**Supplementary Information 3**

**Time Binning Schemes**

To explore the impact of different binning schemes, occurrence data were pooled into: (1) approximately equal length (~10 million year, n = 14) time bins (Alroy, Aberhan et al. 2008, Alroy 2010) (Table S1); and (2) stage-level time bins based on the Standard European Stages and absolute dates provided by (Gradstein, Ogg et al. 2012) (Table S2). Although the former addresses potential problems of uneven time bin duration on biodiversity reconstruction, it obscures the finer scale timings of any changes in biodiversity across the J/K boundary, in that the Kimmeridgian is combined with the Tithonian, and the Berriasian with the Valanginian. To avoid over-counting taxa in multiple time bins, resulting from uncertainty in their temporal durations, only occurrences that could be assigned to a single time bin were used, resulting in 681 non-marine occurrences from 669 collections, and 330 marine occurrences from 284 collections. We followed Mannion *et al*. (in press) by including occurrences from the equivocally-aged Adamantina Formation within K6 (see Table 1) for the analyses with 10 million year time bins, but excluded them from any Stage-level analyses.

|  |  |  |  |
| --- | --- | --- | --- |
| **Abbreviation** | **10 million year time bin** | **Stage equivalent** | **Temporal range** |
| K8 | Cretaceous 8 | Maastrichtian | 72.1–66.0 |
| K7 | Cretaceous 7 | Campanian | 83.6–72.1 |
| K6 | Cretaceous 6 | Turonian–Santonian | 93.9–83.6 |
| K5 | Cretaceous 5 | Cenomanian | 100.5–93.9 |
| K4 | Cretaceous 4 | Albian | 113–100.5 |
| K3 | Cretaceous 3 | Aptian | 126.3–113 |
| K2 | Cretaceous 2 | Hauterivian–Barremian | 133.9–126.3 |
| K1 | Cretaceous 1 | Berriasian–Valanginian | 145.0–133.9 |
| J6 | Jurassic 6 | Kimmeridgian–Tithonian | 157.3–145.0 |
| J5 | Jurassic 5 | Callovian–Oxfordian | 166.1–157.3 |
| J4 | Jurassic 4 | Bajocian–Bathonian | 170.3–166.1 |
| J3 | Jurassic 3 | Toarcian–Aalenian | 182.7–170.3 |
| J2 | Jurassic 2 | Pliensbachian | 190.8–182.7 |
| J1 | Jurassic 1 | Hettangian–Sinemurian | 201.3–190.8 |

**Supplementary Table 1.** Approximately equal 10 million year time bins used in the present study. Absolute dates are based on Gradstein *et al*. (2012).

|  |  |  |  |
| --- | --- | --- | --- |
| **Abbreviation** | **Stage** | **Bin base (Ma)** | |
| K12 | Maastrichtian | 70.6 |
| K11 | Campanian | 83.5 |
| K10 | Santonian | 85.8 |
| K9 | Coniacian | 89.3 |
| K8 | Turonian | 93.5 |
| K7 | Cenomanian | 99.6 |
| K6 | Albian | 112 |
| K5 | Aptian | 125 |
| K4 | Barremian | 130 |
| K3 | Hauterivian | 136.4 |
| K2 | Valanginian | 140.2 |
| K1 | Berriasian | 145.5 |
| J11 | Tithonian | 150.8 |
| J10 | Kimmeridgian | 155.7 |
| J9 | Oxfordian | 161.2 |
| J8 | Callovian | 164.7 |
| J7 | Bathonian | 167.7 |
| J6 | Bajocian | 171.6 |
| J5 | Aalenian | 175.6 |
| J4 | Toarcian | 183 |
| J3 | Pliensbachian | 189.6 |
| J2 | Sinemurian | 196.5 |
| J1 | Hettangian | 201.6 |

**Supplementary Table 2.** Stage-level time bins used in the present study. Absolute dates are based on Gradstein *et al*. (2012).

**Subsampling approach**

Shareholder quorum subsampling (SQS) standardises in-bin taxonomic occurrence samples based on an estimate of coverage to determine the relative magnitude of taxonomic biodiversity trends (Alroy 2010, Alroy 2010). Coverage is estimated by using randomised subsampling to calculate the mean value of Good’s *u* (Good 1953), the sum of the frequencies of sampled taxa within an occurrence list, and used to set the desired quorum level. Coverage of zero implies that data within a bin are poorly sampled, either because occurrences are non-existent or because all taxa are singletons (i.e., taxa with only a single occurrence per bin), whereas a higher coverage value implies more even sampling of taxa. In this model, the frequency of occurrences of each taxon within a pool becomes their share, from which taxa are randomly drawn until the pre-set quorum is met. Although it has been suggested that SQS can remove a genuine signal that might be underlying both sampling and biodiversity (Hannisdal and Peters 2011), Mannion *et al*. (2015) found that the relationships between environmental variables and pseudosuchian biodiversity were strengthened upon application of SQS, suggesting that this signal dampening is unlikely to be a problem, at least for crocodyliforms.

In addition to analyses using the same dataset for calculating SQSP, but using the R script (i.e., SQSRc), we calculated SQSRu using the following rule: if a single non-marine occurrence is present in only two adjacent time bins (e.g., K3 and K4), it can be added to the occurrence lists for both time bins. This provides the basis for two estimates of biodiversity using this version of SQSR: (1) using a strict minimum number of occurrences to provide a minimal estimate, i.e., constrained SQS (SQSRc); and (2) incorporating an additional measure of uncertainty based on low resolution of terrestrial fossil record dating, i.e., unconstrained SQS (SQSRu). The temporal durations of marine crocodyliforms are relatively well-constrained, and therefore we did not calculate SQSRu for them.

**Model fitting procedure**

Because the environmental data (Table S3) were previously presented at the stage level, they were also transformed into 10 million year time bin data by taking the mean of values for data points that fall within our individual time bin intervals. We constrained correlation tests involving PDEs to the Bathonian–Albian interval, and J2 to K7 for PDEt, to remove potential skewing by edge effects associated with phylogenetic methods of estimating biodiversity. We also constrained SQSPs to the Bathonian–Albian, as the results had little resolution outside of this interval. All of these time series data were detrended by using maximum likelihood to fit a first-order autoregressive integrated moving average model using the arima() function, and extracting the residuals to eliminate the effect of serial correlation. The residuals of each of the environmental parameters were independently compared using linear regression to each of our measures of biodiversity. The relative fit of each variable was assessed using the sample-size corrected Akaike Information Criterion (AICc) (Hurvich and Tsai 1989) by calculating the likelihood and weight for each environmental parameter as a way of assessing the probability of each one among the candidate set of models. The strength of the fit of each model was further tested through calculation of the parametric Pearson’s product moment correlation coefficient and the non-parametric Spearman’s rank correlation coefficient. To be considered as having strong statistical support, a parameter had to satisfy the following criteria: (1) a correlation score of greater than 0.5 for both correlation tests; (2) a traditional *p*-value of <0.05 for both correlation tests; (3) having the best-fitting model based on AICc likelihood scores; and (4) having the highest Akaike weight. Combinations were considered where these criteria were met by multiple parameters.

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Source** | **Proxy for** |
| Non-marine rock outcrop area (NMA) | Benson and Butler, 2011 | Area of shallow marine habitat available |
| Fossiliferous marine formation (FMF) | Benson and Butler, 2011 | Geological sampling of marine environments |
| Eustatic sea-level (1) | Miller *et al*., 2005 | Area of shallow marine habitat available |
| Eustatic sea-level (2) | Haq *et al*., 1997 | Area of shallow marine habitat available |
| *δ*18O | Prokoph *et al*., 2008 | Inverse proxy for temperature |
| *δ*13C | Prokoph *et al*., 2008 | Biological activity |
| *δ*34S | Prokoph *et al*., 2008 | Organic nutrient inputs or shelf redox conditions |
| 87Sr/86Sr | Prokoph *et al*., 2008 | Inorganic nutrient inputs |
| Sea-surface temperature (based on δ18O) | Martin *et al*., 2014 | Global sea-surface temperature |
| Global subsampled marine diversity | Hannisdal and Peters, 2011 | Prey availability |

**Supplementary Table 3.** Extrinsic variables used in the present study, their sources, and the environmental factors they represent.

**Informal supertree construction protocol**

***Background***

Phylogenies provide information on ‘hidden’ biodiversity that we know must have existed but that has not been preserved in the fossil record. Based on the bifurcation model of speciation, sister taxa originate at the same time as each other and therefore we can extrapolate their known fossil ranges so that they have equal origination times. The creation of these ‘ghost lineages’ increases biodiversity by extending unsampled taxonomic ranges into older time bins (Norell 1993). To produce a phylogenetic diversity estimate (PDE), we constructed a new crocodyliform ‘informal’ supertree comprising 252 species (source trees below) using Mesquite (version 2.75). This involves the ‘bolting together’ of different parts of independent trees to increase phylogenetic taxon sampling, without creating spurious relationships not found in any of the source trees. We created an additional supertree at the genus level (146 genera) to account for uncertainty in the taxonomy of anomalously speciose genera, such as *Goniopholis*, *Steneosaurus*, and *Teleosaurus*. Here, we provide details of our tree construction. A full list of taxa and sources are provided in Supplementary Information 1 (SI 1).

The taxonomy for our trees is based on a list of all Jurassic–Cretaceous crocodyliform species from the Paleobiology Database (accessed December 1, 2014). This is a comprehensive occurrence-based list that JPT, PDM and numerous others (Carrano *et al*. 2015) have contributed to, and is a faithful representation of the current state of knowledge of crocodyliform taxonomy based on the published literature. Information on phylogenetic relationships was obtained from a range of sources from the primary literature (see below). Phylogenetic information could not be collected for some of the genera, which were omitted. For time-scaling purposes, we used the full genus range implied by each of its constituent species, including specifically indeterminate remains. By comparing the two supertrees, we can identify where taxonomic issues might confound the signal, and identify key areas for future taxonomic research. Both supertrees are available at the end of this document (after the supplementary figures), and can be read into R by creating separate files with a .tre file extension.

These supertrees contained multiple polytomies, which can skew biodiversity estimation by extending the durations of poorly resolved lineages to a more basal position than they should occupy, and therefore incorrectly inflating biodiversity in older time bins (Wagner 2000). To combat this issue, we applied three different methods of resolving polytomies (see main text for details), and calculated PDE as the mean of the results using each of these. In instances where not all species of a multispecific genus have previously been included in a phylogeny, we incorporate these but create a polytomy for all inclusive species. However, if there are only two species then we include them as sister taxa.

***Crocodyliformes***

For crocodyliform taxa outside of Mesoeucrocodylia, we follow Pol *et al*. (2004: fig. 5) as a starting point. The three species of *Hsisosuchus* (*H. chowi*, *H. chungkingensis*, and *H. dashanpuensis*) are resolved according to Halliday *et al*. (2015). Fiorillo and Calvo (2007) was used as the basis to position several basal mesoeucrocodylian taxa: along with *Zosuchus*, *Shantungosuchus* (comprising *S. chuhsienensis* and *S. hangjinensis*) and *Sichuanosuchus* (*S. huidongensis* and *S. shuhanensis*) were placed as sister taxa to *Fruitachampsa*. The position of *Shartegosuchus* was based on Clark (2011), placing it as the sister taxon to *Fruitachampsa*. Additionally, both *Gobiosuchus* (comprising two species: *G. kielanae* and *G. parvus*) and *Protosuchus* (comprising three species: *P. micmac*, *P. haughtoni* and *P. richardsoni*) were forced into multi-specific polytomies. *Entradasuchus* is included within this assemblage of ‘protosuchian’-grade taxa, in an unresolved basal position, based on Hunt and Lockley (1995). Both *Orthosuchus* and *Edentosuchus* are included as successive sister taxa to *Protosuchus* based on Pol *et al*. (2004). *Dianosuchus* was placed within Protosuchia based on discussion in Peng (1996). *Platyognathus* was included in the unresolved polytomy at the base of Crocodyliformes due to its ‘protosuchian’ relationships with *Protosuchus* and *Shantungosuchus* outlined in Wu and Sues (1996). We used this position to place other shartegosuchids, *Kyasuchus* and *Nominosuchus*, in a basal polytomy with *Shartegosuchus*. *Zaraasuchus* was placed as the sister taxon to *Gobiosuchus*, based on Pol and Norell (2004: fig. 11). For the position of Mesoeucrocodylia, we follow Pol *et al*. (2004). Contrary to Adams (2014), this excludes taxa such as *Hsisosuchus* and *Fruitachampsa* as basal mesoeucrocodylians. This decision is based on the fact that Pol *et al*. (2004) sample a much broader range of basal crocodyliform taxa, and therefore we have increased confidence in their placement of these taxa. Leardi *et al*. (2015) found *Microsuchus* to be unstable, but positioned in an resolved position outside of Notosuchia and Neosuchia within Mesoeucrocodylia, a position which we followed here.

***Notosuchia***

For Notosuchia, we used the cladogram from Pol *et al*. (2014: fig. 31). This includes Uruguaysuchidae, Peirosauridae, Sphagesauridae and Baurusuchidae as subclades, with the latter two placed within Ziphosuchia. *Neuquensuchus* was repositioned from a basal crocodyliform to a ziphosuchian based on Leardi *et al*. (2015: fig. 8), and placed with *Pakasuchus* and *Malawisuchus*, which we collapsed into a polytomy. These taxa comprise a basal assemblage of ziphosuchians, along with *Libycosuchus* and *Simosuchus* (Pol *et al*., 2014). We follow Pol *et al*. (2014) for the position of *Stolokrosuchus*, retaining it as a notosuchian (and sister taxon to Peirosauridae + Mahajungasuchidae) instead of the basal-most neosuchian as proposed by Adams (2014). *Doratodon ibericus* and *Doratodon carcharidens* are placed within Ziphosuchia, one step higher than *Libycosuchus*, following Company *et al*. (2005).

**Mahajangasuchidae:** *Mahajangasuchus* and *Kaprosuchus* are placed as sister taxa to Peirosauridae, comprising Mahajangasuchidae.

**Peirosauridae:** Peirosauridae was placed within Notosuchia, together with Uruguaysuchidae + Mahajangasuchidae + *Stolokrosuchus* comprising the sister group to Ziphosuchia. We revised the internal relationships of Peirosauridae (Pol *et al*., 2014) to conform to that of Sertich and O’Connor (2014). Note that this also includes the ‘trematochampsid’ taxon *Trematochampsa.* Unfortunately, this placement of *Trematochampsus* renders the phylogenetic affinities of all other ‘trematochampsids’ as questionable, and therefore we exclude members previously assigned to this group from our supertree, pending further analysis of their taxonomy and phylogenetics. *Barcinosuchus* is placed in a polytomy within Peirosauridae and closely related taxa (including *Lomasuchus* and *Montealtosuchus*) based on discussion within Martinelli *et al*. (2012). *Peirosaurus* is placed in an unresolved position at the base of Peirosauridae based on discussion in Martinelli *et al*. (2012). *Pepesuchus* is also placed in an unresolved polytomy at the base of Peirosauridae, based on discussion in Campos *et al*. (2011).

**Uruguaysuchidae**: Pol *et al*. (2014) found *Araripesuchus* to be paraphyletic. *Araripesuchus rattoides* is placed in the existing polytomy between several species of *Araripesuchus* and *Anatosuchus* based on Sereno and Larsson (2009: fig. 43). *Uruguaysuchus* is included as the sister taxon to *Anatosuchus* + *Araripesuchus*, together comprising Uruguaysuchidae.

**Baurusuchidae:** Baurusuchidae is the sister clade to Sebecidae, which together comprise Sebecosuchia (Pol *et al*., 2014). *Pabwehshi* is placed at the base of Baurusuchidae in a polytomy with *Cynodontosuchus*, based on discussion provided in Wilson *et al*. (2001). *Gondwanasuchus* is placed as the sister taxon to all pissarachampsids and baurusuchines. *Aplestosuchus* is placed within Baurusuchidae, as the sister taxon to ‘*Baurusuchus*’ *albertoi* based on Godoy *et al*. (2014: fig. 9). *Wargosuchus* is placed as the sister taxon to *Pissarachampsa*, which together with *Campinasuchus* comprises Pissarachampsinae, which along with Baurusuchinae comprises Baurusuchidae (Godoy *et al*., 2014). *Pehuenchesuchus* is the most basal sebecosuchian according to Turner and Calvo (2005: fig. 5). Baurusuchids were resolved within Sebecosuchia by Company *et al*. (2005); as such we place them in a basal polytomy with *Pabweshi* and *Cynodontosuchus*.

**Sphagesauridae:** The internal relationships of Sphagesauridae and ‘advanced notosuchians’ are based on Pol *et al*. (2014: fig. 31). Together, these form the sister taxon to Sebecosuchia (to the exclusion of *Comahuesuchus* and *Chimaerasuchus*.

***Neosuchia***

Neosuchia and Notosuchia are sister taxa, and together comprise Mesoeucrocodylia (e.g., Adams, 2014). For Neosuchia, we used the cladogram from Adams (2014: fig. 13). Both species of *Laganosuchus* (*L. thaumastos* and *L. maghrebensis*) are placed within Neosuchia, outside of Eusuchia, and in a position basal to Bernissartiidae, in accordance with Sereno and Larsson (2009: fig. 43).

**Atoposauridae:** Atoposauridae are placed at the base of Neosuchia (Adams, 2014; Martin *et al*., 2014), and we follow Martin *et al*. (2010) for the internal relationships of this clade. For *Alligatorium*, we use the two species *A. meyeri* and *A. franconicum*, although the only specimens of the latter are lost to science. We also include the two species of *Alligatorellus*, based on Tennant and Mannion (2014). *Brillanceausuchus* (Michard *et al*., 1990) and *Karatausuchus* (Storrs and Efimov, 1976) have been considered to belong to Atoposauridae by some authors, but this has never been confirmed via phylogenetic analysis, and therefore we exclude them here.

**Goniopholididae:** The position of Goniopholididae is established using Adams (2014). The internal relationships of this clade follow Andrade *et al*. (2011). The “Hooley goniopholidid” is now named *Anteopthalmosuchus*, and the “Hulke goniopholidid” is *Hulkepholis* (Salisbury and Naish, 2011). *Sunosuchus thailandicus* was recombined recently as *Chalawan thailandicus* (Martin *et al*., 2014). *Goniopholis stovalli* is collapsed into a basal polytomy, as *Eutretauranosuchus* nests within *Sunosuchus* instead of being in a sister taxon relationship, as proposed by Adams (2014). *Denazinosuchus* is also placed in an unresolved basal position based on Andrade *et al*. (2011). *Goniopholis* is a problematic genus, as there are an additional eight species of this taxon not included in either Andrade *et al*. (2011) or Adams (2014), but with a lack of work on them meaning that they are retained in the Paleobiology Database as valid species. For now, we tentatively include each of these species of *Goniopholis* as part of a basal polytomy with *G. stovalli* and *Denazinosuchus*, pending future taxonomic revision. *Goniopholis paulistanus* is excluded as it is explicitly stated as a *nomen dubium* belonging to Neosuchia by Andrade *et al*. (2011). *Coelosuchus* is placed in a basal polytomy within Goniopholididae based on Williston (1906). Given the length of time that has passed since this assignment, this placement is regarded as extremely tentative. *Kanjasuchus* is included as a goniopholidid, according to Halliday *et al*. (2015). These authors recovered it as part of a polytomous assemblage, along with *Calsoyasuchus*, *Sunosuchus* and others. As such, we place it in a basal polytomy with these taxa along with *Entradasuchus*. These authors also considered *Turanosuchus* to be a *nomen dubium*, which we follow here. *Woodbinesuchus* is placed in a basal polytomy within Goniopholididae based on Lee (1997). *Vectisuchus* is placed as part of the basal polytomy within Goniopholididae based on Bronzati *et al*. (2012: fig. 3).

**Thalattosuchia:** For Thalattosuchia, we use the cladogram from Young *et al*. (2013a: fig. 15). Most recently, Wilberg (2015) recovered Thalattosuchia in a more basal position, as the sister group to all remaining crocodyliforms. However, this hypothesis has yet to be subject to further scrutiny, and we retain their position within Neosuchia, pending further analysis.

**Teleosauroidea:** Teleosauroidea is placed as the sister taxon to all other metriorhynchoids. Taxa that are not formally named (e.g., “Ricla crocodile” and “Mr Leeds Specimen”) are not included in our supertree. Those of questionable genus referral (e.g., “*Metriorhynchus*” *westermanni*) are included in their current taxonomic status as recorded within the Paleobiology Database (as of December, 2014). The internal relationships of Teleosauridae follow Young (2014: fig. 7). *Geosaurus araucaniensis* is placed in an unresolved basal position within Geosarini, based on its generic relationship with other species of *Geosaurus*. For *Machimosaurus*, we chose to consider just a single taxon to be valid, *Machimosaurus hugii* (following Martin *et al*. 2014), and not with two or more species(Young, 2014; Young *et al*., 2014). *Haematosaurus* is placed in an unresolved position at the base of Teleosauridae, based on Sauvage (1874). Given the length of time that has passed since this assignment, this placement is regarded as extremely tentative. *Peipehsuchus* is placed within Teleosauridae in an unresolved basal position based on discussion in Li (1993). *Pelagosaurus brongniarti* is placed as sister taxon to *Pelagosaurus typus* based on its generic affinity, within Teleosauridae. *Steneosaurus* is clearly a problematic taxon. According to the Paleobiology Database, there are currently 20 valid species within this genus. Making a taxonomic statement about each of these taxa is beyond the scope of the present study. However, it is obvious that this taxon is in need of a comprehensive taxonomic reappraisal. For the purposes of the present study, we place all taxa not already included by Young (2014) in a generic polytomy at the base of Teleosauridae. We note caution that doing this for such a large number of unstable species is likely to create error in our phylogenetic diversity estimates, and therefore Middle and Late Jurassic diversity should be assessed at both the genus and species level. *Teleosaurus* suffers from similar taxonomic issues to *Steneosaurus* and *Goniopholis*. We include the additional six species in a polytomy with *Teleosaurus cadomensis*, as the sister taxon to *Platysuchus*.

**Metriorhynchoidea:** The node comprising the last common ancestor of *Pelagosaurus* and *Metriorhynchus* is taken as the point to attach Metriorhynchoidea of Young *et al*. (2013a). *Metriorhynchus* is a paraphyletic taxon and clearly in need of taxonomic revision. *M. littoreus, M. moreli, and M. palpebosus*, were placed in an unresolved position at the base of Metriorhynchidae, based on their generic affinity. *Aggiosaurus* is placed at the base of Geosaurini following Young *et al*. (2012). Both *Cricosaurus gracilis* and *Cricosaurus lithographicus* are placed within Metriorhynchidae based on Herrera *et al*. (2013). *Cricosaurus* species were arranged to conform to this relatively well-resolved topology, instead of representing a polytomy as in Young *et al*. (2013a). *Maledictosuchus* is placed at the base of Rhacheosaurini according to Parilla-Bel *et al*. (2013: fig. 17). *Purranisaurus* is placed as the sister taxon to Geosaurini within Metriorhynchidae based on Cau and Fanti (2011: fig. 6). *Suchodus* is placed at the base of Geosaurinae according to Young *et al*. (2009: fig. 2), as the sister taxon to all other geosaurines. *Tyrannoneustes* is placed as the sister taxon to the *Torvoneustes* species, as part of the polytomy within Geosaurini, based on of Young *et al*. (2013b: fig. 21).

**Pholidosauridae:** Pholidosauridae + Dyrosauridae is the sister taxon to Thalattosuchia, which together comprise the sister clade to Goniopholididae and other higher neosuchians (including Eusuchia), following Adams (2014). According to Martin *et al*. (2014), *Pholidosaurus* constitutes the most basal member of Pholidosauridae, and comprises four species which are unresolved with respect to each other (*P. decipiens, P. meyeri, P. purbeckensis* and *P. schaumbergensis*). Similarly, *Terminonaris* includes the two species *T. browni* and *T. robusta*, *Sarcosuchus* includes *S. hartti* and *S. imperator*, and *Elosuchus* includes *E. cherifiensis* and *E. felixi*. We position *Chalawan* in a polytomy with *Elosuchus* and *Sarcosuchus*, as in Martin *et al*. (2014), which also collapses *Terminonaris, Oceanosuchus*, and *Meridiosaurus* into this polytomy.

**Dyrosauridae:** Dyrosauridae is placed as the sister group to Pholidosauridae. The position of this group is still uncertain within ‘Tethysuchia’. *Chenanisuchus* is placed as the sister taxon to *Dyrosaurus*, following Jouve *et al*. (2005).

**Bernissartiidae:** *Koumpiodontosuchus* is placed as sister taxon to *Bernissartia* based on Sweetman *et al*. (2015). *Khoratosuchus* is placed as sister taxon to *Bernissartia* and *Koumpiodontosuchus*, outside of Paralligatoridae and Eusuchia, based on Lauprasert *et al*. (2009). Note that this topology places Bernissartiidae outside of Eusuchia.

**Susisuchidae:** *Susisuchus*, comprising the two species *S. anatoceps* and *S. juaguaribensis*, are placed according to Young *et al*. (2012: fig. 26), who found them to be outside of Eusuchia as the sister taxon to *Isisfordia*, a position recently confirmed by Turner and Pritchard (2015).

**Eusuchia:** Eusuchia follows Holliday and Gardner (2012: fig. 9), and is positioned as the sister taxon to Paralligatoridae following Adams (2014), and more recently Turner (2015). *Allodaposuchus* is placed within Eusuchia as the sister taxon to *Hylaeochampsa* (see below) following Adams (2014) and Puértolas-Pascual *et al*. (2014). *Aigialosuchus* is placed as the basalmost member of Eusuchia, apart from *Isisfordia*, due to its uncertain position within this clade (Martin and Delfino, 2010). *Gilchristosuchus* is placed as the sister taxon to Eusuchia, following Wu and Brinkmann (1993). This position also places it outside of Paralligatoridae, and more derived than *Bernissartia*. The ‘*Shamosuchus*’ complex was historically considered to include ten species. Recently, Turner (2015) reviewed the taxonomy of this genus, finding only *Shamosuchus djadochtaensis*, *S. gradilifrons*, and *S. major* to be valid species. However, Turner (2015) transferred the latter two species to their own genus, *Paralligator*. *Shamosuchus sungaricus*, *S. borealis*, and *S. karakalpakensis* are considered to be *nomina dubia*, and *S. ancestralis, S. ulgicus, S. tersus*, and *S. ulanicus* are considered by Turner (2015) to be junior subjective synonyms of *S. gradilifrons*.

**Hylaeochampsidae:** For Hylaeochampsidae, we used Puértolas-Pascual *et al*. (2014), which includes the taxa *Acynodon*, *Hylaeochampsa, Iharkutosuchus, Pachycheilosuchus* and *Pietraroiasuchus*. *Acynodon* *lopezi* is added to the genus *Acynodon* to form a polytomy. The group is placed as the sister taxon to *Allodaposuchus* following Puértolas-Pascual *et al*. (2014).

***Crocodylia***

The positions of Crocodylia, Gavialoidea and Aegyptosuchidae follow Holliday and Gardner (2012). Along with *Thoracosaurus macrorhynchus*, the other three species of *Thoracosaurus* (*T. bahiensis, T. borissai* and *T. neocesariensis*) are placed in a polytomy in a position more derived than *Eothoracosaurus* at the base of Gavialoidea. *Ocepesuchus* is placed as the sister taxon to *Thoracosaurus* within Gavialoidea, based on Jouve *et al*. (2008: fig. 5). *Arenysuchus* is placed within Crocodylia basal to *Eothoracosaurus*, based on its position within Crocodyloidea in Puértolas *et al*. (2011: fig. 5), a group which is relatively under-sampled in the present study due its Late Cretaceous origins. *Albertochampsa langstoni* is placed as the sister taxon to *Brachychampsus* following Norell *et al*. (1994). *Deinosuchus* is placed in a more derived position than *Leidyosuchus* within Brevirostres according to Erickson and Brochu (1999). Its two species, *D. riograndensis* and *D. rugosus*, are retained as sister taxa to each other based on generic affinity. *Massaliasuchus* is placed in a basal polytomy with *Leidyosuchus* within Brevirostres based on Martin and Buffetaut (2008). Five Cretaceous species attributed to *Crocodylus* are also still considered as valid within the database: *C. blavieri, C. humilis, C. proavus, C. selaslophensis,* and *C. vetustus*. However, these taxa are almost definitely invalid (Mannion *et al*., 2015), with *Crocodylus* more likely originating in the Miocene, and therefore we exclude them.

***Excluded taxa due to unknown or uncertain affinities***

*Amargasuchus minor*, *Artzosuchus brachicephalus,* *Baharijodon carnosauroides, Barreirosuchus franciscoi, Bottosaurus harlani, Brachydectes major, Brasileosaurus pachecoi, Caririsuchus camposi, Chiayusuchus cingulatus, Coringasuchus anisodontis, Dakotasuchus kingi, Dianchungosaurus lufegnesis, Diplosaurus felix, Eopneumatosuchus colberti, Hadangsuchus acerdentis, Heterosuchus valdensis, Hoplosuchus kayi, Ischyrochampsa meridionalis, Itasuchus jesuinoi, Kemkemia auditorei, Leiokarinosuchus brookensis, Lisboasaurus estesi, Lisboasaurus mitracostatus*, *Lusitanisuchus mitracostatus, Megalosaurus mersensis, Miadanasuchus oblita, Musturzabalsuchus buffetauti, Neustosaurus gigondarum, Notochampsa istedana, Pinacosuchus mantiensis, Prodiplocynodon langi, Stomatosuchus inermis, Stromerosuchus aegypticus*, *Tadzhikosuchus macrodentis, Tagarosuchus kulemzini, Unasuchus reginae, Zholsuchus procevus, Zhyrasuchus angustifrons*.

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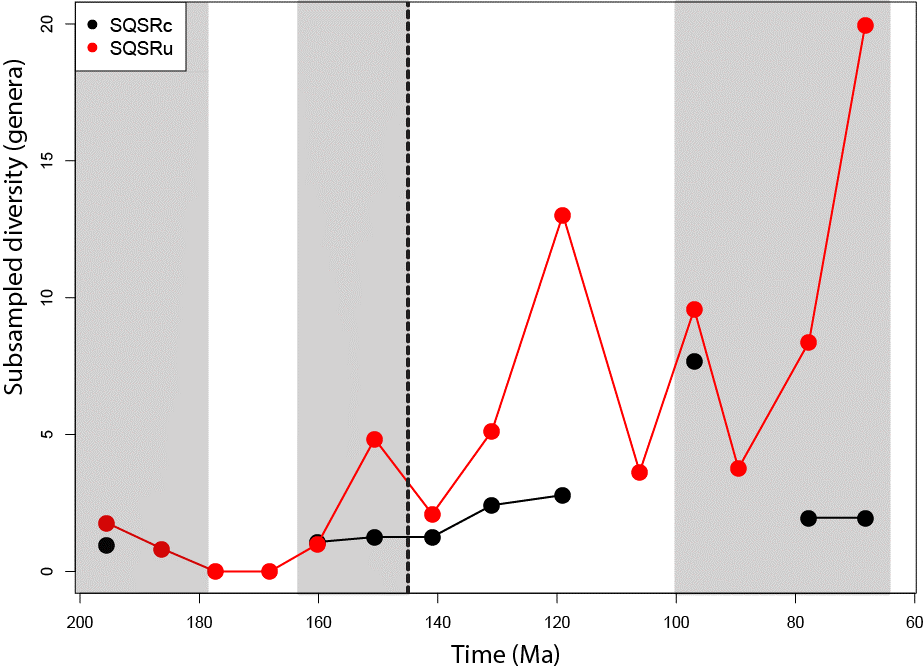
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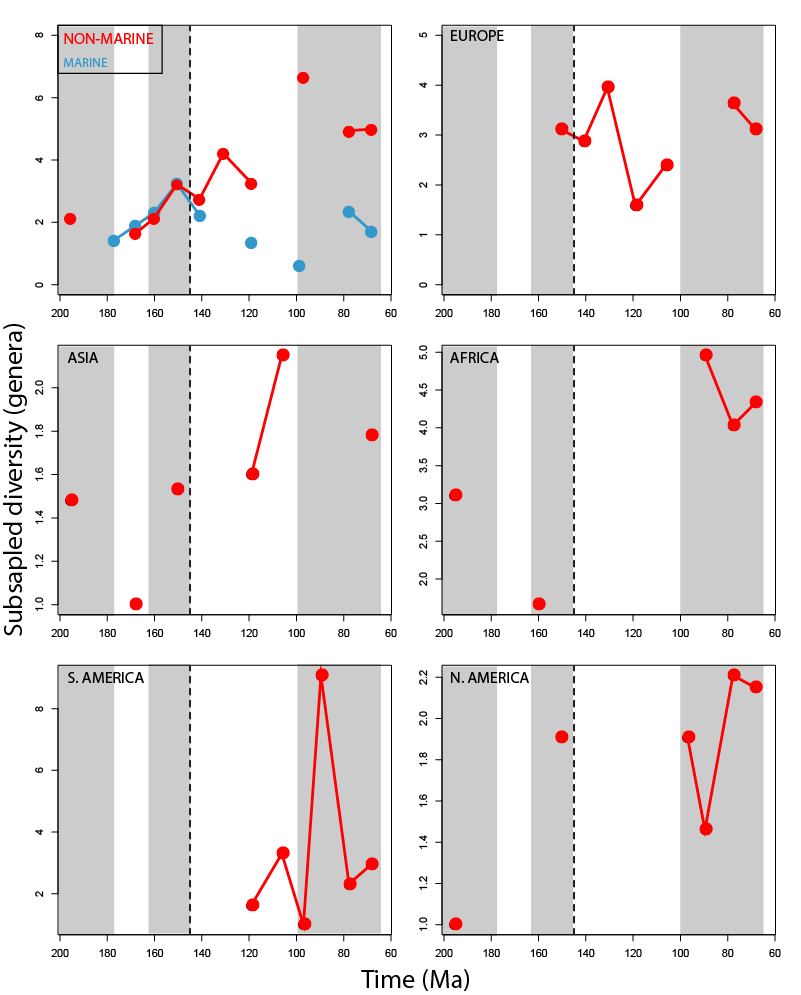
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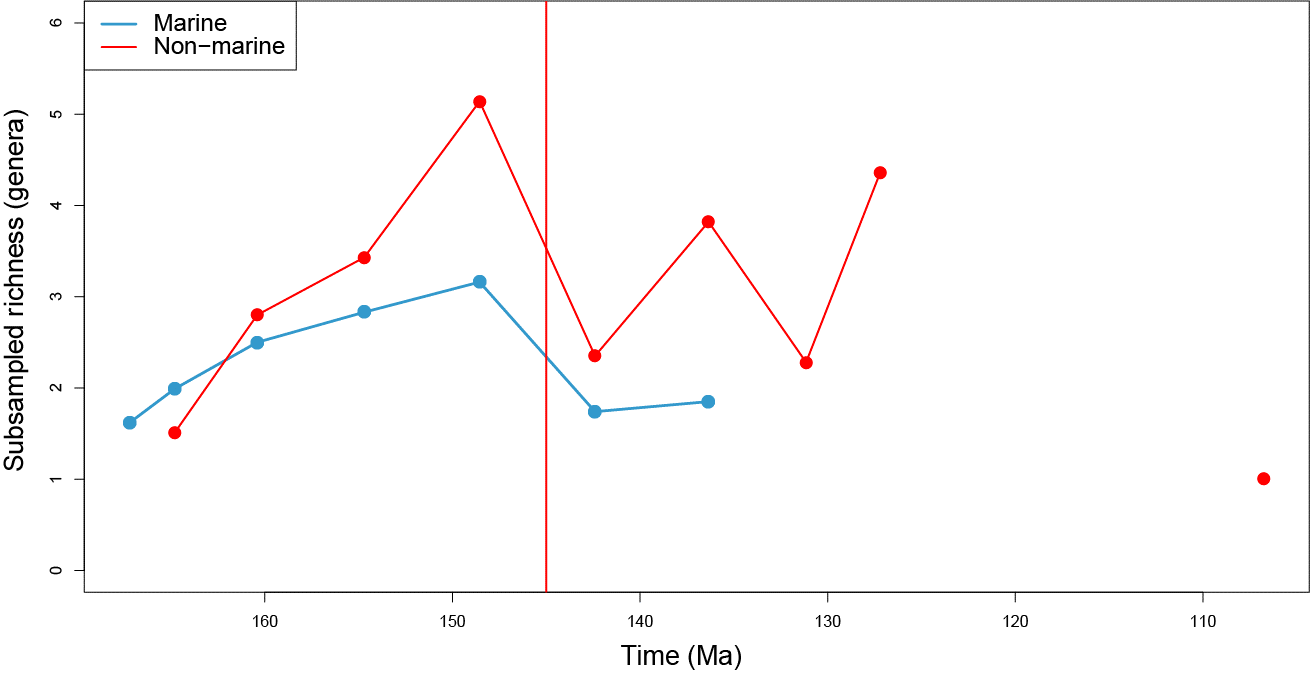
**Supplementary Figure 1.** Palaeolatitudinal distribution of all crocodyliform occurrences assigned to genera through the Jurassic and Cretaceous. The Jurassic/Cretaceous boundary (145 Ma) is highlighted in red. Palaeolatitudes are based on Scotese rotations, and acquired from the Paleobiology Database (SI 2).



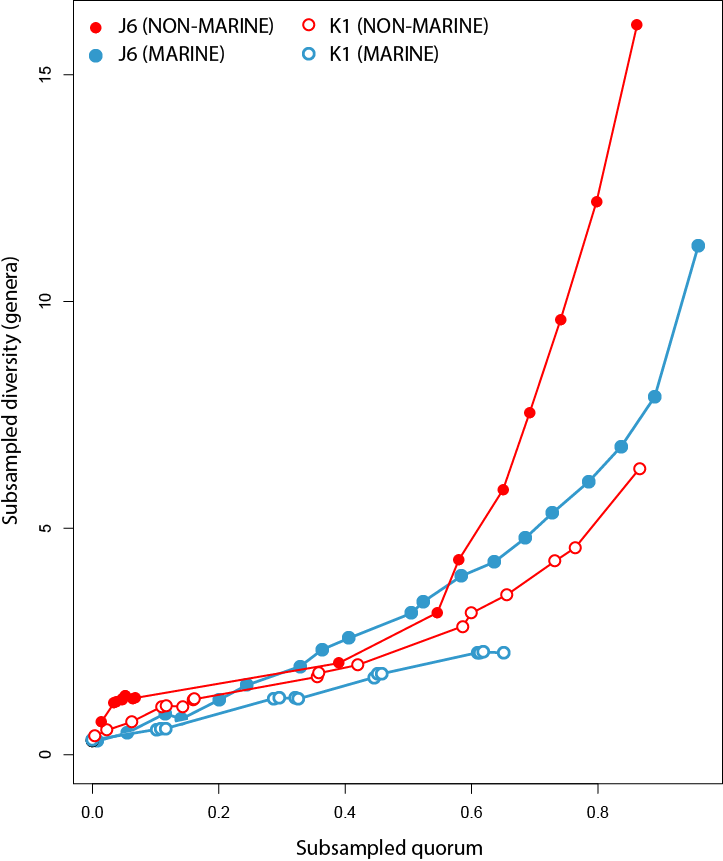
**Supplementary Figure 2.** Comparison between SQSRc and SQSRu for global terrestrial crocodyliforms.



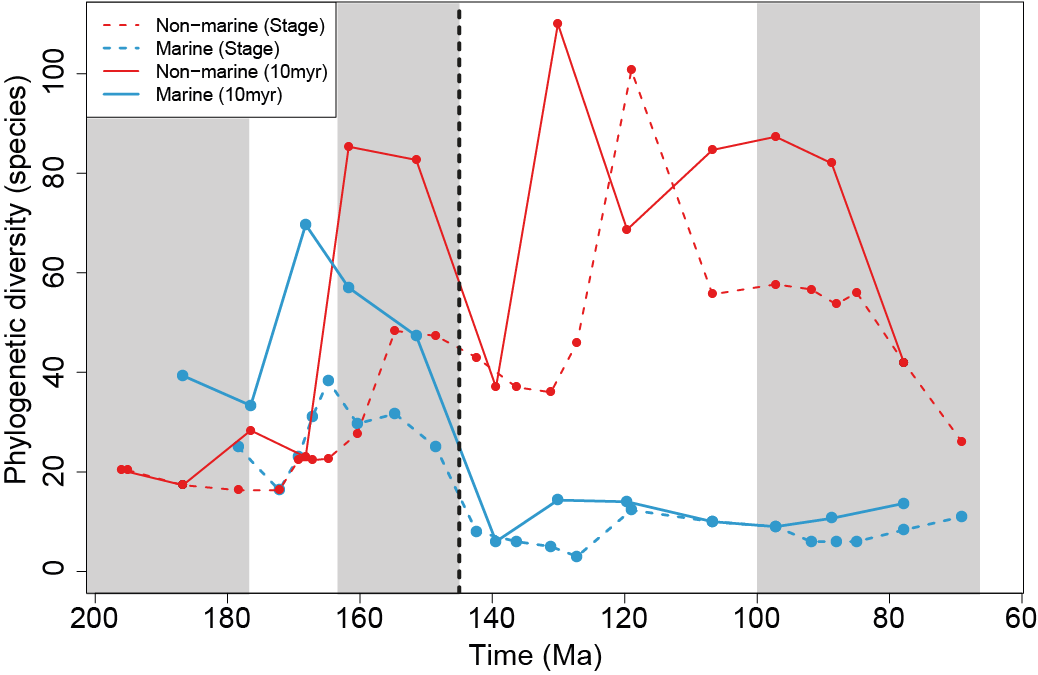
**Supplementary Figure 3.** Results obtained using SQSPt on a global and palaeocontinental level.



**Supplementary Figure 4.** Results obtained using SQSRs for marine and non-marine taxa.



**Supplementary Figure 5.** Comparison between subsampled quorum level and subsampled richness in the time bins either side of the J/K boundary.



**Supplementary Figure 6.** Phylogenetic diversity estimate (PDE) at the species level for marine and non-marine sub-groups.

***Supertrees in machine readable notation***

To read each one of these trees into R, copy them into a new text file, and append the file extension to .tre. See main text for more details.

*Genus tree*

(((((((((((Shamosuchus,Paralligator),Wannchampsus),Batrachomimus),Rugosuchus)Paralligatoridae,(Gilchristosuchus,(Susisuchus,(((((((Eothoracosaurus,(Thoracosaurus,Ocepesuchus))Gavialoidea,Arenysuchus),(((Stangerochampsa,(Albertochampsa,Brachychampsa)),Deinosuchus),Massaliasuchus,Leidyosuchus)Brevirostres),((Aegyptosuchus,Aegisuchus)Aegyptosuchidae,Borealosuchus))Crocodylia,(Allodaposuchus,(((Pachycheilosuchus,Pietraroiasuchus),Iharkutosuchus),(Acynodon,Hylaeochampsa))Hylaeochampsidae)),Aigialosuchus),Isisfordia)Eusuchia))),(Laganosuchus,(Khoratosuchus,(Koumpiodontosuchus,Bernissartia)))),((Calsoyasuchus,(Eutretauranosuchus,Sunosuchus)),Denazinosuchus,Goniopholis,Woodbinesuchus,Coelosuchus,Vectisuchus,(Siamosuchus,(Nannosuchus,(Hulkepholis,Anteophthalmosuchus))))Goniopholididae),Paluxysuchus),((((((Dyrosaurus,Chenanisuchus),Rhabdognathus),Hyposaurus),Sokotosuchus),(Pholidosaurus,(Terminonaris,Sarcosuchus,Oceanosuchus,Elosuchus,Chalawan,Meridiosaurus))Pholidosauridae),((Pelagosaurus,(Teleidosaurus,(Eoneustes,((((((Geosaurus,Dakosaurus,Aggiosaurus,Plesiosuchus,(Tyrannoneustes,Torvoneustes))Geosaurini,Purranisaurus),Neptunidraco),Metriorhynchus),Suchodus)Geosaurinae,(Gracilineustes,(Maledictosuchus,(Cricosaurus,Rhacheosaurus))Rhacheosaurini))Metriorhynchidae))),((Teleosaurus,Platysuchus),Peipehsuchus,Steneosaurus,Haematosaurus,Machimosaurus)Teleosauridae)Thalattosuchia)),Microsuchus,(((((Alligatorium,Alligatorellus),Montsecosuchus),Atoposaurus),Theriosuchus)Atoposauridae,((Candidodon,(Libycosuchus,(Simosuchus,(Doratodon,((Malawisuchus,Pakasuchus,Neuquensuchus),(((((((((Baurusuchus,Aplestosuchus),Campinasuchus),Stratiotosuchus),(Wargosuchus,Pissarrachampsa)),Gondwanasuchus),Pehuenchesuchus,Pabwehshi,Cynodontosuchus)Baurusuchidae,Comahuesuchus),Chimaerasuchus),(Morrinhosuchus,(Notosuchus,((Mariliasuchus,Labidiosuchus),((Yacarerani,Adamantinasuchus),(Caipirasuchus,(Sphagesaurus,(Armadillosuchus,Caryonosuchus))))Sphagesauridae))))))))Ziphosuchia),(((Araripesuchus,Anatosuchus),Uruguaysuchus)Uruguaysuchidae,((Kaprosuchus,Mahajangasuchus),(Gasparinisuchus,Pepesuchus,Barcinosuchus,Peirosaurus,Lomasuchus,(Montealtosuchus,(Trematochampsa,(Hamadasuchus,Rukwasuchus,Stolokrosuchus))))Peirosauridae)))Notosuchia)Neosuchia)Mesoeucrocodylia,(((Protosuchus,Edentosuchus),Orthosuchus),Kansajsuchus,Platyognathus,Entradasuchus,((Gobiosuchus,Zaraasuchus),(((Shantungosuchus,Sichuanosuchus),Zosuchus),((Fruitachampsa,(Nominosuchus,Shartegosuchus,Kyasuchus)),Hsisosuchus)))))Crocodyliformes;

*Species tree*

((((((((((Shamosuchus\_djadochtaensis,Paralligator\_gradilifrons,Paralligator\_major),Wannchampsus\_kirpachi),Batrachomimus\_pastosbonensis),Rugosuchus\_nonganensis)Paralligatoridae,(Gilchristosuchus\_palatinus,((Susisuchus\_jaguaribensis,Susisuchus\_anatoceps),(((((((Eothoracosaurus\_mississippiensis,((Thoracosaurus\_neocesariensis,Thoracosaurus\_bahiensis,Thoracosaurus\_borissiaki,Thoracosaurus\_macrorhynchus),Ocepesuchus\_eoafricanus))Gavialoidea,Arenysuchus\_gascabadiolorum),(((Stangerochampsa\_mccabei,(Albertochampsa\_langstoni,Brachychampsa\_montana)),(Deinosuchus\_riograndensis,Deinosuchus\_rugosus)),Massaliasuchus\_affuvelensis,Leidyosuchus\_canadensis)Brevirostres),((Aegyptosuchus\_peyeri,Aegisuchus\_witmeri)Aegyptosuchidae,(Borealosuchus\_formidabilis,Borealosuchus\_sternbergii)))Crocodylia,((Allodaposuchus\_subjuniperus,Allodaposuchus\_precedens),(((Pachycheilosuchus\_trinquei,Pietraroiasuchus\_ormezzanoi),Iharkutosuchus\_makadii),(Acynodon\_lopezi,Acynodon\_iberoccitanus,Acynodon\_adriaticus,Hylaeochampsa\_vectiana))Hylaeochampsidae)),Aigialosuchus\_villandensis),Isisfordia\_duncani)Eusuchia))),((Laganosuchus\_thaumastos,Laganosuchus\_maghrebensis),(Khoratosuchus\_jintasakuli,(Koumpiodontosuchus\_aprosdokiti,Bernissartia\_fagesii)))),((Calsoyasuchus\_valliceps,((Sunosuchus\_junggarensis,Eutretauranosuchus\_delfsi),Sunosuchus\_miaoi,Sunosuchus\_shunanensis)),Denazinosuchus\_kirtlandicus,Goniopholis\_felchi,Goniopholis\_affinis,Goniopholis\_undidens,Goniopholis\_lucasii,Woodbinesuchus\_byersmauricei,Coelosuchus\_reedii,Vectisuchus\_leptognathus,Goniopholis\_phuwiangensis,Goniopholis\_brodiei,Goniopholis\_crassidens,Goniopholis\_stovalli,(Siamosuchus\_phuphokensis,(Nannosuchus\_gracilidens,(((Hulkepholis\_plotos,Hulkepholis\_willetti),(Anteophthalmosuchus\_hooleyi,Anteophthalmosuchus\_esuchae)),(Goniopholis\_baryglyphaeus,(Goniopholis\_kiplingi,Goniopholis\_simus))))))Goniopholididae),Paluxysuchus\_newmani),((((((Dyrosaurus\_phosphaticus,Chenanisuchus\_lateroculi),Rhabdognathus\_keiniensis),Hyposaurus\_rogersii),Sokotosuchus\_ianwilsoni),((Pholidosaurus\_decipiens,Pholidosaurus\_meyeri,Pholidosaurus\_purbeckensis,Pholidosaurus\_schaumburgensis),((Terminonaris\_browni,Terminonaris\_robusta),(Sarcosuchus\_hartti,Sarcosuchus\_imperator),Oceanosuchus\_boecensis,(Elosuchus\_felixi,Elosuchus\_cherifiensis),Chalawan\_thailandicus,Meridiosaurus\_vallisparadisi))Pholidosauridae),(((Pelagosaurus\_typus,Pelagosaurus\_brongniarti),(Teleidosaurus\_calvadosii,((Eoneustes\_bathonicus,Eoneustes\_gaudryi),((((((((Geosaurus\_grandis,Geosaurus\_giganteus),Geosaurus\_lapparenti),Geosaurus\_araucaniensis,(Dakosaurus\_andiniensis,Dakosaurus\_maximus),Aggiosaurus\_nicaeensis,Plesiosuchus\_manselii,(Tyrannoneustes\_lythrodectikos,(Torvoneustes\_coryphaeus,Torvoneustes\_carpenteri)))Geosaurini,Purranisaurus\_potens),Metriorhynchus\_brachyrhynchus,Neptunidraco\_ammoniticus),(Metriorhynchus\_casamiquelai,Metriorhynchus\_westermanni)),Suchodus\_durobrivensis)Geosaurinae,(Metriorhynchus\_palpebosus,Metriorhynchus\_littoreus,Metriorhynchus\_moreli,(((Metriorhynchus\_geoffroyii,Metriorhynchus\_hastifer),Metriorhynchus\_superciliosus),((Gracilineustes\_acutus,Gracilineustes\_leedsi),(Maledictosuchus\_riclaensis,(((Cricosaurus\_saltillensis,Cricosaurus\_elegans,(Cricosaurus\_gracilis,Cricosaurus\_vignaudi,(Cricosaurus\_araucanensis,Cricosaurus\_macrospondylus,Cricosaurus\_lithographicus))),Cricosaurus\_suevicus),Rhacheosaurus\_gracilis))Rhacheosaurini))))Metriorhynchidae))),(((Teleosaurus\_cadomensis,Teleosaurus\_chapmani,Teleosaurus\_geoffroyi,Teleosaurus\_sublidens,Teleosaurus\_picteti,Teleosaurus\_temporalis,Teleosaurus\_megarhinus),Platysuchus\_multiscrobiculatus),Peipehsuchus\_teleorhinus,Steneosaurus\_boutilieri,(Steneosaurus\_brevidens,Steneosaurus\_brevior,Steneosaurus\_brevirostris,Steneosaurus\_durobrivensis,Steneosaurus\_larteti,Steneosaurus\_morinicus,Steneosaurus\_gerthi,Steneosaurus\_heberti,Steneosaurus\_jugleri,Steneosaurus\_pictaviensis,Steneosaurus\_dasycephalus,Steneosaurus\_rudis,Steneosaurus\_subulidens,Steneosaurus\_gracilirostris,Steneosaurus\_intermedius),Haematosaurus\_lanceolatus,(((Machimosaurus\_hugii,Steneosaurus\_edwardsi),(Steneosaurus\_megistorhynchus,Steneosaurus\_leedsi)),Steneosaurus\_bollensis))Teleosauridae)Thalattosuchia)),Microsuchus\_schilleri,((((((Alligatorium\_meyeri,Alligatorium\_franconicum),(Alligatorellus\_bavaricus,Alligatorellus\_beaumonti)),Montsecosuchus\_depereti),(Atoposaurus\_jourdani,Atoposaurus\_oberndorferi)),((Theriosuchus\_ibericus,Theriosuchus\_sympiestodon),(Theriosuchus\_grandinaris,(Theriosuchus\_pusillus,Theriosuchus\_guimarotae))))Atoposauridae,((Candidodon\_itapecuruense,(Libycosuchus\_brevirostris,(Simosuchus\_clarki,((Doratodon\_carcharidens,Doratodon\_ibericus),((Malawisuchus\_mwakasyungutiensis,Pakasuchus\_kapilimai,Neuquensuchus\_universitas),((((((((((Baurusuchus\_albertoi,Aplestosuchus\_sordidus),(Baurusuchus\_salgadoensis,Baurusuchus\_pachecoi)),Campinasuchus\_dinizi),Stratiotosuchus\_maxhechti),(Wargosuchus\_australis,Pissarrachampsa\_sera)),Gondwanasuchus\_scabrosus),Pehuenchesuchus\_enderi,Pabwehshi\_pakistanensis,Cynodontosuchus\_rothi)Baurusuchidae,Comahuesuchus\_brachybuccalis),Chimaerasuchus\_paradoxus),(Morrinhosuchus\_luziae,(Notosuchus\_terrestris,((Mariliasuchus\_robustus,Mariliasuchus\_amarali,Labidiosuchus\_amicum),((Yacarerani\_boliviensis,Adamantinasuchus\_navae),((Caipirasuchus\_paulistanus,Caipirasuchus\_stenognathus),((Sphagesaurus\_huenei,Sphagesaurus\_montealtensis),(Armadillosuchus\_arrudai,Caryonosuchus\_pricei))))Sphagesauridae))))))))Ziphosuchia),(((Araripesuchus\_wegeneri,Araripesuchus\_rattoides,Araripesuchus\_tsangatsangana,Anatosuchus\_minor),(((Araripesuchus\_patagonicus,(Uruguaysuchus\_aznarezi,Uruguaysuchus\_terrai)),Araripesuchus\_gomesii),Araripesuchus\_buitreraensis))Uruguaysuchidae,((Kaprosuchus\_saharicus,Mahajangasuchus\_insignis),(Gasparinisuchus\_peirosauroides,Pepesuchus\_deiseae,Barcinosuchus\_gradilis,Peirosaurus\_tormini,Lomasuchus\_palpebrosus,((Montealtosuchus\_arrudacamposi,Uberabasuchus\_terrificus),(Trematochampsa\_taqueti,(Hamadasuchus\_rebouli,Rukwasuchus\_yajabalijekundu,Stolokrosuchus\_lapparenti))))Peirosauridae)))Notosuchia)Neosuchia)Mesoeucrocodylia,((((Protosuchus\_haughtoni,Protosuchus\_richardsoni,Protosuchus\_micmac),Edentosuchus\_tienshanensis),Orthosuchus\_stormbergi),Kansajsuchus\_extensus,Platyognathus\_hsui,Entradasuchus\_spinosus,(((Gobiosuchus\_parvus,Gobiosuchus\_kielanae),Zaraasuchus\_shepardi),((((Shantungosuchus\_chuhsienensis,Shantungosuchus\_hangjinensis),(Sichuanosuchus\_huidongensis,Sichuanosuchus\_shuhanensis)),Zosuchus\_davidsoni),((Fruitachampsa\_callisoni,(Nominosuchus\_matutinus,Shartegosuchus\_asperopalatum,Kyasuchus\_saevi)),(Hsisosuchus\_chungkingensis,(Hsisosuchus\_chowi,Hsisosuchus\_dashanpuensis)))))))Crocodyliformes;