point contacts a mesh surface.

During the course of the study, we found several factors critical to the success of the `placePatch` function. First, for studies with morphologically disparate specimens, a simple geometric representation of the skull and its partitions perform better as a template than using actual or mean skull shape. As such, a 360 x 360 uniform-vertex sphere was created in Meshlab (7) and bisected in Blender (Stitching Blender Foundation, Amsterdam, Netherlands) to create a hemispheric template mesh. The mesh, in PLY format, was then imported into Landmark Editor to manually place the same configuration of landmarks and curve semi-landmarks as on meshes of actual specimens (Fig. S1c,d). In addition, we placed semi-landmarks with consistent density within each region of the template to be mapped on specimen meshes as surface semi-landmarks.

Second, the accuracy of patching improved through stepwise application of the `placePatch` function, instead of patching all surface semi-landmarks altogether. This approach allows the fitting of template landmarks and semi-landmarks on actual specimens to occur within one or few regions, rather than enforcing the entire landmark and curve semi-landmarks configuration of the template onto that of the specimens. In some cases, however, an error occurred for largely unknown reasons when attempting to patch within a single region. For these situations, we discovered that patching two or three regions together resolved the issue (e.g., use of landmarks and curve semi-landmarks of the basioccipital and occipital condyle to patch surface semi-landmarks on the basioccipital).

Third, some bones partially cover other regions of interest in various taxa. This results in the patching algorithm placing surface semi-landmarks on adjacent bones rather than the region of interest. For example, patching procedure led to spurious placements of surface semi-landmarks on the dorsal part of the quadrate bone that overlies the squamosal and supratemporal bones in snakes and non-snake squamates (hereby ‘lizards’), respectively. Likewise, the function often placed surface semi-landmarks for the basioccipital region on the pterygoid and palatine in snakes. To rectify this issue in non-snake squamates, we created skull models with the dorsal portion of the quadrate bone virtually removed for accurate patching of the underlying squamosal while maintaining the patching of the jaw joint. For snakes, we constructed similar models for patching the supratemporal, as well as another set of skull meshes without the pterygoid and palatine for patching the basioccipital region. This approach allowed the surface semi-landmarks to be inflated upon fitting the template onto the skull reconstructions without being 'deflated' onto another bone.

Lastly, accurate patching required multiple, user-specified 'inflate' values across partitions and taxa due to two main reasons. First, the 'inflate' argument in the `placePatch` function corresponds to unit size. As such, multiple 'inflate' values were needed to accommodate the spectrum of size differences that exist in our taxonomic sampling (centroid size range: 47.0 – 4381.2 mm). Second, the large morphological variation exhibited by each region necessitated varying 'inflate' values for accurate placement of surface semi-landmarks. Without altering the "inflate" values, running the `placePatch` function resulted in surface semi-landmarks outside of the region of interest (e.g., high inflation relative to the size of the specimen and region) or on the underside of the mesh surface due to insufficient 'inflate' values. Although the use of a single 'inflate' scheme across all specimens is desired, we prioritized the accuracy of landmark placement to minimize the loss of biologically meaningful morphometric data.

With these considerations, we performed the `placePatch` function with the following parameters: `ray=TRUE, tol=0, and relax.patch=FALSE`. After patching of surface semi-landmarks, we used the `retroDeformMesh` function in the `Morpho` R package (6) to retrodeform the coordinate points and model of *Estesia* (AMNH 29072), which exhibits shearing. The retrodeformation was based on the bilateral relationships of landmarks, and the semi-landmarks were translated with the transformation of the landmarks. While Schlager and colleagues (8) recommend the use of semi-landmarks for the retrodeformation procedure, we found that the use of only landmarks yielded visually more accurate results possibly due to their overall stronger evolutionary and geometric equivalence compared to curve and surface semi-landmarks. The accuracy and precision of different approaches to retrodeformation will likely differ across datasets.

Shape Data

Once surface semi-landmarks were mapped to specimen meshes, the right-sided coordinate data were mirrored, creating dummy left-sided coordinates (Fig. S1e). This was done to prevent artifacts of aligning one-sided landmark data, where variation among midline points become exaggerated (9, 10). We utilized the `mirrorfill` function in the `paleomorph` R package (11) to mirror the left-sided curve and surface sliding semi-landmarks based on the bilateral relationships of the landmarks and the median plane defined by the midline landmarks. The mirrored coordinate data were then subjected to a sliding curve and surface semi-landmark alignment within each dataset (i.e., snakes, lizards, extant, combined) under the criterion of minimizing total bending energy. We used the `slider3d` function in the `Morpho` R package (6) to slide the left-sided semi-landmarks that are projected onto the mesh surfaces after each iteration to ensure that their positions are informed by the actual specimens. Parameters specified for the sliding procedure are the following: `tol=1e-30, recursive=TRUE, iterations=3, initproc=TRUE, bending=TRUE, stepsize=0.1`. This function outputs a coordinate dataset with slid semi-landmarks that restores the (centroid) size of specimens in the given coordinate data. We then performed Procrustes analysis to extract centroid size and shape data using the `gpagen` function in the `geomorph` R package (12, 13) on the slid coordinate data. The landmarks and sliding semi-landmarks on the left-side were then removed (Fig. S1f).

Given the high disparity and mean rates in mobile elements (Fig. 4; *SI Appendix*, Fig. S6), additional variation from tissue fixation of mobile elements must be considered despite our efforts to sample only specimens in neutral poses. Two potential approaches for mitigating this factor is to standardize the orientation across joints and to analyze shape data that have been aligned locally within each module. Although these measures may be suitable for studies with a narrow taxonomic scope, they would confound real biological differences in the relative positions of these mobile elements. In addition, there is a good correspondence in shape variation between globally and locally aligned shape data (*SI*

Appendix, Table S12). The latter approach to shape analysis would lead to variance being incomparable across modules due to creation of separate shape spaces. Because of these reasons, we performed analyses on globally aligned coordinate data collected from specimens in visually neutral poses. We also anticipate that the variation from fixation of mobile elements is proportionately small relative to the large interspecific variation in skull shape and bone position.

Phylogenetic Tree

For comparative phylogenetic analyses, we constructed a time-calibrated phylogeny based on published phylogenetic trees and fossil occurrence data. For extant taxa, we used the published time-calibrated tree of squamates (14). We pruned the extant phylogeny to include only sampled taxa. Extinct taxa were incorporated into the extant phylogeny manually using the equal-branching method (15) based on mean age as reported in the Paleobiology Database (paleobiodb.org) and published systematic work. The phylogenetic placement of fossil specimens to immediate taxonomic group was primarily based on a comprehensive squamate phylogeny proposed by combined molecular and morphological data (16), with placement of *Hyporhina antiqua* and *Spathorhynchus fossorium* based on the phylogeny of rhineurids put forward by Hipsley and Müller (1). It should be noted, however, that the phylogenetic placement of mosasaurs and *Slavoia* within Squamata remains unclear. Mosasaurs have been placed as sister group to Varaniformes and more derived than Shinisauridae (17), sister group to Scleroglossa (18), or more closely related to Serpentes (19–21). With regard to overall skull shape, the mosasaur *Plotosaurus* resembles varanoid taxa, including *Varanus*, *Heloderma*, and *Estesia* (Fig. S2) although whether this morphological affinity reflects evolutionary history cannot be determined due to the possibility of convergence. Likewise, *Slavoia darevskii* Sulimski 1984 from the Cretaceous of Mongolia has been problematic to place phylogenetically (22). For the present study, we adopt the phylogenetic hypothesis of Reeder and colleagues (16) with an understanding that a consensus will likely be established for the phylogenetic relationship of these taxa in the future. Nevertheless, the impact of sampled fossil taxa on pattern of covariation, variance, and evolutionary rates tends to be restricted to the extinct lineage. For instance, the analysis infers elevated rates of evolution on the branches leading to extinct taxa (Fig. 3a) while inferred rates remain similar for other branches when compared to the extant-only dataset (Fig. S5a). As such, altering the phylogenetic positions of some fossil taxa is expected to yield consistent results for squamates overall. Additionally, we performed analysis of cranial integration ('Combined Dataset (Alternative Topology)" in Table S7) and estimated rates (Fig. S5n–s) on an alternative topology where the mosasaur *Plotosaurus* is placed as sister group to varanids, *Polyglyphanodon* is placed as sister group to Teiidae and Gymnophthalmidae, and *Estesia* is placed as sister group to helodermatids (17). As anticipated, these analyses yielded very similar results to the original topology. One difference is that the evolutionary rate analysis supported OU model as the most likely model for the combined dataset, instead of BM+λ model. Nevertheless, the distribution of rates across the squamate phylogeny is nearly identical. Therefore, the overall results and conclusions are robust to inclusion, removal, and phylogenetic placement of fossil taxa.

Evolutionary Rates

We used BayesTraitsV3 (23) (http://www.evolution.rdg.ac.uk/) to infer the rates of shape evolution along each branch and identify notable shifts in rate while considering various evolutionary models. Ideally, shape evolution should be evaluated with a full set of Procrustes coordinates but currently available methods do not allow model fitting with high-dimensional continuous data (24). Thus, we performed separate principal components (PC) analysis on the lizard, snake, extant, and combined datasets and within each module to extract PC axes that account for 95% of the variation (Table S3). Then, the PC scores were multiplied by 1000 to prevent underflow during analysis. For each PC shape dataset, we evaluated the fit of five evolutionary models: Ornstein-Uhlenbeck, Brownian motion (BM), and BM with delta, kappa, and lambda transformations. The analyses were run with 'independent contrasts' to make the computational time more feasible than using generalized least-squares method with Markov chain Monte Carlo algorithm for parameter space search. Additional parameters include variable rates ('varrates') to estimate a separate rate of evolution for each branch and 500 stones with 10,000 iterations each for efficient estimation of marginal likelihoods (25). Analyses of skull shape data (i.e., lizard, snake, extant, combined datasets) consisted of 5,500,000 iterations, with the first 500,000 iterations removed as burn-in, to accommodate the more complex shape variation and larger number of PC axes. Within-module analyses comprised 1,010,000 iterations, with the first 10,000 iterations removed as burn-in.

Functions in the `BTRtools` package (https://github.com/hferg/btrtools) were used to process the output files from BayesTraitsV3. Comparisons among the five evolutionary models was based on Bayes Factor. To construct rate through time plots, the phylogenetic tree was subdivided into one-million-year time bins and the mean rate calculated across all branches in the time bin. Calculations of mean evolutionary rates across the skull and modules were based on full shape space using the compare.multi.evol.rates in the geomorph R package based on BM model of evolution (26). Assuming the same evolutionary model allows for standard comparison of mean rates across modules.

Ecological and Life History Traits

Trait data were collected for extant taxa from existing literature (Table S5). While ecological traits are often difficult to define categorically, we used the following definitions:

Locomotion:

- Ground dweller/swimmer: species that spend time in water and on the ground lacking evidence for clear preference for either.
- Ground dweller/digger: species that spend time locomoting on the ground and that regularly dig.
- Ground dweller/climber: species that spend both times locomoting on the ground and climbing on tree or rocks lacking evidence for clear preference for either.
- Climber: species that spend the majority of their time climbing in trees or on rocks.
- Swimmer: species spending majority of their time swimming.
- Ground dweller: species that spend the most part of their time locomoting on the ground, but occasionally climb, swim or dig.
- Digger: species that spend the most part of their time digging or locomoting in burrow.
- Litter dweller: species that spend the most part of their time locomoting in litter.
- Climber/glider: species that spend the majority of their time climbing in trees and gliding from one tree to another.

Habitat:

- Terrestrial: species that spend the most part of their time on the ground, but occasionally climb, swim or dig.
- Fossorial: species that spend the majority of time on burrows.
- Semi-fossorial: species that spend the majority of time on the ground, but regularly dig burrows or dig to find food.
- Aquatic: species that spend the most of their time in water to forage, escape, disperse.
- Semi-aquatic: species that spend both times in water and on the ground without a clear preference for either.
- Arboreal: species that spend the majority of their time in trees.
- Semi-arboreal: species that spend both time in trees and on the ground without a clear preference for either.
- Semi-aquatic/Semi-fossorial: species that spend times on the ground, but regularly dig burrows or dig to find food as well as foraging and disperse in water.

- Terrestrial saxicolous: species that spend both times on rocky environment and on the ground without a clear preference.
- Saxicolous: species that spend the majority of their time on rocky environment.
- Leaf litter: species that spend the majority of their time on the leaf litter.

Diet:
- Invertivore: species that mainly eat invertebrate prey.
- Carnivore: species that mainly eat vertebrate prey.
- Herbivore: species that mainly eat plants.
- Omnivore: species that eat vertebrate and invertebrate prey in addition to feeding on a variety of fruits, eggs, and other foods.

Reproductive mode:
- Oviparous: species that lay eggs.
- Viviparity: species that retain developing eggs inside the maternal body (either reproductive tracts or body cavity) giving birth to a free-living newborn. Due to only few taxa in the category, ovoviviparous species were considered to be viviparous.

For reproductive mode, we analyzed viviparous and oviparous taxa although we acknowledge that viviparity in squamates is characterized as a continuum (27). However, detailed information reflecting the reproductive spectrum is not known for many squamate taxa. Therefore, we relied on categories recorded across squamates in previously published literature and have been used in previous studies.

We plotted mean evolutionary rates for each trait value and partition to visualize any large-scale patterns (Fig. S6). To test for significant predictors of skull shape, we performed phylogenetic generalized least squares (PGLS) analyses on full shape data and trait data using the `procD.pgls` function in `geomorph` (Table S6). Some of the more complex categories ("Ground dweller/Swimmer/Digger" and "Swimmer/Climber/Ground dweller") were assigned as a "generalist" because they were represented by one or two species. However, other categories with multiple assignments were used in our analyses because our high-density morphometric approach, compared to traditional morphometric data, has the capacity to reveal subtle shape differences among these complex categories. Combining these discernible ecological differences into one category (i.e., "generalist") would likely obfuscate genuine signal in our data. Ideally, we would perform analyses that account for overlap of ecological trait categories but existing methods (e.g., PGLS analysis) cannot currently account for this issue. A solution is to analyze percentages of habitat occupation or stomach content types, but adequately detailed data are not available for most squamate taxa.

Cranial Integration

To assess the degree of cranial integration, we employed existing computational tools that are robust to high-dimensional morphometric data. Lizard, snake, extant-only, and combined extant and extinct datasets were subjected to EMMLi, a maximum-likelihood approach, and analysis based on covariance-ratio (CR) with and without phylogenetic correction of the data. For non-phylogenetically informed analyses, CR and EMMLi generated mostly congruent results. In lizards, relatively high correlation and covariation exist between the frontal and parietal, jugal and jaw joint, supra-otoccipital, basioccipital, and occipital condyle, and pterygoid and palatine. Snakes show elevated covariation and correlation between the occipital elements (i.e., supra-otooccipital, basioccipital, occipital condyle) and, in contrast with lizards, between the jaw joint with supra-otoccipital, pterygoid, and occipital condyle. The extant dataset shows high covariation and correlation between the jaw joint and basioccipital, jaw joint and pterygoid, basioccipital and pterygoid, and occipital elements. Although there are some differences between results from CR and EMMLi, the general patterns are consistent.

Despite recent methodological efforts to mitigate statistical issues related to high-dimensional data ("curse of dimensionality" (24, 28)), analysis of such phenotypic data remains challenging. As such, the robustness of statistical results based on high-dimensional datasets requires evaluation. To assess the reliability of the pattern of correlation among regions, we performed EMMLi on datasets subsampled to 10% of the total landmark + sliding semi-landmark dataset for 100 iterations, with a minimum of five landmarks retained for each module. We further analysed the landmark-only dataset with the same partitions, with the exception of the occipital condyle, which was defined by only two landmarks. The correlation patterns for both subsets are consistent with the results from the full dataset (Fig. S9), supporting that the cranial modules identified in this study are robust to dataset dimensionality.

With the characterization of highly disparate morphologies, another potential issue with the shape data is that Procrustes alignment may artifactually spread the variance across the entire skull, such that comparisons of Procrustes coordinates deviate from biological signal. For instance, analysis of modularity and within-partition variation in this study are based on shape coordinates from single, global alignment of the entire skull. As such, the differences in Procrustes coordinates could be due to changes in relative position of the partition to the rest of the skull and not necessarily due to changes in shape within the partition. To optimize the interpretability of results by retaining the spatial relationships of landmark points, we did not perform analyses on Procrustes coordinates from separate, local alignments within each region or module (29). Nevertheless, the effect of this artifact must be addressed. First, the use of high-dimensional morphometric data with sliding semi-landmarks that densely captures the morphology of structures across the skull will mitigate the "Pinocchio effect" (30), where variance in isolated landmark points positioned at the extremes of structures (e.g., anterior tip of the rostrum) is redistributed across other landmark points. Yet, certain regions, such as the jaw joint, may be susceptible to the alignment artifact. To evaluate its impact, we performed a two-block partial least squares analysis (31) within each module to confirm the correspondence between globally and locally aligned datasets. With the exception of the jugal, all partitions showed correlation coefficients $R > 0.7$ and $P < 0.001$ (Table S12). In addition, changes in relative position of partitions is biologically meaningful information that we want to characterize in our analyses.

References

1. Hipsley CA, Müller J (2014) Relict endemism of extant Rhineuridae (Amphisbaenia): Testing for phylogenetic niche conservatism in the fossil record. *Anat Rec* 297:473–481.
2. Felice RN, Goswami A (2018) Developmental origins of mosaic evolution in the avian cranium. *Proc Natl Acad Sci* 115:555–560.
3. Wiley DF, et al. (2005) Landmark Editor. Available at: graphics.idav.ucdavis.edu/research?EvoMorph.
4. R Core Development Team (2017) R: A language and environment for statistical computing. Available at: https://www.r-project.org.
5. Botton-Divet L, Houssaye A, Herrel A, Fabre A-C, Cornette R (2015) Tools for quantitative form description; an evaluation of different software packages for semi-landmark analysis. *PeerJ* 3:e1417.
6. Schlager S (2017) Morpho and Rvcg - shape analysis in R: R-packages for geometric morphometrics, shape analysis and surface manipulations. *Statistical Shape and Deformation Analysis: Methods, Implementation and Applications*, eds Zhen G, Li S, Szekely G (Academic Press), pp 217–256.
7. Cignoni P, Corsini M, Ranzuglia G (2008) Meshlab: an open-source 3d mesh processing system. *ERCIM News* 73:45–46.
8. Schlager S, Profico A, Di Vincenzo F, Manzi G (2018) Retrodeformation of fossil specimens based on 3D bilateral semi-landmarks: Implementation in the R package "Morpho." *PLoS ONE* 13(3):e0194073.
9. Cardini A (2016) Lost in the other half: Improving accuracy in geometric morphometric analyses of one side of bilaterally symmetric structures. *Syst Biol* 65:1096–1106.

10. Cardini A (2017) Left, right or both? Estimating and improving accuracy of one-side-only geometric morphometric analyses of cranial variation. *J Zool Syst Evol Res* 55:1–10.
11. Lucas T, Goswami A (2017) paleomorph: geometric morphometric tools for paleobiology.
12. Adams DC, Otárola-Castillo E (2013) geomorph: An R Package for the collection and analysis of geometric morphometric shape data. *Methods Ecol Evol* 4:393–399.
13. Adams AD, Collyer M, Otárola-Castillo E, Sherratt E, Adams MD (2017) Package ‘ geomorph .’
14. Zheng Y, Wiens JJ (2016) Combining phylogenomic and supermatrix approaches, and a time-calibrated phylogeny for squamate reptiles (lizards and snakes) based on 52 genes and 4162 species. *Mol Phylogenet Evol* 94:537–547.
15. Brusatte SL, Lloyd GT, Wang SC, Norell MA (2014) Gradual assembly of avian body plan culminated in rapid rates of evolution across the dinosaur-bird transition. *Curr Biol* 24(20):2386–2392.
16. Reeder TW, et al. (2015) Integrated analyses resolve conflicts over squamate reptile phylogeny and reveal unexpected placements for fossil taxa. *PLoS ONE* 10(3):e0118199.
17. Conrad J (2008) Phylogeny and systematics of Squamata (Reptilia) based on morphology. *Bull Am Museum Nat Hist* 310:1–182.
18. Gauthier JA, Kearney M, Maisano JA, Rieppel O, Behlke ADB (2012) Assembling the squamate tree of life: Perspectives from the phenotype and the fossil record. *Bull Peabody Museum Nat Hist* 53:3–308.
19. Caldwell MW, Lee MSY (1997) A snake with legs from the marine Cretaceous of the Middle East. *Nature* 386:705–709.
20. Lee MSY, Caldwell MW (1998) Anatomy and relationships of *Pachyrhachis problematicus*, a primitive snake with hindlimbs. *Philos Trans R Soc B Biol Sci* 353(1375):1521–1552.
21. Lee MSY, Caldwell MW (2000) Adriosaurs and the affinities of mosasaurs, dolichosaurs, and snakes. *J Paleontol* 74:915–937.
22. Simões TR, Caldwell MW, Palci A, Nydam RL (2017) Giant taxon-character matrices: Quality of character constructions remains critical regardless of size. *Cladistics* 33:198–219.
23. Meade A, Pagel M (2016) BayesTraitsV3. Available at: http://www.evolution.rdg.ac.uk/BayesTraitsV3.0.1/BayesTraitsV3.0.1.html.
24. Adams DC, Collyer ML (2018) Multivariate phylogenetic comparative methods: Evaluations, comparisons, and recommendations. *Syst Biol* 67:14–31.
25. Xie W, Lewis PO, Fan Y, Kuo L, Chen MH (2011) Improving marginal likelihood estimation for Bayesian phylogenetic model selection. *Syst Biol* 60:150–160.
26. Denton JSS, Adams DC (2015) A new phylogenetic test for comparing multiple high-dimensional evolutionary rates suggests interplay of evolutionary rates and modularity in lanternfishes (Myctophiformes; Myctophidae). *Evolution* 69:2425–2440.
27. Blackburn DG (2006) Squamate reptiles as model organisms for the evolution of viviparity. *Herpetol Monogr* 20:131–146.
28. Collyer ML, Sekora DJ, Adams DC (2015) A method for analysis of phenotypic change for phenotypes described by high-dimensional data. *Heredity (Edinb)* 115(4):357–365.
29. Bookstein FL, et al. (2003) Cranial integration in *Homo*: Singular warps analysis of the midsagittal plane in ontogeny and evolution. *J Hum Evol* 44:167–187.
30. Chapman RE (1990) Conventional Procrustes approaches. *Proceedings of the Michigan Morphometrics Workshop* (University of Michigan Museum of Zoology, Ann Arbor), pp 251–267.
31. Rohlf FJ, Corti M (2000) Use of two-block partial least-squares to study covariation in shape. *Syst Biol* 49:740–753.
32. Goswami A, Finarelli JA (2016) EMMLi: A maximum likelihood approach to the analysis of modularity. *Evolution* 70:1622–1637.
33. Watanabe A (2018) How many landmarks are enough to characterize shape and size variation? *PLoS ONE* 13(6):e0198341.

Table S1. Landmark (LM), curve semi-landmarks (curve sLMs), and surface semi-landmark (surface sLMs) scheme used in this study. LMs and sLM on the jugal and surface sLMs on the pterygoid and palatine were removed for snake and pooled squamate datasets. Combined extant and extinct dataset includes premaxilla, maxilla, frontal, parietal, and supra-otoccipital partitions.

Partition	No. surface sLMs	LM	Landmark definition	No. curve sLMs
Premaxilla	39	1	Right anterior-most median point of premaxilla	1→2: 10
		2	Right posterior-most median point of premaxilla	2→3: 10
		3	Right dorsal point on ventral premaxilla-maxilla suture	3→4: 5
		4	Right ventral point on ventral premaxilla-maxilla suture	4→1: 10
Nasal	42	5	Right anteromedial-most point of nasal	5→6: 10
		6	Right posteromedial most point of nasal	6→7: 10
		7	Right posterolateral most point of nasal	7→8: 10
		8	Right anterolateral point that meets the naris	8→5: 10
Maxilla	92	9	Right premaxilla-maxilla-naris junction on maxilla	9→10: 10
		10	Right posteromedial point of the maxilla	10→11: 20
		11	Right posterior-most point of the maxilla	11→12: 20
		12	Right anteroventral point of maxilla-nasal suture	12→13: 5
		13	Right anterodorsal point of maxilla-nasal suture	13→9: 10
Jugal	31	14	Right anterior jugal-orbital margin junction	14→15: 20
		15	Right posterodorsal point of the jugal	15→16: 20
		16	Right posterior-most point of jugal	16→14: 20
Frontal	86	17	Right anteromedial point of frontal	17→18: 10
		18	Right posterior medial-most point of frontal	18→19: 10
		19	Right posterolateral point of frontal meeting parietal	19→20: 10
		20	Right anterolateral corner of frontal	20→17: 10
Parietal	34	21	Right anterior median point of parietal	21→22: 20
		22	Right posterior median point	22→23: 10
		23	Right posterolateral point	23→24: 20
		24	Right anterolateral point meeting frontal	24→21: 10
Squamosal	19	25	Right anterior-most point	25→26: 10
		26	Right posterodorsal (medial) most point	26→27: 10
		27	Right posteroventral (lateral) most point	27→25: 10
Jaw Joint	18	28	Right anteromedial point of mandibular articular process	28→29: 5
		29	Right posterolateral point of mandibular articular process	29→30: 5
		30	Right posteromedial point of mandibular articular surface	30→31: 5
		31	Right anterolateral point of mandibular articular surface	31→28: 5
Supra-Otooccipital	67	32	Right dorsal median point of supraoccipital	32→33: 10
		33	Right dorsal median point of foramen magnum	33→34: 10
		34	Right ventral median point of foramen magnum (basion)	34→35: 10
		35	Right ventrolateral most point of oto-basioccipital suture	35→36: 10
		36	Right ventral otoccipital-squamosal junction	36→32: 20
Basioccipital + Basisphenoid	58	37	Right median basioccipital-occipital condyle junction	37→38: 20
		38	Right anterior-most median point of (basi)sphenoid	38→39: 10
		39	Right medial sphenoid-pterygoid junction or process	39→40: 20
		40	Right postero-lateral most point of oto-basioccipital suture	40→37: 10
Pterygoid	39	41	Right medial anteroventral point of pterygoid	41→42: 10
		42	Right posterior-most point of pterygoid	42→43: 20
		43	Right lateral anteroventral point of pterygoid	43→41: 20
Palatine	33	44	Right posteroventro-medial point of palate	44→45: 10
		45	Right posteroventro-lateral point of palate	45→46: 20
		46	Right medial ventral palate-maxilla junction	46→47: 10
		47	Right lateral ventral palate-maxilla junction	47→44: 20
—		48	Right ventral premaxilla-tooth row junction	—
Occipital condyle	22	—	—	34→37: 5 37→34: 10

Table S2. List of specimens sampled in this study. Taxonomic designation based on Zheng and Wiens (14). Source signifies whether the skull reconstructions are based on computed tomography (CT) data from the Digital Morphology (DigiMorph) database (digimorph.org), surface data collected by Go!Scan scanner, MorphoSource (morphosource.org), computed tomography (CT) data collected by authors of this study (i.e., Herrel CT by A. H., Müller CT by J. M., and MfN CT by A.W. at Museum für Naturkunde). 'Original label' indicates the original taxonomic assignment given to the specimen. 'Mirrored' denotes reconstructions that were left-right mirrored due to damage or missing bones on the right side. *Sphenodon* was not included in analyses with the exception of morphospaces.

Higher Taxon	Family	Genus	species	Specimen No.	Source	Original label	Mirrored
Rhynchocephalia	Sphenodontidae	*Sphenodon*	*punctatus*	YPM 9194	DigiMorph		.
Iguania	Dactyloidae	*Anolis*	*carolinensis*	FMNH 242298	DigiMorph		
Iguania	Polychrotidae	*Polychrus*	*marmoratus*	FMNH 42501	DigiMorph		
Iguania	Leiosauridae	*Urostrophus*	*vautieri*	FMNH 83576	DigiMorph		
Iguania	Leiosauridae	*Pristidactylus*	*torquatus*	FMNH 206964	DigiMorph		
Iguania	Leiosauridae	*Leiosaurus*	*catamarcensis*	CM 65003	DigiMorph		
Iguania	Corytophanidae	*Basiliscus*	*basiliscus*	FMNH 165622	DigiMorph		
Iguania	Corytophanidae	*Corytophanes*	*cristatus*	FMNH 69227	DigiMorph		
Iguania	Crotaphytidae	*Crotaphytus*	*collaris*	FMNH 48667	DigiMorph		
Iguania	Crotaphytidae	*Gambelia*	*wislizenii*	YPM 14380	DigiMorph		
Iguania	Crotaphytidae	*Gambelia*	*corona*[†]	LACM 42880	Go!Scan		
Iguania	Iguanidae	*Amblyrhynchus*	*cristatus*	MCZ R123791	Herrel CT		
Iguania	Iguanidae	*Ctenosaura*	*pectinata*	Chris Bell Private	DigiMorph		
Iguania	Iguanidae	*Conolophus*	*subcristatus*	MCZ R123792	Herrel CT		
Iguania	Iguanidae	*Brachylophus*	*fasciatus*	FMNH 210158	DigiMorph		
Iguania	Iguanidae	*Dipsosaurus*	*dorsalis*	YPM 14376	DigiMorph		
Iguania	Hoplocercidae	*Enyalioides*	*laticeps*	FMNH 206132	DigiMorph		
Iguania	Hoplocercidae	*Morunasaurus*	*annularis*	USNM 200767	DigiMorph		
Iguania	Opluridae	*Oplurus*	*cyclurus*	YPM 12861	DigiMorph		•
Iguania	Opluridae	*Chalarodon*	*madagascariensis*	YPM 12866	DigiMorph		
Iguania	Phrynosomatidae	*Phrynosoma*	*platyrhinos*	TNHC 18496	DigiMorph		
Iguania	Phrynosomatidae	*Sceloporus*	*variabilis*	FMNH 122866	DigiMorph		
Iguania	Phrynosomatidae	*Petrosaurus*	*mearnsi*	FMNH 8431	DigiMorph		
Iguania	Phrynosomatidae	*Uma*	*scoparia*	FMNH 1203	DigiMorph		
Iguania	Phrynosomatidae	*Uta*	*stansburiana*	FMNH 213914	DigiMorph		
Iguania	Leiocephalidae	*Leiocephalus*	*barahonensis*	USNM 260564	DigiMorph	*L. barohonensis*	

Higher Taxon	Family	Genus	species	Specimen No.	Source	Original Label	Mirrored
Iguania	Liolaemidae	*Liolaemus*	*bellii*	MCZ 125659	DigiMorph		
Iguania	Liolaemidae	*Phymaturus*	*palluma*	FMNH 209123	DigiMorph		
Iguania	Tropiduridae	*Plica*	*plica*	FMNH 81451	DigiMorph		
Iguania	Tropiduridae	*Stenocercus*	*guentheri*	FMNH 27674	DigiMorph		
Iguania	Tropiduridae	*Uranoscodon*	*superciliosus*	YPM 12871	DigiMorph		•
Iguania	Agamidae	*Leiolepis*	*belliana*	USNM 205722	DigiMorph	*U. aegyptius*	
Iguania	Agamidae	*Uromastyx*	*aegyptia*	FMNH 78661	DigiMorph		
Iguania	Agamidae	*Draco*	*quinquefasciatus*	FMNH 221322	DigiMorph		
Iguania	Agamidae	*Agama*	*agama*	FMNH 47531	DigiMorph		
Iguania	Agamidae	*Calotes*	*emma*	FMNH 252264	DigiMorph		
Iguania	Agamidae	*Pogona*	*vitticeps*	ROM 22699	DigiMorph		
Iguania	Chamaeleonidae	*Brookesia*	*brygooi*	FMNH 260015	DigiMorph	*Rhampholeon brevicaudatus*	
Iguania	Chamaeleonidae	*Rieppeleon*	*brevicaudata*	FLMNH H65355	MorphoSource	*R. brevicaudatus*	
Iguania	Chamaeleonidae	*Chamaeleo*	*calyptratus*	TNHC 62768	DigiMorph		
Gekkota	Eublepharidae	*Eublepharis*	*macularius*	CM 67524	DigiMorph		
Gekkota	Eublepharidae	*Aeluroscalabotes*	*felinus*	FMNH 146141	DigiMorph		
Gekkota	Eublepharidae	*Coleonyx*	*variegatus*	YPM 14383	DigiMorph	*Phyllurus cornutus*	
Gekkota	Carphodactylidae	*Saltuarius*	*cornutus*	FMNH 57503	DigiMorph		
Gekkota	Carphodactylidae	*Nephrurus*	*levis*	YPM 12868	DigiMorph		
Gekkota	Gekkonidae	*Gekko*	*gecko*	FMNH 186818	DigiMorph		
Gekkota	Gekkonidae	*Phelsuma*	*lineata*	FMNH 260100	DigiMorph		
Gekkota	Gekkonidae	*Uroplatus*	*lineatus*	ZMB 70059	MfN CT		
Gekkota	Gekkonidae	*Lygodactylus*	*picturatus*	ZMB 1553	MfN CT	*Cyrtodactylus*	
Gekkota	Gekkonidae	*Hemidactylus*	*frenatus*	ZMB 8568	MfN CT		
Gekkota	Gekkonidae	*Hemidactylus*	*mabouia*	ZMB 15541	MfN CT	*Hemidactylus mabuia*	
Gekkota	Gekkonidae	*Gehyra*	*multilata*	ZMB 21420	MfN CT		
Gekkota	Gekkonidae	*Ptychozoon*	*kuhlii*	MCZ R166275	Herrel CT	*P. kuhli*	
Gekkota	Diplodactylidae	*Strophurus*	*ciliaris*	FMNH 215488	DigiMorph	*Diplodactylus ciliaris*	
Gekkota	Diplodactylidae	*Rhacodactylus*	*auriculatus*	CAS 205486	DigiMorph		
Gekkota	Sphaerodactylidae	*Gonatodes*	*albogularis*	FMNH 55929	DigiMorph		•
Gekkota	Sphaerodactylidae	*Teratoscincus*	*przewalskii*	CAS 171013	DigiMorph		
Gekkota	Pygopodidae	*Delma*	*borea*	USNM 128679	DigiMorph		
Gekkota	Pygopodidae	*Lialis*	*burtonis*	FMNH 166958	DigiMorph		

Higher Taxon	Family	Genus	species	Specimen No.	Source	Original Label	Mirrored
Scincomorpha	Scincidae	*Acontias*	*percivali*	YPM 12687	DigiMorph		
Scincomorpha	Scincidae	*Acontias*	*plumbeus*	ZMB 3936	MfN CT	*Typhlosaurus aurantiacus*	
Scincomorpha	Scincidae	*Feylinia*	*polylepis*	FMNH 120968	DigiMorph		
Scincomorpha	Scincidae	*Eugongylus*	*rufescens*	FMNH 142306	DigiMorph		
Scincomorpha	Scincidae	*Sphenomorphus*	*solomonis*	CAS 110021	DigiMorph		
Scincomorpha	Scincidae	*Tiliqua*	*scincoides*	FMNH 57518	DigiMorph		
Scincomorpha	Scincidae	*Scincopus*	*fasciatus*	YPM 12689	DigiMorph	*Eumeces fasciatus*	.
Scincomorpha	Scincidae	*Scincus*	*scincus*	YPM 12686	DigiMorph		
Scincomorpha	Scincidae	*Brachymeles*	*gracilis*	FMNH 52642	DigiMorph		
Scincomorpha	Scincidae	*Amphiglossus*	*splendidus*	FMNH 72807	DigiMorph		
Scincomorpha	Scincidae	*Trachylepis*	*quinquetaeniata*	YPM 12688	DigiMorph	*Mabuya quinquetaeniata*	
Scincomorpha	Cordylidae	*Smaug*	*mossambicus*	YPM 12670	DigiMorph	*Cordylus mossambicus*	
Scincomorpha	Cordylidae	*Chamaesaura*	*anguina*	ZMB56421	Müller CT		•
Scincomorpha	Cordylidae	*Platysaurus*	*capensis*	YPM 12669	DigiMorph	*P. imperator*	
Scincomorpha	Gerrhosauridae	*Cordylosaurus*	*subtesselatus*	FMNH 74082	DigiMorph		
Scincomorpha	Gerrhosauridae	*Zonosaurus*	*ornatus*	YPM 12671	DigiMorph		
Scincomorpha	Xantusiidae	*Cricosaura*	*typica*	USNM 547842	DigiMorph		
Scincomorpha	Xantusiidae	*Xantusia*	*vigilis*	LACM 123671	DigiMorph		
Amphisbaenia	Amphisbaenidae	*Amphisbaena*	*fuliginosa*	FMNH 195924	DigiMorph		
Amphisbaenia	Amphisbaenidae	*Monopeltis*	*capensis*	ZMB 25441	Müller CT	*M. anchieta*	
Amphisbaenia	Amphisbaenidae	*Chirindia*	*swynnertoni*	FMNH265233	Müller CT	*C. rondoense*	
Amphisbaenia	Amphisbaenidae	*Geocalamus*	*acutus*	FMNH 262014	DigiMorph		
Amphisbaenia	Blanidae	*Blanus*	*cinereus*	MCZ R29967	Herrel CT		
Amphisbaenia	Bipedidae	*Bipes*	*biporus*	CAS 126478	DigiMorph		
Amphisbaenia	Rhineuridae	*Rhineura*	*floridana*	FMNH 31774	DigiMorph		
Amphisbaenia	Rhineuridae	*Hyporhina*†	*antiqua*†	YPM 11390	Müller CT		
Amphisbaenia	Rhineuridae	*Spathorhynchus*†	*fossorium*†	USNM 26318	Müller CT		
Amphisbaenia	Trogonophiidae	*Diplometopon*	*zarudnyi*	FMNH 64429	Müller CT		•
Amphisbaenia	Trogonophiidae	*Trogonophis*	*wiegmanni*	FMNH 109462	DigiMorph		
–	–	*Slavoia*†	*darevskii*†	ZPAL MgR-I.112	Go!Scan		
Lacertoidea	Lacertidae	*Gallotia*	*galloti*	ZMB955	Müller CT		
Lacertoidea	Lacertidae	*Atlantolacerta*	*andreanskyi*	ZFMK8751	Müller CT		

Higher Taxon	Family	Genus	species	Specimen No.	Source	Original Label	Mirrored
Lacertoidea	Lacertidae	*Takydromus*	*sexlineatus*	FMNH 255513	DigiMorph	*T. ocellatus*	
Lacertoidea	Lacertidae	*Holaspis*	*guentheri*	MCZ 35520	Herrel CT		
Lacertoidea	Lacertidae	*Nucras*	*tessellata*	MCZ R17359	Herrel CT	*N. tesselata*	
Lacertoidea	Lacertidae	*Lacerta*	*viridis*	YPM 12858	DigiMorph		
Lacertoidea	Teiidae	*Teius*	*teyou*	FMNH 10873	DigiMorph		
Lacertoidea	Teiidae	*Ameiva*	*ameiva*	MCZ 131787	Herrel CT		
Lacertoidea	Teiidae	*Callopistes*	*maculatus*	FMNH 53726	DigiMorph		
Lacertoidea	Teiidae	*Tupinambis*	*teguixin*	FMNH 22416	DigiMorph		
Lacertoidea	Polyglyphanodontidae†	*Polyglyphanodon*†	*sternbergi*†	USNM 16588	Go!Scan		
Lacertoidea	Gymnophthalmidae	*Alopoglossus*	*copii*	ZMB 9986	MfN CT		
Lacertoidea	Gymnophthalmidae	*Bachia*	*flavens*	ZMB 8585	MfN CT	*B. cophias*	•
Lacertoidea	Gymnophthalmidae	*Gymnophthalmus*	*leucomystax*	ZMB 28660A	MfN CT		
Lacertoidea	Gymnophthalmidae	*Pholidobolus*	*montium*	FMNH 197865	DigiMorph		
Lacertoidea	Gymnophthalmidae	*Colobosaura*	*modesta*	USNM 341978	DigiMorph		
Anguimorpha	Anguidae	*Elgaria*	*multicarinata*	FMNH 23601	DigiMorph		
Anguimorpha	Diploglossidae	*Celestus*	*enneagrammus*	FMNH 108860	DigiMorph		
Anguimorpha	Anniellidae	*Anniella*	*pulchra*	FMNH 130481	DigiMorph		
Anguimorpha	Shinisauridae	*Shinisaurus*	*crocodilurus*	FMNH 215541	DigiMorph		
Anguimorpha	Xenosauridae	*Xenosaurus*	*grandis*	FMNH 123702	DigiMorph		
Anguimorpha	Helodermatidae	*Heloderma*	*horridum*	TNHC 64380	DigiMorph		
Anguimorpha	—	*Estesia*†	*mongoliensis*†	AMNH FARB 29072	Go!Scan		
Anguimorpha	Varanidae	*Varanus*	*salvator*	FMNH 35144	DigiMorph		
Anguimorpha	Lanthanotidae	*Lanthanotus*	*borneensis*	YPM 6057	DigiMorph		
Mosasauria	Mosasauridae†	*Plotosaurus*†	*bennisoni*†	UCMP 32778	DigiMorph		
--	Dibamidae	*Dibamus*	*novaeguineae*	ZMB5027A	Müller CT	*D. martensii*	
--	Dibamidae	*Anelytropsis*	*papillosus*	FMNH 100410	DigiMorph		
Typhlopoidea	Leptotyphlopidae	*Rena*	*dulcis*	TNHC 60638	DigiMorph	*Leptotyphlops dulcis*	•
Typhlopoidea	Anomalepididae	*Liotyphlops*	*albirostris*	FMNH 216257	DigiMorph		
Typhlopoidea	Typhlopidae	*Indotyphlops*	*braminus*	MCZ R-182621	DigiMorph	*Liotyphlops braminus*	
Typhlopoidea	Typhlopidae	*Afrotyphlops*	*schlegelii*	ZMB 6884	MfN CT	*Rhinotyphlops schlegelii*	
Booidea	Anomochilidae	*Anomochilus*	*leonardi*	FRIM 0026	DigiMorph		
Booidea	Cylindrophiidae	*Cylindrophis*	*ruffus*	FMNH 60958	DigiMorph,		

Higher Taxon	Family	Genus	species	Specimen No.	Source	Original Label	Mirrored
Booidea	Aniliidae	*Anilius*	*scytale*	USNM 204078	DigiMorph		
Booidea	Xenopeltidae	*Xenopeltis*	*unicolor*	FMNH 148900	DigiMorph		
Booidea	Loxocemidae	*Loxocemus*	*bicolor*	FMNH 104800	DigiMorph		
Booidea	Lamrophiidae	*Lycophidion*	*capense*	FMNH 58322	DigiMorph		
Booidea	Lamrophiidae	*Boaedon*	*fuliginosus*	FMNH 62248	DigiMorph	*Lamprophis fulginosus*	
Booidea	Pythonidae	*Python*	*molurus*	TNHC 62769	DigiMorph		
Booidea	Pythonidae	*Aspidites*	*melanocephalus*	FMNH 97055	DigiMorph		
Booidea	Boidae	*Candoia*	*carinata*	ZMB 14571	Müller CT		
Booidea	Boidae	*Boa*	*constrictor*	FMNH 31182	DigiMorph		•
Booidea	Boidae	*Epicrates*	*cenchria*	USNM 59918	DigiMorph	*E. striatus*	
Booidea	Boidae	*Eryx*	*colubrinus*	FMNH 63117	DigiMorph		
Booidea	Boidae	*Lichanura*	*trivirgata*	YPM 12869	DigiMorph		
Booidea	Boidae	*Ungaliophis*	*continentalis*	UTA 50569	DigiMorph		
Booidea	Calabariidae	*Calabaria*	*reinhardtii*	FMNH 117833	DigiMorph	*C. reinhardii*	
Booidea	Tropidophiidae	*Trachyboa*	*boulengeri*	FMNH 131266	DigiMorph		
Booidea	Tropidophiidae	*Tropidophis*	*haetianus*	TNHC 64040	DigiMorph		
Booidea	Bolyeridae	*Casarea*	*dussumieri*	UMMZ 190285	DigiMorph		
Booidea	Xenophidiidae	*Xenophidion*	*schaeferi*	ZMB 50534	Müller CT		
Acrochordoidea	Acrochordidae	*Acrochordus*	*granulatus*	FMNH 201350	DigiMorph		
Colubroidea	Xenodermatidae	*Xenodermus*	*javanicus*	FMNH 158613	DigiMorph		
Colubroidea	Viperidae	*Azemiops*	*feae*	FMNH 218627	DigiMorph		
Colubroidea	Viperidae	*Bothrops*	*asper*	FMNH 31162	DigiMorph		
Colubroidea	Viperidae	*Trimeresurus*	*albolabris*	ZMB 33921	MfN CT		
Colubroidea	Viperidae	*Lachesis*	*stenophrys*	UMMZ H-76715	MorphoSource		
Colubroidea	Viperidae	*Agkistrodon*	*contortrix*	FMNH 166644	DigiMorph		
Colubroidea	Viperidae	*Bitis*	*arietans*	ZMB 16732	Müller CT		
Colubroidea	Viperidae	*Causus*	*rhombeatus*	FMNH 74241	DigiMorph		
Colubroidea	Viperidae	*Daboia*	*russelii*	FMNH 121477	DigiMorph		
Colubroidea	Lamprophiidae	*Aparallactus*	*modestus*	ZMB6910	Müller CT		
Colubroidea	Lamprophiidae	*Atractaspis*	*irregularis*	FMNH 62204	DigiMorph		
Colubroidea	Lamprophiidae	*Calliophis*	*bivirgata*	ZMB 29637A	Müller CT		
Colubroidea	Lamprophiidae	*Micrurus*	*fulvius*	FMNH 29479	DigiMorph		•
Colubroidea	Lamprophiidae	*Laticauda*	*colubrina*	FMNH 202810	DigiMorph		

Higher Taxon	**Family**	**Genus**	**species**	**Specimen No.**	**Source**	**Original Label**	**Mirrored**
Colubroidea	Lamprophiidae	*Drysdalia*	*coronoides*	ZMB 4702A	Müller CT		
Colubroidea	Lamprophiidae	*Langaha*	*madagascariensis*	ZMB 14371	Müller CT		
Colubroidea	Homalopsidae	*Enhydris*	*enhydris*	ZMB 33627	MfN CT		•
Colubroidea	Homalopsidae	*Homalopsis*	*buccata*	FMNH 259340	DigiMorph		
Colubroidea	Pareatidae	*Pareas*	*hamptoni*	FMNH 128304	DigiMorph		
Colubroidea	Colubridae	*Sibynophis*	*collaris*	ZMB 4964	MfN CT	*S. germinatus*	
Colubroidea	Colubridae	*Grayia*	*smithii*	ZMB 24321	Müller CT		
Colubroidea	Colubridae	*Afronatrix*	*anoscopus*	FMNH 179335	DigiMorph		
Colubroidea	Colubridae	*Coluber*	*constrictor*	FMNH 135284	DigiMorph		
Colubroidea	Colubridae	*Sonora*	*semiannulata*	FMNH 26876	DigiMorph		
Colubroidea	Colubridae	*Trimorphodon*	*biscutatus*	FMNH 42171	DigiMorph		
Colubroidea	Colubridae	*Lampropeltis*	*getula*	FMNH 95184	DigiMorph		
Colubroidea	Colubridae	*Elaphe*	*dione*	MNHN 1909-69	Müller CT		
Colubroidea	Colubridae	*Pseudoxenodon*	*bambusicola*	ZMB 65459	Müller CT		
Colubroidea	Colubridae	*Prosymna*	*meleagris*	ZMB 78750	Müller CT	*P. ambigua*	
Colubroidea	Colubridae	*Psammophis*	*sibilans*	ZMB 66045	Müller CT		
Colubroidea	Colubridae	*Amphiesma*	*stolatum*	FMNH 169627	DigiMorph		
Colubroidea	Colubridae	*Xenochrophis*	*flavipunctatus*	FMNH 179132	DigiMorph		
Colubroidea	Colubridae	*Regina*	*grahami*	ZMB 49380	Müller CT	*R. grahamae*	
Colubroidea	Colubridae	*Thamnophis*	*marcianus*	FMNH 26260	DigiMorph		
Colubroidea	Colubridae	*Natrix*	*natrix*	FLMNH 1917.6.22.1	MorphoSource		
Colubroidea	Colubridae	*Diadophis*	*punctatus*	FMNH 244371	DigiMorph		
Colubroidea	Colubridae	*Heterodon*	*platirhinos*	FMNH 194529	DigiMorph		
Colubroidea	Colubridae	*Uromacer*	*oxyrhynchus*	ZMB 28564	Müller CT		
Colubroidea	Colubridae	*Philodryas*	*olfersii*	ZMB 2609	Müller CT		•
Colubroidea	Colubridae	*Imantodes*	*cenchoa*	FMNH 57616	DigiMorph		
Colubroidea	Colubridae	*Dipsas*	*variegata*	ZMB 1818	Müller CT		

Table S3. The number of principal component axes (No. PCs) encompassing >95% of shape variation and marginal log-likelihoods for evolutionary models. The models of trait evolution evaluated include Brownian Motion (BM), Ornstein-Uhlenbeck (OU), δ, κ, and λ models. Gray cells indicate evolutionary model supported by Bayes Factor.

Dataset	No. PCs	BM	OU	δ	κ	λ
Combined	25	-18490.9	-18438.9	-18504.3	-18520.3	-18446.0
Extant	31	-21825.4	-21764.2	-21791.9	-21825.0	-21761.4
Lizard	32	-14055.9	-13993.0	-14043.6	-14052.0	-13999.5
Snake	25	-7050.0	-7030.4	-7045.7	-7037.4	-7036.3
Premaxilla	6	-4045.6	-4031.6	-4033.0	-4038.5	-4028.3
Nasal	7	-4170.0	-4349.4	-4167.1	-4178.6	-4156.2
Maxilla	9	-6695.7	-6696.2	-6694.5	-6706.3	-6688.5
Jugal	6	-2595.9	-2592.0	-2594.5	-2591.0	-2589.5
Frontal	7	-5072.2	-5056.7	-5060.9	-5068.3	-5046.6
Parietal	10	-6882.7	-6873.8	-6881.4	-6892.9	-6857.9
Squamosal/Supratemporal	6	-3908.3	-4037.1	-3887.4	-3897.5	-3897.1
Jaw Joint	3	-2303.4	-2305.0	-2300.8	-2305.3	-2302.1
Supra-otooccipital	13	-8297.4	-8250.9	-8291.2	-8304.8	-8244.0
Basioccipital	6	-3925.6	-3916.9	-3924.6	-3929.0	-3915.9
Occipital condyle	2	-1304.6	-1305.5	-1300.3	-1302.0	-1298.7
Pterygoid	7	-4450.5	-4435.8	-4435.5	-4448.9	-4423.9
Palatine	10	-5653.8	-5655.6	-5655.6	-5661.3	-5652.3

Table S4. Disparity and mean evolutionary rates across modules for the lizard, snake, extant, and combined datasets. Disparity, as measured by Procrustes variance (uncorrected) and mean evolutionary rate (σ^2) under Brownian motion model.

Partition	$Disparity_{combined}$	$Disparity_{extant}$	$Disparity_{lizard}$	$Disparity_{snake}$	$\sigma^2_{combined}$	σ^2_{extant}	σ^2_{lizard}	σ^2_{snake}
Premaxilla	0.0016	0.0008	0.0006	0.0007	6.584e-8	3.476e-8	2.818e-8	4.309e-8
Nasal	—	0.0009	0.0006	0.0009	—	2.941e-8	2.042e-8	4.400e-8
Maxilla	0.0068	0.0036	0.0015	0.0039	1.073e-7	5.877e-8	2.703e-8	1.067e-7
Jugal	—	—	0.0024	—	—	—	4.973e-8	—
Frontal	0.0037	0.0022	0.0019	0.0010	7.573e-8	4.128e-8	3.810e-8	4.156e-8
Parietal	0.0038	0.0027	0.0024	0.0011	1.021e-7	6.812e-8	6.894e-8	5.709e-8
Squamosal/Supratemporal	—	0.0017	0.0013	0.0009	6.929e-8	7.531e-8	6.226e-8	8.990e-8
Jaw Joint	—	0.0042	0.0097	0.0030	—	1.799e-7	6.304e-8	3.418e-7
Supra-otoccipital	00029	0.0014	0.0015	0.0012		3.247e-8	2.518e-8	4.910e-8
Basioccipital	—	0.0029	0.0011	0.0014	—	3.675e-8	2.232e-8	6.005e-8
Occipital condyle	—	0.0004	0.0006	0.0032	—	3.036e-8	2.511e-8	4.694e-8
Pterygoid	—	0.0021	0.0012	0.0017	—	8.482e-8	3.664e-8	1.458e-7
Palatine	—	0.0010	0.0010	0.0010	—	4.876e-8	2.378e-8	8.455e-8
Total	0.0188	0.0240	0.0170	0.0172	4.203e-7	5.867e-7	4.117e-7	8.898e-7

Table S5. Ecological and developmental traits of sampled taxa. Note that ovoviviparous taxa were considered viviparous in MANOVA.

Species	Habitat	Locomotion	Diet	Reproductive mode	Reference
Acontias percivali	Fossorial	Digger	Invertivore	Viviparous	Heideman NJL, Daniels SR, Mashinini PL, Mokone ME, Thibedi ML, Hendricks MGJ, Wilson BA, Douglas RM (2008) Sexual dimorphism in the Afrian legless skink subfamily Acontinae (Reptilia: Scincidae). *Afr Zool* 43:192–201.; Spawls S, Howell, K, Drewes R, Ashe J (2002) Reptiles of East Africa (Academic Press).
Aeluroscalabotes felinus	Semi-arboreal	Climber	Invertivore	Oviparous	Grismer LL (2006) Slender toes in southern Malaysia. *Iguana* 13:3–6.; Kratochvíl L, Frynta D (2006) Body-size effects on egg size in eublepharid geckos (Squamata: Eublepharidae), lizards with invariant clutch size: Negative allometry for egg size in ectotherms is not universal. *Biol J Linn Soc* 88:527–532.; Das I (2010) A Field Guide to the Reptiles of South-east Asia (New Holland Publishers).
Agama agama	Terrestrial saxicolous	Ground dweller/climber	Invertivore	Oviparous	Enge KM, Krysko KL, Tablley B (2004) Distribution and ecology of the introduced African Rainbow lizard, *Agama agama africana* (Sauria: Agamidae), in Florida. *Fl Acad Sci* 67:303–310.; Chirio L, LeBreton M (2007) Atlas des reptiles du Cameroun. Publications Scientifiques du Muséum National d'Histoire naturelle, vol. 67 (Naturelle & IRD Editions).
Alopoglossus copii	Leaf litter	Litter dweller	Invertivore	Oviparous	Duellman WE (1978) The biology of an equatorial herpetofauna in Amazonian Ecuador. *Univ Kansas Sci Bull* 65:1–352.; Köhler G, Diethert H-H, Vesely M (2012) A contribution to the knowledge of the lizard genus *Alopoglossus* (Squamata: Gymnophthalmidae). *Herpteol Monogr* 26:173–188.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Amblyrhynchus cristatus	Semi-aquatic	Ground dweller/swimmer	Herbivore	Oviparous	Trillmich KGK, Trillmich F (1986) Foraging strategies of the marine Iguana, *Amblyrhynchus cristatus*. *Behav Ecol Sociobiol* 18:259–266.; Rauch N (1988) Competition of marine iguana females (*Amblyrhynchus cristatus*) for egg-laying sites. *Behaviour* 107:91–106.
Ameiva ameiva	Terrestrial	Ground dweller	Invertivore	Oviparous	Vitt LJ (1991) An introduction to the ecology of cerrado lizards. *J Herpetol* 25:79–90.
Amphiglossus splendidus	Leaf litter	Litter dweller	Invertivore	Oviparous	Raxworthy CJ, Nussbaum RA (1993) Four new species of *Amphiglossus* from Madagascar (Squamata: Scincidae). *Herpetologica* 49:326–341.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Melstrom KM (2017) The relationship between diet and tooth complexity in living dentigerous saurian. *J Morphol* 278:500–522.
Amphisbaena fuliginosa	Leaf litter	Litter dweller	Invertivore	Oviparous	Andrade DV, Nascimento LB, Abe AS (2006) Habits hidden underground: a review on the reproduction of the Amphisbaenia with notes on four neotropical species. *Amphib Reptil* 27:207217.; Starace

					F (2013) Serpents et amphisbenes de Guyane francaise (Ibis Rouge Editions).
Anelytropsis papillosus	Fossorial	Digger	Unknown	Oviparous	Canseco-Márquez L, Mendoza-Quijano F, Ponce-Campos P. (2007) *Anelytropsis papillosus*. The IUCN Red List of Threatened Species 2007: e.T64016A12735885. http://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T64016A12735885.en
Anniella pulchra	Fossorial	Digger	Invertivore	Viviparous	Miller CM (1944) Ecologic relations and adaptations of the limbless lizards of the genus *Anniella*. *Ecol Monogr* 14:271–289.
Anolis carolinensis	Arboreal	Climber	Invertivore	Oviparous	Lister BC (1976) The nature of niche expansion in West Indian *Anolis* lizards I: Ecological consequences of reduced competition. *Evolution* 30:659–676.; Meiri S, Feldman A, Kratochvíl L (2015) Squamate hatchling size and the evolutionary causes of negative offspring allometry. *J Evol Biol* 28:438–446.
Atlantolacerta andreanskyi	Terrestrial	Ground dweller	Invertivore	Oviparous	Busack SD (1987) Notes on the biology of *Lacerta andreanskyi* (Reptilia: Lacertidae). *Amphib Reptil* 8:231–236.; Carretero MA, Perera A, Harris DJ, Batista V, Punho C (2006) Spring diet and trophic partitioning in an alpine lizard community from Morocco. *Afr Zool* 41:113–122.
Bachia flavescens	Leaf litter	Litter dweller	Invertivore	Oviparous	Barros FC, Herrel A, Kohlsdorf T (2011) Head shape evolution in Gymnophthalmidae: Does habitat use constrain the evolution of cranial design in fossorial lizards? *J Evol Biol* 24:2423–2433.; *Bachia flavescens*. The Reptile Database. http://reptile-database.reptarium.cz/species?genus=Bachia&species=flavescens.
Basiliscus basiliscus	Semi-arboreal	Ground dweller/climber	Omnivore	Oviparous	Fleet, RR, Fitch HS (1974) Food Habits of *Basiliscus basiliscus* in Costa Rica. *J Herpetol* 8:260–262.; Lieberman A (1980) Nesting of the Basilisk lizard (*Basiliscus basiliscus*). *J Herpetol* 14:103–105.; Van Devender RW (1982) Comparative demography of the lizard *Basiliscus basiliscus*. *Herpteol* 38:189–208.
Bipes biporus	Fossorial	Digger	Invertivore	Oviparous	Maisano JA (2001) A survey of state of ossification in neonatal squamates. *Herpetol Monogr* 15:135–157.; Kearney M (2003) Diet in the amphisbaenian *Bipes biporus*. *J Herpetol* 37:404–408.
Blanus cinereus	Fossorial	Digger	Invertivore	Oviparous	Lopez P, Martin J, Salvador A (1991) Diet selection by the amphisbaenian *Blanus cinereus*. *Herpetologica* 47:210–218.; Packard MJ, DeMarco VG (1991) Eggshell structure and formation in eggs of oviparous reptiles. *Egg Incubation: Its Effects on Embryonic Development in Birds and Reptiles*, eds Deeming DC, Ferguson MWJ, pp 53–69 (Cambridge University Press).
Brachylophus fasciatus	Arboreal	Climber	Omnivore	Oviparous	Birchard GF, Marcellini D (1996) Incubation time in reptilian eggs. *J Zool* 240:621–635.; Morrison C, Osborne T, Harlow PS, Thomas N, Biciloa P, Niukula J (2007) Diet and habitat preferences of the Fijian crested iguana (*Brachylophus vitiensis*) on Yadua Taba, Fiji: Implications for conservation. *Austr J Zool* 55:341–350.
Brachymeles gracilis	Leaf litter	Litter dweller	Invertivore	Ovoviviparous	Smith BE (1993) Notes on a collection of squamate reptiles from Eastern Mindanao, Philippine Islands Part 1: Lacertilia. *Asia*

					Herpetol Res 5:85–95.; Diesmos AC (2008) Ecology and diversity of herpetofaunal communities in fragmented lowland rainforests in the Philippines. Unpublished PhD Thesis. University of Singapore.
Brookesia brygooi	Leaf litter	Litter dweller	Invertivore	Oviparous	Blackburn DG (1993) Standardized criteria for the recognition of reproductive modes in squamate reptiles. *Herpetologica* 49:118–132. Glaw F, Vences M (2007) A Field Guide to the Amphibians and Reptiles of Madagascar (Vences & Glaw).; Randrianantoandro JC, Randrianavelona R, Andriantsimanarilafy RR, Fideline HE, Rakotondravony D, Jenkins RKB (2008) Roost site characteristics of sympatric dwarf chameleons (genus *Brookesia*) from Western Madagascar. *Amphib Reptil* 28:577–581.; Crottini A, Miralles AM, Glaw F, Harris DJ, Lima A, Vences M (2012) Description of a new pygmy chameleon (Chamaeleonidae: *Brookesia*) from central Madagascar. *Zootaxa* 3490:63–74.
Callopistes maculatus	Terrestrial	Ground dweller	Carnivore	Oviparous	Donoso-Barros R (1966) Reptiles de Chile (Ediciones Universidad de Chile).; Fuentes ER (1976) Ecological convergence of lizard communities in Chile and California. *Ecology* 57:3–17.; Packard GC, Tracy CR, Roth JJ (1977) The physiological ecology of reptilian eggs and embryos and the evolution of viviparity within the class Reptilia. *Biol Rev* 52:71–105.; Vidal MA, Labra A (2008) Dieta de anfibios y reptiles. *Herpetologia de Chile*, eds Vidal MA, Labra A, pp 453–482 (Springer Verlag).
Calotes emma	Arboreal	Climber	Invertivore	Oviparous	Schaedla WH (2004) Anomalous (?) nocturnal feeding by the agamid lizard *Calotes emma* in Northeastern Thailand. *Asian Herpetol Res* 10:295–297.; Das I (2010) A Field Guide to the Reptiles of South-east Asia (New Holland Publishers).; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Celestus enneagrammus	Terrestrial	Ground dweller	Unknown	Viviparous	Canseco-Márquez L, Campbell JA, Ponce-Campos P, Muñoz-Alonso A, García-Aguayo A (2007) *Celestus enneagrammus*. The IUCN Red List of Threatened Species 2007: e.T63696A12699497. http://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63696A12699497.en.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Chalarodon madagascariensis	Terrestrial	Ground dweller	Omnivore	Oviparous	Brillet C (1982) Contribution à l'étude des relations entre individus chez cinq espèces d'iguanes malgaches du genre *Oplurus*. *Rev Ecol-Terre Vie* 36:79–148.; Gardner C, Jasper L (2012) Cannibalism in *Chalarodon madagascariensis* (Squamata: Iguanidae) from southwest Madagascar. *Herptel Notes* 5:127–128.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Chamaeleo calyptratus	Arboreal	Climber	Invertivore	Oviparous	Krysko KL, Enge KM, King FW (2004) The veiled chameleon, *Chamaeleo calyptratus*: A new exotic lizard species in Florida. *Florida Scientist* 67:249–253.

Chamaesaura anguina	Terrestrial	Ground dweller	Invertivore	Viviparous	du Toit A (2001) The ecology of the Cape grass lizard, *Chamaesaura anguina*. MSc Thesis. University of Stellenbosch.
Chirindia swynnertoni	Fossorial	Digger	Invertivore	Oviparous	Broadley DG, Gans C (1978) Southern forms of *Chirindia* (Amphisbaenia, Reptilia) (Carnegie Museum of Natural History).; Branch B (1998) Field Guide to the Snakes and Other Reptiles of Southern Africa (Struik).; Andrade DV, Nascimento LB, Abe AS (2006) Habits hidden underground: A review on the reproduction of the Amphisbaenia with notes on four neotropical species. *Amphib Reptil* 27:207–217.
Coleonyx variegatus	Terrestrial	Ground dweller	Invertivore	Oviparous	Knowlton GF (1938) Lizards in insect control.; Parker WS (1972) Aspects of the ecology of a Sonoran Desert population of the Western Banded gecko. *Am Midl Nat* 88:209–224.; Birchard GF, Marcellini D (1996) Incubation time in reptilian eggs. *J Zool* 240:621–635.; Stebbins RC (2003) A Field Guide to Western Reptiles and Amphibians (3rd ed.) (Houghton Mifflin).
Colobosaura modesta	Leaf litter	Litter dweller	Invertivore	Oviparous	Freire EMX, da Silva Jorge J, Ribeiro LB (2012) First record of *Colobosaura modesta* (Reinhardt and Lütken, 1862) (Squamata: Gymnophthalmidae) to the Cariri region, state of Ceará, Brazil, with a map of its geographical distribution. *Check List* 8:970–972.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Torelli A, Eisemberg CC, Brassaloti RA, Bertoluci J (2017) *Colobosaura modesta* (Bahia Colobosaura). Diet. *Herpetol Rev* 48:641–642.
Conolophus subcristatus	Terrestrial	Ground dweller	Herbivore	Oviparous	Ellis HI, Ross, JP (1978) Field observations of cooling rates of Galapagos Land iguanas (*Conolophus subcristatus*). *Comp Biochem Physiol* 59A:205–209.; Birchard GF, Marcellini D (1996) Incubation time in reptilian eggs. *J Zool* 240:621–635.; Zug GR (2013) Reptiles and Amphibians of the Pacific Islands: Comprehensive Guide (University of California Press).
Cordylosaurus subtessellatus	Terrestrial	Ground dweller	Unknown	Oviparous	Packard GC, Tracy CR, Roth JJ (1977) The physiological ecology of reptilian eggs and embryos and the evolution of viviparity within the class Reptilia. *Biol Rev* 52:71–105.; Mouton PLEFN, Van Wyk JH (1997) Adaptive radiation in cordyliform lizards: An overview. *Afr J Herpetol* 46(2):78–88.; Branch B (1998) Field Guide to the Snakes and Other Reptiles of Southern Africa (Struik).
Smaug mossambicus	Terrestrial saxicolous	Ground dweller/climber	Invertivore	Ovoviviparous	Branch B (1998) Field Guide to the Snakes and Other Reptiles of Southern Africa (Struik).
Corytophanes cristatus	Arboreal	Climber	Invertivore	Oviparous	Andrews RM (1979) The lizard *Corytophanes cristatus*: An extreme "sit-and-wait" predator. *Biotropica* 11:136–139.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Cricosaura typica	Leaf litter	Litter dweller	Invertivore	Viviparous	Packard GC, Tracy CR, Roth JJ (1977) The physiological ecology of reptilian eggs and embryos and the evolution of viviparity within the class Reptilia. *Biol Rev* 52:71–105.; Schwartz A, Henderson RW

					(1991) Amphibians and Reptiles of the West Indies (University of Florida Press).
Crotaphytus collaris	Terrestrial	Ground dweller	Invertivore	Oviparous	Packard MJ, DeMarco VG (1991) Eggshell structure and formation in eggs of oviparous reptiles. *Egg Incubation: Its Effects on Embryonic Development in Birds and Reptiles*, eds Deeming DC, Ferguson MWJ, pp 53–69 (Cambridge University Press).; Husak JF, McCoy JK (2000) Diet composition of the collared lizard (*Crotaphytus collaris*) in west-central Texas. *Texas J Sci* 52:93–100.
Ctenosaura pectinata	Semi-arboreal	Ground dweller/climber	Herbivore	Oviparous	Tauber E, Rojas-Ramírez J, Peón RH (1968) Electrophysiological and behavioral correlates of wakefulness and sleep in the lizard, *Ctenosaura pectinate*. *Electroencephalogr Clin Neurophysiol* 24:424–433.; Packard MJ, DeMarco VG (1991) Eggshell structure and formation in eggs of oviparous reptiles. *Egg Incubation: Its Effects on Embryonic Development in Birds and Reptiles*, eds Deeming DC, Ferguson MWJ, pp 53–69 (Cambridge University Press).; Durtsche RD (2000) Ontogenetic plasticity of food habits in the Mexican Spiny-tailed iguana, *Ctenosaura pectinata*. *Oecologia* 124:185–195.
Hemidactylus frenatus	Arboreal	Climber	Invertivore	Oviparous	Tyler MJ (1961) On the diet and feeding habits of *Hemidactylus frenatus* (Dumeril and Bibron) (Reptilia; Gekkonidae) at Rangoon, Burma. *Trans R Soc South Austr* 84:45–49.; Hoskin CJ (2011) The invasion and potential impact of the Asian House Gecko (*Hemidactylus frenatus*) in Australia. *Austr Ecol* 36:240–251.; Tkaczenko GK, Fischer AC, Weterings R (2014) Prey preference of the Common House geckos *Hemidactylus frenatus* and *Hemidactylus platyurus*. *Herpetol Notes* 7:483–488.
Delma borea	Terrestrial	Ground dweller	Invertivore	Oviparous	Cogger HG (2000) Reptiles & Amphibians of Australia (New Holland Publishers).; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Brennan IG (2014) Interspecific and intraspecific relationships, and biogeography of Flap-footed geckos, *Delma* Gray 1831 (Squamata: Pygopodidae). MSc Thesis, Villanova University.
Dibamus novaeguineae	Fossorial	Digger	Omnivore	Oviparous	Allison A (1982) Distribution and ecology of New Guinea lizards. *Biogeography and Ecology of New Guinea*, ed Gressitt JL, pp. 803–813 (Springer Dordrecht).; Rieppel O (1984) The cranial morphology of the fossorial lizard genus *Dibamus* with a consideration of its phylogenetic relationships. *J Zool Lond* 204:289–327.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Strophurus ciliaris	Arboreal	Climber	Invertivore	Oviparous	Pianka ER, Pianka HD (1976) Comparative ecology of twelve species of nocturnal lizards (Gekkonidae) in the Western Australian Desert. *Copeia* 1976:125–142.; Cogger HG (2000) Reptiles & Amphibians of Australia (New Holland Publishers).

Diplometopon zarudnyi	Fossorial	Digger	Invertivore	Oviparous	Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Al-Sadoon MK, Paray BA, Rudayni HA (2016) Diet of the worm lizard, *Diplometopon zarudnyi* (Nikolsky, 1907), in Riyadh province, Saudi Arabia (Reptilia: Trogonophidae). *Zoology in the Middle East* 62:227–230.
Dipsosaurus dorsalis	Terrestrial	Ground dweller	Herbivore	Oviparous	Birchard GF, Marcellini D (1996) Incubation time in reptilian eggs. *J Zool* 240:621–635.; Jayne BC, Irschick DJ (1999) Effects of incline and speed on the three-dimensional hindlimb kinematics of a generalized iguanian lizard (*Dipsosaurus dorsalis*). *J Exp Biol* 202:143–159.; Dibble CJ, Smith GR, Lemos-Espinal JA (2008) Diet and sexual dimorphism of the Desert iguana, *Dipsosaurus dorsalis*, from Sonora, Mexico. *Western North American Naturalist* 68:521–523.
Draco quinquefasciatus	Arboreal	Climber/glider	Invertivore	Oviparous	Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Ord TJ, Klomp DA (2014) Habitat partitioning and morphological differentiation: The Southeast Asian *Draco* lizards and Caribbean *Anolis* lizards compared. *Oecologia* 175:651–666.
Elgaria multicarinata	Leaf litter	Litter dweller	Invertivore	Oviparous	Fitch HS (1935) Natural History of the Alligator Lizards (Academy of Science of Saint Louis).; Cunningham JD (1956) Food habits of the San Diego Alligator lizard. *Herpetologica* 12:225–230.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Enyalioides laticeps	Semi-arboreal	Ground dweller/climber	Invertivore	Oviparous	Duellman WE (1978) The biology of an equatorial herpetofauna in Amazonian Ecuador. *Misc Publ Mus Nat Hist Univ Kansas* 65:1–352.; Avila-Pires TCS (1995) Lizards of Brazilian Amazonia (Reptilia: Squamata). *Zool Verh* 299:1–706.; Wiens JJ, Etheridge RE (2003) Phylogenetic relationships of hoplocercid lizards: Coding and combining meristic, morphometric, and polymorphic data using step matrices. *Herpetologica* 59:375–398.
Eublepharis macularius	Terrestrial	Ground dweller	Invertivore	Oviparous	Bonke R, Böhme W, Opiela K, Rödder D (2011) A remarkable case of cannibalism in juvenile Leopard Geckos, *Eublepharis macularius* (Blyth, 1854) (Squamata: Eublepharidae). *Herpetol Notes* 4:211–212.; Fuller PO, Higham TE, Clark AJ (2011) Posture, speed, and habitat structure: three-dimensional hindlimb kinematics of two species of padless geckos. *Zool* 114:104–112.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Eugongylus rufescens	Leaf litter	Litter dweller	Unknown	Oviparous	Heatwole H (1975) Biogeography of reptiles on some of the islands and cays of Eastern Papua—New Guinea. *Atoll Res Bull* 180:1–32.; Cogger HG (2000) Reptiles & Amphibians of Australia (New Holland Publishers).; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.

Scincopus fasciatus	Terrestrial	Ground dweller	Invertivore	Oviparous	Schleich HH, Kastle W, Kabisch K (1996) Amphibians and Reptiles of North Africa (Koeltz Scientitic Publishers).; Hecnar SJ, M'Closkey RT (1998) Effects of human disturbance on Five-lined skink, *Eumeces fasciatus*, abundance and distribution. *Biol Conserv* 85:213–222.; Steward JR, Florian JD Jr (2000) Ontogeny of the extraembryonic membranes of the oviparous lizard, *Eumeces fasciatus* (Squamata: Scincidae). *J Morphol* 244:81–107.
Feylinia polylepis	Fossorial	Digger	Unknown	Viviparous	Gans C (1975) Tetrapod limblessness: Evolution and function corollaries. *Amer Zool* 15:455–467.; Greer A (2007) The Biology and Evolution of Scincid Lizards (Chipping Norton).; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Gallotia galloti	Terrestrial saxicolous	Ground dweller	Omnivore	Oviparous	Valido A, Nogales M, Medina FM (2003) Fleshy fruits in the diet of Canarian lizards *Gallotia galloti* (Lacertidae) in a xeric habitat of the Island of Tenerife. *J Herpetol* 37:741–747.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Gambelia wislizenii	Terrestrial	Ground dweller	Carnivore	Oviparous	Schorr RA, Lambert BA, Freels E (2011) Habitat use and home range of Long-nosed Leopard lizards (*Gambelia wislizenii*) in Canyons of the Ancients National Monument, Colorado. *Herpetol Conserv Biol* 6:312–323.
Gehyra mutilata	Arboreal	Climber	Invertivore	Oviparous	Fisher RN (1997) Dispersal and evolution of the Pacific Basin gekkonid lizards *Gehyra oceanica* and *Gehyra mutilata*. *Evolution* 51:906–921. Barragán-Ramírez JL, Reyes-Luis OE, de Jesús Ascencio-Arrayga J, Navarrete-Heredia JL, Vásquez-Bolaños M (2015) Diet and reproductive aspects of the exotic gecko *Gehyra mutilata* (Wiegmann, 1834) (Sauria: Gekkonidae) in the urban area of Chapala, Jalisco, Mexico. *Acta Zool Mex, Nueva Serie* 31:67–73.
Gekko gecko	Arboreal	Climber	Invertivore	Oviparous	Meshaka WE Jr., Clouse RM, McMahon L (1997) Diet of the Tokay gecko (*Gekko gecko*) in southern Florida. *Florida Field Nat* 25:105–107.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Geocalamus acutus	Fossorial	Digger	Invertivore	Oviparous	Spawls S, Howell K, Drewes R, Ashe J (2002) Reptiles of East Africa (Academic Press).; Kearney M, Stuart BL (2004) Repeated evolution of limblessness and digging heads in worm lizards revealed by DNA from old bones. *Proc R Soc Lon B* 271:1677–1683.
Gonatodes albogularis	Semi-arboreal	Ground dweller/climber	Invertivore	Oviparous	Krysko KL (2005) Ecological status of the introduced Yellow-headed gecko, *Gonatodes albogularis* (Sauria: Gekkonidae), in Florida. *Florida Scientist* 68:272–280.
Gymnophthalmus leucomystax	Terrestrial	Ground dweller	Invertivore	Oviparous	Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Ribeiro MA Jr. (2017) Catalogue of distribution of

					lizards (Reptilia: Squamata) from the Brazilian Amazonia. IV. Alopoglossidae, Gymnophthalmidae. *Zootaxa* 4269:151–196.
Heloderma horridum	Semi-arboreal	Ground dweller/climber	Carnivore	Oviparous	Beck DD, Lowe CH (1991) Ecology of the Beaded lizard, *Heloderma horridum*, in a tropical dry forest in Jalisco, México. *J Herpetol* 25:395–406.
Hemidactylus mabouia	Arboreal	Climber	Invertivore	Oviparous	Bonfiglio F, Lucchesi Balestrin R, Cappellari L (2007) Diet of *Hemidactylus mabouia* (Sauria, Gekkonidae) in urban area of southern Brazil. *Biociencias* 14:107–111.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Malonza PK, Bauer AM (2014) A new species of arboreal forest-dwelling gecko (*Hemidactylus*: Squamata: Gekkonidae) from coastal Kenya, East Africa. *Zootaxa* 3786:192–200.
Holaspis guentheri	Arboreal	Climber/glider	Invertivore	Oviparous	Arnold EN (2002) *Holaspis*, a lizard that glided by accident: Mosaics of cooption and adaptation in a tropical forest lacertid (Reptilia, Lacertidae). *Bull Nat Hist Mus Lond (Zool)* 68:155–163.; Spawls S, Howell K, Drewes R, Ashe J (2002) Reptiles of East Africa (Academic Press).
Lacerta viridis	Terrestrial	Ground dweller	Invertivore	Oviparous	Angelici FM, Luiselli L, Rugiero L (1997) Food habits of the Green lizard, *Lacerta bilineata*, in central Italy and a reliability test of faecal pellet analysis. *Ital J Zool* 64:267–272.
Lanthanotus borneensis	Semi-aquatic	Ground dweller/swimmer	Invertivore	Oviparous	Das I (2010) A Field Guide to the Reptiles of South-east Asia (New Holland Publishers).; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Langner C (2017) Hidden in the heart of Borneo-shedding light on some mysteries of an enigmatic lizard: First records of habitat use, behavior, and food items of *Lanthanotus borneensis* Steindachner, 1878 in its natural habitat. *Russ J Herpetol* 24:1–10.
Leiocephalus barahonensis	Terrestrial	Ground dweller	Omnivore	Oviparous	Schwartz A, Henderson RW (1991) Amphibians and Reptiles of the West Indies (University of Florida Press).; Gifford ME, Herrel A, Mahler DL (2008) The evolution of locomotor morphology, performance, and anti-predator behavior among populations of *Leiocephalus* lizards from the Dominican Republic. *Biol J Linn Soc* 93:445–456.; Melstrom KM (2017) The relationship between diet and tooth complexity in living dentigerous saurian. *J Morphol* 278:500–522.
Leiolepis belliana	Semi-fossorial	Ground dweller/digger	Omnivore	Oviparous	Cooper WE (2009) Food chemical discrimination by the omnivorous lizard *Leiolepis belliana*. *J Herpetol* 37:189–190.; Grismer JL, et al. (2014) Multiple origins of parthenogenesis, and a revised species phylogeny for the Southeast Asian Butterfly lizards, *Leiolepis*. *Biol J Linn Soc* 113:1080–1093.
Leiosaurus catamarcensis	Terrestrial	Ground dweller	Carnivore	Oviparous	Scolaro A (2005) Reptiles Patagonicos Sur: Una Guía de Campo (Universidad Nacional de la Patagonia).; Laspiur A, Acosta JC, Abdala CS (2007) A new species of *Leiosaurus* (Iguania:

					Leiosauridae) from central-western Argentina. *Zootaxa* 1470:47–57.; Abdala V, Tulli MJ, Russell AP, Powell GL, Curz FB (2014) Anatomy of the crus and pes of neotropical iguanian lizards in relation to habitat use and digitally based grasping capabilities. *Anat Rec* 297:397–409.
Lialis burtonis	Leaf litter	Litter dweller	Carnivore	Oviparous	Wall M, Shine R (2013) Ecology and behaviour of Burton's Legless lizard (*Lialis burtonis*, Pygopodidae) in tropical Australia. *Asian Herpetol Res* 4:9–21.
Liolaemus bellii	Terrestrial/ saxicolous	Ground dweller	Omnivore	Ovoviviparous	Celedón-Neghme C, San Martin LA, Victoriano PF, Cavieresa LA (2008) Legitimate seed dispersal by lizards in an alpine habitat: The case of *Berberis empetrifolia* (Berberidaceae) dispersed by *Liolaemus belii* [*sic*] (Tropiduridae). *Acta Oecologia* 33:265–271.
Lygodactylus picturatus	Arboreal	Climber	Invertivore	Oviparous	Greer AE (1967) The ecology and behavior of two sympatric *Lygodactylus* geckos. *Breviora* 268:1–19.; Hardy LM, Crnkovic AC (2006) Diet of amphibians and reptiles from the Engare Ondare river region of central Kenya, during the dry season. *Afr J Herpetol* 55:143–159.
Trachylepis quinquetaeniata	Terrestrial saxicolous	Ground dweller	Invertivore	Oviparous	Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Kadry MAM, Mohamed HRH, Hosney M (2017) Ecological and biological studies on Five-lined skink, *Trachylepis* (= *Mabuya*) *quinquetaeniata* inhabiting two different habitats in Egypt. *Cell Mol Biol* 63:28–36.
Monopeltis capensis	Fossorial	Digger	Invertivore	Viviparous	Broadley DG, Gans C, Visser J (1976) Studies on amphisbaenians (Amphisbaenia Reptilia). 6. The genera *Monopeltis* and *Dalophia* in Southern Africa. *Bull Am Mus Nat Hist* 2:38–39.; Branch B (1998) Field Guide to the Snakes and Other Reptiles of Southern Africa (Struik).; Webb JK, Shine R, Branch WR, Harlow PS (2000) Life underground: Food habits and reproductive biology of two amphisbaenian species from Southern Africa. *J Herpetol* 34:510–516.; Maritz B, Alexander GJ (2008) Breaking ground: Quantitative fossorial herpetofaunal ecology in South Africa. *Afr J Herpetol* 58:1–14.
Morunasaurus annularis	Semi-fossorial	Ground dweller/digger	Invertivore	Oviparous	Köhler G, Seipp R, Moya S, Almendáriz A (1999) Zur Kenntnis von *Morunasaurus annularis* (O'Shaughnessy, 1881). *Salamandra, Rheinbach* 35:181–190.
Nephrurus levis	Terrestrial	Ground dweller/digger	Invertivore	Oviparous	Pianka ER, Pianka HD (1976) Comparative ecology of twelve species of nocturnal lizards (Gekkonidae) in the Western Australian Desert. *Copeia* 1976:125–142.; How RA, Dell J, Wellington BD (1990) Reproductive and dietary biology of *Nephrurus* and *Underwoodisaurus* (Gekkonidae) in Western Australia. *Rec West Aust Mus* 14:449–459.; Cogger HG (2000) Reptiles & Amphibians of Australia (New Holland Publishers).
Nucras tessellata	Terrestrial	Ground dweller	Invertivore	Oviparous	Huey RB, Pianka ER (1981) Ecological consequences of foraging mode. *Ecology* 62:991–999

Oplurus cyclurus	Arboreal	Climber	Invertivore	Oviparous	Brillet C (1982) Contribution a l'étude des relations entre individus chez cinq especes d'iguanes malgaches du genre *Oplurus*. *Rev Ecol (TerreVie)* 36:79–148.; Chan LM, Choi D, Raselimanana AP, Rakotondravony HA, Yoder AD (2012) Defining spatial and temporal patterns of phylogeographic structure in Madagascar's iguanid lizards (genus *Oplurus*) *Molec Ecol* 21:3839–3851.; Glaw F, Vences M (2007) A Field Guide to the Amphibians and Reptiles of Madagascar (Vences & Glaw).
Petrosaurus mearnsi	Saxicolous	Ground dweller/Climber	Invertivore	Oviparous	De Lisle HF (1991) Behavioral ecology of the Banded Rock lizard (*Petrosaurus mearnsi*). *Bull Southern Cal Acad Sci* 90:102–117.
Phelsuma lineata	Arboreal	Climber	Invertivore	Oviparous	Nussbaum RA, Raxworthy CJ, Raselimanana AP, Ramanamanjato JB (2000) New species of Day Gecko, *Phelsuma* Gray (Reptilia: Squamata: Gekkonidae), from the Réserve Naturelle Intégrale d'Andohahela, Southern Madagascar. *Copeia* 2000:763–770.; Fölling M, Knogge C, Böhme W (2001) Geckos are milking honeydew-producing planthoppers in Madagascar. *J Nat Hist* 35:279–284.
Pholidobolus montium	Terrestrial	Ground dweller	Invertivore	Oviparous	Montanucci RR (1973) Systematics and evolution of the Andean lizard genus *Pholidobolus* (Sauria: Teiidae). *Misc Publ Univ Kansas Mus Nat Hist* 59:1–52.; Bursey CR, Goldberg SR (2011) Helminths of *Pholidobolus montium* (Sauria: Gymnophthalmidae) from Ecuador with description of a new species of *Skrjabinodon* (Nematoda: Oxyuroidea: Pharyngodonidae). *J Parasitol* 97:94–96.
Phrynosoma platyrhinos	Terrestrial	Ground dweller	Invertivore	Oviparous	Pianka ER, Parker WS (1975) Ecology of horned lizards; a review with special reference to *Phrynosoma platyrhinos*. *Copeia* 1:141–162.; Birchard GF, Marcellini D (1996) Incubation time in reptilian eggs. *J Zool* 240:621–635.
Saltuarius cornutus	Arboreal	Climber	Invertivore	Oviparous	Couper PJ, Gregson RAM (1994) Redescription of *Nephrurus asper* Günther and desription of *N. amyae* sp. nov. and *N. sheai* sp. nov. *Mem Queensland Mus* 37:67–81.; Cogger HG (2000) Reptiles & Amphibians of Australia (New Holland Publishers).; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Phymaturus palluma	Saxicolous	Ground dweller/climber	Herbivore	Viviparous	Vicenzi N, Massarelli R (2018) *Phymaturus palluma* (High Mountain lizard). Diet. *Herpetol Rev* 49:121.
Platysaurus capensis	Saxicolous	Ground dweller/climber	Invertivore	Oviparous	Whiting MJ, Greeff JM (1997) Facultative frugivory in the Cape Flat Lizard, *Platysaurus capensis* (Sauria: Cordylidae). *Copeia* 1997:811–818.; Greeff JM, Whiting MJ (2000) Foraging-mode plasticity in the lizard *Platysaurus broadleyi*. *Herpetologica* 56:402–407.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Plica plica	Arboreal	Climber	Invertivore	Oviparous	Goldberg SR, Bursey CR, Vitt LJ (2009) Diet and parasite communities of two lizard species, *Plica plica* and *Plica umbra* from Braziland Ecuador. *J Herpetol* 19:49–52.; Pyron RA, Burbrink FT

					(2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Pogona vitticeps	Semi-arboreal	Ground dweller/climber	Omnivore	Oviparous	Melville J, Harmon LJ, Losos JB (2006) Intercontinental community convergence of ecology and morphology in desert lizards. *Proc R Soc B* 273:557–563.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Oonincx DG, van Leeuwen JP, Hendriks WH, van der Poel AF (2015) The diet of free-roaming Australian Central Bearded Dragons (*Pogona vitticeps*). *Zoo Biol* 34:271–277.
Polychrus marmoratus	Arboreal	Climber	Invertivore	Oviparous	Avila-Pires TCS (1995) Lizards of Brazilian Amazonia (Reptilia: Squamata). *Zool Verh* 299:1–706.
Pristidactylus torquatus	Terrestrial	Ground dweller	Invertivore	Oviparous	Donoso-Barros R (1964) Reptiles de Chile (Universidad de Chile).; Cei JM, Scolaro JA, Videla F (2001) The present status of Argentinian polychrotid species of the genus *Pristidactylus* and description of its southernmost taxon as a new species. *J Herpetol* 35:597–605.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Ptychozoon kuhli	Arboreal	Climber/glider	Invertivore	Oviparous	Vetter RS, Brodie ED, Jr. (1977) Background color selection and antipredator behavior of the Flying Gecko, *Ptychozoon kuhli* 33:464–467.; Das I (2010) A Field Guide to the Reptiles of South-east Asia (New Holland Publishers).; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Rhacodactylus auriculatus	Arboreal	Climber	Omnivore	Oviparous	Snyder J, Snyder L, Bauer AM (2010) Ecological observations on the Gargoyle Gecko, *Rhacodactylus auriculatus* (Bavay, 1869), in southern New Caledonia. *Salamandra* 46:37–47.
Rieppeleon brevicaudatus	Terrestrial	Ground dweller	Invertivore	Oviparous	Spawls S, Howell K, Drewes R, Ashe J (2002) Reptiles of East Africa (Academic Press).; Riedel J, Böhme W, Bleckmann H, Spinner M (2015) Microornamentation of Leaf chameleons (Chamaeleonidae: *Brookesia*, *Rhampholeon*, and *Rieppeleon*)—with comments on the evolution of microstructures in Chamaeleonidae. *J Morphol* 276:167–184.
Rhineura floridana	Fossorial	Digger	Invertivore	Oviparous	Conant R (1975) A Field Guide to the Reptiles and Amphibians of Eastern and Central North America (Houghton Mifflin Company).; Bursey CR (2002) *Paradollfusnema tefordi* n. sp. (Nematoda: Cosmocercidae) from the worm lizard, *Rhineura floridana* (Amphisbaenia), of Florida. *J Parasitol* 88:554–556.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Sceloporus variabilis	Terrestrial	Ground dweller	Invertivore	Oviparous	Conant R (1975) A Field Guide to the Reptiles and Amphibians of Eastern and Central North America (Houghton Mifflin Company).; Benabib M (1994) Reproduction and lipid utilization of tropical populations of *Sceloporus variabilis*. *Herpetol Monogr* 8:160–180.; Granados-González G, Villagrán-SantaCruz M, Peña-Herrera E,

					Rheubert JL, Gribbins KM, Hernández-Gallegos O (2017) Spermatogenesis in *Sceleoporus variabilis* (Squamata, Phrynosomatidae): A non-quiescent pattern. *Acta Zool* 100:43–52.
Scincus scincus	Fossorial	Digger	Omnivore	Oviparous	Hetherington TE (1990) Behavioural use of seismic cues by the Sandswimming lizard *Scincus scincus*. *Ethol Ecol Evol* 4:5–14.; Schleich HH, Kastle W, Kabisch K (1996) Amphibians and Reptiles of North Africa (Koeltz Scientific Publishers).; Attum O, Covell C, Eason P (2004) The comparative diet of three Sharan sand dune skinks. *Afr J Herpetol* 53:91–94.
Shinisaurus crocodilurus	Semi-aquatic	Ground dweller/swimmer	Invertivore	Viviparous	Ziegler T, Quyet LK, Thanh VN, Hendrix R, Böhme W (2008) A comparative study of Crocodile lizards (*Shinisaurus crocodilurus* Ahl, 1930) from Vietnam and China. *Raffles Bull Zool* 56:181–187.
Sphenomorphus solomonis	Leaf litter	Litter dweller	Invertivore	Oviparous	Thornton IWB, Cook S, Edwards JS, Harrison RD, Schipper C, Shanahan M, Singadan R, Yamuna R (2001) Colonization of an island volcano, Long Island, Papua New Guinea, and an emergent island. *J Biogeogr* 28:1389–1408.; Goldberg SR, Bursey CR, Kraus F (2009) Endoparasites in 12 species of *Sphenomorphus* (Squamata: Scincidae) from Papua New Guinea. *Comp Parasitol* 76:58–83.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Zug GR (2013) Reptiles and Amphibians of the Pacific Islands: Comprehensive Guide (University of California Press).
Stenocercus guentheri	Terrestrial	Ground dweller	Invertivore	Oviparous	Torres-Carvajal O (2000) Ecuadorian lizards of the genus *Stenocercus* (Squamata: Tropiduridae). *Sci Papers Nat Hist Mus Univ Kansas* 15:1–38.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Dávila-Jativa M, Cisneros-Heredia D (2017) Use of human-made building by *Stenocercus* lizards (Iguania, Tropiduridae). *Herpetol Notes* 10:517–519.
Takydromus sexlineatus	Terrestrial	Ground dweller	Invertivore	Oviparous	Das I (2010) A Field Guide to the Reptiles of South-east Asia (New Holland Publishers).; Cooper WE, Paulissen MA, habegger JJ (2000) Discrimination of prey, but no plant, chemicals by actively foraging, insectivorous lizards, the lacertid *Takydromus sexlineatus* and the teiid *Cnemidophorus gularis*. *J Chem Ecol* 26:1623–1634.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Hawkeswood TJ, Sommung B (2017) A record of the Long-tailed Lizard, *Takydromus sexlineatus* (Daudin, 1802) (Reptilia: Lacertidae) from the farming district of Ubon Ratchathani, Thailand. *Calodema* 564:1–3.
Teius teyou	Terrestrial	Ground dweller	Omnivore	Oviparous	Milstead WW (1961) Notes on teiid lizards in Southern Brazil. *Copeia* 1961:493–495.; Packard GC, Tracy CR, Roth JJ (1977) The physiological ecology of reptilian eggs and embryos and the evolution of viviparity within the class Reptilia. *Biol Rev* 52:71–105.; Varela RO, Bucher EH (2002) The lizard *Teius teyou*

					(Squamata: Teiidae) as a legitimate seed disperser in the dry Chaco forest of Argentina. *Studies on Neotropical Fauna and Environment* 36:115–117.
Teratoscincus przewalskii	Terrestrial	Ground dweller	Invertivore	Oviparous	Semenov DV, Borkin LJ (1992) On the ecology of Przewalsky's Gecko (*Teratoscincus przewalskii*) in the Transaltai Gobi, Mongolia. *Asiatic Herpetol Res* 4:99–112.
Tiliqua scincoides	Terrestrial	Ground dweller	Omnivorous	Viviparous	Koenig J, Shine R, Shea G (2001) The ecology of an Australian reptile icon: How do Blue-tongued lizards (*Tiliqua scincoides*) survive in suburbia? *Wildlife Res* 28:215–227.
Trogonophis wiegmanni	Fossorial	Digger	Invertivore	Viviparous	Martin J, Ortega Gimenez J, Lopez P, Perez-Cembranos A (2013) Fossorial life does not constrain diet selection in the amphisbaenian *Trogonophis wiegmanni. J Zool* 291:226–233.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Tupinambis teguixin	Terrestrial	Ground dweller	Omnivore	Oviparous	Presch W (1973) A review of the Tegus, lizard genus *Tupinambis* (Sauria: Teiidae) from South America. *Copeia* 1973:740–746.; Packard GC, Tracy CR, Roth JJ (1977) The physiological ecology of reptilian eggs and embryos and the evolution of viviparity within the class Reptilia. *Biol Rev* 52:71–105.; Mercolli C, Yanosky A (1994) The diet of adult *Tupinambis teguixin* (Sauria: Teiidae) in the eastern Chaco of Argentina. J Herpetol 4:15–19.
Acontias plumbeus	Fossorial	Digger	Invertivore	Viviparous	Broadley DG, Greer AE (1969) A revision of the genus *Acontias* Cuvier (Sauria: Scincidae). *Arnoldia* 36:1–20.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Bolet A, Augé M (2014) A new miniaturized lizard from the Late Eocene of France and Spain. *Anat Rec* 297:505–515.
Uma scoparia	Terrestrial	Ground dweller/digger	Omnivore	Oviparous	Carpenter CC (1963) Patterns of behavior in three forms of the Fringe-toed lizards (*Uma*-Iguanidae). *Copeia* 1963:406–412.; Mayhew WW (1966) Reproduction in the Psammophilus lizard *Uma scoparia*. *Copeia* 1966:114–122.; Gadsen HE, Palacios-Orona LE (1997) Seasonal dietary patterns of the Mexican Fringe-toed lizard (*Uma paraphygas*). *J Herpetol* 31:1–9.
Uranoscodon superciliosus	Arboreal	Climber	Invertivore	Oviparous	Howland JM, Vitt LJ, Lopez PT (1990) Life on the edge: The ecology and life history of the tropidurine iguanid lizard *Uranoscodon superciliosum*. *Can J Zool* 68:1366–1373.; Avila-Pires TCS (1995) Lizards of Brazilian Amazonia (Reptilia: Squamata). *Zool Verh* 299:1–706.
Uromastyx aegyptia	Terrestrial	Ground dweller	Herbivore	Oviparous	Castilla AM, Richer R, Herre A, Conkey A, Tribuna J, Al-Thani M (2011) First evidence of scavenging behaviour in the herbivorous lizard *Uromastyx aegyptia microlepis*. *J Arid Environm* 75:671–673.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.

Uroplatus lineatus	Arboreal	Climber	Invertivore	Oviparous	Glaw F, Vences M (2007) A Field Guide to the Amphibians and Reptiles of Madagascar (Vences & Glaw).; Raxworthy CJ, et al. (2008) Continental speciation in the tropics: Contrasting biogeographic patterns of divergence in the *Uroplatus* Leaf-tailed gecko radiation of Madagascar. *J Zool* 275:423–440.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; McAllister CT, Scott Seville R, Hartdegen R (2016) Two new species of coccidia (Apicomplexa: Eimeriidae) from Leaf-tailed geckos, *Uroplatus* spp. (Sauria: Gekkonidae) from Madagascar, including a new host of *Eimeria brygooi* Upton & Barnard, 1987. *Syst Parasitol* 93:815–823.
Urostrophus vautieri	Arboreal	Climber	Invertivore	Oviparous	Henle K, Knogge C (2009) Water-filled bromeliad as roost site of a tropical lizard, *Urostrophus vautieri* (Sauria: Leiosauridae) *Stud Neotrop Fauna Environ* 44(3):161–162.; Novelli I, Morton G, Tadeu Trinidade I, Friero-Costa FA. 2013. *Urostrophus vautieri* (Brazilian Steppe iguana). Diet. *Herpetol Rev* 44:516.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Uta stansburiana	Terrestrial	Ground dweller	Invertivore	Oviparous	Davis J, Verbeek NAM (1972) Habitat preferences and the distribution of *Uta stansburiana* and *Sceloporus occidentalis* in coastal California. *Copeia* 1972:643–649.; Best TL, Gennaro AL (1984) Feeding ecology of the lizard, *Uta stansburiana*, in Southeastern New Mexico. *J Herpetol* 18:291–301.
Varanus salvator	Semi-aquatic	Ground dweller/swimmer	Carnivore	Oviparous	Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Karunarathna DMSS, Surasinghe TD, De Silva MC, Madawala MB, Gabadage DE, Botejue WMS (2015) Dietary habits of *Varanus salvator salvator* in Sri Lanka with a new record of predation on an introduced Clown knifefish, *Chitala ornata*. *Herpetol Bull* 133:23–28.
Xantusia vigilis	Terrestrial saxicolous	Ground dweller/climber	Invertivore	Viviparous	Miller MR (1951) Some aspects of the life history of the Yucca Night lizard, *Xantusia vigilis*. *Copeia* 1951:114–120.; Packard GC, Tracy CR, Roth JJ (1977) The physiological ecology of reptilian eggs and embryos and the evolution of viviparity within the class Reptilia. *Biol Rev* 52:71–105.
Xenosaurus grandis	Saxicolous	Ground dweller/climber	Invertivore	Viviparous	Packard GC, Tracy CR, Roth JJ (1977) The physiological ecology of reptilian eggs and embryos and the evolution of viviparity within the class Reptilia. *Biol Rev* 52:71–105.; Ballinger RE, Lemos-Espinal JA, Sanoja-Sarabia S, Coady NR (1995) Ecological observations of the lizard, *Xenosaurus grandis* in Cuautlapán, Veracruz, México. *Biotropica* 27:128–132.
Zonosaurus ornatus	Terrestrial	Ground dweller	Invertivore	Oviparous	Packard GC, Tracy CR, Roth JJ (1977) The physiological ecology of reptilian eggs and embryos and the evolution of viviparity within the class Reptilia. *Biol Rev* 52:71–105.; Meier H (1988) Zur Ökologie,

					Ethologie und Taxonomie einiger Schildechsen der Gattungen *Tracheloptychus* und *Zonosaurus* auf Madagaskar. *Herpteofauna (Münster)*, 10(57):22–26.; Recknagel H, et al. (2013) Multi-gene phylogeny of Madagascar's Plated lizards, *Zonosaurus* and *Tracheloptychus* (Squamata: Gerrhosauridae). *Mol Phylogenet Evol* 69:1215–1221.
Acrochordus granulatus	Aquatic	Swimmer	Carnivore	Viviparous	Voris HK, Glodeck GS (1980) Habitat, diet, and reproduction of the File snake, *Acrochordus granulatus*, in the Straits of Malacca. *J Herpetol* 14:108–111.
Afronatrix anoscopus	Semi-aquatic	Ground dweller/ Swimmer	Carnivore	Oviparous	Luiselli L, Akani GC, Angelici MA, Politano E, Ude L, Wariboko SM (2003) Diet of the semi-aquatic snake, *Afronatrix anoscopus* (Colubridae) in southern Nigeria. *Afr J Herpetol* 52:123–126.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Agkistrodon contortrix	Terrestrial	Ground dweller	Carnivore	Viviparous	Smith CF, Schuett GW, Earley RL, Schwenk K (2009) The spatial and reproductive ecology of the Copperhead (*Agkistrodon contortrix*) at the northeastern extreme of its range. *Herpetological Monographs* 23:45–73.; Garton JS, Dimmick RW (1969) Food habits of the Copperhead in middle Tennessee. *J Tenn Acad Sci* 44:113–117; Fitch HS (1982) Resources of a snake community in prairie–woodland habitat of northeastern Kansas. *Herpetological Communities*, ed Scott NJ, 83–98.
Amphiesma stolatum	Terrestrial	Ground dweller	Carnivore	Oviparous	Pryce D, Thorpe CJ, Kulkarni S, Lewis TR (2016) *Amphiesma stolatum* (Striped keelback): Habitat and reproduction. *The Herpetological Bulletin* 136:37–38.; Baruah M, Das M, Sengupta S (2001) Food and feeding of *Amphiesma stolatum* (Linnaeus 1758). *J Environm Biol* 22:315–317.
Anilius scytale	Terrestrial	Ground dweller	Carnivore	Viviparous	Maschio GF, da Costa Prudente AL, de Lima AC, Feitosa DT (2007) Reproductive Biology of *Anilius scytale* (Linnaeus 1758) (Serpentes, Aniliidae) from Eastern Amazonia, Brazil. *South Am J Herpetol* 2:179–183.; Maschio GF, Prudente ALC, Rodrigues FS, Hoogmoed MS (2010) Food habits of *Anilius scytale* (Serpentes: Aniliidae) in the Brazilian Amazonia. *Zoologia* 27:184–190.
Anomochilus leonardi	Fossorial	Digger	Unknown	Oviparous	Stuebing RB, Goh R (1993) A new record of Leonard's pipe snake, *Anomochilus leonardi* Smith (Serpentes: Uropeltidae: Cylindrophrinae) from Sabah, North Western Borneo. *Raffles Bull Zool* 41:311–314.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Aparallactus modestus	Semi-fossorial	Ground dweller/digger	Invertivore	Oviparous	Luiselli L, Akani GC, Rugiero L, Politano E (2005) Relationships between body size, population abundance and niche characteristics in the communities of snakes from three habitats in southern Nigeria. *J Zool Lond* 265:207–213.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Naik H (2017) The evolution of diet in

					the Lamprophiidae. PhD Dissertation. University of the Witwatersrand.
Aspidites melanocephalus	Terrestrial	Ground dweller	Carnivore	Oviparous	Johnson CR, Webb GJW, Johnson C (1975) Thermoregulation in pythons—III. Thermal ecology and behavior of the Black-headed Rock Python, *Aspidites melanocephalus*. *Herpetologica* 31:326–332.; Charles N, Field R, Shine R (1985) Notes on the reproductive biology of Australian pythons, genera *Aspidites*, *Liasis* and *Morelia*. *Herpetol Rev* 16:45–48.; Shine R, Slip DJ (1990) Biological aspects of the adaptive radiation of Australasian pythons (Serpentes: Boidae). *Herpetologica* 46: 283–290; Tyler MJ, Edwards A, Johnston, GR (1990) Amphibians and reptiles. *Natural History of the North East Deserts*, eds Tyler MJ, Twidale CR, Davies M, Wells CB, 183–188.
Atractaspis irregularis	Fossorial	Digger	Carnivore	Oviparous	Price RM (1982) Dorsal snake scale microdermatoglyphics: Ecological indicator or taxonomic tool? *J Herpetol* 16:294–306.; Deufel A, Cundall D (2003) Feeding in *Atractaspis* (Serpentes: Atractaspididae): A study in conflicting functional constraints. *Zool* 106:43–61.; Chirio L, LeBreton M (2007) Atlas des reptiles du Cameroun. Publications Scientifiques du Muséum National d'Histoire naturelle, vol. 67 (Naturelle & IRD Editions).; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Azemiops feae	Terrestrial	Ground dweller	Carnivore	Oviparous	Orlov N, Ananjeva N, Khalikov R (2002) Natural history of pitvipers in Eastern and Southeastern Asia. *Biology of the Vipers*, eds Campbell JA, Brodies ED (Selva Publishing).
Bitis arietans	Terrestrial	Ground dweller	Carnivore	Viviparous	Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Glaudas X, Kearney TC, Alexander G (2017) Museum specimens bias measures of snake diet: A case study using the ambush foraging Puff Adder (*Bitis arietans*). *Herpetologica* 73:121–128.
Boa constrictor	Semi-arboreal	Ground-dweller/climber	Carnivore	Viviparous	Attademo A, Bertona M, Kozykariski M, Chiaraviglio M (2004) Uso del hábitat por *Boa constrictor occidentalis* (Serpentes: Boidae) durante la estación seca en Córdoba, Argentina. *Cuadernos de Herpetología* 18:33–41.; Sironi M, Chiaraviglio M, Cervantes R, Bertona M, Rio M (2000) Dietary habits of *Boa constrictor occidentalis*, in the Cordoba Province, Argentina. *Amphibia-Reptilia* 21:226–232.; Boback SM (2004) Boa constrictor (*Boa constrictor*). Diet. *Herpetol Rev* 35:175.; Quick JS, Reinert HK, de Cuba ER, Odum RA (2005) Recent occurrence and dietary habits of *Boa constrictor* on Aruba, Dutch West Indies. *J Herpetol* 39:304–307.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.

Bothrops asper	Terrestrial	Ground dweller	Carnivore	Viviparous	Sasa M, Wasko DK, Lamar WW (2009) Natural history of the terciopelo *Bothrops asper* (Serpentes: Viperidae) in Costa Rica. *Toxicon* 54:904–922.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Calabaria reinhardtii	Semi-fossorial	Ground dweller/Digger	Carnivore	Oviparous	Angelici FM, Inyang MA, Effah C, Luiselli L (2000) Analysis of activity patterns and habitat use of radiotracked African burrowing pythons, *Calabaria reinhardtii*. *Isr J Zool* 46:131–141.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Calliophis bivirgata	Leaf litter	Litter dweller	Carnivore	Oviparous	Kgaditse M (2016) The evolution and diversification of diet in elapids. PhD Dissertation. University of the Witwatersrand.; Das I (2010) A Field Guide to the Reptiles of South-east Asia (New Holland Publishers).; Sokolov AY (2003) On the morphofunctional peculiarities of the jaw apparatus of ophiophagous elapid snakes and on the some stages in evolution of Elapidae. *Herpetologia Petropolitana*, eds Ananjeva N, Tsinenko O, 307–309.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Candoia carinata	Terrestrial	Ground dweller	Carnivore	Viviparous	Harlow P, Shine R (1992) Food habits and reproductive biology of the Pacific Island Boas (*Candoia*). *J Herpetol* 26:60–66.
Casarea dussumieri	Terrestrial	Ground dweller	Carnivore	Oviparous	Vinson J (1949) L'île Ronde et l'île aux Serpents*. Proceedings of the Royal Society of Arts and Sciences Mauritius* 1:32–52.; Bullock DJ (1977) Round Island—A tale of destruction. *Oryx* 14: 51–58.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Causus rhombeatus	Terrestrial	Ground dweller	Carnivore	Oviparous	Menzies JI (1966) The snakes of Sierra Leone. *Copeia* 1966: 169–179.; Ineich I, Bonnet X, Shine R, Shine T, Brishoux F, Lebreton M, Chirio L (2006) What, if anything, is a 'typical' viper? Biological attributes of basal viperid snakes (genus *Causus* Wagler, 1830). *Biol J Linn Soc* 89:575–588.;
Coluber constrictor	Terrestrial	Ground dweller	Invertivore	Oviparous	Packard GC, Tracy CR, Roth JJ (1977) The physiological ecology of reptilian eggs and embryos and the evolution of viviparity within the class Reptilia. *Biol Rev* 52:71–105.; Klimstra WD (1959) Foods of the Racer, *Coluber constrictor*, in Southern Illinois. *Copeia* 1959:210–214.; Shewchuk CH, Austin JD (2001) Food habits of the racer (*Coluber constrictor* Mormon) in the northern part of its range. *Herpetological Journal* 11:151–155.; Brown WS (1973) Ecology of the racer, *Coluber constrictor* Mormon (Serpentes, Colubridae), in a cold temperate desert in northern Utah. PhD Dissertation. University of Utah.
Cylindrophis ruffus	Semi-fossorial	Ground dweller/digger	Carnivore	Viviparous	Greene HW (1983) Dietary correlates of the origin and radiation of snakes. *Integr Comp Biol* 23:431–441.; Houssaye A, Boistel R, Böhme W, Herrel A (2013) Jack-of-all-trades master of all? Snake vertebrae have a generalist inner organization. *Naturwissenschaften*

					100:997–1006.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Daboia russelii	Terrestrial	Ground dweller	Carnivore	Ovoviviparous	Wuster W (1998) The genus *Daboia* (Serpentes: Viperidae): Russelus viper. *Hamadryad* 23:33–40.
Diadophis punctatus	Terrestrial	Ground dweller	Carnivore	Oviparous	Bush FM (1959) Foods of some Kentucky herptiles. *Herpetologica* 15(2):73–77.; Myers CW (1965) Biology of the Ringneck Snake, *Diadophis punctatus*, in Florida. *Bull Florida State Mus* 10(2): Ernst CH, Ernst EM (2003) Snakes of the United States and Canada (Smithsonian Books).; Henderson RW (1970) Feeding behavior, digestion, and water requirements of *Diadophis punctatus arnyi* Kennicott. *Herpetologica* 26:520–526.
Dipsas variegata	Arboreal	Climber	Invertivore	Oviparous	Lotzkat S, Natera-Mumaw M, Hertz A, Sunyer J, Mora D (2008) New state records of *Dipsas variegate* (Duméril, Bibron and Duméril 1854) (Serpentes: Colubridae) from Northern Venezuela, with comments on natural history. *Herpetotropicos* 4(1):25–29.; Ray JM, Montgomery CE, Mahon HK, Savitzky AH, Lips KR (2012) Goo-eaters: Diets of the neotropical snakes *Dipsas* and *Sibon* in Central Panama. *Copeia* 2012:197–202.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Drysdalia coronoides	Terrestrial	Ground dweller	Carnivore	Viviparous	Webb GA (1991) A survey of the reptiles and amphibians of Bondi State Forest and surrounding areas, near Bombala, New South Wales. *Austr Zool* 27:14–19.; Shine R (2002) Allometric patterns in the ecology of Australian snakes. *Copeia* 1994:851–867.
Elaphe dione	Terrestrial	Ground dweller	Carnivore	Oviparous	Mori A (2010) Prey-handling behavior of newly hatched snakes in two species of the genus *Elaphe* with comparison to adult behavior. *Ethol* 97:198–214.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Aghasyan A., et al (2017) *Elaphe dione*. The IUCN Red List of Threatened Species 2017: e.T157275A747623. http://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T157275A747623.en.
Enhydris enhydris	Aquatic	Swimmer	Carnivore	Viviparous	Karns DR, Voris HK, Chanard T, Goodwin JC, Murphy JC (2000) The spatial ecology of the Rainbow Water snake, *Enhydris enhydris* (Homalopsinae) in southern Thailand. *Herpetological Natural History* 7: 97–115.; Voris HK, Murphy JC (2002) The prey and predators of homalopsine snakes. *J Nat Hist* 36:1621–1632.
Epicrates cenchria	Semi-arboreal	Ground-dweller/Climber	Carnivore	Viviparous	Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Solis JM, Bowman D, Ward D (2015) *Epicrates cenchria* (Rainbow Boa): Feeding observation. *The Herpetol Bull* 132:25–26.; Martin-Solano S, Toulkeridis T, Addison A, Pozo-Rivera WE (2016) Predation of *Desmodus rotundus* Geoffroy 1810 (Phyllostomatidae,

					Chiroptera) by *Epicrates cenchria* (Linnaeus, 1758) (Boidae, Reptilia) in an Ecuadorian Cave. *Subterr Biol* 19:41–50.
Eryx colubrinus	Fossorial	Digger	Carnivore	Viviparous	Rodriguez-Robles JA, Bell CJ, Greene HW (1999) Gape size and evolution of diet in snakes: Feeding ecology of erycine boas. *J Zool* 248:49–58.; Lanza B, Nistri A (2005) Somali Boidae (genus *Eryx* Daudin 1803) and Pythonidae (genus *Python* Daudin 1803) (Reptilia Serpentes) *Trop Zool* 18:67–136.
Grayia smythii	Semi-aquatic	Ground-dweller/Swimmer	Carnivore	Oviparous	Luiselli L, Akani GC, Angelici GM, Ude L, Wariboko SM (2005) Seasonal variation in habitat use in sympatric afrotropical semi-aquatic snakes, *Grayia smythii* and *Afronatrix anoscopus* (Colubridae). *Amphibia Reptilia* 26: 372–376.; Akani GC, Luiselli L (2001) Ecological studies on a population of the water snake *Grayia smythii* in a rainforest swamp of the Niger Delta, Nigeria. *Contributions to Zoology* 70(3):139–146.
Heterodon platirhinos	Semi-fossorial	Ground dweller/Digger	Carnivore	Oviparous	Edgren RA (1955) The natural history of the Hog-nosed snakes, genus *Hetrodon*: A review. *Herpetologica* 11:105–117.; Cooper WE, Secor S (2007) Strong response to anuran chemical cues by an extreme dietary specialist, the Eastern Hog-nosed snake (*Heterodon platirhinos*). *Can J Zool* 85:619–625.
Homalopsis buccata	Semi-aquatic	Ground dweller/swimmer	Carnivore	Ovoviviparous	Berry PY, Lim GS (1967) The breeding pattern of the Puff-faced Water Snake, *Homalopsis buccata* Boulenger. *Copeia* 1967:307–313.; Voris HK, Murphy JC (2002) The prey and predators of homalopsine snakes. *J Nat Hist* 36:1621–1632.; Karns DR, Murphy JC, Voris HK, Suddeth JS (2005) Comparison of semi-aquatic snake communities associated with the Khorat Basin, Thailand. *Nat Hist J Chulalongkorn Univ* 5(2):73–90.
Imantodes cenchoa	Arboreal	Climber	Carnivore	Oviparous	de Sousa KRM, Prudente ALC, Maschio GF (2014) Reproduction and diet of *Imantodes cenchoa* (Dipsadidae: Dipsadinae) from the Brazilian Amazon. *Zoologia* 31(9):8–19.
Lachesis stenophrys	Terrestrial	Ground dweller	Carnivore	Oviparous	Solórzano A (2004) Serpientes de Costa Rica: Distribución, taxonomía, ehistoria natural (Instituto Nacional de Biodiversidad).; Corrales G, Meidinger R, Rodríguez S, Chacón D, Gómez A (2014) Reproduction in captivity of the Central American bushmaster (*Lachesis stenophrys*, Serpentes: Viperidae), in Costa Rica. *Cuad Herpetol* 28(2):137–139.
Lampropeltis getula	Terrestrial	Ground dweller	Carnivore	Oviparous	Birchard GF, Marcellini D (1996) Incubation time in reptilian eggs. *J Zool* 240:621–635.; Jackson K, Kley NJ, Brainerd EL (2004) How snakes eat snakes: The biomechanical challenges of ophiophagy for the California kingsnake, *Lampropeltis getula californiae* (Serpentes: Colubridae). *Zoology* 107:191–200.; Steen DA, Linehan JM, Smith LL (2010) Multiscale habitat selection and refuge use of Common Kingsnakes, *Lampropeltis getula*, in Southwestern Georgia. *Copeia* 2010:227–231.
Boaedon fuliginosus	Terrestrial	Ground dweller	Carnivore	Oviparous	Byars DJ, Ford NB, Sparkman AM, Bronikowski AM (2010) Influences of diet and family on age of maturation in brown house

					snakes, *Lamprophis fuliginosus*. *Herpetologica* 66:456–463.; Greenbaum E, Portillo F, Jackson K, Kusamba C (2015) A phylogeny of Central African *Boaedon* (Serpentes: Lamprophiidae), with the description of a new cryptic species form the Albertine Rift. *Afr J Herpetol* 64:18–38.
Langaha madagascariensis	Arboreal	Climber	Carnivore	Oviparous	Krysko KL (2003) Reproduction in the Madagascar Leaf-nosed snake, *Langaha madagascariensis* (Serpentes: Colubridae: Pseudoxyrhophiinae). *Afr J Herpetol* 52:61–68.; Krysko KL (2005) Feeding behaviour of the Madagascar Leaf-nosed snake, *Langaha madagascariensis* (Serpentes: Colubridae: Pseudoxyrhophiinae), with an alternative hypothesis for its bizarre head structure. *Afr J Herpetol* 54: 195–200.; Tingle JL (2012) Field observations on the behavioral ecology of the Madagascan Leaf-Nosed Snake, *Langaha madagascariensis*. *Herpetol Conserv Biol* 7:442−448.
Laticauda colubrina	Aquatic	Swimmer	Carnivore	Oviparous	Shetty S, Shine R (2008) Sexual divergence in diets and morphology in Fijian sea snakes *Laticauda colubrina* (Laticaudinae). *Austral Ecology* 27:77–84.; Pernetta JC (1977) Observations on the habits and morphology of the sea snake *Laticauda colubrina* (Schneider) in Fiji. *Can J Zool* 55:1612–1619.
Rena dulcis	Fossorial	Digger	Invertivore	Oviparous	Klauber LM (1940) The worm snakes of the genus *Leptotyphlops* in the United States and northern Mexico. *Trans San Diego Soc Nat Hist* 9(18):87–162.; Parga VM, Jr (2018) Arthropod diets in Chihuahuan Desert Snakes. PhD Dissertation. The University of Texas at El Paso.
Lichanura trivirgata	Terrestrial	Ground dweller	Carnivore	Viviparous	Rodriguez-Robles JA, Bell CJ, Greene HW (1999) Gape size and evolution of diet in snakes: Feeding ecology of erycine boas. *J Zool* 248:49–58.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Indotyphlops braminus	Fossorial	Digger	Invertivore	Oviparous	The Brhaminy Blind snake (*Ramphotyphlops braminus*) in the Seychelles Archipelago: Distribution, variation, and further evidence for parthenogenesis. *Herpetologica* 36:215–221.; Mizuno T, Kojima Y (2015) A blindsnake that decapitates its termite prey. *J Zool* 297:220–224.
Loxocemus bicolor	Semi-fossorial	Ground dweller/Digger	Carnivore	Oviparous	Mora JM, Robinson DC (1984) Predation of sea turtle eggs (*Lepidochelys*) by the snake *Loxocemus bicolor* Cope. *Rev Biol Trop* 32:161–162.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Figgener C, Beck E, Dunlop D, McCarthy AC (2018) *Loxocemus bicolor.* Diet. *Herpetol Rev* 49:133.
Lycophidion capense	Terrestrial	Ground dweller	Carnivore	Oviparous	Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Naik H (2017) The evolution of diet in the Lamprophiidae. Ph.D Dissertation. University of Witswatersrand.

Afrotyphlops schlegelii	Fossorial	Digger	Invertivore	Oviparous	Webb JK, Branch WR, Shine R (2001) Dietary habits and reproductive biology of typhlopid snakes from Southern Africa. *J Herpetol* 35:558–567.; Maritz B, Alexander GJ (2008) Breaking ground: Quantitative fossorial herpetofaunal ecology in South Africa. *Afr J Herpetol* 58:1–14.
Micrurus fulvius	Terrestrial	Ground dweller	Carnivore	Oviparous	Jackson DR, Franz R (1981) Ecology of the Eastern Coral snake (*Micrurus fulvius*) in northern peninsular Florida. *Herpetologica* 37:213–228.; Birchard GF, Marcellini D (1996) Incubation time in reptilian eggs. *J Zool* 240:621–635.
Natrix natrix	Terrestrial	Ground dweller	Carnivore	Oviparous	Birchard GF, Marcellini D (1996) Incubation time in reptilian eggs. *J Zool* 240:621–635.; Luiselli L, Capula M (1997) Food habits, growth rates, and reproductive biology of grass snakes, *Natrix natrix* (Colubridae) in the Italian Alps. *J Zool Lond* 241:371–380.; Hojati V, Faghiri A, Shiravi A (2012) Diet of the Grass snake, *Natrix natrix* (Linnaeus,1758) (Serpentes: Colubridae), in northern Iran. *Zool Middle East* 55:132–134.
Pareas hamptoni	Arboreal	Climber	Invertivore	Oviparous	Das I (2010) A Field Guide to the Reptiles of South-east Asia (New Holland Publishers).; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Vogel G (2015) A new montane species of the genus *Pareas* Wagler, 1830 (Squamata: Pareatidae) from Northern Myanmar. *Taprobanica* 7:1–7.
Philodryas olfersii	Semi-arboreal	Ground dweller/ Climber	Carnivore	Oviparous	Hartmann PA, Marques OAV (2005) Diet and habitat use of two sympatric species of *Philodryas* (Colubridae), in south Brazil. *Amphib Reptil* 26:25–31.; Leite PT, Kaefer IL, Cechin SZ (2009) Diet of *Philodryas olfersii* (Serpentes, Colubridae) during hydroelectric dam flooding in southern Brazil. *North-Western J Zool* 5:53–60.
Prosymna meleagris	Fossorial	Digger	Carnivore	Oviparous	Broadley DG (1979) Predation on reptile eggs by African snakes of the genus *Prosymna*. *Herpetologica* 35:338–341.; Maritz B, Alexander GJ (2008) Breaking ground: Quantitative fossorial herpetofaunal ecology in South Africa. *Afr J Herpetol* 58:1–14.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Psammophis sibilans	Terrestrial	Ground dweller	Carnivore	Oviparous	Menzies JI (1966) The snakes of Sierra Leone. *Copeia* 1966:169–179.; Packard GC, Tracy CR, Roth JJ (1977) The physiological ecology of reptilian eggs and embryos and the evolution of viviparity within the class Reptilia. *Biol Rev* 52:71–105.; Chirio L, LeBreton M (2007) Atlas des reptiles du Cameroun. Publications Scientifiques du Muséum National d'Histoire naturelle, vol. 67 (Naturelle & IRD Editions).; Corlett RT (2011) Vertebrate carnivores and predation in the oriental (Indomalayan) region. *Raffles Bull Zool* 59:325–360.
Pseudoxenodon bambusicola	Terrestrial	Ground dweller	Carnivore	Oviparous	Das I (2010) A Field Guide to the Reptiles of South-east Asia (New Holland Publishers).; Corlett RT (2011) Vertebrate carnivores and

					predation in the oriental (Indomalayan) region. *Raffles Bull Zool* 59:325–360.; Liu Y, Ding L, Lei J, Zhao E, Tang Y (2012) Eye size variation reflects habitat and daily activity patterns in colubrid snakes. *J Morphol* 273:883–893.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Python molurus	Terrestrial	Ground dweller	Carnivore	Oviparous	Birchard GF, Marcellini D (1996) Incubation time in reptilian eggs. *J Zool* 240:621–635.; Rochford M, et al. (2010) *Python molurus bivittatus* (Burmese Python). Diet. *Herpetol Rev* 41:97.; Corlett RT (2011) Vertebrate carnivores and predation in the oriental (Indomalayan) region. *Raffles Bull Zool* 59:325–360.
Regina grahami	Aquatic	Swimmer	Invertivore	Viviparous	Kofron CP (1978) Foods and habitats of aquatic snakes (Reptilia, Serpentes) in a Louisiana swamp. *J Herpetol* 12:543–554.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Sibynophis collaris	Terrestrial	Ground dweller	Carnivore	Oviparous	Das I (2010) A Field Guide to the Reptiles of South-east Asia (New Holland Publishers).; Corlett RT (2011) Vertebrate carnivores and predation in the oriental (Indomalayan) region. *Raffles Bull Zool* 59:325–360.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Sonora semiannulata	Terrestrial	Ground dweller	Invertivore	Oviparous	Goldberg SR (2001) Reproduction in the Ground snake, *Sonora semiannulta* (Serpentes: Colubridae), from Arizona. *Southwest Nat* 46:387–391.; Parga VM (2018) Arthropod diets in Chihuahuan Desert snakes. PhD Dissertation. University of Texas at El Paso.
Thamnophis marcianus	Semi-aquatic	Ground dweller/swimmer	Carnivore	Viviparous	Seigel RA, Ford NB, Mahrt LA (2000) Ecology of an aquatic snake (*Thamnophis marcianus*) in a desert environment: Implications of early timing of birth and geographic variation in reproduction. *Am Midl Nat* 143:453–462.
Trachyboa boulengeri	Semi-aquatic	Ground dweller/swimmer	Carnivore	Viviparous	Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Dwyer Q, Arteaga A, Barrio-Amoros C, Flage A (2018) *Trachyboa boulengeri*. Diet. *Herpetol Rev* 49:359–360.
Trimeresurus gramineus	Arboreal	Climber	Carnivore	Viviparous	Créer S, Malhotra A, Thorpe RS, Stocklin R, Favreau P, Hao Chou W (2003) Genetic and ecological correlates of intraspecific variation in pitviper venom composition detected using matrix-assisted laser desorption time-of-flight mass spectrometry (MALDI-TOF-MS) and isoelectric focusing. *J Mol Evol* 56:317–329.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Trimorphodon biscutatus	Semi-arboreal	Ground dweller/Climber	Carnivore	Oviparous	Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Lara Resendiz RA, diaz de la Vega-Perez A (2016) Natural history notes: *Trimorphodon biscuta*tus. Diet, prey size, and

					accidental mortality (*Ctenosaura pectinata*). *Mesoam Herpetol* 3:750–751.
Tropidophis haetianus	Terrestrial	Ground dweller	Carnivore	Viviparous	Hedges SB (2002) Morphological variation and the definition of species in the snake genus *Tropidophis* (Serpentes, Tropidophiidae). *Bull Nat Hist Mus Lond (Zool)* 68(2):83–90.
Ungaliophis continentalis	Terrestrial	Ground dweller	Carnivore	Viviparous	McCranie JR, Castañeda FE (2005) The herpetofauna of Parque Nacional Pico Bonito, Honduras. *Phyllomedusa* 4:1–16.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Uromacer oxyrhynchus	Arboreal	Climber	Carnivore	Oviparous	Henderson RW, Noeske-Hallin TA, Crother BI, Schwartz A (1988) The diets of Hispaniolan colubrid snakes. II. Prey species, prey size, and phylogeny. *Herpetologica* 44:55–70.; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Xenochrophis flavipunctatus	Semi-aquatic	Ground dweller/swimmer	Carnivore	Oviparous	Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Poo S, Low M-R, Devan-Song A (2016) *Xenochrophis flavipunctatus* (Yellow-spotted Keelback Watersnake). Diet. *Herpetol Rev* 47:319.
Xenodermus javanicus	Semi-fossorial	Ground dweller/Digger	Carnivore	Oviparous	Corlett RT (2011) Vertebrate carnivores and predation in the Oriental (Indomalayan) region. *Raffles Bull Zool* 59:325–360.; Rovatsos M, Pokorná MJ, Kratochvíl L (2015) Differentiation of sex chromosomes and karyotype characterisation in the Dragonsnake *Xenodermus javanicus* (Squamata: Xenodermatidae). *Cytogenet Genome Res* 147:48–54.; Das I (2010) A Field Guide to the Reptiles of South-east Asia (New Holland Publishers).; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.
Xenopeltis unicolor	Semi-fossorial	Ground dweller/Digger	Carnivore	Oviparous	Teynié A (2004) Notes on Reptiles of Nam Lan Conservation Area in Phongsaly Province of Lao PDR (Societé d'Histoire Naturelle).; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.; Milto KD (2014) *Xenopeltis unicolor* (Asian Sunbeam Snake). Diet. *Herpetol Rev* 45: 522.
Xenophidion schaeferi	Semi-fossorial	Ground dweller/Digger	Unknown	Oviparous	Quah ESH, Grismer LL, Jetten T, Wood PL, Jr., Miralles A, Sah SAM, Guek KHP, Brady ML (2018) The rediscovery of Schaefer's Spin-jawed Snake (*Xenophidion schaeferi* Günther & Manthey, 1995) (Serpentes, Xenophidiidae) from Peninsular Malaysia with notes on its variation and the first record of the genus from Sumatra, Indonesia. *Zootaxa* 4441:366–378.; Das I (2010) A Field Guide to the Reptiles of South-east Asia (New Holland Publishers).; Pyron RA, Burbrink FT (2013) Early origin of viviparity and multiple reversions to oviparity in squamate reptiles. *Ecol Lett* 17:13–21.

Table S6. R^2 from phylogenetically corrected MANOVA for each partition and trait ($^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$).

Lizard Dataset

Partition	Diet	Habitat	Locomotion	Reproductive mode
Premaxilla	0.071*	0.188***	0.159**	0.008
Nasal	0.068*	0.191***	0.200***	0.004
Maxilla	0.043	0.169***	0.142***	0.010
Jugal	0.030	0.190***	0.166***	0.021
Frontal	0.036	0.228***	0.205***	0.007
Parietal	0.016	0.139*	0.117*	0.004
Squamosal	0.035	0.119*	0.118*	0.022
Jaw joint	0.075*	0.169**	0.123*	0.004
Supra-otoccipital	0.031	0.173***	0.167***	0.020*
Basioccipital	0.040	0.202***	0.181***	0.021*
Pterygoid	0.037	0.166***	0.147***	0.009
Palatine	0.042	0.204***	0.200***	0.007
Occipital condyle	0.032	0.219***	0.216***	0.038*
Whole skull	0.039	0.176***	0.158**	0.012

Snake Dataset

Partition	Diet	Habitat	Locomotion	Reproductive mode
Premaxilla	0.011	0.161	0.162	0.013
Nasal	0.018	0.178*	0.178*	0.032
Maxilla	0.014	0.148	0.148	0.020
Frontal	0.023	0.159	0.159	0.019
Parietal	0.032	0.245***	0.245***	0.020
Supratemporal	0.049*	0.225**	0.225**	0.017
Jaw joint	0.053*	0.173	0.173	0.028
Supra-otoccipital	0.062**	0.224**	0.224**	0.010
Basioccipital	0.034**	0.141	0.141	0.010
Pterygoid	0.084**	0.221**	0.221**	0.020
Palatine	0.020	0.189*	0.189*	0.011
Occipital condyle	0.087**	0.172	0.172	0.019
Whole skull	0.038*	0.181***	0.181***	0.021

Table S7. Between-partition covariance ratios (upper triangle), between-partition correlations (bottom triangle), and within-partition correlations (diagonal) across partitions after correcting for phylogenetic structure. Values calculated using phylogenetically-informed `modularity.test` in the `geomorph` R package (12, 13) and `EMMLi` (32), respectively.

Lizard Dataset

	Premaxilla	Nasal	Maxilla	Jugal	Frontal	Parietal	Squamosal	Jaw Joint	Supra-otoccipital	Basioccipital	Pterygoid	Palatine	Occipital condyle
Premaxilla	0.84	0.625	0.744	0.503	0.533	0.464	0.635	0.594	0.475	0.549	0.507	0.464	0.338
Nasal	0.31	0.68	0.701	0.594	0.596	0.477	0.462	0.480	0.514	0.468	0.520	0.627	0.416
Maxilla	0.35	0.21	0.54	0.789	0.738	0.645	0.699	0.631	0.695	0.685	0.649	0.658	0.652
Jugal	0.10	0.16	0.31	0.81	0.661	0.617	0.693	0.639	0.727	0.548	0.617	0.649	0.711
Frontal	0.26	0.29	0.16	0.12	0.76	0.798	0.583	0.500	0.782	0.713	0.594	0.580	0.783
Parietal	0.16	0.06	0.08	0.14	0.35	0.62	0.561	0.519	0.755	0.671	0.596	0.506	0.708
Squamosal	0.05	0.09	0.11	0.16	0.05	0.08	0.82	0.561	0.662	0.645	0.501	0.485	0.522
Jaw Joint	0.12	0.09	0.17	0.29	0.13	0.19	0.36	0.98	0.610	0.509	0.651	0.540	0.497
Supra-otoccipital	0.07	0.09	0.08	0.16	0.16	0.18	0.15	0.18	0.54	0.785	0.590	0.604	0.860
Basioccipital	0.11	0.08	0.11	0.12	0.20	0.16	0.07	0.18	0.31	0.59	0.647	0.618	0.768
Pterygoid	0.08	0.12	0.15	0.11	0.09	0.19	0.13	0.42	0.13	0.15	0.64	0.819	0.584
Palatine	0.16	0.15	0.21	0.15	0.05	0.11	0.05	0.16	0.06	0.11	0.41	0.65	0.650
Occipital condyle	0.08	0.05	0.10	0.27	0.38	0.31	0.09	0.07	0.45	0.49	0.09	0.07	0.95

Snake Dataset

	Premaxilla	Nasal	Maxilla	Frontal	Parietal	Supratemporal	Jaw Joint	Supra-otoccipital	Basioccipital	Pterygoid	Palatine	Occipital condyle
Premaxilla	0.85	0.647	0.509	0.384	0.513	0.462	0.502	0.530	0.389	0.483	0.462	0.400
Nasal	0.34	0.74	0.596	0.608	0.569	0.520	0.528	0.506	0.453	0.547	0.574	0.478
Maxilla	0.26	0.34	0.74	0.632	0.637	0.564	0.387	0.611	0.580	0.529	0.539	0.544
Frontal	0.14	0.31	0.21	0.82	0.599	0.442	0.245	0.404	0.470	0.427	0.570	0.397
Parietal	0.14	0.15	0.19	0.39	0.62	0.623	0.679	0.800	0.571	0.696	0.539	0.662
Supratemporal	0.12	0.13	0.16	0.04	0.19	0.78	0.682	0.671	0.560	0.664	0.467	0.581
Jaw Joint	0.05	0.15	0.22	0.10	0.36	0.27	0.99	0.832	0.575	0.818	0.416	0.783
Supra-otoccipital	0.18	0.10	0.20	0.13	0.35	0.36	0.59	0.73	0.620	0.789	0.505	0.886
Basioccipital	0.14	0.12	0.20	0.13	0.18	0.30	0.41	0.44	0.61	0.723	0.586	0.616
Pterygoid	0.15	0.20	0.30	0.13	0.27	0.24	0.60	0.37	0.40	0.81	0.705	0.769
Palatine	0.18	0.26	0.30	0.15	0.13	0.12	0.15	0.12	0.20	0.49	0.70	0.482
Occipital condyle	0.18	0.08	0.19	0.26	0.23	0.24	0.67	0.69	0.51	0.45	0.18	0.97

Extant Dataset

	Premaxilla	Nasal	Maxilla	Frontal	Parietal	Supratemporal	Jaw Joint	Supra-otoccipital	Basioccipital	Pterygoid	Palatine	Occipital condyle
Premaxilla	0.82	0.682	0.597	0.578	0.599	0.653	0.642	0.533	0.561	0.679	0.443	0.253
Nasal	0.26	0.69	0.721	0.562	0.562	0.570	0.692	0.531	0.672	0.712	0.551	0.323
Maxilla	0.20	0.22	0.67	0.643	0.596	0.536	0.692	0.590	0.818	0.741	0.488	0.469
Frontal	0.27	0.27	0.15	0.77	0.882	0.694	0.602	0.599	0.716	0.689	0.431	0.526
Parietal	0.13	0.06	0.08	0.35	0.60	0.730	0.696	0.634	0.703	0.754	0.425	0.485
Supratemporal	0.08	0.10	0.07	0.05	0.09	0.78	0.661	0.671	0.650	0.734	0.477	0.353
Jaw Joint	0.11	0.03	0.22	0.06	0.18	0.14	0.99	0.646	0.842	0.930	0.522	0.397
Supra-otoccipital	0.16	0.10	0.10	0.14	0.16	0.18	0.28	0.57	0.581	0.612	0.531	0.793
Basioccipital	0.12	0.07	0.10	0.17	0.10	0.11	0.15	0.29	0.55	0.870	0.466	0.399
Pterygoid	0.13	0.14	0.23	0.06	0.15	0.10	0.51	0.14	0.15	0.71	0.573	0.349
Palatine	0.10	0.18	0.28	0.06	0.09	0.05	0.19	0.08	0.12	0.47	0.72	0.449
Occipital condyle	0.21	0.08	0.11	0.36	0.21	0.10	0.38	0.49	0.43	0.19	0.12	0.94

Combined Dataset

	Premaxilla	Maxilla	Frontal	Parietal	Supra-otoccipital
Premaxilla	0.80	0.713	0.498	0.539	0.543
Maxilla	0.23	0.64	0.701	0.646	0.509
Frontal	0.23	0.17	0.77	0.867	0.748
Parietal	0.13	0.07	0.29	0.50	0.782
Supra-otoccipital	0.21	0.07	0.26	0.21	0.60

Combined Dataset (Alternative Topology)

	Premaxilla	Maxilla	Frontal	Parietal	Supra-otoccipital
Premaxilla	0.80	0.712	0.493	0.535	0.541
Maxilla	0.23	0.64	0.702	0.648	0.510
Frontal	0.23	0.17	0.77	0.867	0.748
Parietal	0.13	0.07	0.29	0.50	0.781
Supra-otoccipital	0.21	0.07	0.27	0.22	0.61

Table S8. Between-partition covariance ratios (upper triangle), between-partition correlations (bottom triangle), and within-partition correlations (diagonal) across partitions based on phylogenetically naïve analyses. Values calculated using `modularity.test` in the `geomorph` (12, 13) R package and `EMMLi` (32), respectively.

Lizard Dataset

	Premaxilla	Nasal	Maxilla	Jugal	Frontal	Parietal	Squamosal	Jaw Joint	Supra-otoccipital	Basioccipital	Pterygoid	Palatine	Occipital condyle
Premaxilla	0.81	0.600	0.690	0.400	0.505	0.447	0.574	0.488	0.442	0.509	0.454	0.404	0.332
Nasal	0.31	0.77	0.678	0.571	0.583	0.476	0.650	0.496	0.488	0.478	0.530	0.622	0.432
Maxilla	0.31	0.21	0.54	0.816	0.766	0.696	0.701	0.658	0.730	0.740	0.678	0.693	0.717
Jugal	0.13	0.18	0.27	0.79	0.728	0.685	0.706	0.719	0.798	0.686	0.663	0.685	0.788
Frontal	0.20	0.39	0.23	0.17	0.80	0.838	0.619	0.598	0.845	0.814	0.642	0.657	0.854
Parietal	0.15	0.11	0.16	0.15	0.41	0.62	0.591	0.584	0.779	0.737	0.647	0.581	.0.751
Squamosal	0.07	0.10	0.09	0.23	0.10	0.12	0.85	0.610	0.662	0.671	0.558	0.548	0.596
Jaw Joint	0.10	0.12	0.17	0.42	0.07	0.20	0.35	0.98	0.754	0.657	0.675	0.597	0.689
Supra-otoccipital	0.08	0.13	0.15	0.29	0.29	0.26	0.19	0.33	0.62	0.887	0.654	0.669	0.942
Basioccipital	0.12	0.12	0.13	0.21	0.25	0.20	0.08	0.22	0.36	0.59	0.697	0.705	0.905
Pterygoid	0.12	0.23	0.21	0.15	0.24	0.23	0.16	0.26	0.21	0.19	0.69	0.836	0.647
Palatine	0.16	0.31	0.23	0.18	0.21	0.17	0.15	0.16	0.18	0.17	0.53	0.73	0.705
Occipital condyle	0.13	0.26	0.16	0.29	0.59	0.41	0.17	0.36	0.57	0.52	0.30	0.32	0.97

Snake Dataset

	Premaxilla	Nasal	Maxilla	Frontal	Parietal	Supratemporal	Jaw Joint	Supra-otoccipital	Basioccipital	Pterygoid	Palatine	Occipital condyle
Premaxilla	0.85	0.632	0.520	0.373	0.534	0.500	0.508	0.547	0.431	0.509	0.458	0.437
Nasal	0.34	0.74	0.591	0.624	0.577	0.544	0.572	0.509	0.446	0.550	0.557	0.473
Maxilla	0.26	0.34	0.74	0.600	0.625	0.555	0.375	0.572	0.571	0.506	0.545	0.489
Frontal	0.14	0.31	0.21	0.82	0.567	0.440	0.309	0.398	0.439	0.344	0.540	0.380
Parietal	0.14	0.15	0.19	0.39	0.62	0.656	0.665	0.754	0.588	0.693	0.525	0.596
Supratemporal	0.12	0.13	0.16	0.04	0.19	0.78	0.710	0.711	0.595	0.692	0.471	0.633
Jaw Joint	0.05	0.15	0.22	0.10	0.36	0.27	0.99	0.883	0.675	0.852	0.432	0.851
Supra-otoccipital	0.18	0.10	0.20	0.13	0.35	0.36	0.59	0.73	0.714	0.827	0.517	0.931
Basioccipital	0.14	0.12	0.20	0.13	0.18	0.30	0.41	0.44	0.61	0.774	0.602	0.712
Pterygoid	0.15	0.20	0.30	0.13	0.27	0.24	0.60	0.37	0.40	0.81	0.689	0.799
Palatine	0.18	0.26	0.30	0.15	0.13	0.12	0.15	0.12	0.20	0.49	0.70	0.497
Occipital condyle	0.18	0.08	0.19	0.26	0.23	0.24	0.67	0.69	0.51	0.45	0.18	0.97

Extant Dataset

	Premaxilla	Nasal	Maxilla	Frontal	Parietal	Squamosal/ Supratemporal	Jaw Joint	Supra-otoccipital	Basioccipital	Pterygoid	Palatine	Occipital condyle
Premaxilla	0.81	0.664	0.590	0.578	0.596	0.643	0.589	0.511	0.561	0.652	0.432	0.324
Nasal	0.32	0.78	0.718	0.544	0.545	0.568	0.687	0.489	0.669	0.708	0.559	0.342
Maxilla	0.24	0.29	0.70	0.632	0.596	0.532	0.670	0.562	0.819	0.732	0.506	0.469
Frontal	0.21	0.26	0.21	0.75	0.879	0.666	0.483	0.637	0.695	0.601	0.470	0.612
Parietal	0.19	0.10	0.23	0.43	0.68	0.717	0.620	0.611	0.699	0.710	0.444	0.506
Supratemporal	0.07	0.07	0.13	0.09	0.11	0.85	0.633	0.612	0.648	0.714	0.496	0.386
Jaw Joint	0.11	0.09	0.36	0.25	0.38	0.22	0.99	0.640	0.808	0.926	0.544	0.477
Supra-otoccipital	0.12	0.13	0.15	0.18	0.18	0.16	0.28	0.57	0.563	0.569	0.550	0.906
Basioccipital	0.14	0.18	0.25	0.21	0.19	0.12	0.52	0.31	0.67	0.857	0.493	0.442
Pterygoid	0.15	0.23	0.31	0.22	0.27	0.21	0.62	0.14	0.34	0.72	0.585	0.375
Palatine	0.09	0.20	0.17	0.12	0.08	0.19	0.17	0.10	0.14	0.39	0.71	0.506
Occipital condyle	0.15	0.18	0.09	0.41	0.23	0.14	0.33	0.52	0.40	0.13	0.16	0.96

Combined Dataset

	Premaxilla	Maxilla	Frontal	Parietal	Supra-otoccipital
Premaxilla	0.80	0.703	0.533	0.558	0.578
Maxilla	0.28	0.69	0.686	0.644	0.530
Frontal	0.15	0.22	0.75	0.877	0.788
Parietal	0.13	0.20	0.37	0.59	0.800
Supra-otoccipital	0.18	0.15	0.32	0.31	0.61

Table S9. Regression coefficients (R^2) from least-squares regression analysis of within-partition correlation (ρ), disparity, and mean evolutionary rates under Brownian motion model ($^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$). ρ values are from phylogenetically informed EMMLi analyses. Rate has been corrected by number of landmarks within partitions.

Dataset	ρ ∝ disparity	ρ ∝ rate	disparity ∝ rate	ρ ∝ corr. disparity	corr. disparity ∝ rate
Combined (*N* = 5)	0.114	0.387	0.700	0.309	0.984^{***}
Extant (*N* = 12)	0.002	0.243	0.481^{*}	0.232	0.969^{***}
Lizard (*N* = 13)	0.086	0.127	0.286	0.205	0.857^{***}
Snake (*N* = 12)	0.013	0.259	0.400^{*}	0.258	0.995^{***}

Table S10. Results from performing LaSEC with 100 iterations on individual cranial partitions of the extant squamate dataset. Values for Fit = 0.9, 0.95, and 0.99 denote the median number of randomly subsampled landmarks at these fit values. Fixed-only column indicates the degree of fit (0 to 1) between datasets with only fixed landmarks to the respective full high-dimensional coordinate data.

Dataset	Number of Landmarks	Fit = 0.90	Fit = 0.95	Fit = 0.99	Fixed-only
Premaxilla	78	15	23	49	0.713
Nasal	86	15	25	54	0.664
Maxilla	162	16	27	74	0.696
Jugal	94	13	20	51	0.645
Frontal	130	14	25	66	0.721
Parietal	98	16	28	64	0.647
Squamosal	52	17	25	43	0.452
Jaw joint	42	20	27	38	0.484
Supra- otoccipital	132	30	55	90	0.597
Occipital condyle	37	22	27	34	—
Basioccipital	122	14	26	66	0.805
Pterygoid	53	14	21	39	0.421
Palatine	64	16	23	45	0.457

Table S11. The effect of phylogenetic signal (K_{mult}), allometry, and evolutionary allometry on skull and partition shapes ($^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$). Partition shape of combined datasets were used for premaxilla, maxilla, frontal, parietal, and supra-otoccipital.

Dataset	K_{mult}	$R^2_{\text{allometry}}$	$R^2_{\text{evolutionary allometry}}$
Combined	0.723^{***}	0.094^{***}	0.055^{***}
Extant	0.889^{***}	0.079^{***}	0.071^{***}
Lizard	0.699^{***}	0.183^{***}	0.058^{**}
Snake	1.050^{***}	0.107^{***}	0.117^{***}
Premaxilla	0.634^{***}	0.081^{***}	0.066^{***}
Nasal	0.701^{***}	0.035^{***}	0.010
Maxilla	0.817^{***}	0.043^{***}	0.032^{**}
Jugal	0.953^{***}	0.191^{***}	0.067^{***}
Frontal	0.714^{***}	0.144^{***}	0.072^{***}
Parietal	0.721^{***}	0.093^{***}	0.041^{***}
Squamosal/Supratemporal	0.803^{***}	0.039^{***}	0.025^{*}
Jaw Joint	1.364^{***}	0.082^{***}	0.160^{***}
Supra-otoccipital	0.606^{***}	0.159^{***}	0.092^{***}
Basioccipital	1.378^{***}	0.069^{***}	0.101^{***}
Occipital condyle	0.783^{***}	0.432^{***}	0.300^{***}
Pterygoid	1.028^{***}	0.033^{**}	0.076^{***}
Palatine	0.619^{***}	0.058^{***}	0.024^{**}

Table S12. Correlation coefficient (R) from two-block partial least squares analysis across partitions based on shape data from globally aligned skull data and within-partition generalized Procrustes alignment ($^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$). Analysis performed using the `two.b.pls` function in the `geomorph` R package (12, 13).

Premaxilla	Nasal	Maxilla	Jugal	Frontal	Parietal	Squamosal/ Supratemporal	Jaw Joint	Supra-otoccipital	Occipital condyle	Basioccipital + Basisphenoid	Pterygoid	Palatine
0.786^{***}	0.783^{***}	0.774^{***}	0.594^{***}	0.871^{***}	0.855^{***}	0.911^{***}	0.701^{***}	0.783^{***}	0.860^{***}	0.877^{***}	0.768^{***}	0.686^{***}

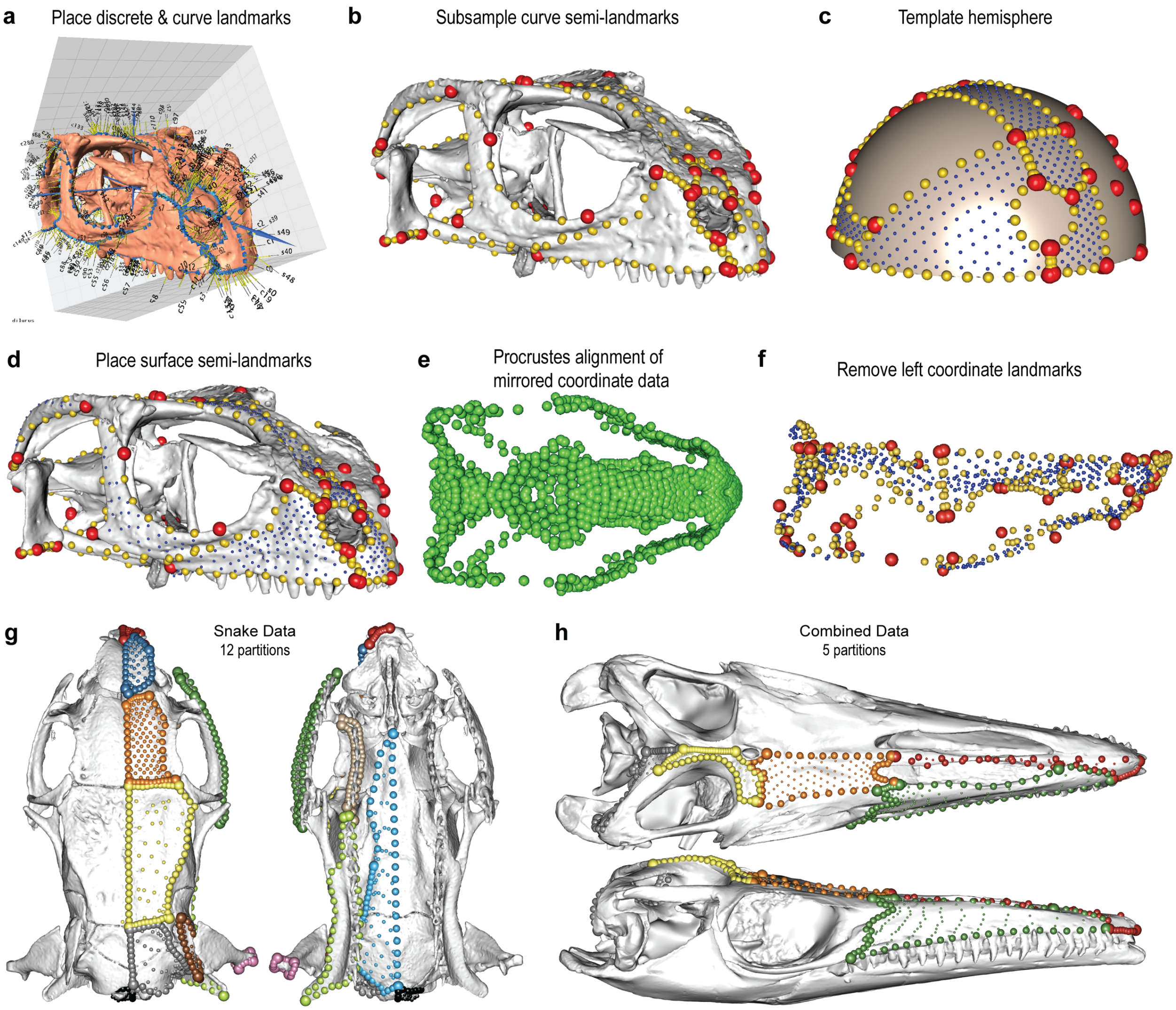


Fig. S1. Procedure used in this study for collecting high-dimensional coordinate data. a, virtual placement of landmarks and curve semi-landmarks in the program Landmark Editor to delineate anatomical partitions (3). **b,** Subsampling of curve semi-landmarks (yellow points) in R by adapting code from ref. (5). **c,** Template mesh with equivalent landmarks and curve semi-landmarks with surface semi-landmarks placed in similar densities within each partition (blue points). **d,** Use of `placePatch` function in the `Morpho` (6) R package to semi-automatically map surface semi-landmarks within partitions (blue points) onto 3-D mesh of actual specimens using thin plate spline method based on positions of landmarks (red points) and curve semi-landmarks (yellow points) on the template mesh and specimens. **e,** Mirroring of primarily right-sided coordinate data onto the left side prior to Procrustes alignment to avoid artifact originating from aligning one-sided data of bilaterally symmetric structures (9, 10). **f,** Removal of left-sided coordinate data (with the exception of occipital condyle digitized on the left side) after Procrustes alignment. **g,** Landmark scheme for snake dataset on skull of *Sonora semiannulata* (FMNH 26876) in dorsal and ventral views. **h,** Landmark scheme for combined dataset on skull of the mosasaur *Plotosaurus bennisoni* (UCMP 32778) in dorsal and lateral views.

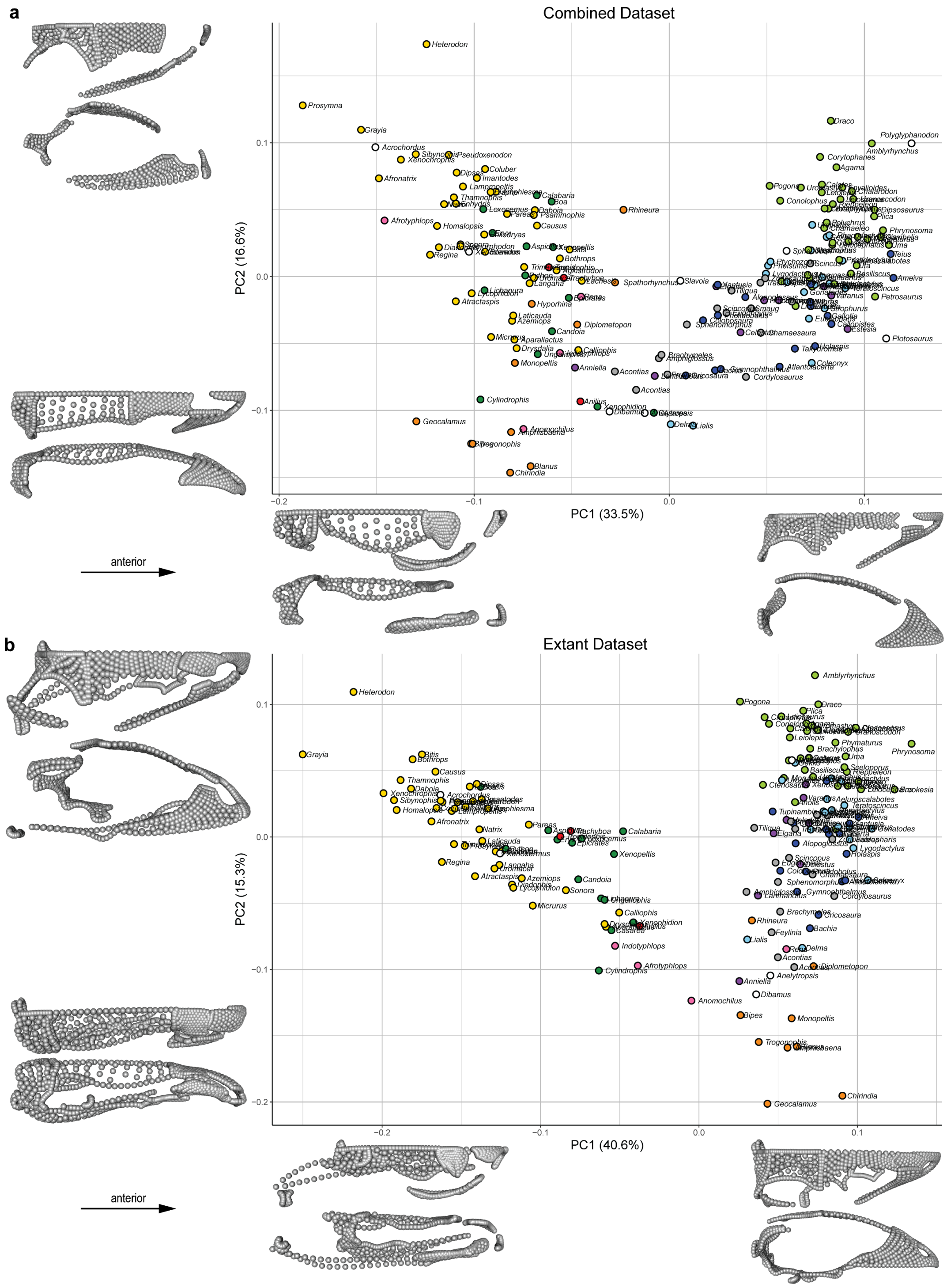


Fig. S2. Morphospace constructed from first two principal components (PC) of skull shape. a, PC2 vs PC1 plot of combined dataset with taxonomic labels. **b,** PC2 vs. PC1 plot of extant-only dataset with taxonomic labels. Shapes along PC axes represent those at maximum and minimum scores in respective PC axes to illustrate shape changes associated with PC axes (top, dorsal view; bottom, lateral view).

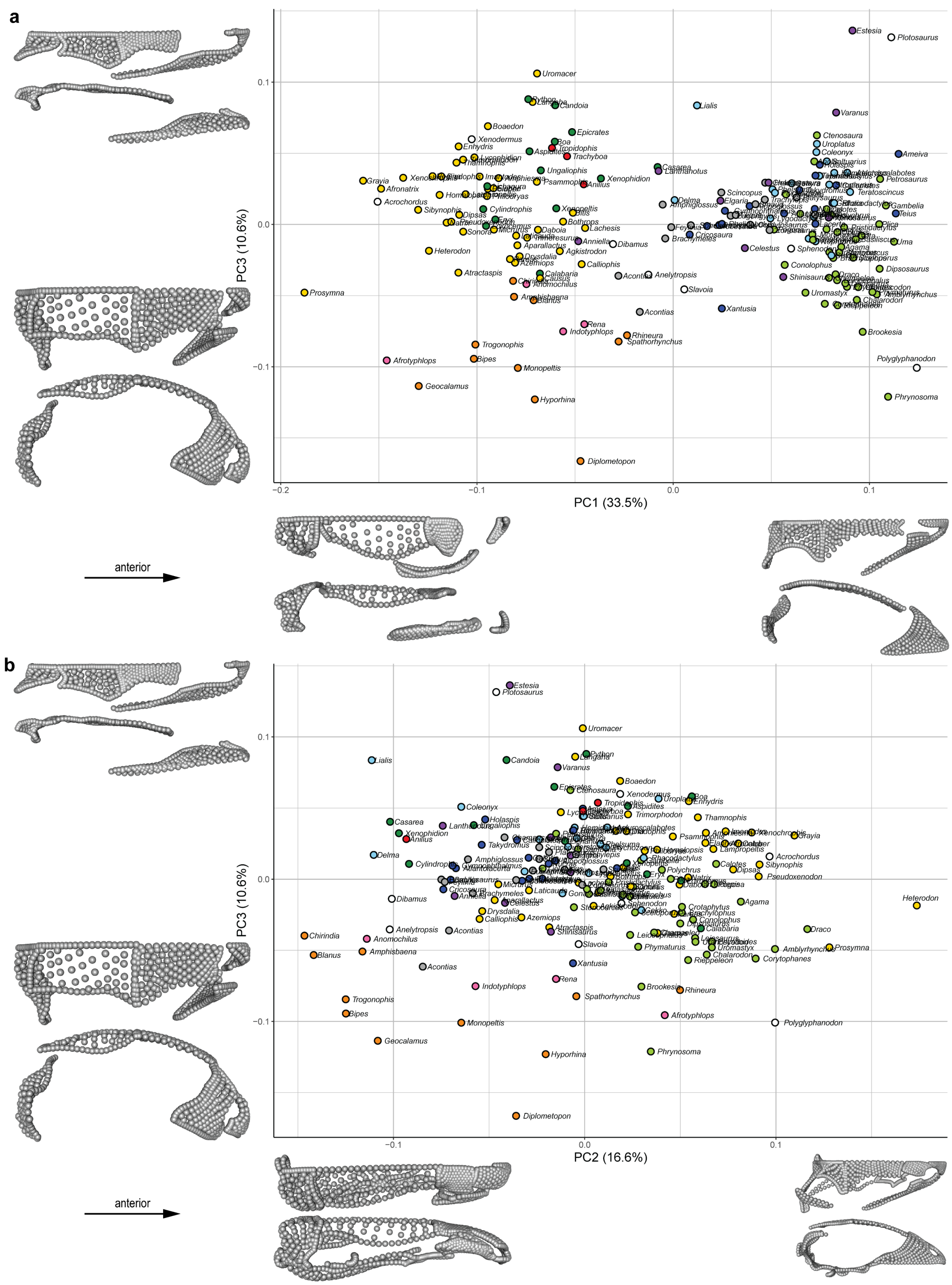


Fig. S3. Morphospace constructed from first three principal components (PC) of skull shape. a, PC3 vs PC1 plot of combined dataset with taxonomic labels. **b,** PC3 vs. PC2 plot of combined dataset with taxonomic labels. Shapes along PC axes represent those at maximum and minimum scores in respective PC axes to illustrate shape changes associated with PC axes (top, dorsal view; bottom, lateral view).

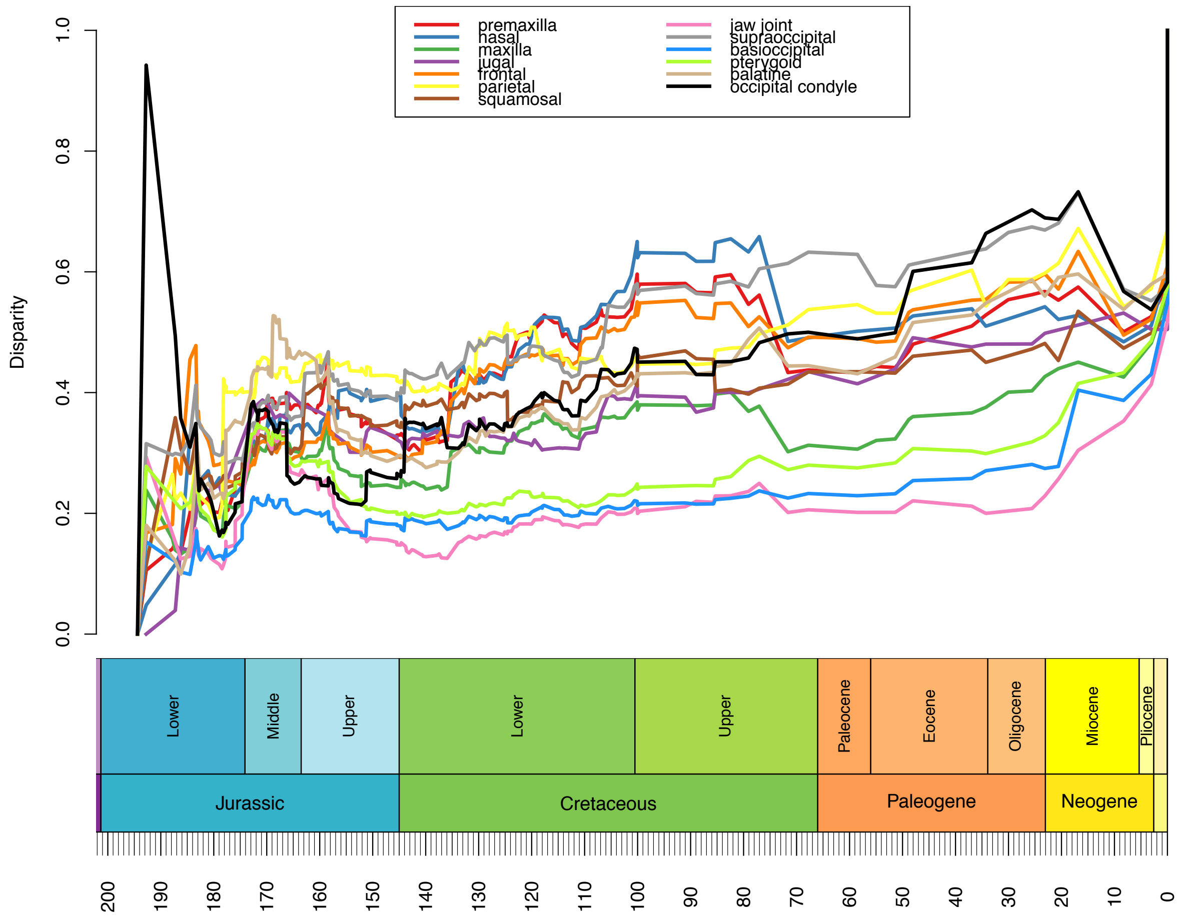
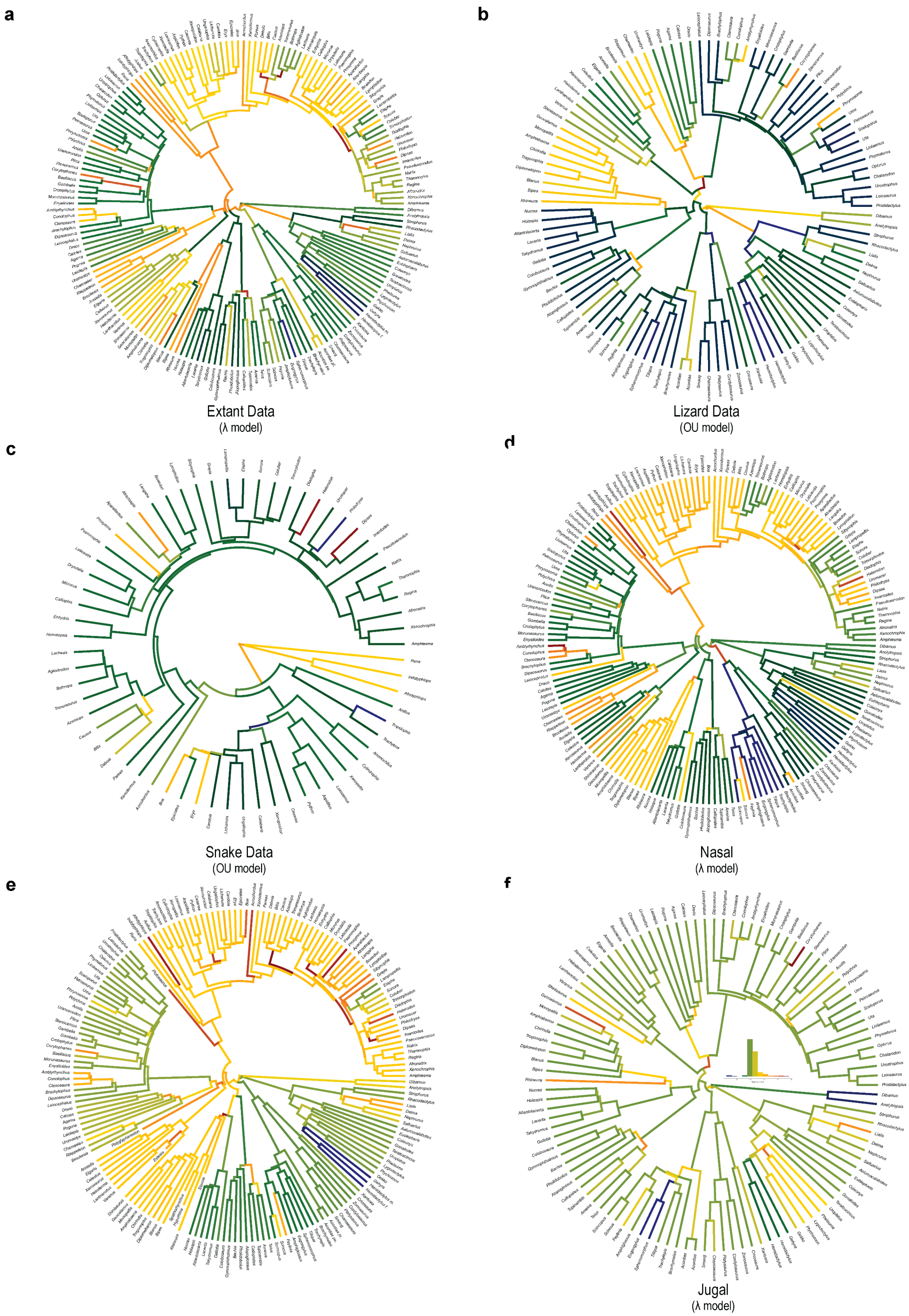
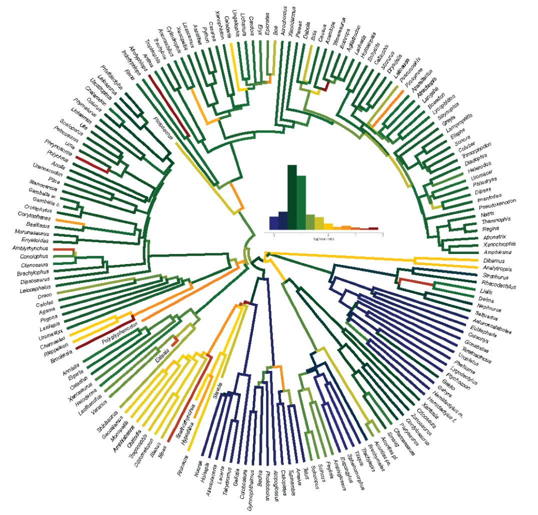


Fig. S4. Disparity (Procrustes variance) through geologic time across modules. For ease of comparing temporal dynamics, Procrustes variance is corrected by the number of landmarks and sliding semi-landmarks within each module.

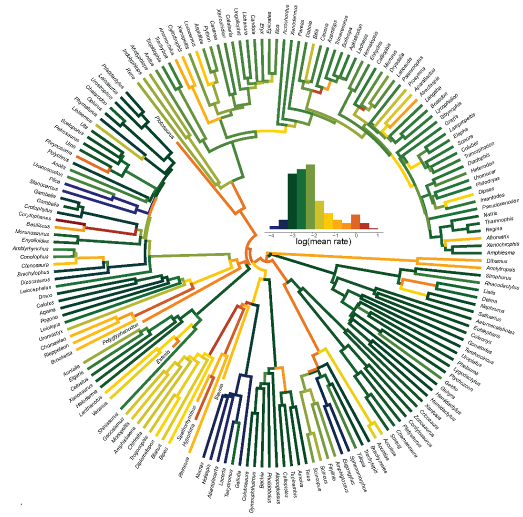

a
Extant Data
(λ model)
b
Lizard Data
(OU model)
c
Snake Data
(OU model)
d
Nasal
(λ model)
e
f
Jugal
(λ model)

g



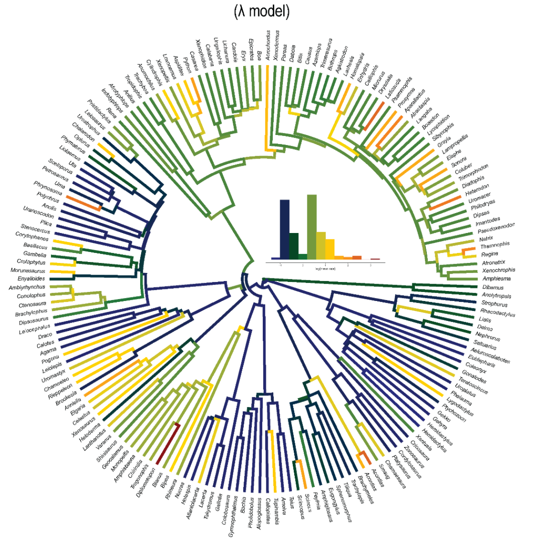
Frontal
(λ model)

h



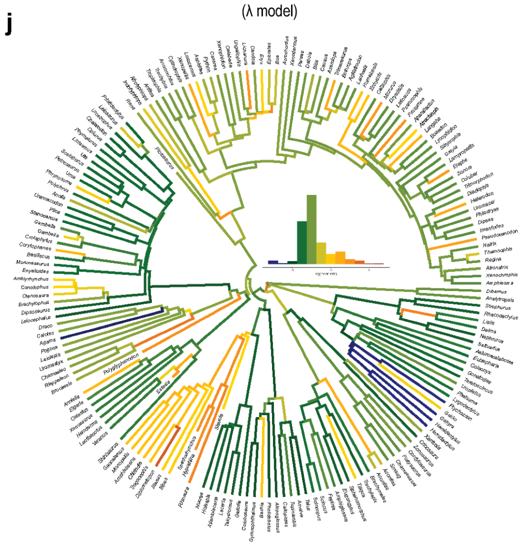
Parietal
(λ model)

i



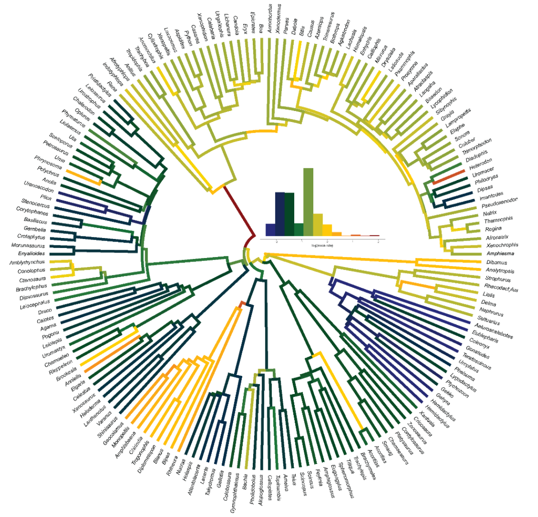
Squamosal/supratemporal
(δ model)

j



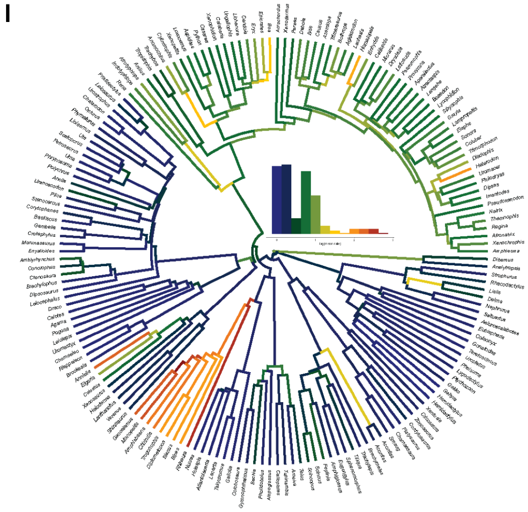
Supraoccipital
(λ model)

k



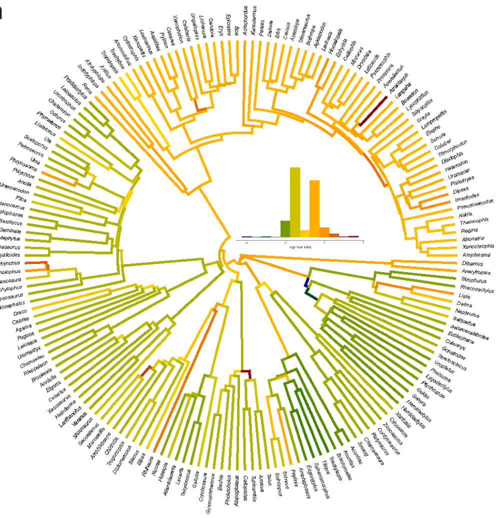
Basioccipital
(λ model)

l



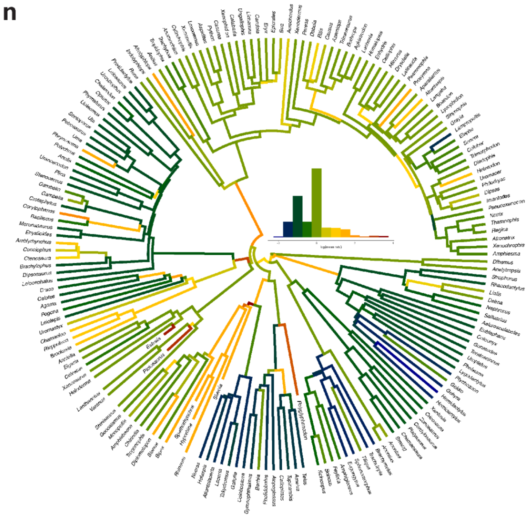
Occipital condyle
(λ model)

m



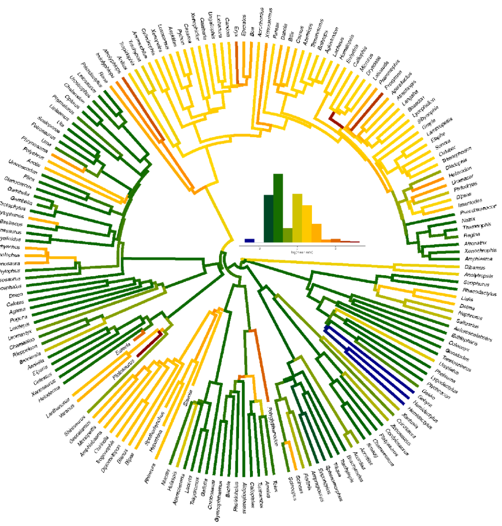
Palatine
(λ model)

n



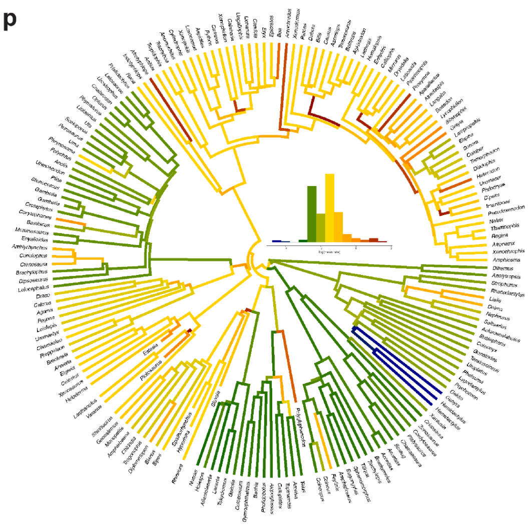
Combined Dataset (Alternative Topology)
(OU model)

o



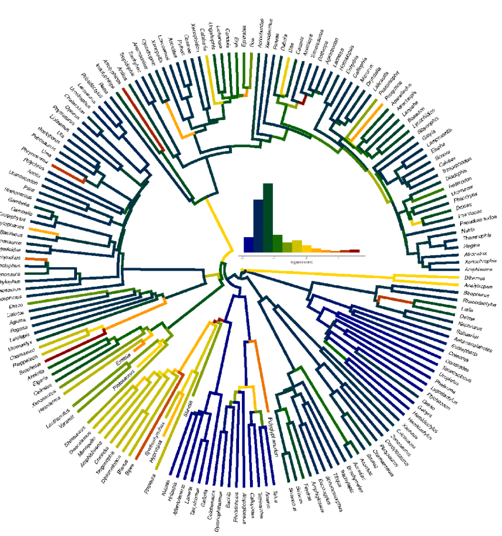
Premaxilla (Alternative Topology)
(λ model)

p



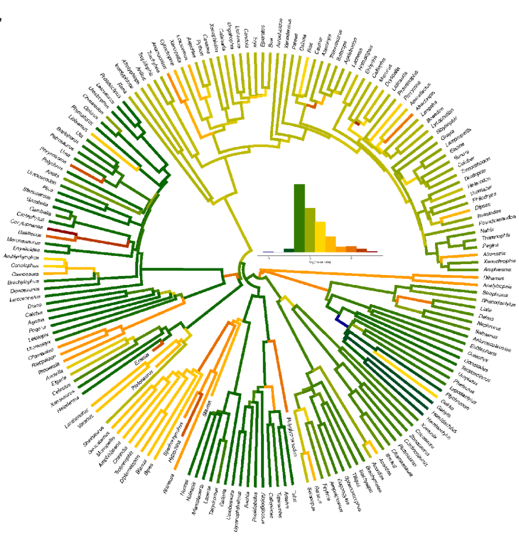
Maxilla (Alternative Topology)
(λ model)

q



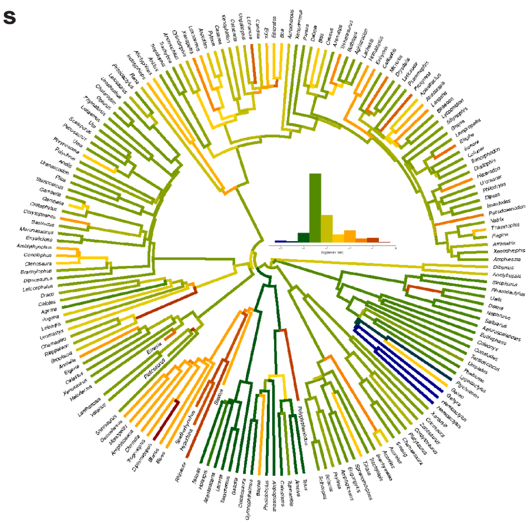
Frontal (Alternative Topology)
(λ model)

r



Parietal (Alternative Topology)
(λ model)

s



Supra-otoccipital (Alternative Topology)
(λ model)

Fig. S5. Estimated rates of cranial shape evolution mapped on time-calibrated phylogeny of squamates under the best-supported models of trait evolution. a, Evolutionary rates of overall skull shape of extant dataset under λ model. **b,** Evolutionary rates of overall skull shape of lizard dataset under OU model. **c,** Evolutionary rates of overall skull shape of snake dataset under OU model. **d,** Evolutionary rates of nasal of extant dataset under λ model. **e,** Evolutionary rates of maxilla of combined dataset under λ model. **f,** Evolutionary rates of jugal of lizard dataset under λ model. **g,** Evolutionary rates of frontal of combined dataset under λ model. **h,** Evolutionary rates of parietal of combined dataset under λ model. **i,** Evolutionary rates of squamosal (supratemporal) of extant dataset under δ model. **j,** Evolutionary rates of supra-otoccipital of combined dataset under λ model. **k,** Evolutionary rates of basioccipital of extant dataset under λ model. **l,** Evolutionary rates of occipital condyle of extant dataset under λ model. **m,** Evolutionary rates of palatine of extant dataset under λ model. **n,** Evolutionary rates of overall skull shape of combined dataset with alternative topology under OU model. **o,** Evolutionary rates of premaxilla of combined dataset with alternative topology under λ model. **p,** Evolutionary rates of maxilla of combined dataset with alternative topology under λ model. **q,** Evolutionary rates of frontal of combined dataset with alternative topology under λ model. **r,** Evolutionary rates of parietal of combined dataset with alternative topology under λ model. **s,** Evolutionary rates of supra-otoccipital of combined dataset with alternative topology under λ model. Color gradient on branches indicates rate of shape evolution as indicated by histogram. Color of circular band denotes taxonomic group as specified in Fig. 2. Rates estimated using BayesTraitsV3 (23). Time-calibrated tree based on Zheng & Wiens (14) and occurrence data from Paleobiology Database (paleobiodb.org).

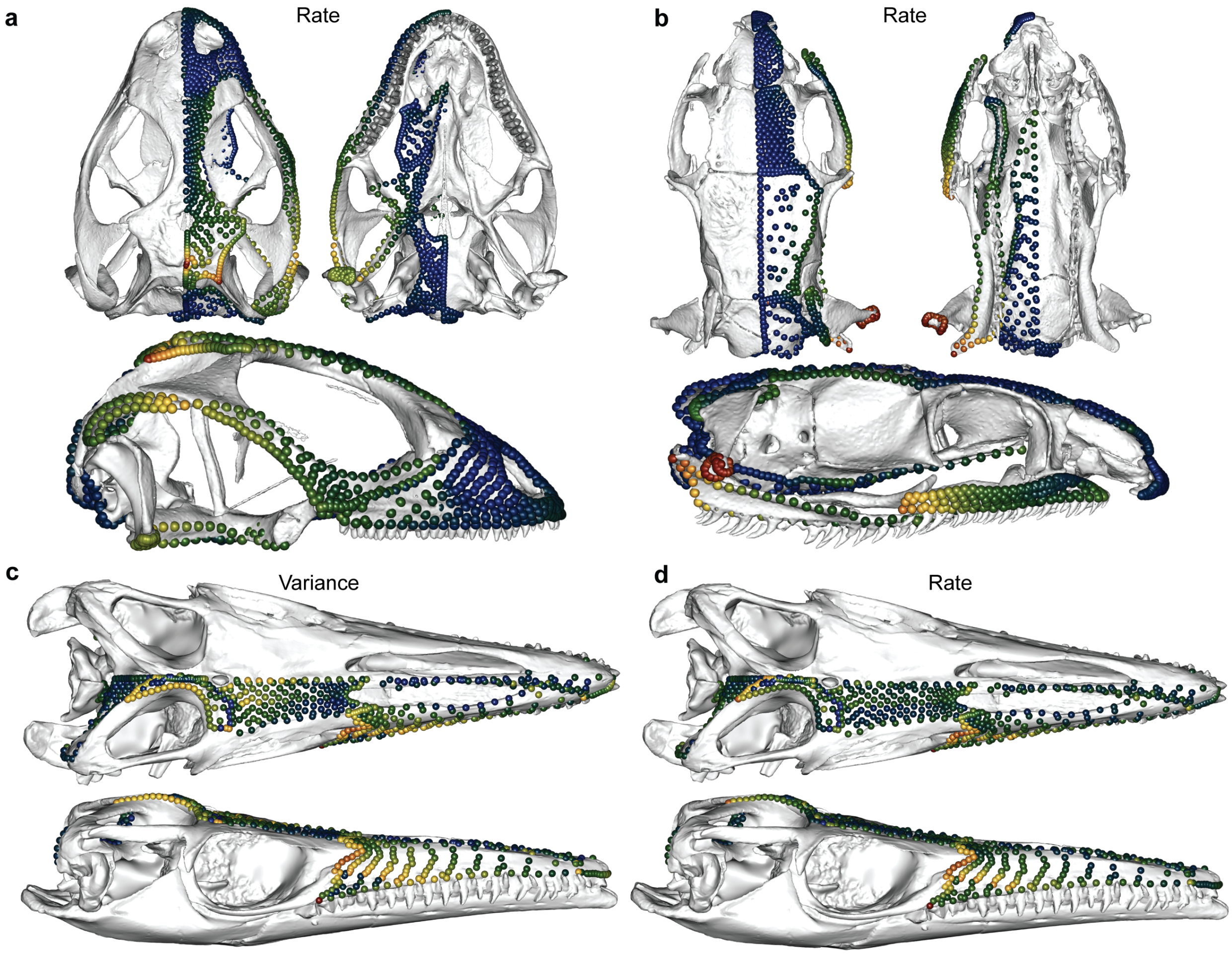


Fig. S6. Procrustes variance and rate within landmarks for the lizard, snake, and combined datasets. Landmarks on skull reconstruction in dorsal (top left), ventral (top right), and lateral (bottom) views indicating mean evolutionary rates in lizards **(a)** and snakes **(b)**. Landmarks on skull reconstruction of *Plotosaurus bennisoni* (UCMP 32778) in dorsal and lateral views colored by Procrustes variance **(c)** and mean evolutionary rates (**d)** of combined dataset. Warmer colors indicate greater values.

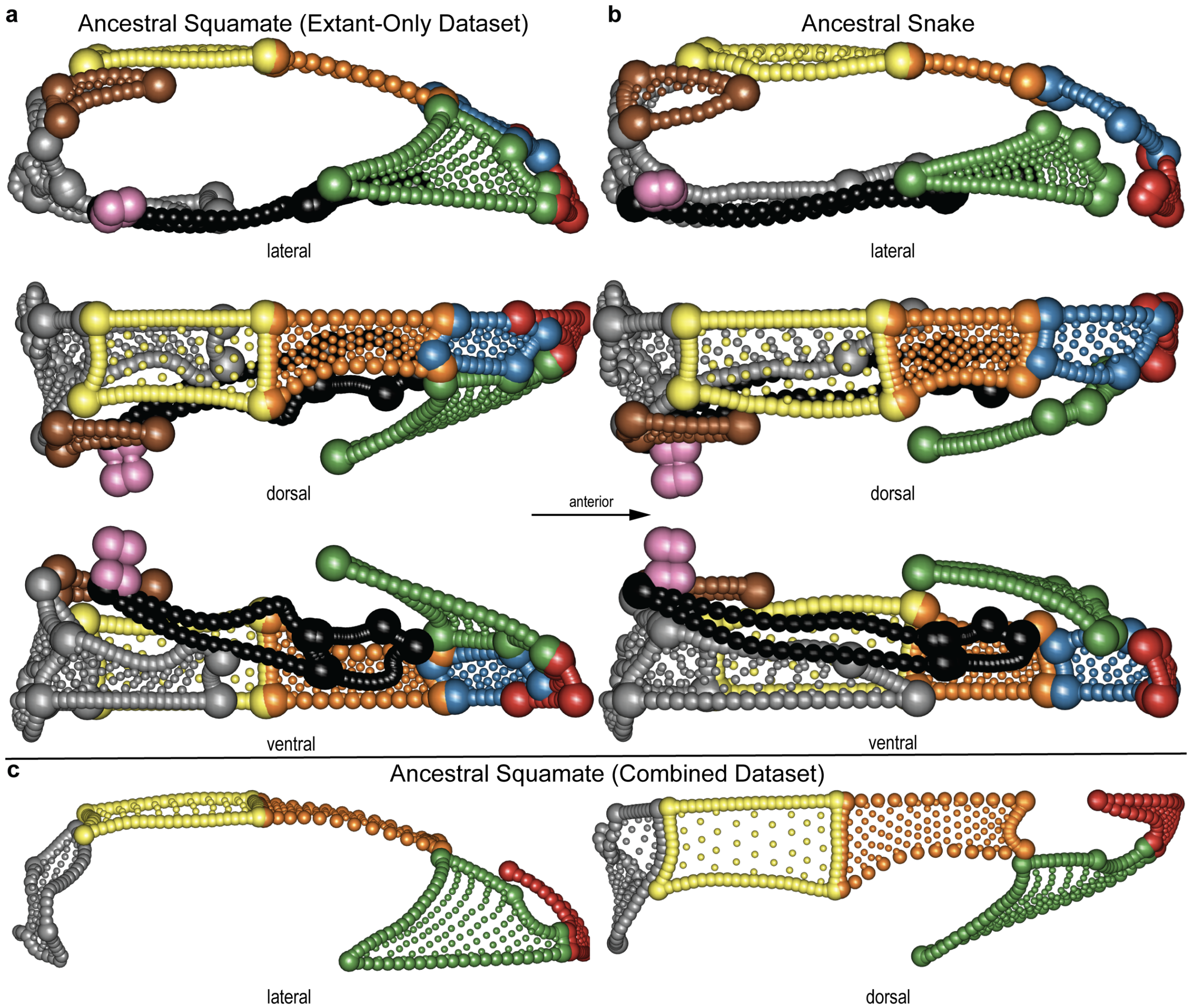
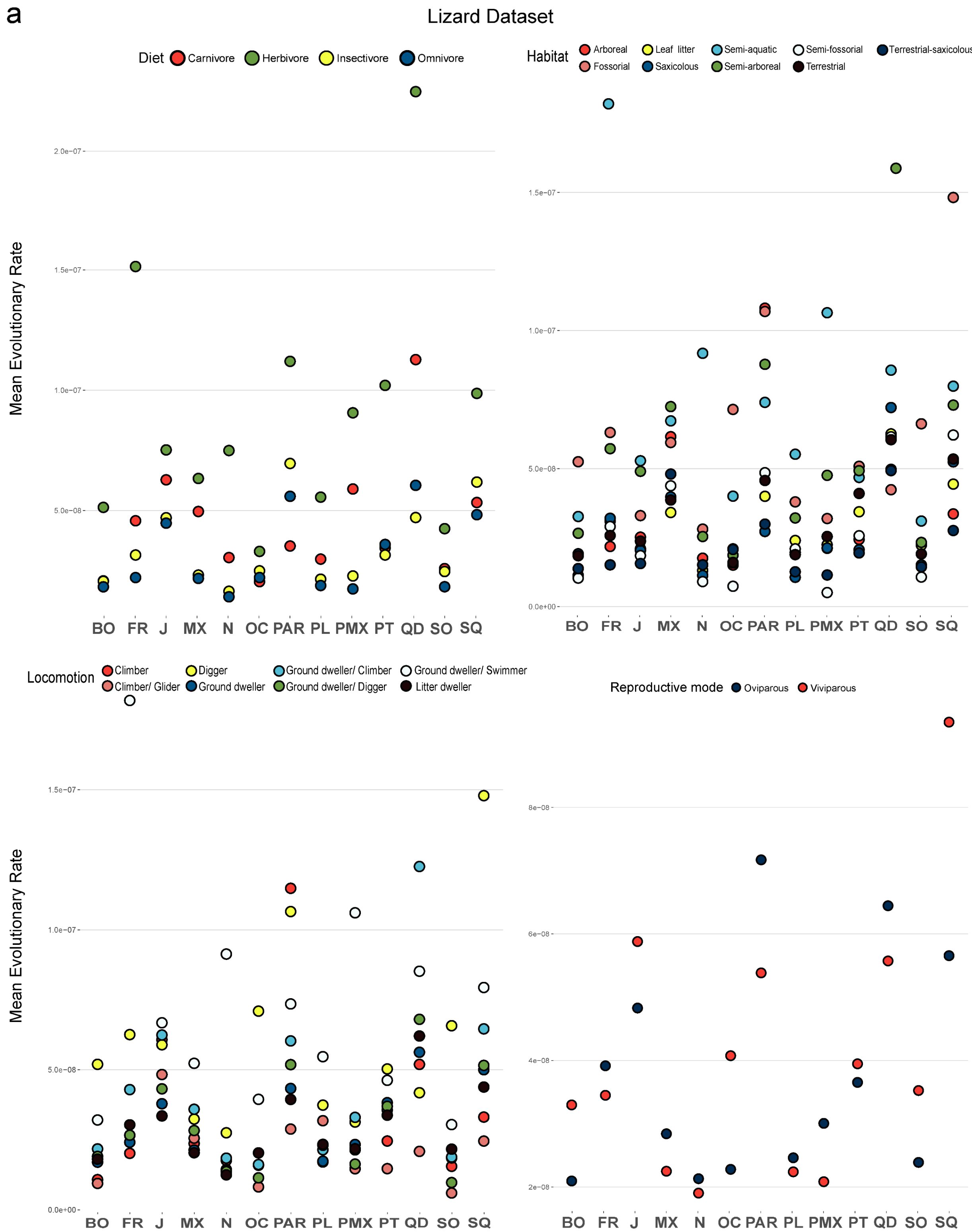


Fig. S7. Estimated ancestral skull shape of (a) crown-group squamates; **(b)** snakes, in lateral, dorsal, and ventral views; **(c)** combined dataset with five partitions. Colors correspond to partitions as specified in Fig. 1a of the main text.


a
Lizard Dataset
Diet
Carnivore
Herbivore
Insectivore
Omnivore
Habitat
Arboreal
Leaf litter
Semi-aquatic
Semi-fossorial
Terrestrial-saxicolous
Fossorial
Saxicolous
Semi-arboreal
Terrestrial
Mean Evolutionary Rate
2.0e-07
1.5e-07
1.0e-07
5.0e-08
0.0e+00
BO FR J MX N OC PAR PL PMX PT QD SO SQ
Locomotion
Climber
Digger
Ground dweller/ Climber
Ground dweller/ Swimmer
Climber/ Glider
Ground dweller
Ground dweller/ Digger
Litter dweller
Reproductive mode
Oviparous
Viviparous
8e-08
6e-08
4e-08
2e-08

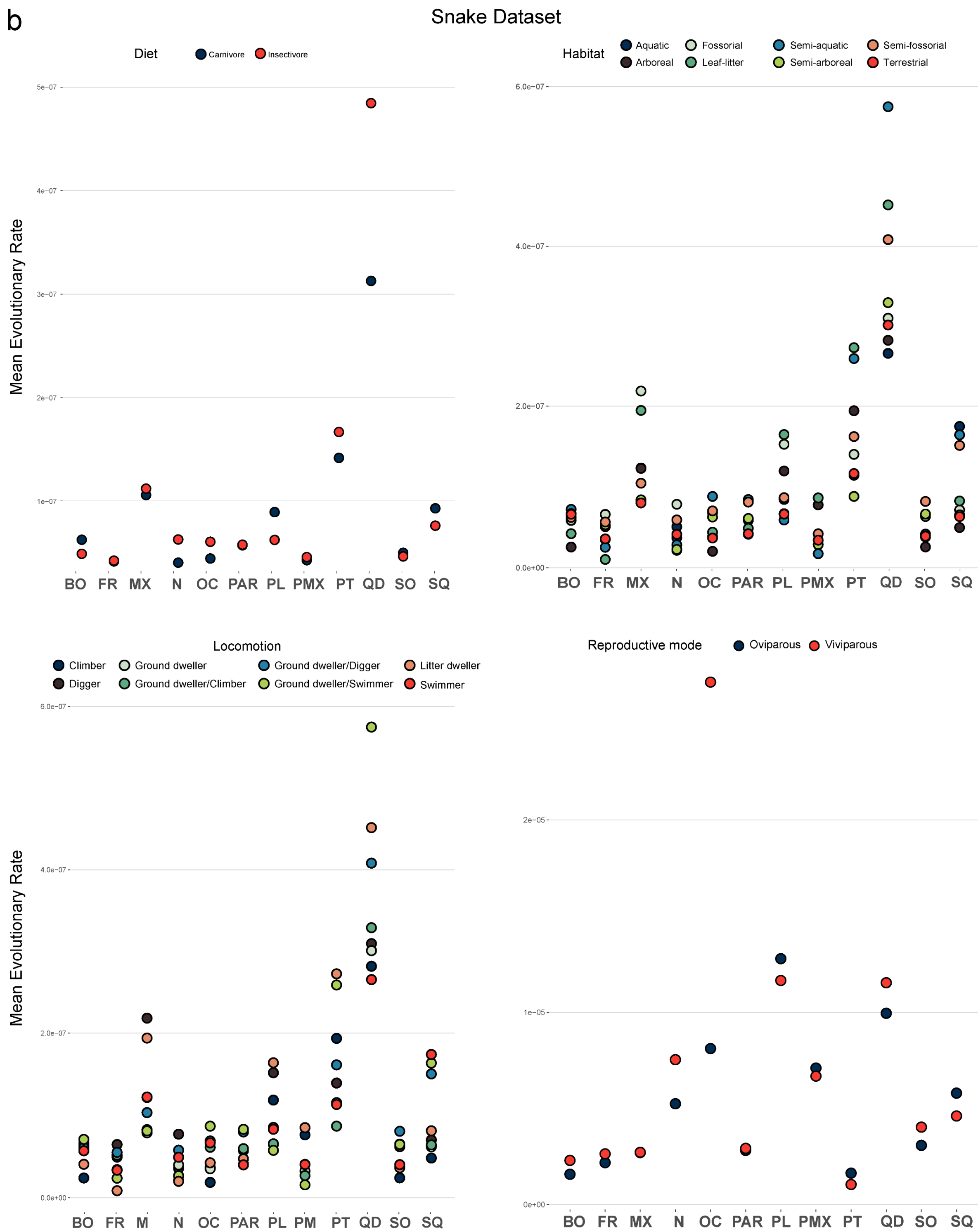


Fig. S8. Mean evolutionary rate of each partition colored by trait values in (a) lizards and (b) snakes. Mean evolutionary rates calculated from the lizard and snake datasets using the `compare.multi.evol.rates` function in `geomorph` R package (12). **Abbreviations: BO,** basioccipital; **FR,** frontal; **MX,** maxilla; **N,** nasal; **OC,** occipital condyle; **PAR,** parietal; **PL,** palatine; **PMX,** premaxilla; **PT,** pterygoid; **QD,** jaw joint of the quadrate; **SO,** supra-otoccipital; **SQ,** squamosal (supratemporal).

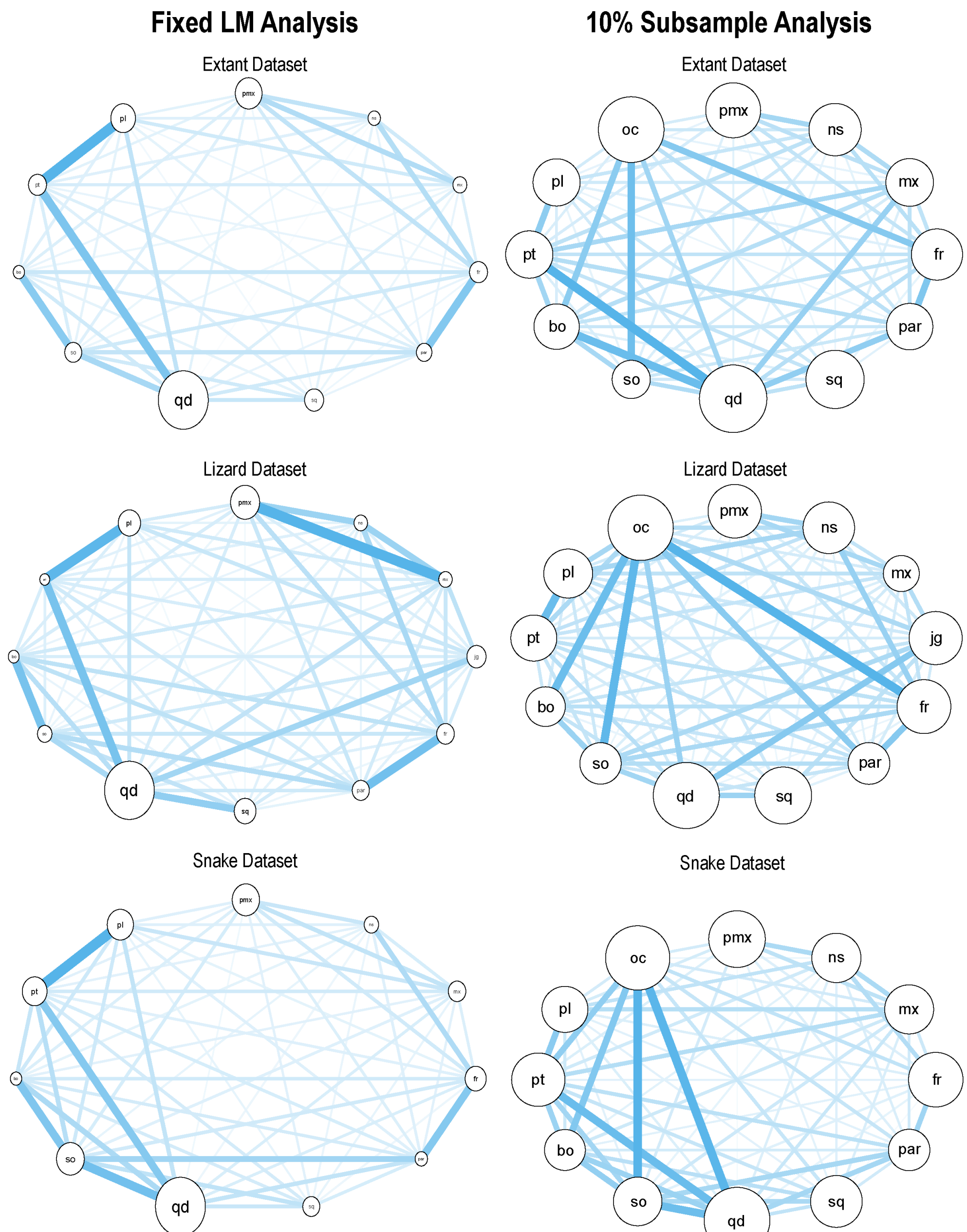


Fig. S9. Network diagram showing the strength of correlation within and between cranial partitions based on EMMLi analysis with only fixed (left) and subsampled (right) landmarks. The thickness of the lines and size of the circles are concomitant with the strength of between- and within-partition correlations, respectively. Note the general congruence of the results to that of the full shape data reported in the manuscript, where strong correlation was observed between supra-otoccipital-basioccipital and parietal-palatine (occipital condyle was excluded from fixed landmark-only analysis because the two fixed landmarks defining the region are part of other regions (i.e., supra-otoccipital, basioccipital)). In snakes, the quadrate has greater correlations with occipital elements, as reported in the manuscript. Strong correlation between the frontal and parietal in lizards, as reported in the manuscript, but greater correlation observed in fixed-only analysis may be due to exaggerated correlation from shared border. **Abbrevations: bo,** basioccipital; **fr,** frontal; **jg,** jugal; **mx,** maxila; **ns,** nasal; **oc,** occipital condyle; **par,** parietal; **pl**, palatine; **pt,** pterygoid; **qd,** jaw joint on quadrate; **so,** supra-otoccipital; **sq,** squamosal/supratemporal.

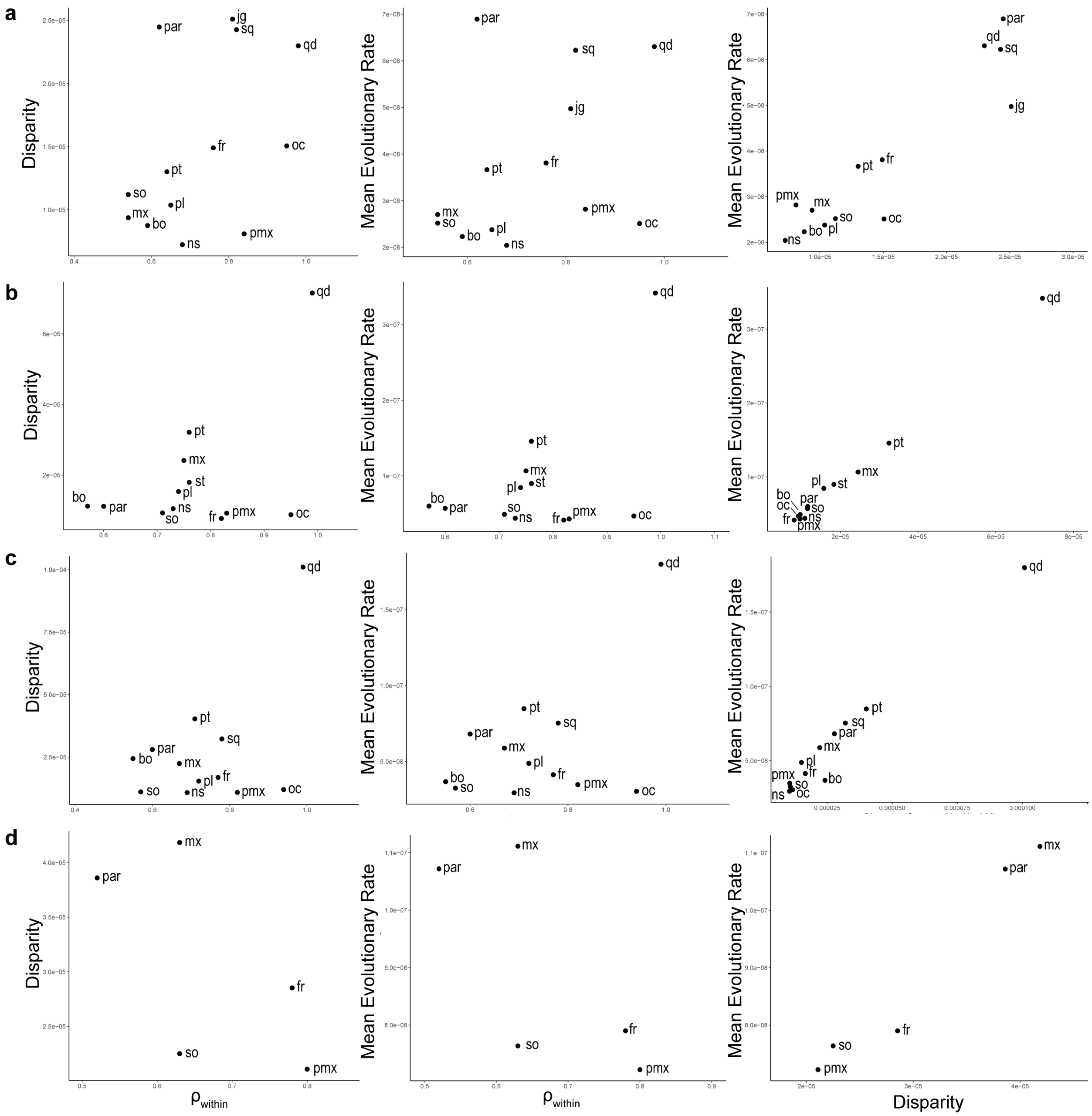


Fig. S10. Bivariate plots of disparity, mean evolutionary rate, and within-partition trait correlation (ρ_{within}). a, lizard dataset; **b,** snake dataset; **c,** extant dataset; **d,** combined dataset. Disparity and mean rates are corrected by the number of landmarks and sliding semi-landmarks in the partition.

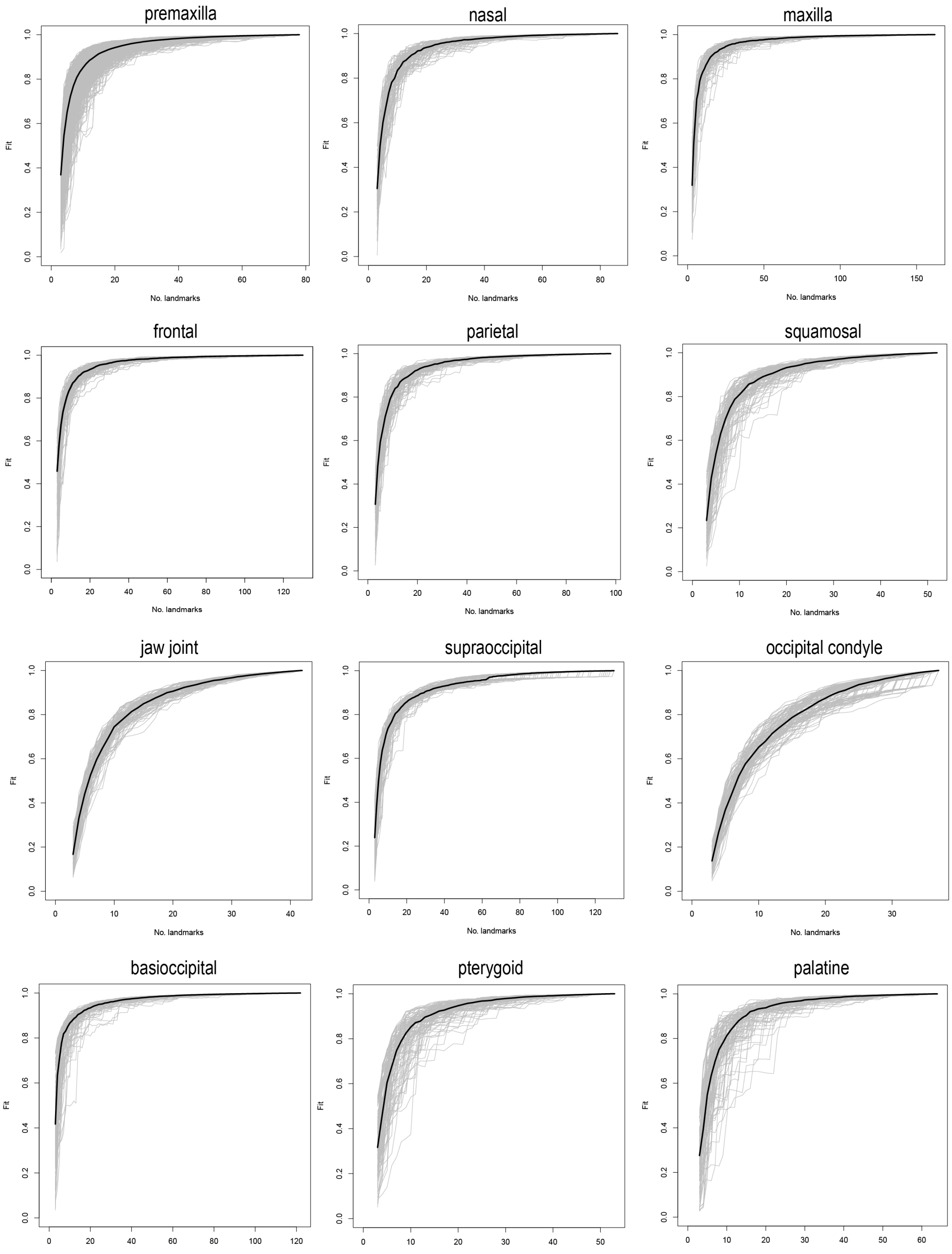


Fig. S11. Landmark and sliding semi-landmark sampling plots from performing LaSEC (33) **on extant data for each partition.** These plots indicate how iteratively subsampled data converge to the pattern of shape variation in the full shape data as landmark and sliding semi-landmark sampling is increased by one each time. Bold line indicates median 'fit' value, as measured by Procrustes sum of squares. Note that for many partitions, 10–25 landmarks and sliding semi-landmarks are required to reach a plateau (stationarity) in the characterization of shape variation.