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Supplementary information

A giant soft-shelled egg from the Late Cretaceous of Antarctica

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Lucas J. Legendre✉, David Rubilar-Rogers, Grace M. Musser, Sarah N. Davis, Rodrigo A. Otero, Alexander O. Vargas & Julia A. Clarke✉

Supplementary Information

for

'A giant soft-shelled egg from the Late Cretaceous of Antarctica'

Lucas J. Legendre[1†], David Rubilar-Rogers[2], Grace M. Musser[1], Sarah N. Davis[1], Rodrigo A. Otero[3], Alexander O. Vargas[3] & Julia A. Clarke[1†]

[1]Department of Geological Sciences, University of Texas at Austin, Austin, TX, USA.

[2]Área Paleontología, Museo Nacional de Historia Natural, Casilla 787, Santiago, Chile.

[3]Departamento de Biología, Facultad de Ciencias, Universidad de Chile, Santiago, Chile.

[†]e-mail: lucasjlegendre@gmail.com; Julia_Clarke@jsg.utexas.edu

Supplementary Methods

Geological setting

Specimen SGO.PV 25.400 was recovered from the upper levels of the López de Bertodano Formation (LBF) of Seymour Island, during the 47th Antarctican Scientific Expedition (2011), organized by the Chilean Antarctic Institute (INACH). Seymour Island is located about 80 km off the east coast of the Antarctic Peninsula, and the fossil was recovered roughly near the centre of the island with the coordinates: 64° 16' 17.20" S, 56° 44' 37.50" W. The specimen was collected with permits in accordance with the Antarctic Treaty, provided by the Chilean Antarctic Institute Authorities (permits: INACH 065-2011) to Anillo de Ciencia Antártica (ACT-105, Conicyt-Chile). Logistical support for fieldwork was provided by INACH.

The LBF primarily consists of tan, loosely consolidated concretionary sandstones and contains fine-grained, grey sandy siltstone horizons throughout[1–3]. There is an increase in glauconite and volcanic material moving upward through the unit but is otherwise relatively consistent in both grain size and mud percentage[4]. Spherical concretions are distributed within different beds of the LBF, ranging in size from 2 cm to 1 m and often contain mollusk fossils[1]. These concretions become less common in the upper units of the formation[1]. The age of LBF has been constrained to Maastrichtian to early Danian (~71.1 – 65.0 Ma) on Seymour Island based on fossil and strontium isotope stratigraphy[1,3,5–8]. The LBF is unconformably overlain by the Danian Sobral Formation[5,8]. The formation has been subdivided unto 10 informal lithostratigraphic and faunal units (Klb1-10). SGO.PV 25.400 was retrieved from the lower level of Klb9, a tan silt layer with high sand content that is characterized as fossiliferous and with high macrofaunal diversity[2,3], although vertebrate fossils are relatively rare[3–5]. The K-Pg boundary lies at the contact between Klb9 and Klb10[3,5,8]; the base of Klb9 is ~68Ma[3].

Thin-sectioning, light microscopy, SEM/EDS, XRD, ICP-MS, and CT scan

Eggshell pieces were sampled from five different locations on the surface of *A. bradyi* (Extended Data Fig. 1), representing all sides of the specimen. The darker color and vitreous sheen of the eggshell allows it to be clearly differentiated from the surrounding rock matrix (Fig. 1; Extended Data Figs 1, 2). Samples of *A. bradyi* were taken using a small chisel. The chisel was positioned along the internal side of shell in the matrix. All samples were individually wrapped and kept in sample bags to prevent contamination from other sampling locations and matrix. Several fragments of around 2 x 2 mm in size were obtained from these individual eggshell pieces. We selected four fragments for embedding in epoxy resin. 50–100 µm thin sections were prepared from resin blocks following standard palaeohistological procedures[9], observed using an Axio Scope.A1 microscope (Carl Zeiss AG, Germany) under plane and cross-polarized light, and imaged with an AxioCam MRc in ZEN lite (Carl Zeiss AG, Germany). The relatively high thickness of the sections is due to the high risk of destruction of the eggshell material during polishing and grounding, which prevented further thinning of the samples. Other fragments from the same locations were selected for scanning electron microscopy (SEM), using a JSM-6490LV SEM and associated software (JEOL, Ltd., Japan) in low-vacuum mode (20 kV), following standard guidelines for electron microscopy[10]. For each extant lepidosaur species sampled for this study (Supplementary Table 2; see below), two eggshell fragments were also sampled – one for embedding and thin-sectioning (Fig. 1g, h; Extended Data Fig. 3a-c), and one for SEM analysis (Extended Data Figs 2, 3d–h).

Three eggshell fragments from locations 2, 3, and 4 (Extended Data Fig. 1) of *A. bradyi* were selected for energy-dispersive X-ray spectroscopy (EDS). Two fragments of sediment from the rock matrix surrounding the egg were also sampled to assess the potential difference in chemical composition between eggshell and sediment. All samples were analysed using a FEX XL30 ESEM (Philips, Netherlands) in low-vacuum mode[10]. For each fragment, multiple spots on the surface were chosen for generation of X-ray spectra and identification of individual elements for corresponding peaks (Extended Data Fig. 4), using AZtecOne v 3.3 (Oxford Instruments, UK).

Two fragments from location 2 (Extended Data Fig. 1) were sampled for powder X-ray diffraction (XRD), following standard guidelines[11]. Both samples were ground in an agate mortar, mounted on glass with mineral oil, and processed using a Rigaku R-AXIS SPIDER (Applied Rigaku Technologies, TX, USA) with curve image plate (Type: 2Th/Th locked - Start: 23.502° - End: 57.772° - Step: 0.010° - Step time: 1 s - Temperature: 25°C (Room) - Time Started: 0 s - 2-Theta: 23.502° - Theta: 11.751° - Chi: 0). Data were acquired in RINT RAPID and analyzed in EVA (Bruker Corporation, MA, USA), using the Bruker Search/Match utility to match XRD scans of the samples with known patterns in the PDF database of the International Center for Diffraction Data (Extended Data Fig. 8).

To further investigate the presence of phosphate in *A. bradyi* and discuss the potential diagenesis of its microstructure, we also selected samples for laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), a commonly used method to map relative concentrations of elements in biological samples[12], including eggshells[13,14]. Four thin sections were selected: two from *A. bradyi*, and two from species in our extant lepidosaur eggshell sample (*Tupinambis teguixin* and *Masticophis flagellum*; see Supplementary Table 2). All thin sections were processed in an Agilent 7500ce ICP-MS (Agilent Technologies, Inc., CA, USA) using MACS-3 and MAPS-4 calibration standards for carbonate and phosphate, respectively[15]. A value of 31.4 %Wt for ^{43}Ca in the *A. bradyi* thin sections was used, following the results obtained with EDS (Extended Data Fig. 4; Supplementary Discussion). Data were reduced and analyzed in Iolite v3.1 (University of Melbourne) and IGOR Pro 8 (WaveMetrics, OR, USA), following standard recent guidelines for ICP-MS on biomineralized samples[16,17] (Extended Data Fig. 7).

All thin sections, SEM, EDS, and ICP-MS analyses were performed at the Jackson School of Geosciences, and XRD analysis at the College of Natural Sciences, both part of the University of Texas at Austin (TX, USA). A CT scan of the specimen (Supplementary Video) was obtained at Clínica Las Condes (Santiago, Chile) on a SOMATOM Definition Flash (Siemens AG, Germany – voltage: 140 kV; current: 650 mA; voxel size: 0.5 x 0.5 x 0.5 mm). Visualization and segmentation of the CT data were performed in Avizo 2019.1 (Thermo Fischer Scientific, MA, USA).

Extant lepidosaur eggs dataset

To compare *A. bradyi* to extant soft-shelled eggs, we assembled a comprehensive dataset (Dataset 1) for 259 species of lepidosaurs (Supplementary Table 1). Fossil soft-shelled egg layers were not included in the dataset, due to the lack of comparable body measurements (i.e., snout-vent length) for these taxa. The dataset includes four variables: egg volume (V, in mm^3, estimated from length (L) and width (W) of individual eggs, in mm); eggshell thickness (ET, in µm); snout-vent length (SVL, in mm); and body mass (BM, in g). V was estimated using a new allometric equation designed for this study (see below). If no species average was provided in the original reference, mean values were compiled when several observations were available. To improve ontogenetic control, we only used data collected from adult specimens for SVL and BM, and at the latest stage of egg development for V and ET in cases where eggs had been dissected from oviducts prior to oviposition. Values for the first two variables were assembled from previous literature and museum specimens (see list of specimens measured for this study in Supplementary Table 2), while data for the last two variables were compiled from the literature (Supplementary Table 1). L and W of eggs sampled for this study were measured with calipers, while ET was measured from pictures of eggshell thin sections in ImageJ[18]. For some species for which measurements of adult body mass were unavailable in the literature, we used body mass estimates calculated from SVL measurements using clade-specific allometric equations[19]. Most studies on lepidosaur eggshells tend to focus on either macroscopic (egg length and width) or microscopic (eggshell thickness) measurements; the final dataset includes values of V for 241 species, of ET for 83 species, and of SVL and BM for all 259 species.

Estimation of lepidosaur egg volume

In the literature, V has been estimated from L and W using modeling equations approximating the shape of an egg as an ellipsoid or a bicone, depending on the taxon of interest[20,21]. The accuracy of the different possible models, however, has been tested for avian and turtle eggs, but not for lepidosaurs[22]. In all case studies reporting egg volume estimations for lepidosaurs, such estimations are made using the formula for the volume of a prolate ellipsoid[23] ($V = \frac{4}{3}\pi ab^2 = \frac{\pi}{6}LW^2$), which has been shown to overestimate the volume of an egg when L/W is high[20]. A solution to this problem can be found by estimating the contour of the egg using its polar coordinates[24,25], and the corresponding formula for egg volume estimation:

$$V = \frac{2\pi L^3}{3(3n+1)}$$

With

$$n = \alpha\left(\frac{L}{W}\right)^{\beta}$$

The α and β coefficients being estimated from a log-log regression between values of n and L/W for the known range of values found in eggs of the taxon of interest[25]. This model was shown to accurately approximate avian egg shape and volume using a range of 0.5 – 1 for L/W[26–28]; lepidosaur eggs, however, have a much wider range of 0.1 – 1[22]. We thus compiled values of n with a 0.5 increment for a range of 1 – 142, corresponding to values of 0.1 – 1 for L/W[25], and performed a log-log regression of the two variables, giving us the following new values for α and β, which we used to estimate egg volume from measurements of L and W for our sample:

$$n = 1.291\left(\frac{L}{W}\right)^{2.063}$$

The estimations provided by this model being, as expected, slightly lower than, but in the same order of magnitude as, those found using the prolate ellipsoid formula.

Phylogenetic comparative analyses

Phylogenetic comparative methods were used to correct for the non-independence of observations in our dataset, due to the hierarchical structure of phylogenetic interrelationships between biological species[29,30]. A time-calibrated phylogeny of all species in our sample was compiled in Mesquite[31] from two recent calibrated trees generated from phylogenomic supermatrices and calibrated using penalized likelihood[32,33], as recently advocated in a case study on lepidosaur macrophylogenies[34]. For eight species in our sample that were not included in either calibrated tree, phylogenetic position was assessed either as the sister group to another species in the same genus – with an internal branch length of 0.5 Ma analogous to minimal branch lengths of 5 Ma suggested for larger scale trees[35] – or using another reference when available[36,37]. The taxonomy of many original references for species in our dataset was updated using the Reptile Database[38].

All subsequent analyses were performed in R v3.6.3[39]. A supplementary tutorial for all statistical procedures described in this section, along with associated datasets and phylogenetic trees, is available as an R Markdown script and HTML file on the first author's GitHub profile at https://github.com/LucasLegendre/Antarcticoolithus_project. All variables were log-transformed (natural logarithm) to account for length and mass allometry in eggshell-related parameters, as documented in most reptile species[22,40–43]. To test for a significant difference in ET between oviparous and viviparous taxa that could be used to assess the reproductive strategy in *A. bradyi*, we coded a discrete variable for reproductive type (oviparity vs viviparity), performed a phylogenetic one-way analysis of variance (ANOVA)[44] with ET as the dependent variable, and performed posthoc pairwise t-tests between means among groups, using the function 'phylANOVA' in package phytools[45] (Extended Data Fig. 5). To correct for size allometry in ET, we transformed it in the dimensionless ratio ET/L prior to log-conversion. Since ontogenetic information was not always available for eggs used to measure ET in the literature, we also tested if ET differed between oviposited eggs and eggs dissected from oviduct for oviparous eggs, resulting in a three-state independent variable ('oviposited egg'/'non-oviposited egg'/'viviparous'). No significant difference was found between oviposited and non-oviposited oviparous eggs ($p = 0.3140$), but a difference was found between each of these categories and viviparous eggs (F value = 9.666903; $p = 0.0015$; see Extended Data Fig. 5). We corrected for multiple testing using false discovery rate[46].

We tested the functional relationships between variables in our sample by performing phylogenetic generalized least squares (PGLS) regressions using the 'gls' function of package nlme[47], with the correlation structure specifying the evolutionary model as implemented in package ape[48]. For each regression analysis, the model with the best fit was selected using AICc[49] in package AICcmodavg[50] from several candidate models: Brownian Motion[51], Ornstein-Uhlenbeck[52], Early Burst[53], Lambda[54], and White Noise – i.e. non-phylogenetic ordinary least squares regression. Tested relationships include: V~SVL, as hypothesized and/or described in many different lepidosaur clades[22,40,55,56] (Fig. 2b); ET~BM, as identified in birds[41], but never tested on a large sample of lepidosaurs; and ET~V, to visualize how the scaling relationship between the two egg measurements for *A. bradyi* compares to that of modern soft-shelled eggs. A Lilliefors test was performed for each regression model to meet the assumption of normality of PGLS residuals, using package nortest[57]. Homoscedasticity of the residuals was checked graphically by plotting residuals against fitted values, following standard guidelines for PGLS[58].

Since *A. bradyi* is much larger than the eggs of any extant lepidosaur species, we also compared it to eggs in a similar size range by performing PGLS on eggshell thickness and egg mass (ET~EM), using a sample of extant and fossil reptilian eggs, with a focus on large-sized specimens (Fig. 2a). For that purpose, we used another comprehensive sample from a recent study on reptilian eggshells[59], with additional lepidosaur species from Dataset 1, as well as other specimens of very large eggs taken from the literature, representing each major amniote clade (n = 148; Dataset 2; see Supplementary Table 3). The original dataset from Stein et al.[59] did not include a measurement of ET as total thickness, but as calcareous layer thickness (µm); for this reason, we measured this variable on *A. bradyi* and on the lepidosaur specimens sampled for this study and included its value when available in the original reference. For hard-shelled eggs (i.e. Testudines, Crocodilia, and Dinosauria including Aves) for which values of calcareous layer thickness were not available, the value for total thickness was used since the eggshell of those eggs consists almost entirely in its calcareous layer[60,61]. Egg mass (g) was estimated from egg length and width, using the equations provided by Stein et al.[59]. Because the resulting scatterplot of ET vs EM clearly discriminates hard-shelled from soft-shelled eggs (Fig. 2a), we also performed a separate regression for each of the two eggshell types in the dataset. Ancestral state reconstruction was performed for eggshell thickness (i.e. a continuous character, using restricted maximum likelihood) and presence/absence of a prismatic calcareous layer (i.e. a binary character, using Markov chain Monte Carlo stochastic character mapping), using functions ‘fastAnc’ and ‘make.simmap’ in phytools[45], respectively.

In order to infer the size and mass of the animal that may have laid such an enormous egg, we built phylogenetic predictive models of SVL and BM, using ET and V as predictors. To assess the potential predictive power of those variables, we first performed phylogenetic path analysis[62] on our dataset, using package phylopath[63]. The default Lambda model was selected as the best model for most PGLS analyses performed on the same characters. Six individual relationships between pairs of variables among the four in our dataset were tested: V~SVL, V~BM, ET~SVL, ET~BM, as well as ET~V and BM~SVL to account for potential relationships among exogenous and endogenous variables, respectively[62]. Combinations of these individual relationships resulted in thirteen candidate models or paths to be included in the selection procedure based on CICc (C-statistic information criterion[62]). The best model identified the variation of V, but not of ET, as being correlated with that of SVL and BM. We therefore built two predictive models to provide estimates of SVL and BM, respectively, for *A. bradyi*, using phylogenetic eigenvector maps (PEM) in package MPSEM[64], with V as a co-predictor for each model (Fig. 2b; Extended Data Fig. 6). PEM require a calibrated phylogeny that includes the taxa used to build the model and those for which missing values of the dependent variable are to be inferred by the model; following the hypothesis that *A. bradyi* might be a mosasaur egg (see Supplementary Discussion), we placed it as the sister-group to snakes, following many recent phylogenetic studies that recovered Pythonomorpha as a monophyletic group[65–68]. Additionally, we estimated SVL and BM of *A. bradyi* using the equations obtained from PGLS regressions for V~SVL and V~BM, to compare these estimates with those obtained using PEM (Fig. 2b; Extended Data Fig. 6).

Supplementary Discussion

Supplemental description of *Antarcticoolithus bradyi*

A. bradyi presents an ovoid shape, with a “deflated” aspect most similar to that of most extant lepidosaur eggs[60,22]. The eggshell is well-preserved, except on the superior most side of the specimen where only matrix is visible; it ranges from black to a light brown in color, with a vitreous appearance (Fig. 1; Extended Data Fig. 1). By contrast, the surrounding matrix has a distinct brown color and a rougher, more granular surface. One side of the specimen (here referred to as the inferior side) is deeply flattened, which may indicate it was located along the ground when collapse occurred (Fig. 1; Extended Data Fig. 1; Supplementary Video). The eggshell surface shows several cracks with jagged edges sometimes associated with conchoidal fracturing, which might reflect diagenetic alteration. The layered pattern of the eggshell is conspicuous on the edges of the cracks. One side presents a deep central depression (Fig. 1) – likely due to sediment infill linked with desiccation, crushing, and/or puncture – from which a rounded fold with three elongate, deep creases extend to the superior most side. Such large, continuous folds, completely infilled with matrix, are also present on the inferior side, consistent with a material that was originally soft and exhibited a plastic response to force (Extended Data Fig. 1). On all sides, several small holes in the eggshell can be found, revealing the underlying matrix. On the inferior side, part of a small ammonite phragmocone is exposed through a window surrounded by eggshell; most of its structure is visible on the CT scan of the specimen (Supplementary Video), suggesting the ammonite was preserved inside the sediment that infilled the egg, consistent with exceptional preservation (see below). The fine ridging on the phragmacone is consistent with *Maorities* sp.[69], although a more precise taxonomic identification is beyond the scope of the present study. No embryonic remains can be seen inside the egg (Supplementary Video); the presence of the ammonite suggests that skeletal elements would have been preserved if an embryo had been present. This, along with the deflated and creased aspect of the eggshell, may indicate that the egg had already hatched prior to its permineralization. The collapsed aspect of the egg may also suggest that it was unfertilized, as documented in extant lizards[70], but this would not necessarily result in an eggshell thickness different from that of fertilized eggs of the same species[71], and thus cannot be determined simply on the basis of a very thin eggshell.

The microstructure of *A. bradyi* closely matches that of extant soft-shelled eggs, with a thin calcareous layer and comparatively thick membrana testacea[60,72–74] (Fig. 1g, h; Extended Data Figs 2, 3). The layered pattern of the eggshell is consistent through its whole thickness: ~15 consecutive yellow-to-brown layers of equal thickness (~50 μm) can be observed, delimited by thinner dark lines through the whole section (Fig. 1g, h; Extended Data Fig. 3a), similar to the membrana testacea of sauropod eggs[75]. On the outer surface, some fragments present a darker, thicker layer (~100μm) that shows a furrowed, granular surface, likely corresponding to the calcareous layer (Fig. 1g, h). This outer surface is very smooth (Fig. 1g, h), with no trace of erosion due to acidic conditions, suggesting that no prismatic layer was originally present and eroded, as often documented in fossil hard-shelled eggs[76–78]. When compared to large dinosaur eggs with a preserved membrana testacea (egg length and width: 12 cm; total thickness: 1750 μm; membrana testacea thickness: 200 μm)[76], *Antarcticoolithus* shows a 600 μm-thick membrana testacea, meaning that if its shell presented shell units that were dissolved during diagenesis, it would have been 4650 μm thick – i.e. more than 1000 μm thicker than the thickest known eggshell found in the elephant bird (*Aepyornis maximus*)[79] – which would likely be too thick for the enclosed embryo to hatch properly[41]. The hypothesized calcareous layer could also correspond to an apatite crust, as often documented on the outer surface of organic samples preserved as apatite in marine sediments[80,81]. This outer layer, however, contains a higher amount of calcium, but not of phosphate, than the rest of the eggshell (Extended Data Fig. 7; see below), suggesting it did originally present a high amount of calcium, compatible with its identification as a calcareous layer. Conversely, other fragments show a more fibrous outer surface that might correspond to protein fibrils of the membrana testacea, suggesting that the calcareous layer was not always preserved (Extended Data Figs 2a, 3e, f).

The inner surface is smooth, with thin straight grooves resembling the fibrillar structures of the outer surface, consistent with the structure of the boundary layer in lepidosaur eggshells[60,74] (Extended Data Fig. 2b). In several instances, parts of the boundary layer are missing, revealing the underlying structure of the membrana testacea (Extended Data Figs 2b-d, 3e, f), which consists in many small aggregated globules (diameter: 1–2 µm), contrasting with the coarse granules of the matrix (Extended Data Fig. 3d). Globules can be locally fused, with some of them being linearly organized in ~2 µm-thick fibrous structures that likely correspond to original protein fibrils (Extended Data Figs 2d, 3e). This globular pattern has been documented in the membrana testacea of many extant lepidosaurs (Extended Data Fig. 3g, h), but its fused aspect resembles that of fossil lepidosaur and non-avian dinosaur eggshells[60,75,82], and could thus be of diagenetic origin[75]. The surrounding sediment matrix (Fig. 1g, h; Extended Data Fig. 3a, d) exhibit the microstructure of fine-grained sandy siltstone, as documented in the LBF[1,4,83], with a clay matrix containing many angular quartz grains of similar size (~50–60 µm in diameter). The grains present a high birefringence under cross-polarized light (light blue and yellow grains in Fig. 1h), which is due to the thickness (~50 µm; see Supplementary Methods) of the thin sections (M. Cloos, pers. comm., 2020).

Chemical and elemental composition of the eggshell

A. bradyi is composed of calcium phosphate (i.e. apatite), with traces of silicon, sodium, sulfur, and iron (Extended Data Fig. 4). Powder XRD identifies fluorapatite and its carbonate-rich variety francolite as the two most likely matches for the mineral structure of the shell (Extended Data Fig. 8), which indicates that carbonates are also likely present – albeit not as calcite, as would be expected in extant reptile eggshells[60]. ICP-MS also confirms the high amounts of calcium and phosphorus present in the eggshell (Extended Data Fig. 7; see below). While the calcareous layer in extant reptile eggshells is usually composed of calcium carbonate, diagenetic alteration of the mineral composition of both calcareous layer and membrana testacea to apatite is common in fossil eggs[59,75,82,84]. In marine sediments, exceptional preservation of soft tissue as apatite has been well documented[85–87]. Recent investigations of the geology and taphonomy of such sediments[80,81,88,89], as well as empirical results obtained from marine organisms involved in this process[90,91], have shown it to be controlled by two types of bacteria: 1) sulphate-reducing bacteria (SRB) consume sulphate and release hydrogen sulphide (H_2S) in the sediment, which is then consumed by 2) sulphide-oxidizing bacteria (SOB) that re-oxidize the sulphide into sulphate using oxygen or nitrate[81,88]. In oxic conditions, high amounts of nutrients provide a source of oxygen to be used as an electron acceptor, resulting in lower sulphate reduction from SRB. This results in lower amounts of sulphide available to SOB, which instead of oxidizing sulphide will then primarily consume the available oxygen and nitrate, and store polyphosphates in their vacuoles as energy reserves[91]. Conversely, in anoxic conditions, the lower availability of organic material causes SRB to increase the reduction of the high amount of sulphate available; SOB then switch from oxidizing organic sulphur (and probably glycogen) to oxidizing the more readily available sulphide. In that process, SOB tend to hydrolyse the previously stored polyphosphates and release phosphate into the sediment, which will then precipitate as apatite[88]. This suggests that the shallow waters environment of the LBF were rich in such bacteria and presented highly euxinic conditions (i.e. anoxic and sulphidic), as confirmed by previous studies, particularly at the level of the K-Pg boundary[92]. In the LBF, the alternance of oxic and anoxic conditions (and corresponding variation of available amounts of nutrients) was likely regulated by the accumulation of nutrients draining from the forested highlands of the Antarctic Peninsula and seasonal pulses of productivity associated with the return of solar light in the polar spring, stimulating phytoplankton blooms[92]. This is also congruent with the high concentration of large framboidal and octahedral pyrite crystals on the surface of the membrana testacea of *A. bradyi* (Extended

Data Figs 2e, f, 4), analogous to rhombohedral calcite crystals in the membrana testacea of sauropod eggs[75]. Pyrite framboids are very common in the LBF, and their presence and size are highly correlated with euxinic conditions in the corresponding stratigraphic units of the formation[92].

In normal oxic conditions, the high ambient concentration of bicarbonate ions in sea water leads to precipitation of calcium carbonate (e.g. calcite, aragonite) in marine sediments, which inhibits the formation of apatite and does not preserve soft tissues[93]. Apatite formation is dependent on acidic conditions: the fall in pH prevents the precipitation of calcite, and shifts the equilibrium to favour the precipitation of apatite. This fall in pH is usually controlled by microbial activity, namely the release of sulphide by SRB, itself influenced by the amount of oxygen available in the microenvironment (see above). SOB consume sulphide to oxidize available organic matter, forming pyrite (i.e. FeS_2, iron disulphide) in the process when the sediment contains a high amount of iron that can be solubilized[94,95]. The main factor limiting pyrite formation in that case has been proposed to be the availability of organic matter[92,96], which might explain why pyrite framboids are concentrated on the proteinaceous inner part of *A. bradyi*, and absent in its surrounding sediment matrix (Extended Data Figs 2c, d, 3d–f, 4). Hence the presence of an enclosed system, such as a large egg – usually considered an example of anaerobic closed systems with a high amount of organic material[82], likely contributed to create such a controlled environment. Additionally, Seymour Island has been hypothesized to have been a protected, shallow water area in the Late Maastrichtian with minimal perturbation of its sediment deposition in the upper LBF[3] (see below), which would also have influenced the 'switch' in preservation mode of organic material from calcite to apatite[93]. It is important to note, however, that other factors have been proposed as contributing to the phosphatisation of soft tissue, such as the high amount of phosphorus naturally present in decaying organisms (e.g. nucleic acids, lipid membranes), which contributes to porewater phosphate concentration in the degradation microenvironment[85,97]. The relative importance of these additional factors in the formation of apatite has been reviewed in the literature[85], and a detailed description of each of them is beyond the scope of the present study.

The infilling sediment matrix in *A. bradyi* also contains apatite, but is mostly composed of silicates (Extended Data Fig. 4), congruent with the siltstone deposits that constitute most of LBF[4,98,99]. ICP-MS also shows a clear difference between the eggshell (high amounts of calcium and phosphorus, low amounts of silicon and aluminium) and the matrix (low amounts of calcium and phosphorus, high amounts of silicon and aluminium; Extended Data Fig. 7a, c). The high amounts of aluminium and silicon in the sediment is congruent with the stratigraphy of Unit Klb9 of the LBF, which displays an increased glauconite content[4], also shown to be correlated with hypoxic/anoxic conditions and sulphide accumulation[92]. The amount of calcium present in the eggshell is relatively homogeneous through its whole thickness, but a slightly higher amount can be detected in its thin outermost layer (Extended Data Fig. 7h), similar to what can be observed in extant lepidosaur eggshells (Extended Data Fig. 7i). This could be due to the presence of residual amounts of calcite in that outermost layer, and supports our interpretation of it being the preserved, non-prismatic calcareous layer (see above). The difference in surface texture, inner structure, and relative elemental composition between eggshell and matrix (Fig. 1; Extended Data Figs 1–4, 7, 8) is thus interpreted as evidence against SGO.PV 25.400 being a phosphatic concretion, as was previously hypothesized for another large putative fossil soft-shelled egg[100].

Reproductive strategy of *Antarcticoolitus bradyi* and identity of its egg layer

Considering that *Antarcticoolithus* is a soft-shelled egg with a non-prismatic calcareous layer, it can only be assigned to one of four reptilian clades known to lay such eggs. Of extant taxa, only lepidosaurs lay similar eggs. Choristoderes, some pterosaurs, and some dinosaurs have been described as having a similar egg type (see Main Text; next section). Choristoderes are currently unknown in Antarctic deposits. The first known remains of Late Cretaceous Antarctic pterosaurs were recently described[101]; however, the largest known pterosaur eggs with known taxonomic affinities (*Pterodaustro guiñazui*, egg length: ~60 mm)[77] belonged to a species with a ~2.5 m adult wingspan[102]. Hence, if the 290 mm-long *Antarcticoolithus* was a pterosaur egg, it would have been laid by a species with a wingspan of over 12 m, which is much larger than the maximum wingspan of 4–5 m described in known Antarctic pterosaurs[101].

Similarly, the eggs of two non-avian dinosaur species – the Late Triassic sauropodomorph *Mussaurus patagonicus,* and the Late Cretaceous ceratopsian *Protoceratops andrewsi* – have recently been described in a conference abstract as soft-shelled[103]. These eggs do not possess a conspicuous calcareous layer, and their microstructure shows "a stratified arrangement resembling soft turtle eggshell" (p. 162)[103]. The eggshell of *Mussaurus* had been described in a previous study as presenting a calcareous layer, but the outer part of the eggshell in this specimen was highly diagenetic and no conspicuous shell units could be observed[59]. Based on this preliminary description, it is therefore possible that *Antarcticoolithus* belonged to a non-avian dinosaur. Many non-avian dinosaur specimens from the Late Cretaceous of Antarctica have been described[104,105], including ankylosaurids[106], ornithopods[107], sauropods[108], and theropods[109,110]. A hadrosaurid tooth was recovered in Unit Klb9 of the LBF[111], showing that remains of large dinosaurs can be preserved in the same marine sediments *Antarcticoolithu*s was recovered from, potentially supporting a dinosaurian identity. It is, however, noteworthy to mention that the two described dinosaurian soft-shelled eggs belong to two groups (non-sauropod sauropodomorphs and ceratopsians) currently unknown in the James Ross Basin[105]. All other non-avian dinosaur eggs, and all in a similar size class to *Antarcticoolithus,* are hard-shelled with a prismatic layer[112]. Additionally, the only Antarctic dinosaurs large enough (>10 m in body size) to bear an egg the size of *Antarcticoolithus* are sauropods (the largest Antarctic ornithopods are estimated to be around 5 m long[105], and ornithopods in that size range laid eggs smaller than *Antarcticoolithus*[113]). Sauropods laid eggs with a spherical to subspherical outer shape[61], distinct from the elongated ellipsoidal shape of *Antarcticoolithus*; among dinosaurs, only theropods (including birds) do lay elongated eggs[114], but no large theropod is currently known from the Late Cretaceous of Antarctica[105]. By constrast, the vast majority of lepidosaur eggs are soft-shelled[60] and present an elongated shape[22]. Hence, even if a dinosaurian identity cannot be ruled out in the absence of skeletal remains of an embryo or egg layer associated with *Antarcticoolithus*, we consider it more likely to be the egg of an extinct lepidosaur, or a closely related non-archosaurian taxon.

Two clades found in the LBF of Antarctica are either recovered in Lepidosauria or are sometime recovered with lepidosaur affinities[68,115]: mosasaurs (Mosasauroidea) and plesiosaurs (Sauropterygia). Many specimens of both groups have been described in the Late Cretaceous of the Antarctic Peninsula from individuals of very large body sizes. For mosasaurs, several isolated teeth, maxillae, vertebrae and ribs have been described[98,116,117], as well as more complete skeletons[99,118]. These specimens have been attributed to tylosaurines, mosasaurines, or plioplatecarpines – three clades of large mosasaurs with body lengths estimated at ≥10 m for several species, matching the SVL estimate obtained for the egg layer of *A. bradyi* using PEM[119] (see Supplementary Methods). All plesiosaur specimens in the LBF have been identified as large elasmosaurids, and consist mostly of vertebrae and propodial elements[98,120,121]; more complete specimens include some of the largest members of the clade, also reaching ≥10 m in body length[122]. For both clades, many juvenile specimens have also been described in the LBF of Vega Island[117,123–125] and Seymour Island[124,126,127], but also in the Snow Hill Island formation of Vega Island[128] and James Ross Island[129]. For this reason, the encompassing region (the James Ross Basin) has been repeatedly described as a breeding area and a 'nursery' site for these marine reptiles in the Late Cretaceous[125,130], and the discovery of a giant egg potentially associated with either clade in the LBF is consistent with that interpretation.

Both groups are generally assumed to be ancestrally viviparous[131], especially the largest species, which presented highly derived hydropedal limbs and would likely have been too heavy to lay their eggs on land like extant oviparous marine reptiles[132,133]. For this reason, we hypothesize that oviposition most likely occurred in shallow water. The protected shallow waters described in the LBF, similar to a cove or estuary-like environment, would likely have made it easier for juveniles to hatch immediately after oviposition and swim to the surface to get air quickly without a high risk of predation[98,125,130]. This might also have been helped by some form of parental care, as has been hypothesized in large marine reptiles with comparatively large offspring (as found from the body length estimation for the egg layer of *Antarcticoolithus*)[134]. The hatchlings would then have been able to stay in that protected area with minimal predation and competition for food until reaching adult size, when they would have been able to hunt larger prey in more open waters[123,125,130].

While viviparity in itself is not necessarily incompatible with the presence of a soft eggshell (see Main Text), it is worth noticing that no eggshell has ever been recovered in any fossil marine reptile specimen[131,134]. Evidence of viviparity (i.e. well-preserved embryos without an eggshell inside adult specimens) has been reported for many sauropterygian clades[131,134–136]; for mosasaurs, however, the picture is less clear. Juvenile mosasaurs found in pelagic environments have been interpreted as indirect evidence of ancestral viviparity[137]. Two conference abstracts have preliminarily described gravid mosasaur specimens[138,139], but these results remain unpublished[137]; one explicitly specified that no shell fragments were found. The only formally described pregnant mosasauroid specimen is *Carsosaurus marchesetti*[140], a small species originally recovered as an aigialosaurid – an early diverging clade of mosasauroids[141] (although the monophyly and inner relationships of aigialosaurids are not well-established[133,142], and *Carsosaurus* was not included in recent studies on mosasauroid phylogeny[142]). This specimen also did not contain any eggshell remains[140].

The viviparity described in *Carsosaurus*, however, does not allow for a straightforward assessment of the reproductive strategy of mosasaurs as a whole, since mosasaurs have been consistently recovered as lepidosaurs[68] – a clade in which viviparity has independently appeared more than 100 times[143]. The relative eggshell thickness (i.e. ratio eggshell thickness/egg length) of *A. bradyi* falls in-between that of oviparous and viviparous extant lepidosaurs in our sample (Supplementary Table 1; Extended Data Fig. 5), which prevents a direct assessment of its reproductive strategy based on eggshell (also made difficult by the very small sample of viviparous taxa, due to the paucity of existing data on their eggshell thickness in the literature). Viviparity, however, is a highly plastic character in lepidosaurs: parameters such as eggshell thickness, developmental stage at oviposition, or gestation length can vary considerably depending on the species[144,145], and many species exhibit bimodal reproduction (i.e. viviparity and oviparity, with populational variations often linked with various environmental constraints[146–149]). Most lepidosaurs present a poorly mineralized eggshell, the thickness of which is highly variable regardless of reproductive strategy[145,150]. Furthermore, studies of eggshell thickness and structure in viviparous lepidosaurs have only focused on a handful of species (Extended Data Fig. 5), which cannot be considered a comprehensive sample of the many independent acquisitions of viviparity for the whole clade[151–153]. For this reason, while viviparity in large plesiosaurs is well-established[133], the phylogenetic position of mosasaurs as highly derived lepidosaurs may suggest a higher phenotypic plasticity of their reproductive strategy is expected. The limited information available on mosasaur reproduction does not currently allow to know the ancestral strategy for the clade[131]. If our new specimen is a mosasaur egg, it would not contradict previous evidence interpreted as consistent with viviparity in the absence of any eggshell remains described in basal mosasauroids.

Interestingly, *A. bradyi* was discovered ~200 m away from, and in the same stratigraphic unit as, the tylosaurine mosasaur *Kaikaifilu hervei*[99]. While this does not suggest any direct association of the two specimens, *K. hervei* has been described as a very large species[99] with a body length compatible with that estimated for *A. bradyi* using PEM, and it is likely that *A. bradyi* belonged to a similarly-sized animal. In the absence of embryonic remains or an associated gravid female, however, the identity of the egg layer remains conjectural.

The evolution of hard- and soft-shelled eggs in amniotes

When reconstructing the ancestral states of a prismatic calcareous layer (i.e. characteristic of hard-shelled eggs) on the phylogeny of our amniote sample (Fig. 3), the presence of such a prismatic layer is recovered as the ancestral condition for Amniota. Indeed, hard-shelled eggs are found not only turtles[154] and archosaurs[60], but also monotreme mammals[143]. The eggshell microstructure of the platypus and echidnas has been poorly studied, but the few available descriptions identify a well-developed prismatic layer in both groups[155]. Several archelosaurian eggs (e.g. in some turtles and non-avian dinosaurs) have been described in the literature as 'soft-shelled' due to their eggshell appearing pliable and wrinkled in macroscopic observations[59,103,154]. However, as shown in a recent study on such 'soft-shelled' non-avian dinosaur eggs[59], all of them present a prismatic layer with shell units (albeit sometimes very thin compared to that of, for example, bird eggshells), clearly distinct from the thin, vestigial calcareous layer found in most extant lepidosaurs and in *Antarcticoolithus*. The prismatic layer is recovered as lost three times among amniotes: in lepidosaurs, in choristoderes, and in pterosaurs (and, as discussed above, possibly in dinosaurs[103]). A reacquisition of a thick prismatic layer with shell units, distinct from that of archosaurs, occurs in some geckos[156] (Fig. 3) and in one fossil anguimorph species[157] (not depicted on Fig. 3 due to its uncertain phylogenetic position).

Even though a soft eggshell appears to be the ancestral condition for lepidosaurs in our sample, the structure of ancestral lepidosaurian eggshell is actually unknown. This is due to the distinct states present in the three early diverging clades of lepidosaurs (i.e. tuatara, dibamids, and geckos). The tuatara presents a soft eggshell with a unique calcareous layer composed of vertical calcite "columns" inserted in its membrana testacea, which have been proposed to be homologous to the shell units of hard-shelled gecko eggs[158]; thus fossil rhynchocephalians might have presented a hard eggshell. Similar vertical calcite columns have also been documented in other lizard species, e.g. the eastern bearded dragon (*Pogona barbata*)[159] and soft-shelled gecko eggs[156], and have been proposed as ancestral to the whole lepidosaurian clade[156]. The eggs of dibamids, a poorly studied clade of limbless lizards endemic to Mexico and Southeast Asia, have been repeatedly referred to as hard-shelled in the literature[72,156], but their microstructure has actually never been described. The hypothesis of dibamid eggs being hard-shelled originates from the preliminary description of one egg in a 1912 monograph as presenting a "brittle and highly calcareous shell" (p. 100), without any further details or illustrations[160], and dibamid eggshell microstructure is currently unknown. Hence much uncertainty remains as to the ancestral eggshell microstructure for lepidosaurs, accentuated by the lack of a comprehensive terminology to describe that of extant soft-shelled eggs (see below). Similarly, soft-shelled eggs in choristoderes have been recovered in a specimen of *Hyphalosaurus baitaigouensis* from the Early Cretaceous of China[161], but another specimen of the same species was found with live embryos inside it and no visible eggshell[162]. It is thus likely that this species used bimodal reproduction, also described in many species of viviparous squamates[152]. The phylogenetic position of choristoderes among diapsids is currently unknown, but the clade has been recovered by some studies as the sister group to Lepidosauromorpha[131], meaning their soft eggshell could be homologous to that of lepidosaurs and represent one single acquisition of that feature in the phylogeny of reptiles.

Interestingly, the two specimens of pterosaurs in our sample fall within the range of soft-shelled lepidosaur eggs, despite one of them showing a prismatic calcareous layer[59] (Fig. 3). Pterosaur eggs have been repeatedly described as soft-shelled due to the thin and pliable aspect of their eggshell[77,163,164]. The first detailed description of a pterosaur egg microstructure, however, showed a conspicuous prismatic layer[163]. Another specimen was reported to lack a calcareous layer, and be most similar in structure to a lepidosaur eggshell, but no description of its microstructure using microscopy techniques was provided, preventing a clear identification of a soft-shelled structure[164]. Since these first descriptions, more specimens of exceptionally preserved eggs have been described for a handful of pterosaur species[77] – some hard-shelled[165], some soft-shelled[166]. There is currently no consensus on whether such a soft eggshell was widespread among pterosaurs, nor on the relationship of the structure of that soft eggshell to that of lepidosaur eggshells[77]. More studies on pterosaur eggshells are thus necessary to assess their potential microstructural similarity with extant soft-shelled eggs. While the possibility of *Antarcticoolithus* being a fossilized pterosaur egg cannot definitely be ruled out, it should be noted that no remains of giant pterosaurs likely to have laid such a large egg are known from Antarctic deposits[101], contrary to giant marine reptiles (see above). Overall, the evolution of soft versus hard eggshells in amniotes has been poorly studied in an evolutionary context (see next section), and more comparative studies of large datasets of eggshell microstructural features are needed to clarify the potential homology of the various soft-shelled eggs currently identified. The unique features of *Antarcticoolithus bradyi* provide a fascinating example of the diversity of amniotic eggs and the many constraints involved in their evolution.

Scaling relationships and shell microstructure of lepidosaur eggs

A primary focus of this study concerns assessing the distinctiveness of lepidosaur eggs compared to other reptile eggs in terms of microstructure and proportions. Lepidosaurs are the second most diverse group of extant reptiles, after birds, with more than 9000 species[167], and the only one that lay soft-shelled eggs without a prismatic calcareous layer[60]. This soft and thin eggshell has been described as one of the main evolutionary novelties potentially responsible for the many independent occurrences of viviparity in lepidosaurs[144,145,168]. The hard eggshell of geckos was recently found to develop very differently from that of other reptilian hard-shelled eggs[156], and has been showed to be linked with specific lifestyle constraints[40]. This further indicates that the eggshell morphology and microstructure of lepidosaurs is much more variable than that of any other reptile group.

In our sample of lepidosaurs (Dataset 1 – see Supplementary Table 1), it is therefore not surprising to find that despite a strong size allometry for egg volume and shape (Fig. 2; Extended Data Fig. 6), the eggshell thickness is only weakly correlated with either body mass (PGLS: R-squared = 0.1537; p = 0.000665) or egg volume (PGLS: R-squared = 0.3642; p = 7.828e-08). Conversely, other clades (e.g. birds) with a much less variable eggshell structure present a stronger correlation[41]. Accordingly, lepidosaurs have the highest range of eggshell thickness among reptiles, the majority of which is clearly distinct from that of other reptile clades (Fig. 2a). In other groups, a size allometry for eggshell thickness is visible in our sample of amniotes (Dataset 2 – see Supplementary Table 3), with birds at lower values than the largest groups such as crocodilians and non-avian dinosaurs, the latter showing the highest values likely due to their very large body size. When correcting for egg mass, however, non-avian dinosaurs have much lower values (Fig. 3), indicating a proportionally thinner eggshell that could be linked with the upper egg size limit also documented in very large birds (e.g. palaeognaths[41]; also see Main Text). *Antarcticoolithus* presents the lowest value after correction for egg mass, supporting the hypothesis of a very thin eggshell constrained by a viviparous reproductive strategy and a very large body size, as inferred in giant marine reptiles (see Main Text).

In general, the lack of comparative studies on lepidosaur eggshell microstructure has prevented the classification of soft-shelled eggs in recent literature. Many studies describe such eggshells using a terminology that might be ambiguous – for example, "parchment-like" or "leathery" have been used to describe the eggshells of lepidosaurs, but also those of turtles and crocodilians, which do contain a prismatic calcareous layer with shell units[60,61,154]. While there is a vast literature available on the classification and evolution of eggshell microstructure for birds, turtles, and crocodilians[60,61,169,170], the unique microstructure of lepidosaur eggshells has been only superficially described. The few comparative studies available do describe an incredible diversity of their surface ornamentation and the relative arrangement of their protein fibrils, and have proposed functional hypotheses regarding their ontogeny[60,73,74]. Unlike the taxonomy of shell units[61,169], this diversity has never been described nor analysed in an evolutionary context[159]. While many macroscopic measurements of lepidosaur eggs have been used in small-scale (i.e. <20 species) quantitative studies to study their reproductive abilities, the only microstructural measurement ever quantified in lepidosaur eggs is eggshell thickness (see Supplementary Table 1 and associated references), which until now had never been included in any comparative study. The present study provides the first large-scale dataset for lepidosaur egg measurements, including eggshell thickness (Supplementary Table 1) and calcareous layer thickness (Supplementary Table 3). Both absolute and relative eggshell thickness are highly variable in our lepidosaur dataset, emphasizing the high plasticity of eggshell morphological features in this group compared to that of other amniote clades (Fig. 3; Supplementary Table 1, 3). While a comprehensive analysis of the evolutionary patterns of egg measurements in lepidosaurs and amniotes is beyond the scope of the present study, this dataset is thus a preliminary first step in describing the diversity of soft eggshell microstructure and associated evolutionary constraints. More data and subsequent analyses are needed to provide a comprehensive terminology of lepidosaur eggshells in an evolutionary context.

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- Pictures of *Varanus niloticus* (in red, Fig. 2b), *Antarcticoolithus bradyi* (in black, Figs 2 and 3), and *Homo sapiens* (Fig. 1) were not made using any preexisting file.

Silhouettes in Fig. 3 are the same as in Fig. 2.

Supplementary Tables

Supplementary Table 1. Dataset 1. Measurements of egg parameters (L, W, ET, and V), SVL, and BM for *Antarcticoolithus bradyi* and 259 species of extant lepidosaurs, with corresponding references (see full list of references below).

Order	Suborder	Family	Species	Egg length (mm)	Egg width (mm)	Eggshell thickness (µm)	Egg volume (mm³)	Snout-vent length (mm)	Body mass (g)	Source (egg measurements)	Source (SVL)	Source (M)
?	?	?	*Antarcticoolithus_bradyi*	290	200	721.9367	5471405.789	NA	NA	This study	NA	NA
Rhynchocephalia	Sphenodontia	Sphenodontidae	*Sphenodon_punctatus*	35	27	200	11791.51888	257.2307692	608.2307692	Packard et al. (1982b)	Castanet et al. (1988)	Castanet et al. (1988)
Squamata	Anguimorpha	Anguidae	*Elgaria_multicarinata*	16.6	10.5	52.27	873.8342893	100.60	31.7	Brodie et al. (1969). this study	Meiri (2010)	Meiri (2010)
Squamata	Anguimorpha	Varanidae	*Varanus_bengalensis*	39	30	NA	16230.72945	610.00	4940.0	Minton (1966)	Meiri (2010)	Meiri (2010)
Squamata	Anguimorpha	Varanidae	*Varanus_gouldii*	55.1	27.4	550	20174.07132	385.15	821.06	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Anguimorpha	Varanidae	*Varanus_indicus*	64	48	550	68532.6737	421	1287	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Anguimorpha	Varanidae	*Varanus_komodoensis*	86.5	55.5	NA	126985.2433	872.5	37140	Iverson and Ewert (1991)	Meiri (2010)	Meiri (2010)
Squamata	Anguimorpha	Varanidae	*Varanus_salvator*	70	40	400	54067.44507	571	4345	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Eublepharidae	*Aeluroscalabotes_felinus*	20	12	NA	1383.558927	63.36	6.12	Kratochvíl and Frynta (2006)	Starostova et al. (2013)	Starostova et al. (2013)
Squamata	Gekkota	Eublepharidae	*Coleonyx_brevis*	12.7	7.3	NA	326.5345061	56.05	3.2	Kratochvíl and Frynta (2006)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Eublepharidae	*Coleonyx_elegans*	18.6	9.8	NA	868.0226657	85.725	11.15	Kratochvíl and Frynta (2006)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Eublepharidae	*Coleonyx_mitratus*	18.1	9.4	NA	777.9047682	80.65	12.125	Kratochvíl and Frynta (2006)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Eublepharidae	*Coleonyx_reticulatus*	22	11	NA	1297.821901	81	8.9	Kratochvíl and Frynta (2006)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Eublepharidae	*Coleonyx_variegatus*	16.3	8.6	NA	585.7450239	59.83	3.88	Vitt (1977); Kratochvíl and Frynta (2006)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Eublepharidae	*Eublepharis_angramainyu*	38.7	21.7	NA	8812.179216	155.75	86.575	Kratochvíl and Frynta (2006)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Eublepharidae	*Eublepharis_macularius*	27.4	14.7	37.5	2873.320319	125.05	59.65	Schleich and Kästle (1988); Kratochvíl and Frynta (2006)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Eublepharidae	*Eublepharis_turcmenicus*	31	19.2	NA	5470.376879	143	62	Kratochvíl and Frynta (2006)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Eublepharidae	*Goniurosaurus_lichtenfelderi*	20	12	NA	1383.558927	93.83	12.44	Kratochvíl and Frynta (2006)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Eublepharidae	*Goniurosaurus_luii*	26.4	13.5	NA	2342.5869	108.895	23.035	Kratochvíl and Frynta (2006)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Eublepharidae	*Hemitheconyx_caudicinctus*	27.7	13.2	NA	2358.914017	113.55	44.025	Kratochvíl and Frynta (2006)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Bunopus_blanfordii*	13	8.7	NA	466.2370162	42.80625	1.65	Werner (1989)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Cyrtopodion_kachhense*	9.5	7	NA	217.0794718	37.45	3.3	Minton (1966)	Minton (1966)	Feldman et al. (2016)
Squamata	Gekkota	Gekkonidae	*Gehyra_dubia*	NA	NA	NA	545	65.3	5.38	Doughty (1996)	Doughty (1996)	Doughty (1996)
Squamata	Gekkota	Gekkonidae	*Gehyra_variegata*	NA	NA	NA	671	49.50	3.0	Doughty (1996)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Gekko_gecko*	23	23	280	5229.325921	151.6	63.15	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Gymnodactylus_amarali*	8.8	5.7	NA	136.0944503	43.77	4.3	Colli et al. (2003)	Colli et al. (2003)	Feldman et al. (2016)

Squamata	Gekkota	Gekkonidae	*Gymnodactylus_geckoides*	9.2	6	NA	157.5060794	39.33	2.15	Colli et al. (2003)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Hemidactylus_bouvieri*	9	9	55	313.3211635	46	2.8	Schleich and Kästle (1988)	Meiri (2008)	Feldman et al. (2016)
Squamata	Gekkota	Gekkonidae	*Hemidactylus_frenatus*	9.8	8.3	NA	305.3241301	49.20	3.3	Minton (1966)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Hemidactylus_imbricatus*	9.8	9	NA	350.9497819	49.25	3.8	Minton (1966)	Minton (1966)	Feldman et al. (2016)
Squamata	Gekkota	Gekkonidae	*Hemidactylus_mabouia*	9.4	7	NA	214.3657106	58.3	4.19	Vitt (1986)	Vitt (1986)	Vitt (1986)
Squamata	Gekkota	Gekkonidae	*Hemidactylus_turcicus*	10.1	8.4	NA	323.7757603	47.1	2.84	Schleich and Kästle (1988); Werner (1989)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Lygodactylus_klugei*	6.6	4.5	NA	63.15133385	29.7	0.73	Iverson and Ewert (1991)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Mediodactylus_amictopholis*	10.3	6.6	NA	213.8702677	39	1.4	Werner (1989)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Mediodactylus_kotschyi*	8.7	7.3	40	210.1705927	40.9	2	Schleich and Kästle (1988); Werner (1989)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Phelsuma_madagascariensis*	23.5	13.5	130	2066.51626	94.46666667	20.68	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Stenodactylus_doriae*	12.3	10.5	NA	612.0325343	63.235	8.2325	Werner (1989)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Stenodactylus_sthenodactylus*	10.9	8.9	NA	394.0054928	49.09625	4.35	Werner (1989)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Gekkonidae	*Tropiocolotes_steudneri*	7	5.4	NA	94.33215104	26.33	0.3	Werner (1989)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Phyllodactylidae	*Phyllopezus_pollicaris*	13	9.4	NA	537.5144084	75.25	10.58	Vitt (1986)	Vitt (1986)	Vitt (1986)
Squamata	Gekkota	Phyllodactylidae	*Ptyodactylus_guttatus*	14	13.1	NA	1056.048487	75.515	10.9	Werner (1989)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Phyllodactylidae	*Ptyodactylus_hasselquistii*	13.3	13.3	150	1011.153583	80	9.34375	Werner (1989)	Meiri (2010)	Meiri (2010)
Squamata	Gekkota	Phyllodactylidae	*Ptyodactylus_puiseuxi*	13.5	11	NA	745.8105269	70	9.7	Werner (1989)	Pincheira-Donoso and Meiri (2013)	Zlotkin et al. (2003)
Squamata	Gekkota	Phyllodactylidae	*Tarentola_delalandii*	12.2	10	NA	556.233375	52.64	6.03	Schleich and Kästle (1988)	De Fuentes-Fernández et al. (2016)	De Fuentes-Fernández et al. (2016)
Squamata	Gekkota	Phyllodactylidae	*Tarentola_gigas*	20	20	40	3438.366677	127	93	Schleich and Kästle (1988)	Meiri (2008)	Feldman et al. (2016)
Squamata	Gekkota	Phyllodactylidae	*Tarentola_mauritanica*	12.9	10.3	48	627.7731493	70	7.3	Schleich and Kästle (1988); Werner (1989)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Agamidae	*Agama_lionotus*	13	8	NA	398.5681431	72.1	105.9	Schleich and Kästle (1988)	Maisano (2001)	Feldman et al. (2016)
Squamata	Iguania	Agamidae	*Agama_planiceps*	13	9	92.5	496.3689775	114	49.3	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Agamidae	*Amphibolurus_muricatus*	NA	NA	NA	951.3	91.5	28.37	James and Shine (1988)	James and Shine (1988)	Harlow and Taylor (2000)
Squamata	Iguania	Agamidae	*Bronchocela_marmorata*	42.91	11.07	188	2570.372382	100.82	66.8	This study	Hallermann (2005)	Feldman et al. (2016)
Squamata	Iguania	Agamidae	*Calotes_versicolor*	13.3	7.5	NA	361.5859543	100.25	23.84	Shanbhag et al. (2000)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Agamidae	*Diporiphora_bilineata*	NA	NA	NA	215.9	54.5	3.63	James and Shine (1988)	James and Shine (1988)	Meiri et al. (2013)
Squamata	Iguania	Agamidae	*Laudakia_tuberculata*	16.2	9	200	635.033294	150	94.2	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Agamidae	*Lophognathus_gilberti*	NA	NA	NA	751.3	82.6	8.9	James and Shine (1988)	James and Shine (1988)	Feldman et al. (2016)
Squamata	Iguania	Agamidae	*Pogona_barbata*	30	18	80	4669.511377	250	373	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)

Squamata	Iguania	Agamidae	*Rankinia_diemensis*	NA	NA	NA	408.5	65.15	10.0	James and Shine (1988)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Agamidae	*Sitana_ponticeriana*	9.1	5.2	NA	118.7861768	62.2	6.84	Radder and Shanbhag (2003)	Radder and Shanbhag (2003)	Radder and Shanbhag (2003)
Squamata	Iguania	Agamidae	*Trapelus_megalonyx*	12	12	NA	742.6872023	65.5	13.7	Minton (1966)	Minton (1966)	Feldman et al. (2016)
Squamata	Iguania	Agamidae	*Trapelus_mutabilis*	20	10	125	975.0728031	85.55	15	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Chamaeleonidae	*Calumma_parsonii*	NA	NA	245	NA	188.45	295	Schleich and Kästle (1988)	Tessa et al. (2017)	Kubo (2010)
Squamata	Iguania	Chamaeleonidae	*Chamaeleo_senegalensis*	16	9	500	626.5245325	125	31.1	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Chamaeleonidae	*Chamaeleo_zeylanicus*	18	9	NA	710.8280735	118	227.8	Minton (1966)	Minton (1966)	Feldman et al. (2016)
Squamata	Iguania	Chamaeleonidae	*Kinyongia_tavetana*	13	7	45	309.0430902	97	21.3	Schleich and Kästle (1988)	Meiri (2008)	Feldman et al. (2016)
Squamata	Iguania	Chamaeleonidae	*Trioceros_jacksonii*	14.775	8.725	180.62	541.2377925	105	37.46	This study	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Corytophanidae	*Basiliscus_plumifrons*	27	18	110	4147.399704	118.46	66.16	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Corytophanidae	*Basiliscus_vittatus*	24	14	82.5	2266.372089	137.45	70	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Crotaphytidae	*Crotaphytus_collaris*	21.3	12.8	93.3	1676.222399	102.45	37.1	Length and width: Vitt (1977); Thickness: Trauth et al. (1994)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Crotaphytidae	*Gambelia_wislizenii*	20.5	12.5	NA	1536.06178	109.5	47	Vitt (1977)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Dactyloidae	*Anolis_aeneus*	14.1	NA	NA	NA	51.66	10.6	Stamps (1976)	Stamps et al. (1997)	Feldman et al. (2016)
Squamata	Iguania	Dactyloidae	*Anolis_carolinensis*	10.5	6	170	182.4776271	49.25	2.25	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Dactyloidae	*Anolis_limifrons*	NA	NA	45	NA	37.005	1.8	Sexton et al. (1979)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Iguanidae	*Ctenosaura_pectinata*	33	21	65	6943.263716	309.2	961.4	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Iguanidae	*Iguana_iguana*	40.4	29.3	124.81	16220.90565	387.55	1530.0	Lopez-Torres et al. (2011); this study	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Opluridae	*Oplurus_cuvieri*	27	17.5	NA	3935.592638	144.49	117.6627273	Randriamahazo and Mori (2001)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Callisaurus_draconoides*	15.2	7.5	29	417.1502979	73.4	10.285	Vitt (1977); Packard et al. (1982a)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Cophosaurus_texanus*	15.6	8.4	NA	534.0264598	70.07	10.2	Vitt (1977)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Holbrookia_maculata*	11.2	7.2	NA	276.6462568	54.15	4.9	Vitt (1977)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Phrynosoma_cornutum*	14	9	35.62	540.3247202	114	38	Vitt (1977); this study	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Phrynosoma_platyrhinos*	15.3	10.1	NA	740.9889444	75.25	18.8	Vitt (1977)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Sceloporus_clarkii*	15.5	9.5	57.96	670.4401099	92.3	33.25	Vitt (1977); Mathies (1998); Kratochvíl and Frynta (2006)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Sceloporus_horridus*	14.2	7.9	NA	428.8322561	82.7	49.1	Valdéz-González and Ramírez-Bautista (2002)	Valdéz-González and Ramírez-Bautista (2002)	Feldman et al. (2016)
Squamata	Iguania	Phrynosomatidae	*Sceloporus_magister*	15	10	73.54	711.1453539	86.3	43.58	Vitt (1977); Mathies (1998)	Meiri (2010)	Meiri (2010)

Squamata	Iguania	Phrynosomatidae	*Sceloporus_occidentalis*	12	7	NA	283.2965112	66.15	13.55	Vitt (1977)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Sceloporus_scalaris*	10.1	6.1	27	180.4165802	51.9	3.85	Length and width: Vitt (1977); Thickness: Mathies and Andrews (1995)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Sceloporus_spinosus*	15.1	8.8	71.1	563.4386269	88.74	22.7	Length and width: Valdéz-González and Ramírez-Bautista (2002); Thickness: Calderón-Espinoza et al. (2006)	Valdéz-González and Ramírez-Bautista (2002)	Blob (2000)
Squamata	Iguania	Phrynosomatidae	*Sceloporus_undulatus*	12.7	7.3	45.1	326.5345061	62.5	11.25	Vitt (1977)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Sceloporus_virgatus*	11.4	7	40.92	267.6641121	54.95	7.1	Vitt (1977)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Urosaurus_graciosus*	10.3	6.5	NA	207.8412416	48.7	3.49	Vitt (1977)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Urosaurus_ornatus*	9.8	6.5	52.36	196.4440322	50.87	3.35	Vitt (1977); this study	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Phrynosomatidae	*Uta_stansburiana*	11.9	7	65.59	280.7012321	46.17	3	Vitt (1977); Sinervo and Licht (1991); this study	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Tropiduridae	*Plica_plica*	28.6	14.1	NA	2774.28042	109.15	79.39	Vitt (1991a)	Meiri (2010)	Meiri (2010)
Squamata	Iguania	Tropiduridae	*Tropidurus_torquatus*	NA	NA	NA	598.5628205	94.25	37.45	Kiefer et al. (2008)	Vitt and Goldberg (1983)	Vitt and Goldberg (1983)
Squamata	Lacertoidea	Amphisbaenidae	*Chirindia_ewerbecki*	31	2	NA	56.37017236	153.0	1.3	Iverson and Ewert (1991)	Feldman et al. (2016)	Feldman et al. (2016)
Squamata	Lacertoidea	Blanidae	*Blanus_cinereus*	34	6	30	589.1332874	174.9	6	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Acanthodactylus_erythrurus*	15.3	9.4	NA	647.7514113	70.485	8.714067	Castilla et al. (1992)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Algyroides_fitzingeri*	14.9	8.9	NA	567.2560292	29.1	2.2	in den Bosch and Bout (1998)	Capula and Luiselli (1994)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Algyroides_marchi*	15.8	9.8	NA	726.253075	35.3	3.5	in den Bosch and Bout (1998)	Barbadillo and Martínez-Solano (2002)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Algyroides_moreoticus*	15.1	9.4	NA	638.2975374	45	3.19	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Algyroides_nigropunctatus*	15.8	11.2	NA	930.6403908	60.04	3.63	in den Bosch and Bout (1998)	Bejakovic et al. (1996)	Foufopoulos and Ives (1999)
Squamata	Lacertoidea	Lacertidae	*Anatololacerta_anatolica*	18	11.8	NA	1191.06468	62.552	9.8	in den Bosch and Bout (1998)	Yakin and Tok (2015)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Anatololacerta_danfordi*	17.9	12	NA	1221.041149	64	4.5	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Anatololacerta_pelasgiana*	16.4	12	NA	1102.723717	67	7	in den Bosch and Bout (1998)	Feldman et al. (2016)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Apathya_cappadocica _schmidtlerorum*	16.7	11.3	NA	1008.762755	69.19	10.2	in den Bosch and Bout (1998)	Gül et al. (2015)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Apathya_cappadocica_wolteri*	18.5	10.1	NA	914.5974666	69.19	10.2	in den Bosch and Bout (1998)	Meiri (2008)	Foufopoulos and Ives (1999)
Squamata	Lacertoidea	Lacertidae	*Archaeolacerta_bedriagae*	22.2	14.5	NA	2219.254027	72.22	10.3	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)

Squamata	Lacertoidea	Lacertidae	*Atlantolacerta_andreanskyi*	15.3	8.6	NA	547.077734	54	3	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Dalmatolacerta_oxycephala*	18.2	11.4	NA	1130.70127	60.26	8.03	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Darevskia_armeniaca*	16.8	11.4	NA	1032.40122	53.5	2.13	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Darevskia_chlorogaster*	17	10.9	NA	962.7023877	58.2415	4.38668	in den Bosch and Bout (1998)	Choopani et al. (2014)	Choopani et al. (2014)
Squamata	Lacertoidea	Lacertidae	*Darevskia_clarkorum*	17.8	12.4	NA	1288.857805	58.8	7.6	in den Bosch and Bout (1998)	Ilgaz (2007)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Darevskia_daghestanica*	14.1	8.8	NA	522.2054414	58	4.6	in den Bosch and Bout (1998)	Meiri (2008)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Darevskia_derjugini*	14	9.6	NA	609.1183957	56.6	4.126666667	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Darevskia_parvula*	17.1	9.9	NA	808.0708316	53.05	5.7	in den Bosch and Bout (1998)	Bülbül et al. (2016)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Darevskia_praticola*	15.5	10	NA	738.1914019	54.74	2.509151414	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Darevskia_raddei*	17.5	10.8	NA	977.5092274	62.84	10.2	in den Bosch and Bout (1998)	Dehghani et al. (2014)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Darevskia_rudis*	19.1	12.8	NA	1482.485027	65.9	15.9	in den Bosch and Bout (1998)	Arribas et al. (2003)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Darevskia_unisexualis*	18.4	11.4	NA	1144.625003	58.83	4.75	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Darevskia_valentini*	17.6	11.4	NA	1088.755602	60.59	11.8	in den Bosch and Bout (1998)	Kurnaz et al. (2017)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Dinarolacerta_mosorensis*	20.5	10.8	NA	1161.90431	63.935	5.821052632	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Gallotia_atlantica*	20.9	14.1	NA	1966.496844	74	12.75	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Gallotia_galloti*	21	15.7	NA	2407.251194	108.345	38.5	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Gallotia_stehlini*	26	14.6	35	2679.643964	192.5	208	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Hellenolacerta_graeca*	19.4	12.9	NA	1531.121728	79.44	9.85	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Iberolacerta_horvathi*	17.4	11.4	NA	1074.713812	55.46	4.12	in den Bosch and Bout (1998)	Martin and Salvador (1993)	Martin and Salvador (1993)
Squamata	Lacertoidea	Lacertidae	*Iberolacerta_monticola*	16.5	10.1	NA	806.8095906	67.205	8.6	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Lacerta_agilis*	18.8	14.1	50	1737.125923	77.57	8.285	Schleich and Kästle (1988); in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Lacerta_media*	24.1	17.2	NA	3343.940867	118	44.23225	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)

Squamata	Lacertoidea	Lacertidae	*Lacerta_pamphylica*	19.2	13.8	NA	1712.817089	120	39.1	in den Bosch and Bout (1998)	Meiri (2008)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Lacerta_schreiberi*	20.5	15.8	NA	2365.504212	102.06	26.87	in den Bosch and Bout (1998)	Braña (1996)	Grimm et al. (2014)
Squamata	Lacertoidea	Lacertidae	*Lacerta_strigata*	22.1	14.3	NA	2151.454944	92	20.55	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Lacerta_viridis*	18	11	47.5	1044.200129	101	39	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Ophisops_elegans*	17	9.7	NA	772.2697928	46.66666667	3.000349085	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Ophisops_jerdonii*	7	5	NA	82.06547871	35.75	2.8	Minton (1966)	Minton (1966)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Parvilacerta_fraasii*	18.5	10.8	NA	1039.561252	60	5.1	in den Bosch and Bout (1998)	Meiri (2008)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Parvilacerta_parva*	17.8	11	NA	1031.269251	50.32	3.07	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Phoenicolacerta_laevis*	15.7	11	NA	893.7577681	67.205	7.52	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Podarcis_bocagei*	16	10.8	NA	883.1648185	56.365	4.56	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Podarcis_erhardii*	20.6	14	NA	1908.762311	65.335	9.52	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Podarcis_filfolensis*	19.8	12	NA	1368.223893	63.68	14.6	in den Bosch and Bout (1998)	Carretero et al. (2010)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Podarcis_hispanicus*	15.4	9.7	NA	692.2043278	53.8	3.65	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Podarcis_lilfordi*	18.7	12.9	NA	1467.721362	66.35	7.33	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Podarcis_melisellensis*	18	12.9	NA	1403.859984	60.88	5.98	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Podarcis_milensis*	20.1	12.1	NA	1413.242933	52.67	4.09	in den Bosch and Bout (1998)	Adamopoulou and Valakos (2000)	Lamprecht et al. (1991)
Squamata	Lacertoidea	Lacertidae	*Podarcis_muralis*	15.7	10.3	NA	791.4574169	61.86	6.355	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Podarcis_peloponnesiacus*	20.1	12.5	NA	1502.653294	74.55	9.23	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Podarcis_pityusensis*	21.7	14.5	NA	2162.309866	68.7	6.807058	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Podarcis_siculus*	15.4	11.3	NA	917.7271723	71.35	8	Schleich and Kästle (1988); in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Podarcis_tauricus*	19.3	11.8	NA	1288.320715	60.575	7.35	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Podarcis_tiliguertus*	21.4	12.5	NA	1610.795889	61.375	4.99	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)

Squamata	Lacertoidea	Lacertidae	*Podarcis_waglerianus*	18.1	11.4	NA	1123.728661	65.55	10.2	in den Bosch and Bout (1998)	Cascio and Pasta (2006)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Psammodromus_blanci*	16.7	9.9	NA	787.3061875	38	2.5	in den Bosch and Bout (1998)	Van Damme and Vanhooydonck (2002)	Feldman et al. (2016)
Squamata	Lacertoidea	Lacertidae	*Psammodromus_hispanicus*	14	10.5	NA	717.3677697	39.37	3	in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Scelaris_perspicillata*	19.7	11.9	95	1339.206772	54.085	3.36	Schleich and Kästle (1988); in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Teira_dugesii*	25.3	14	NA	2400.583371	70	9	Schleich and Kästle (1988); in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Timon_lepidus*	26.3	18.7	105	4316.208473	164.94	119.75	Schleich and Kästle (1988); in den Bosch and Bout (1998)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Zootoca_vivipara_oviparous*	10.1	7.2	40.4	245.6162526	50.99	3.9	Length and width: in den Bosch and Bout (1989); Thickness: Heulin et al. (1992)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Zootoca_vivipara_viviparous*	12.3	9.1	8.7	474.6319253	50.99	3.9	Length and width: in den Bosch and Bout (1989); Thickness: Heulin et al. (1992)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Lacertidae	*Zootoca_vivipara_hybrid*	NA	NA	20.4	NA	50.99	3.9	Heulin et al. (1992)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Teiidae	*Aspidoscelis_communis*	14.9	10.6	NA	785.6362646	93.12	27.91	Ramírez-Bautista and Pardo-De La Rosa (2002)	Ramírez-Bautista and Pardo-De La Rosa (2002)	Ramírez-Bautista and Pardo-De La Rosa (2002)
Squamata	Lacertoidea	Teiidae	*Aspidoscelis_lineattissimus*	14.4	9.72	NA	643.8271527	78.09	18.9	Ramírez-Bautista et al. (2000)	Ramírez-Bautista et al. (2000)	Ramírez-Bautista et al. (2000)
Squamata	Lacertoidea	Teiidae	*Aspidoscelis_sexlineatus*	16.6	9.61	123.8	NA	61	7.191	Trauth and Fagerberg (1984); this study	Ballinger et al. (1979)	Ballinger et al. (1979)
Squamata	Lacertoidea	Teiidae	*Aspidoscelis_tigris*	17.8	9.7	NA	811.7869219	82.22	13.21	Vitt (1977)	Vitt (1977)	Vitt (1977)
Squamata	Lacertoidea	Teiidae	*Crocodilurus_amazonicus*	34.7	18.5	NA	5765.974238	220.00	198.9	Mesquita et al. (2006)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Teiidae	*Kentropyx_altamazonica*	17.6	11.34	246.95	1078.080122	85.00	23.5	This study	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Teiidae	*Kentropyx_calcarata*	23.9	17.1	NA	3276.324555	100.80	31.8	Vitt (1991b)	Meiri (2010)	Meiri (2010)
Squamata	Lacertoidea	Teiidae	*Tupinambis_teguixin*	48.65	27.88	354.41	18250.32187	362.15	2212.0	This study	Meiri (2010)	Meiri (2010)
Squamata	Scincomorpha	Gerrhosauridae	*Gerrhosaurus_flavigularis*	20	15	NA	2091.451224	141	80	Schleich and Kästle (1988)	Nasseri (2009)	Feldman et al. (2016)
Squamata	Scincomorpha	Gerrhosauridae	*Zonosaurus_madagascariensis*	20	11	115	1172.122167	124	45	Schleich and Kästle (1988)	Meiri (2010)	Meiri (2010)
Squamata	Scincomorpha	Scincidae	*Carlia_amax*	NA	NA	NA	83.6	36.80	1.2	James and Shine (1988)	James and Shine (1988)	Feldman et al. (2016)

Squamata	Scincomorpha	Scincidae	*Carlia_gracilis*	NA	NA	NA	70.2	36.30	1.2	James and Shine (1988)	James and Shine (1988)	Feldman et al. (2016)
Squamata	Scincomorpha	Scincidae	*Carlia_tetradactyla*	NA	NA	NA	252.7	52.30	5.1	James and Shine (1988)	James and Shine (1988)	Feldman et al. (2016)
Squamata	Scincomorpha	Scincidae	*Carlia_triacantha*	NA	NA	NA	165.7	42.40	2.8	James and Shine (1988)	James and Shine (1988)	Feldman et al. (2016)
Squamata	Scincomorpha	Scincidae	*Cryptoblepharus_plagiocephalus*	NA	NA	NA	80.8	39.30	1.0	James and Shine (1988)	Meiri (2010)	Meiri (2010)
Squamata	Scincomorpha	Scincidae	*Cryptoblepharus_poecilopleurus*	19.32	13.86	67.75	1739.117556	41.27	2.6	This study	Goldberg and Kraus (2011)	Feldman et al. (2016)
Squamata	Scincomorpha	Scincidae	*Ctenotus_essingtonii*	NA	NA	NA	279.9	59.10	7.8	James and Shine (1988)	James and Shine (1988)	Feldman et al. (2016)
Squamata	Scincomorpha	Scincidae	*Ctenotus_robustus*	NA	NA	NA	590.3333333	98.60	13.0	James and Shine (1988)	James and Shine (1988)	John-Alder and Bennett (1987)
Squamata	Scincomorpha	Scincidae	*Ctenotus_taeniolatus*	NA	NA	NA	471.9	68.50	4.5	James and Shine (1988)	Meiri (2010)	Meiri (2010)
Squamata	Scincomorpha	Scincidae	*Eremiascincus_douglasi*	NA	NA	NA	229.9	72.6	11.3	James and Shine (1988)	James and Shine (1988)	Feldman et al. (2016)
Squamata	Scincomorpha	Scincidae	*Eremiascincus_isolepis*	NA	NA	NA	202.6	59.4	3.0	James and Shine (1988)	James and Shine (1988)	D'Amore et al. (2018)
Squamata	Scincomorpha	Scincidae	*Lampropholis_delicata*	NA	NA	NA	75.44827586	40.00	1.2	Forsman and Shine (1995)	Meiri (2010)	Meiri (2010)
Squamata	Scincomorpha	Scincidae	*Lerista_bougainvillii_intermediate*	NA	NA	13.86	NA	57.75	1.57	Qualls (1996)	Meiri (2010)	Meiri (2010)
Squamata	Scincomorpha	Scincidae	*Lerista_bougainvillii_oviparous*	NA	NA	18.31	NA	57.75	1.57	Qualls (1996)	Meiri (2010)	Meiri (2010)
Squamata	Scincomorpha	Scincidae	*Lerista_bougainvillii_viviparous*	NA	NA	6.33	NA	57.75	1.57	Qualls (1996)	Meiri (2010)	Meiri (2010)
Squamata	Scincomorpha	Scincidae	*Lerista_karlschmidti*	NA	NA	NA	124.8	63.6	2.3	James and Shine (1988)	James and Shine (1988)	Feldman et al. (2016)
Squamata	Scincomorpha	Scincidae	*Lygisaurus_foliorum*	NA	NA	NA	105.5	38.70	1.4	James and Shine (1988)	James and Shine (1988)	Feldman et al. (2016)
Squamata	Scincomorpha	Scincidae	*Saiphos_equalis_oviparous*	NA	NA	37.4	NA	76.18	4.02	Stewart et al. (2010)	Smith and Shine (1997)	Smith and Shine (1997)
Squamata	Scincomorpha	Scincidae	*Saiphos_equalis_viviparous*	NA	NA	18.4	NA	76.18	4.02	Stewart et al. (2010)	Smith and Shine (1997)	Smith and Shine (1997)
Squamata	Scincomorpha	Xantusiidae	*Xantusia_vigilis*	9.4	5	NA	114.1143518	40.95	1.5	Vitt (1977)	Meiri (2010)	Meiri (2010)
Squamata	Serpentes	Boidae	*Eunectes_notaeus*	90.43	37.14	576.81	61254.05994	1937	5322.79	This study	Waller et al. (2007)	Waller et al. (2007)
Squamata	Serpentes	Colubridae	*Amphiesma_stolatum*	21	13.5	NA	1823.595931	402	21.5	Minton (1966)	Minton (1966)	Zug and Mitchell (1995)
Squamata	Serpentes	Colubridae	*Boiga_irregularis*	54	16	NA	6781.719419	1084	146.9	Shine (1991)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Boiga_trigonata*	35	14	NA	3370.169968	465	206	Minton (1966)	Minton (1966)	Feldman et al. (2016)
Squamata	Serpentes	Colubridae	*Coluber_constrictor*	26.9	19.2	60.92	4650.856286	765	121	Iverson and Ewert (1991); this study	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Contia_tenuis*	28	7	NA	669.9775082	194	5.72	Brodie et al. (1969)	Engelstoft and Ovaska (2000)	Govindarajulu et al. (2011)

Squamata	Serpentes	Colubridae	*Dendrelaphis_punctulatus*	41	15.8	NA	5030.532286	1006	166.3	Shine (1991)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Diadophis_punctatus*	27.8	7.5	45.38	765.3883443	459.3	19	Brodie et al. (1969); this study	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Elaphe_taeniura*	76	32	315	38196.9873	1455	516.45	Schleich and Kästle (1988)	Du and Ji (2008)	Du and Ji (2008)
Squamata	Serpentes	Colubridae	*Erythrolamprus_mossoroensis*	26.1	12.3	NA	1930.870891	479	50.75	Vitt and Vangilder (1983)	Pizzatto et al. (2008b)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Erythrolamprus_poecilogyrus*	28.9	11.6	NA	1910.378707	420	42	Vitt and Vangilder (1983)	Quintela et al. (2017)	Zhang et al. (2018)
Squamata	Serpentes	Colubridae	*Erythrolamprus_viridis*	33.6	8.8	NA	1272.467057	388	20.7	Vitt and Vangilder (1983)	Pizzatto et al. (2008a)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Helicops_angulatus_oviparous*	NA	NA	122.9	NA	419.9784861	39.4	Braz et al. (2018)	Scartozzoni (2009)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Helicops_angulatus_viviparous*	NA	NA	19.5	NA	419.9784861	39.4	Braz et al. (2018)	Scartozzoni (2009)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Helicops_carinicaudus*	NA	NA	5.7	NA	534.612	243	Braz et al. (2018)	Scartozzoni (2009)	Rocha et al. (2008)
Squamata	Serpentes	Colubridae	*Helicops_gomesi*	NA	NA	102.5	NA	557.2785714	171.7	Braz et al. (2018)	Scartozzoni (2009)	Feldman et al. (2016)
Squamata	Serpentes	Colubridae	*Helicops_hagmanni*	NA	NA	120.8	NA	504.6793893	146.1	Braz et al. (2018)	Scartozzoni (2009)	Feldman et al. (2016)
Squamata	Serpentes	Colubridae	*Helicops_infrataeniatus*	NA	NA	4.7	NA	441.1525773	168.7	Braz et al. (2018)	Scartozzoni (2009)	Feldman et al. (2016)
Squamata	Serpentes	Colubridae	*Heterodon_platirhinos*	38.6	18	83	6118.305646	660	280	Carpenter (1958)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Hydrops_martii*	NA	NA	106.7	NA	589.0398058	267.8	Braz et al. (2018)	Scartozzoni (2009)	Feldman et al. (2016)
Squamata	Serpentes	Colubridae	*Lampropeltis_calligaster*	31.8	18.4	NA	5191.221574	822	198.08	Carpenter (1958)	Seigel et al. (1986)	Fitch (1978)
Squamata	Serpentes	Colubridae	*Lampropeltis_getula*	49.8	23.8	100	13785.07982	933	188	Schleich and Kästle (1988); this study	Wund et al. (2007)	Zhang et al. (2018)
Squamata	Serpentes	Colubridae	*Lampropeltis_mexicana*	38.5	21.6	NA	8685.601691	719.5	203.1	Tryon and Murphy (1982)	Secor (1990)	Secor (1990)
Squamata	Serpentes	Colubridae	*Lampropeltis_triangulum*	41.3	19.3	NA	7525.316877	685.9	101.5	Tryon and Murphy (1982)	Meshaka (2010)	Guyer and Donnelly (1990)
Squamata	Serpentes	Colubridae	*Lampropeltis_zonata*	43	17	NA	6106.083408	531	57.9	Tryon and Murphy (1982)	Greene and Rodríguez-Robles (2003)	Greene and Rodríguez-Robles (2003)
Squamata	Serpentes	Colubridae	*Lycodon_striatus*	26.5	10	NA	1302.654914	530	19	Minton (1966)	Bhakat et al. (2018)	Feldman et al. (2016)
Squamata	Serpentes	Colubridae	*Lygophis_lineatus*	31.5	10.9	NA	1839.749763	423.5	26.5	Vitt and Vangilder (1983)	Feldman and Meiri (2013)	Feldman and Meiri (2013)

Squamata	Serpentes	Colubridae	*Lytorhynchus_paradoxus*	35	9	NA	1385.643195	203.5	10	Minton (1966)	Agarwal and Srikanthan (2013)	Feldman et al. (2016)
Squamata	Serpentes	Colubridae	*Masticophis_bilineatus*	45.2	19.32	199.54	8277.734447	865.92	450.9	This study	Goldberg (1998)	Feldman et al. (2016)
Squamata	Serpentes	Colubridae	*Masticophis_flagellum*	40	24	230.01	11068.47141	939	173	Carpenter (1958); this study	Secor (1995)	Secor (1995)
Squamata	Serpentes	Colubridae	*Natrix_maura*	37	19	NA	6501.574333	483	44.4	Schleich and Kästle (1988)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Natrix_natrix*	40	24	120	11068.47141	320	13	Schleich and Kästle (1988)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Opheodrys_aestivus*	30.7	11	NA	1826.264139	485	17	Carpenter (1958)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Oxybelis_aeneus*	35.2	12.5	NA	2703.940695	836	57.5	Vitt and Vangilder (1983)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Oxyrhopus_guibei*	29.5	15.6	NA	3487.589627	439	43	Pizzatto and Marques (2002)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Pantherophis_emoryi*	55.9	20.9	NA	12003.53772	885	174.3	Clark (1953)	Klug et al. (2011)	Klug et al. (2011)
Squamata	Serpentes	Colubridae	*Pantherophis_guttatus*	35.3	18.3	95	5750.691181	1216	695	Schleich and Kästle (1988); Ford and Seigel (1989); this study	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Philodryas_nattereri*	40.1	14.7	NA	4260.031486	771	170.5	Vitt and Vangilder (1983)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Philodryas_olfersii*	43.3	16.5	NA	5794.436241	685.5	91.5	Vitt and Vangilder (1983)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Philodryas_patagoniensis*	NA	NA	175	NA	677	168	Schleich and Kästle (1988)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Pituophis_catenifer*	55.2	30	214.47	24085.28995	757.17	413.68	Carpenter (1958); this study	Rodríguez-Robles (2002)	Iverson et al. (2008)
Squamata	Serpentes	Colubridae	*Pituophis_melanoleucus*	57.5	31	NA	26805.8764	961.9626168	548	Brodie et al. (1969)	Diller and Wallace (1996)	Zhang et al. (2018)
Squamata	Serpentes	Colubridae	*Sibynomorphus_mikanii*	27.1	14.9	NA	2914.145175	406.9777778	11	Albuquerque and Ferrarezzi (2004)	Pizzatto et al. (2008b)	Zhang et al. (2018)
Squamata	Serpentes	Colubridae	*Sonora_semiannulata*	21.25	6	NA	374.8822367	255.16	18.2	Carpenter (1958)	Goldberg (2001)	Feldman et al. (2016)
Squamata	Serpentes	Colubridae	*Spalerosophis_atriceps*	68.2	23.8	NA	18991.10074	1168.307692	411.6	Minton (1966)	Baig and Masroor (2008)	Feldman et al. (2016)
Squamata	Serpentes	Colubridae	*Stegonotus_cucullatus*	35	20	NA	6758.430633	1040	298	Shine (1991)	Shine (1991)	Shine (1991)
Squamata	Serpentes	Colubridae	*Tantilla_gracilis*	22.4	5	NA	272.3421086	133.8	1.6	Carpenter (1958)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Tropidonophis_mairii*	24.3	13.6	NA	2173.739842	670	126.9	Shine (1991); Shine and Brown (2002)	Shine (1991)	Shine (1991)
Squamata	Serpentes	Colubridae	*Xenochrophis_piscator*	28.5	16.5	NA	3741.068665	555	131.6	Minton (1966)	Feldman and Meiri (2013)	Feldman and Meiri (2013)

Squamata	Serpentes	Colubridae	*Xenodon_merremii*	33	18.8	NA	5632.075723	615.3	201.8	Vitt and Vangilder (1983)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Colubridae	*Zamenis_longissimus*	45	24	NA	12584.13428	645	199	Schleich and Kästle (1988)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Elapidae	*Micrurus_ibiboboca*	44.6	12	NA	3143.251301	643.5	53	Vitt and Vangilder (1983)	Feldman and Meiri (2013)	Vitt and Vangilder (1983)
Squamata	Serpentes	Elapidae	*Micrurus_mipartitus*	37.72	9.91	78.8	1811.763375	1130	338.7	This study	Feldman et al. (2016)	Feldman et al. (2016)
Squamata	Serpentes	Elapidae	*Naja_melanoleuca*	59.4	28.4	204.28	23412.10669	1569.398374	2756.1	Tryon (1979); this study	Luiselli et al. (2002)	Feldman et al. (2016)
Squamata	Serpentes	Elapidae	*Ogmodon_vitianus*	14.4	6.5	NA	298.0110993	234	18.3	Zug and Ineich (1993)	Zug and Ineich (1993)	Feldman et al. (2016)
Squamata	Serpentes	Lamprophiidae	*Boaedon_fuliginosus*	36.2	15.8	NA	4431.340387	466.5	30.8	Ford (2001)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Lamprophiidae	*Madagascarophis_colubrinus*	39.7	21.5	NA	8899.31814	740	177.2	Erasmus and Branch (1982)	Boulenger (1896)	Feldman et al. (2016)
Squamata	Serpentes	Leptotyphlopidae	*Leptotyphlops_scutifrons*	16.8	3.2	NA	83.09997877	131.96	4.7	Webb et al. (2000)	Webb et al. (2000)	Feldman et al. (2016)
Squamata	Serpentes	Leptotyphlopidae	*Myriopholis_blanfordi*	25	2.5	NA	72.92262643	186	3.4	Iverson and Ewert (1991)	Minton (1966)	Feldman et al. (2016)
Squamata	Serpentes	Pythonidae	*Morelia_spilota*	52.5	36.4	NA	32782.00868	1587.6	2120.15	Kortlang (1994)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Pythonidae	*Morelia_viridis*	37	22	130	8611.295272	1021	1002	Schleich and Kästle (1988)	Feldman and Meiri (2013)	Pees et al. (2009)
Squamata	Serpentes	Pythonidae	*Python_anchietae*	86.5	45.8	NA	88137.84328	1250	798	Patterson and Erasmus (1978)	Patterson and Erasmus (1978)	Morgan and Boycott (1990)
Squamata	Serpentes	Pythonidae	*Python_molurus*	96	58	225	155026.6556	2530	12370	Schleich and Kästle (1988)	Secor and White (2010)	Zhang et al. (2018)
Squamata	Serpentes	Pythonidae	*Python_regius*	75.7	45.4	NA	74960.63877	2933.333333	1486	Morrill (2011)	Brashears and DeNardo (2013)	Morrill (2011)
Squamata	Serpentes	Pythonidae	*Python_sebae*	90	60	NA	153607.3964	3370	13250	Schleich and Kästle (1988)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Typhlopidae	*Indotyphlops_braminus*	15	4.4	NA	142.4331311	116.9	2.1	Kamosawa and Ota (1996)	Ota et al. (1991)	Feldman et al. (2016)
Squamata	Serpentes	Viperidae	*Bothrops_atrox*	32.82	26.61	42.92	10622.87367	1532	1803.4	This study	Feldman et al. (2016)	Feldman et al. (2016)
Squamata	Serpentes	Viperidae	*Calloselasma_rhodostoma*	32	24	59.5	8566.584212	645.8333333	264	Schleich and Kästle (1988)	Hill et al. (2006)	Hill et al. (2006)
Squamata	Serpentes	Viperidae	*Crotalus_viridis*	27.27	12.8	19.69	2185.160579	683.31	211.71	This study	Diller and Wallace (1984)	Diller and Wallace (1984)
Squamata	Serpentes	Viperidae	*Daboia_palaestinae*	30	22	80	6777.193012	872	437.5	Schleich and Kästle (1988)	Feldman and Meiri (2013)	Feldman and Meiri (2013)
Squamata	Serpentes	Viperidae	*Ovophis_okinavensis*	40	24	NA	11068.47141	502	137.14	Ford and Seigel (1989)	Ford and Seigel (1989)	Vincent and Mori (2008)

Squamata	Serpentes	Viperidae	*Protobothrops_flavoviridis*	60	30	NA	26326.96568	1226	433.1	Ford and Seigel (1989)	Ford and Seigel (1989)	Nishimura and Kamura (1994)

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Supplementary Table 2. List of lepidosaur egg specimens sampled for this study. Abbreviations: AMNH, American Museum of Natural History; CAL, California Academy of Sciences; UTA, University of Texas at Austin.

Species	Specimen number	Host institution	Sample type	Number of eggs measured
Aspidoscelis sexlineatus	R46872	AMNH	Whole egg	1
Bothrops atrox	R52046	AMNH	Whole egg	1
Bronchocela marmorata	CAS 15524	CAS	Egg fragment	1
Coluber constrictor	R8260	AMNH	Whole egg	1
Crotalus viridis	CAS 43622	CAS	Egg fragment	1
Cryptoblepharus poecilopleurus	CAS 47469	CAS	Egg fragment	1
Diadophis punctatus	R130448	AMNH	Whole egg	1
Elgaria multicarinata	CAS-SUR 12034	CAS	Egg fragment	1
Eunectes notaeus	R173742	AMNH	Whole egg	1
Heterodon platirhinos	R44951	AMNH	Whole egg	1
Iguana iguana	R12614	AMNH	Whole egg	1
Kentropyx altamazonica	R73471	AMNH	Whole egg	1
Lampropeltis getula	LGE1	UTA	Whole egg	3
Masticophis bilineatus	CAS 48889	CAS	Egg fragment	1
Masticophis flagellum	R46870	AMNH	Whole egg	1
Micrurus mipartitus	R110067	AMNH	Whole egg	1
Naja melanoleuca	R173759	AMNH	Whole egg	1
Panterophis guttatus	CS10	UTA	Whole egg	9
Phrynosoma cornutum	R8232	AMNH	Whole egg	1
Pituophis catenifer	R3569	AMNH	Whole egg	1
Sceloporus magister	R68907	AMNH	Whole egg	1
Sceloporus undulatus	R50941	AMNH	Whole egg	1
Trioceros jacksonii	M-16350	UTA	Whole egg	4
Tupinambis teguixin	R37456	AMNH	Whole egg	1
Urosaurus ornatus	TNHC 76001, TNHC 76031, TNHC 76044, TNHC 76041	UTA	Whole egg	19
Uta stansburiana	TNHC 94277	UTA	Whole egg	7

Supplementary Table 3. Dataset 2. Measurements of calcareous layer thickness and egg mass for *Antarcticoolithus bradyi* and 148 species of extant and extinct amniotes, with corresponding references (see full list of references below).

Clade	***Taxon***	**Calcareous layer thickness (µm)**	**Egg mass (g)**	**Source**
Birds	*Prinia_gracilis*	69	1.12	Stein et al. (2019)
Birds	*Carduelis_carduelis*	70	1.23	Stein et al. (2019)
Birds	*Passer_moabiticus*	88	1.5	Stein et al. (2019)
Birds	*Muscicapa_striata*	76	1.85	Stein et al. (2019)
Birds	*Carduelis_chloris*	68	1.94	Stein et al. (2019)
Birds	*Melopsittacus_undulatus*	116	2.25	Stein et al. (2019)
Birds	*Erythropygia_galactotes*	80	2.3	Stein et al. (2019)
Birds	*Lanius_nubicus*	95	2.46	Stein et al. (2019)
Birds	*Passer_domesticus*	102	2.76	Stein et al. (2019)
Birds	*Galerida_cristata*	95	2.93	Stein et al. (2019)
Birds	*Pycnonotus_capensis*	83	3.05	Stein et al. (2019)
Birds	*Turdus_merula*	122	6.36	Stein et al. (2019)
Birds	*Streptopelia_senegalensis*	120	6.63	Stein et al. (2019)
Birds	*Streptopelia_decaocto*	132	7.45	Stein et al. (2019)
Birds	*Streptopelia_risoria*	119	8.03	Stein et al. (2019)
Birds	*Streptopelia_turtur*	137	8.3	Stein et al. (2019)
Birds	*Glareola_pratincola*	151	8.42	Stein et al. (2019)
Birds	*Falco_naumanni*	194	10.84	Stein et al. (2019)
Birds	*Athene_noctua*	187	14	Stein et al. (2019)
Birds	*Chlidonias_leucoptera*	148	14.04	Stein et al. (2019)
Birds	*Gallinula_chloropus*	229	14.29	Stein et al. (2019)
Birds	*Corvus_corone*	177	14.99	Stein et al. (2019)
Birds	*Falco_tinnunculus*	242	18.09	Stein et al. (2019)
Birds	*Alectoris_graeca*	278	18.23	Stein et al. (2019)
Birds	*Himantopus_himantopus*	185	18.51	Stein et al. (2019)
Birds	*Tyto_alba*	241	18.71	Stein et al. (2019)
Birds	*Sterna_hirundo*	171	19.5	Stein et al. (2019)
Birds	*Nycticorax_nycticorax*	205	20.75	Stein et al. (2019)
Birds	*Bubulcus_ibis*	204	23.22	Stein et al. (2019)
Birds	*Egretta_garzetta*	218	28.52	Stein et al. (2019)
Birds	*Phasianus_colchicus*	308	29.22	Stein et al. (2019)
Birds	*Burhinus_oedicnemus*	266	33.51	Stein et al. (2019)
Birds	*Gallus_domesticus*	295	35.88	Stein et al. (2019)
Birds	*Strix_aluco*	268	36.14	Stein et al. (2019)
Birds	*Larus_ridibundus*	231	37.5	Stein et al. (2019)
Birds	*Ardea_cinerea*	242	49.6	Stein et al. (2019)
Birds	*Geronticus_eremita*	394	50.16	Stein et al. (2019)
Birds	*Anas_platyrhynchos*	315	54	Stein et al. (2019)
Birds	*Buteo_rufinus*	371	60.72	Stein et al. (2019)
Birds	*Bubo_bubo*	349	69.3	Stein et al. (2019)
Birds	*Ciconia_ciconia*	502	78.78	Stein et al. (2019)
Birds	*Aquila_rapax*	520	92.83	Stein et al. (2019)
Birds	*Anser_anser*	741	173.01	Stein et al. (2019)
Birds	*Gyps_fulvus*	676	243.88	Stein et al. (2019)
Birds	*Nectarinia_osea*	52	0.86	Stein et al. (2019)
Birds	*Struthio_camelus*	2245	1460.85	Stein et al. (2019)
Crocodilians	*Alligator*	530	99.35	Stein et al. (2019)
Crocodilians	*Crocodylus_niloticus*	530	113.61	Stein et al. (2019)
Crocodilians	*Crocodylus_acutus*	450	75.08	Stein et al. (2019)
Chelonians	*Lepidochelys_kempi*	40	30.73	Stein et al. (2019)
Chelonians	*Geochelone_elephantopus*	400	101.64	Stein et al. (2019)
Chelonians	*Chelydra_serpentina*	110	8.34	Stein et al. (2019)
Chelonians	*BMNH_47208*	900	56.7	Stein et al. (2019)
Chelonians	*Testudoolithus_jiangi*	730	57.7	Stein et al. (2019)
Chelonians	*Testudoolithus_rigidus*	235	46.43	Stein et al. (2019)
Non-avian_dinosaurs	*Elongatoolithidae*	1300	323	Stein et al. (2019)
Non-avian_dinosaurs	*Macroolithus_yaotunensis*	1450	911	Stein et al. (2019)
Non-avian_dinosaurs	*Macroolithus_rugustus*	1420	592	Stein et al. (2019)
Non-avian_dinosaurs	*Elongatoolithus_andrewsi*	980	384	Stein et al. (2019)
Non-avian_dinosaurs	*Lourinhanosaurus_antunesi*	900	643	Stein et al. (2019)

Non-avian_dinosaurs	*Macroelongatoolithus_xixianensis*	2100	3145	Stein et al. (2019)
Non-avian_dinosaurs	*Prismatoolithus_levis_troodontid*	1000	331	Stein et al. (2019)
Non-avian_dinosaurs	*indet_theropod1*	300	168	Stein et al. (2019)
Non-avian_dinosaurs	*indet_theropod2*	1300	224	Stein et al. (2019)
Non-avian_dinosaurs	*indet_theropod3*	1200	210	Stein et al. (2019)
Non-avian_dinosaurs	*indet_theropod4*	1300	273	Stein et al. (2019)
Non-avian_dinosaurs	*Titanosaur*	2300	2045	Stein et al. (2019)
Non-avian_dinosaurs	*Titanosaur_Type2*	1400	1756	Stein et al. (2019)
Non-avian_dinosaurs	*Cairanoolithus_roussetenssis*	1700	2751	Stein et al. (2019)
Non-avian_dinosaurs	*Cairanoolithus_dughii*	2100	3001	Stein et al. (2019)
Non-avian_dinosaurs	*Cairanoolithus_dughii_Titanosaur_Type1*	1900	3001	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_sp.1*	1600	1890	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_sp.2*	2400	2751	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_mamillare_Titanosaur_type3.1*	1600	5186	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_mamillare_Titanosaur_type3.2*	1300	5565	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_mamillare2*	1800	5186	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_siruguei_Titanosaur_Type4_1*	2200	3546	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_siruguei_Titanosaur_Type4_2*	2200	4121	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_siruguei1*	3000	4536	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_siruguei3*	2200	4152	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_sp._Telmatosaurus_transsylvanicus*	2300	2446	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_aureliensis2*	1100	5186	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_pseudomamillare*	1600	3629	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_petralta*	1800	2691	Stein et al. (2019)
Non-avian_dinosaurs	*Megaloolithus_microtuberculata*	2200	2294	Stein et al. (2019)
Non-avian_dinosaurs	*Massospondylus*	100	158	Stein et al. (2019)
Non-avian_dinosaurs	*Mussaurus*	80	660	Stein et al. (2019)
Non-avian_dinosaurs	*Lufengosaurus*	85	500	Stein et al. (2019)
Non-avian_dinosaurs	*Spheroolithidae*	1500	247	Stein et al. (2019)
Non-avian_dinosaurs	*Spheroolithus_albertensis*	1000	287	Stein et al. (2019)
Non-avian_dinosaurs	*Spheroolithus_sp.*	2100	287	Stein et al. (2019)
Non-avian_dinosaurs	*Dendroolithidae*	2300	751	Stein et al. (2019)
Pterosaurs	*MHIN_UNSL_GEO_V246_Pterodaustro*	30	16	Stein et al. (2019)
Pterosaurs	*Hamipterus_tianshanensis*	60	45	Stein et al. (2019)
Antarcticoolithus	*Antarcticoolithus_bradyi*	100	6496	This study
Chelonians	*Testudoflexoolithus_bathonicae*	225	18.17088	Lawver and Jackson (2016)
Chelonians	*Emydoolithus_laiyangensis*	450	24.66464	Lawver and Jackson (2016)
Chelonians	*Testudoolithus_lordhowensis*	800	87.69085864	Lawver and Jackson (2016)
Non-avian_dinosaurs	*Troodon_formosus*	1000	346.90992	Varrichio et al. (2013)
Birds	*Aepyornis_maximus*	3400	8661.38112	Silyn-Roberts and Sharp (1986); Balanoff and Rowe (2007)
Birds	*Dromaius_novaehollandiae*	948.683298050514	539.218181084	Tyler (1969), Beutel et al. (1984)
Birds	*Rhea_americana*	900	580.862464	Tyler (1969); Lábaque et al. (2010)
Birds	Moa_indet	2100	4167.07968	Gill (2000)
Non-avian_dinosaurs	*Continuoolithus*	1000	960.4	Jackson et al. (2015)
Crocodilians	*Crocodylus_mindorensis*	430	53.99318232	Marzola et al. (2015)
Crocodilians	*Caiman_latirostris*	540	59.0167368	Marzola et al. (2015)
Crocodilians	*Crocodylus_johnstoni*	400	63.1261512	Marzola et al. (2015)
Crocodilians	*Crocodylus_porosus*	548	116.7065088	Marzola et al. (2015)
Crocodilians	*Gavialis_gangeticus*	445	144.00512	Marzola et al. (2015)
Squamates	*Gekko_gecko*	280	6.81352	See Supplementary Table 1
Squamates	*Hemidactylus_bouvieri*	55	0.40824	See Supplementary Table 1
Squamates	*Mediodactylus_kotschyi*	39	0.25962888	See Supplementary Table 1
Squamates	*Phelsuma_madagascariensis*	130	2.39841	See Supplementary Table 1
Squamates	*Ptyodactylus_hasselquistii*	150	1.31747672	See Supplementary Table 1
Squamates	*Tarentola_gigas*	33	4.48	See Supplementary Table 1
Squamates	*Tarentola_mauritanica*	41.3	0.76639416	See Supplementary Table 1
Squamates	*Agama_planiceps*	42.5	0.58968	See Supplementary Table 1
Squamates	*Kinyongia_tavetana*	2.5	0.35672	See Supplementary Table 1
Squamates	*Anolis_carolinensis*	50	0.21168	See Supplementary Table 1
Squamates	*Lacerta_viridis*	6	1.21968	See Supplementary Table 1
Squamates	*Lampropeltis_getula*	12	15.79687872	See Supplementary Table 1
Squamates	*Pantherophis_guttatus*	10	6.62010552	See Supplementary Table 1
Squamates	*Python_molurus*	55	230	See Supplementary Table 1
Squamates	*Calloselasma_rhodostoma*	6.3	10.32192	See Supplementary Table 1
Squamates	*Elgaria_multicarinata*	9	1.024884	See Supplementary Table 1

Squamates	*Bronchocela_marmorata*	9	2.94470492904	See Supplementary Table 1
Squamates	*Cryptoblepharus_poecilopleurus*	6.5	2.07836399232	See Supplementary Table 1
Squamates	*Crotalus_viridis*	3	2.502033408	See Supplementary Table 1
Squamates	*Masticophis_bilineatus*	45	9.4480178688	See Supplementary Table 1
Squamates	*Pituophis_catenifer*	22.4	27.8208	See Supplementary Table 1
Squamates	*Phrynosoma_cornutum*	6	0.63504	See Supplementary Table 1
Squamates	*Coluber_constrictor*	5.6	5.55319296	See Supplementary Table 1
Squamates	*Iguana_iguana*	18.1	19.42247776	See Supplementary Table 1
Squamates	*Tupinambis_teguixin*	56.2	21.1766086336	See Supplementary Table 1
Squamates	*Heterodon_platirhinos*	13.1	7.003584	See Supplementary Table 1
Squamates	*Masticophis_flagellum*	35.3	12.9024	See Supplementary Table 1
Squamates	*Aspidoscelis_sexlineatus*	8.9	0.8585051216	See Supplementary Table 1
Squamates	*Sceloporus_undulatus*	5.4	0.37899848	See Supplementary Table 1
Squamates	*Bothrops_atrox*	5.6	13.01416632432	See Supplementary Table 1
Squamates	*Sceloporus_magister*	6.4	0.84	See Supplementary Table 1
Squamates	*Kentropyx_altamazonica*	15.7	1.2674382336	See Supplementary Table 1
Squamates	*Micrurus_mipartitus*	4.5	2.07446933792	See Supplementary Table 1
Squamates	*Diadophis_punctatus*	11	0.8757	See Supplementary Table 1
Squamates	*Eunectes_notaeus*	40.9	69.85288644768	See Supplementary Table 1
Squamates	*Naja_melanoleuca*	20.5	26.82941184	See Supplementary Table 1
Squamates	*Urosaurus_ornatus*	21.7	0.231868	See Supplementary Table 1
Squamates	*Uta_stansburiana*	14.2	0.326536	See Supplementary Table 1
Mammals	*Ornithorhynchus_anatinus*	167.8	1.907388	Hill and Hill (1933)
Choristoderes	*Hyphalosaurus_baitagouensis*	10	2.29593	Hou et al. (2010)

Supplementary references for Dataset 2 (extant and extinct reptiles, Supplementary Table 3)

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