Origin, Diversity and Evolution of the Most Common Crocodylians of Europe in the Paleogene Greenhouse Context

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ORIGIN, DIVERSITY AND EVOLUTION OF THE MOST COMMON CROCODYLIANS OF EUROPE IN THE PALEOGENE GREENHOUSE CONTEXT

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“*the alligator-skin drums are resounding*”

- From Shih-King, translated from the traditional Chinese by Fauvel, 1879

“*I refer to the* Diplocynodon *species as the “rats” of the tertiary crocodile world*.”

- Rauhe M., 1995

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EXTENDED ABSTRACT

Crocodylia is an iconic reptile vertebrate group whose extant representatives inhabit most of the continental land masses. Modern Europe is a notable exception, as no crocodyliform populations are found in this region of the world, which is greatly contrasting with the past biogeographical history of the group. The early Cenozoic, specifically, shows an exceptionally diverse crocodyliform fauna mainly dominated by alligatoroids. Morphological disparity, complex biogeography or even stratigraphically young age of the earliest-branching forms have been difficult to reconcile with consistently inferred phylogenetic relationships to alligatorids, an otherwise freshwater and small-bodied group in the Paleogene. The European putative alligatoroid genus *Diplocynodon* is recognised as the most common and best sampled crocodyliform in the Paleogene of Europe, as demonstrated by the extensive fossil record spread across multiple occurrences throughout the Cenozoic. This record hints at an exceptional survivorship of the genus from the late Paleocene to the middle Miocene, that perplexes the comprehensive investigation of the taxon systematics and taxonomy, indication of an overdue revision.

The thesis presents an expanded phylogeny with increased spatiotemporally coherence that reinterprets *Diplocynodon* spp. (recovered closely related to the North American *Borealosuchus*) as well as the North American *Deinosuchus* spp. and *Leidyosuchus canadensis* as stem-group crocodylians. The novel topology elucidates the evolution of osmoregulation in Crocodylia and its close relatives by inferring plesiomorphic saltwater tolerance for *Deinosuchus* and the crown-group, and secondary loss already in stem-group alligatorids. Divergence of Alligatoroidea coincided with extreme mid-Cretaceous sea level highs and the distribution of *Deinosuchus* across the American Western Interior Seaway can be best explained by marine dispersal. Phylogenetic body-length analysis using a head-width proxy reveals phyletic dwarfism early in alligatoroid evolution and a reasonable total length estimate for the most complete specimen of *Deinosuchus riograndensis*. Gigantism in crocodyliforms is suggested as being correlated with high-productive extensive aquatic ecosystems in the present and in the past.

The second and third chapters tackle the complex ingroup taxonomy of *Diplocynodon*. The diagnoses of currently accepted *Diplocynodon* species commonly include shared and/or irreproducible characters, hampering specific delimitations. Based on the review of all currently known species, the first taxonomic revision of the group since its inclusion in modern phylogenetic works is presented. An identification key to assist researchers with the identification of the valid species is additionally provided. Furthermore, the present work quantitatively reviews the state of the entire fossil record of *Diplocynodon* (based on two openly available databases) and discusses the waste-basket status of the taxon with respect to better taxonomical practices. Within *Diplocynodon*, the Eocene species *Diplocynodon darwini* Ludwig, 1877 has the largest sample in the Paleogene period, consisting of tens of complete well-preserved specimens, but yet critically lacks a detailed osteological description. The taxon is here redescribed for the first time based on type specimens collected 150 years ago and abundant excellently preserved material from the Messel and Geiseltal Konservat-Lagerstätten. Insights into the intraspecific variation in the taxon are provided in a detailed morphological description on the skeletal elements, including ontogenetic variation in temporally restricted populations. The complex ingroup taxonomy of *Diplocynodon* is furthermore explored and discussed through a review of previously published and newly retrieved phylogenies.

ERWEITERTE ZUSAMMENFASSUNG (DEUTSCH)

Kontinentaleuropa stellt heute eine Ausnahme dar, da es hier keine Krokodilpopulationen mehr gibt, was in starkem Kontrast zur biogeografischen Geschichte der Gruppe steht. Vor allem das frühe Känozoikum weist eine außergewöhnlich vielfältige Krokodilfauna auf, die hauptsächlich von Alligatoroiden dominiert wird. Morphologische Unterschiede, eine komplexe Biogeographie oder sogar ein stratigraphisch junges Alter der frühesten Formen lassen sich nur schwer mit den konsequent abgeleiteten phylogenetischen Verwandtschaftsverhältnissen der Alligatoroiden vereinbaren, die im Paläogen eine kleinwüchsige Süßwassergruppe waren. Die europäische mutmaßliche Alligatoroid Gattung *Diplocynodon* gilt als die häufigste und am besten untersuchte Gattung der Krokodyliforme im Paläogen Europas, welche durch umfangreiche Fossilienfunde an mehreren Fundorten im gesamten Känozoikum belegt ist. Diese Funde deuten auf ein außergewöhnlich langes Überleben der Gattung vom späten Paläozän bis zum mittleren Miozän hin, was die umfassende Untersuchung der Systematik und Taxonomie der Gattung vor ein Rätsel stellt, und ein deutlicher Hinweis auf eine längst überfällige Überarbeitung der Gattung ist.

Die Dissertation präsentiert eine erweiterte Phylogenie mit erhöhter räumlich-zeitlicher Kohärenz, die *Diplocynodon* spp. (eng verwandt mit der nordamerikanischen Gattung *Borealosuchus*) sowie die nordamerikanischen *Deinosuchus* spp. und *Leidyosuchus canadensis* als Stammgruppe der Crocodylia neu interpretiert. Die neue Topologie gibt Aufschluss über die Evolution der Osmoregulation bei Crocodylia und ihren nahen Verwandten, indem sie auf eine plesiomorphe Salzwassertoleranz bei *Deinosuchus* und der Kronengruppe sowie auf einen sekundären Verlust bereits bei den Stammgruppenvertretern der Alligatoriden schließen lässt. Die Divergenz der Alligatoroidea fiel mit dem extremen Hochstand des Meeresspiegels in der mittleren Kreidezeit zusammen, und die Verbreitung von *Deinosuchus* über das westliche Innere Amerikas lässt sich am besten über eine marine Ausbreitung erklären. Die phylogenetische Analyse der Körperlänge unter Verwendung eines Proxys für die Kopfbreite zeigt phyletischen Zwergwuchs zu Beginn der Alligatoroid-Evolution und bietet außerdem eine vernünftige Schätzung der Gesamtlänge für das vollständigste Exemplar von *Deinosuchus riograndensis*. Es wird angenommen, dass Gigantismus bei Krokodyliformes mit hochproduktiven, extensiven aquatischen Ökosystemen in der Gegenwart und in der Vergangenheit zusammenhängt.

Das zweite und dritte Kapitel befassen sich mit der komplexen inner-Gruppen Taxonomie von *Diplocynodon*. Die Diagnosen der derzeit anerkannten *Diplocynodon*-Arten enthalten häufig gemeinsame und/oder nicht reproduzierbare Merkmale, die eine spezifische Abgrenzung erschweren. Auf der Grundlage der Überprüfung der derzeit bekannten Arten wird die erste taxonomische Revision der Gattung seit ihrer Aufnahme in moderne phylogenetische Arbeiten vorgelegt. Zusätzlich wird ein Bestimmungsschlüssel zur Verfügung gestellt, der Forscher bei der Identifizierung der gültigen Arten unterstützt. Darüber hinaus gibt die vorliegende Arbeit einen quantitativen Überblick über den Stand des gesamten Fossilnachweises von *Diplocynodon* (auf der Grundlage von zwei frei zugänglichen Datenbanken) und diskutiert den "Waste-basket"-Status des Taxons im Hinblick auf eine bessere taxonomische Praxis. Innerhalb von *Diplocynodon* hat die eozäne Art *Diplocynodon darwini* Ludwig, 1877 die größte Stichprobe im Paläogen, die aus Dutzenden von vollständigen, gut erhaltenen Exemplaren besteht. Trotzdem steht eine detaillierte osteologische Beschreibung der Art noch aus. Das Taxon wird hier erstmals anhand von Typusexemplaren, die vor 150 Jahren gesammelt wurden, und einer Fülle von hervorragend erhaltenem Material aus den Konservat-Lagerstätten Messel und Geiseltal neu beschrieben. Es werden Einblicke in die intraspezifische Variation des Taxons, einschließlich der ontogenetischen Variation in zeitlich begrenzten Populationen, gegeben. Die komplexe inner-Gruppen Taxonomie von *Diplocynodon* wird durch einen Überblick über bereits veröffentlichte und neu gefundene Phylogenien weiter erforscht und diskutiert.

ABSTRACT ESTESO (ITALIANO)

Le popolazioni di coccodrilli esistenti abitano quasi esclusivamente le regioni tropicali, distribuite sulla maggior parte delle terre emerse continentali. L'Europa continentale moderna rappresenta tuttavia una notevole eccezione, poiché non si trovano crocodiliformi in questa regione del mondo, in grande contrasto con la storia biogeografica passata del gruppo. Il Cenozoico iniziale, in particolare, mostra una fauna di crocodiliformi eccezionalmente diversificata, dominata principalmente da alligatoroidi. La disparità morfologica, la complessa biogeografia o anche la giovane età stratigrafica delle forme più primitive sono state difficili da conciliare con le relazioni filogenetiche dedotte con gli alligatoridi, un gruppo d'acqua dolce e di piccole dimensioni nel Paleogene. Il genere europeo di possibili alligatoroidi *Diplocynodon* è riconosciuto come il più comune e meglio campionato crocodiliforme nel Paleogene europeo, come dimostrato dall'ampio record fossile distribuito in diverse località del Cenozoico. Il record suggerisce un'eccezionale sopravvivenza del genere dal tardo Paleocene al Miocene medio, complicando l'indagine completa della sistematica e della tassonomia del genere, e indicando la necessità di una revisione completa del genere.

La tesi presenta una filogenesi ampliata con una maggiore coerenza spazio-temporale che reinterpreta *Diplocynodon* spp. (qui strettamente imparentato con *Borealosuchus* del Nordamerica), nonché i nordamericani *Deinosuchus* spp. e *Leidyosuchus canadensis* come stem-group Crocodylia. La nuova topologia chiarisce l'evoluzione dell'osmoregolazione in Crocodylia e nei suoi parenti stretti, deducendo una tolleranza plesiomorfa all'acqua salata per *Deinosuchus* e il crown-group e una perdita secondaria già negli alligatoridi basali. La divergenza degli Alligatoroidea ha coinciso con i massimi livelli marini della metà del Cretaceo e la distribuzione di *Deinosuchus* attraverso la via marittima interna occidentale americana può essere meglio spiegata dalla dispersione marina. L'analisi filogenetica della taglia corporea utilizzando un proxy della larghezza del cranio rivela un nanismo basale nelle prime fasi dell'evoluzione degli alligatoroidi e una stima ragionevole della taglia totale per l'esemplare più completo di *Deinosuchus riograndensis*. Si suggerisce che il gigantismo nei crocodiliformi sia correlato a ecosistemi acquatici estesi, altamente produttivi nel presente e nel passato.

Il secondo e il terzo capitolo affrontano la complessa tassonomia del gruppo di *Diplocynodon*. Le diagnosi delle specie di *Diplocynodon* attualmente accettate includono comunemente caratteri condivisi e/o irriproducibili, ostacolando delimitazioni specifiche. Sulla base della revisione di tutte le specie attualmente conosciute, viene presentata la prima revisione tassonomica del gruppo dopo la sua inclusione nei moderni lavori filogenetici. Viene inoltre fornita una chiave di identificazione per assistere i ricercatori nell'identificazione delle specie valide. Inoltre, il presente lavoro esamina quantitativamente lo stato dell'intera record fossile di *Diplocynodon* (sulla base di due database disponibili online) e discute lo stato di waste-basket taxon, e suggerendo migliori pratiche tassonomiche. All'interno di *Diplocynodon*, la specie eocenica *Diplocynodon* darwini (Ludwig, 1877) e rappresentata dal più grande campione del periodo paleogenico in termini di numero di individui, costituito da decine di esemplari completi ben conservati, ma manca ancora una descrizione osteologica dettagliata. Il taxon viene qui ridescritto per la prima volta sulla base di esemplari tipo raccolti 150 anni fa e di abbondante materiale ottimamente conservato proveniente dal Messel e dal Geiseltal Konservat-Lagerstätten. Vengono fornite informazioni sulla variazione intraspecifica del taxon, compresa la variazione ontogenetica in popolazioni temporalmente ristrette. La complessa tassonomia del gruppo *Diplocynodon* viene inoltre esplorata e discussa attraverso una revisione delle filogenesi precedentemente pubblicate e di quelle ottenute recentemente.

RESUME ETENDU (FRANÇAIS)

Les populations actuelles de crocodiliens habitent presque exclusivement les régions tropicales, réparties sur la plupart des masses continentales. L'Europe continentale moderne est toutefois une exception notable, car on ne trouve aucun crocodyliforme dans cette région du monde aujourd'hui, ce qui contraste fortement avec l'histoire biogéographique passée de ce groupe. Le début du Cénozoïque, en particulier, exhibe une faune crocodyliforme exceptionnellement diversifiée, dominée principalement par les alligatoroïdes. Les relations phylogénétiques des alligatoroïdes les plus primitifs avec les formes plus dérivées (généralement de petite taille et vivant en eau douce au Paléogène) ont souvent été difficiles à concilier, de part leurs disparité morphologique, la biogéographie complexe ou même l'âge stratigraphique. Le genre européen *Diplocynodon* est reconnu comme le crocodyliforme le plus commun et le mieux échantillonné du Paléogène sur le continent, illustré par le vaste registre fossile réparti sur de multiples localités tout au long du Cénozoïque. L'ensemble de ces données suggèrent une présence du genre exceptionnellement longue, de la fin du Paléocène au milieu du Miocène, ce qui rend l'étude complète de sa systématique et de sa taxonomie d'autant plus difficile mais nécessaire.

La thèse présente une phylogénie globale avec une cohérence spatio-temporelle accrue qui réinterprète *Diplocynodon* spp. (retrouvé étroitement apparenté au *Borealosuchus* nord-américain), *Deinosuchus* spp. et *Leidyosuchus canadensis* (tous deux nord-américains) comme appartenant au groupe souche des crocodyliens. La nouvelle topologie explique l'évolution de l'osmorégulation dans le groupe couronne Crocodylia et leurs proches parents, en déduisant une tolérance plésiomorphe à l'eau salée pour *Deinosuchus* et le groupe souche, ainsi qu'une perte secondaire de ce trait chez les alligatoridés basaux. Les estimations de la longueur totale du corps (corrigé phylogénétiquement) calculées à l'aide de la largeur du crâne révèlent un nanisme phylétique au début de l'histoire évolutive des alligatoroïdes, ainsi qu'une taille plus raisonnable pour *Deinosuchus riograndensis* sur la base d'un des spécimens les plus complets. Le gigantisme chez les crocodyliformes serait corrélé à des écosystèmes aquatiques riches et très productifs dans le présent et dans le passé.

Les deuxième et troisième chapitres abordent la taxonomie non résolue de *Diplocynodon*. Les diagnoses morphologiques des espèces de *Diplocynodon* actuellement acceptées comprennent souvent des caractères partagés et/ou impossibles à reproduire à l'observation, ce qui entrave donc les délimitations spécifiques. Sur la base de l'examen de toutes les espèces actuellement connues, la première révision taxonomique du groupe depuis son inclusion dans les travaux phylogénétiques modernes est présentée. Une clé d'identification pour aider les chercheurs à identifier les espèces évaluées comme valides est également fournie. En outre, le présent travail examine de manière quantitative et qualitative l'état de l'ensemble du registre fossile du *Diplocynodon* (sur la base de deux bases de données accessibles publiquement), et discute du statut de «waste-basket» du taxon en rapport à de meilleures pratiques taxonomiques. Au sein de *Diplocynodon*, l'espèce *Diplocynodon darwini* Ludwig, 1877 datant de l'Eocène possède le plus grand échantillon de la période Paléogène, constitué de dizaines de spécimens complets bien conservés, mais manque critiquement d'une description ostéologique détaillée. Le taxon est ici redécrit pour la première fois sur la base de spécimens types collectés il y a 150 ans et d'un matériel abondant découvert plus récemment et bien conservé provenant des Konservat-Lagerstätten de Messel et de Geiseltal en Allemagne. Des informations sur la variation intraspécifique du taxon sont fournies, y compris la variation ontogénétique de deux populations limitées dans le temps. La taxonomie complexe du groupe *Diplocynodon* est de plus explorée et discutée par le biais d'un examen des phylogénies publiées antérieurement et de phylogénies calculées dans cette étude.

GENERAL INTRODUCTION

In the aftermath of the Cretaceous/Paleogene mass extinction (Alvarez et al., 1980), global warming and cooling events give the tempo to the climate of the following geological period, namely the Paleogene (Zachos et al., 2008; Solórzano et al., 2020; Westerhold et al., 2020; CenCO2PIP, 2023). Flora and fauna paleobiodiversity studies of the latter period (frequently investigating the Paleocene-Eocene Thermal Maximum, PETM) agree on a general co-occurrence of global climatic fluctuations and ecosystems alterations, with the resulting impacts observed through the record of multiple extinctions and diversifications in distant taxonomic groups, ranging from plants, invertebrates and vertebrates (Hutchison, 1998; Mayr, 2022; Lyson et al., 2019; Yasuhara et al., 2022; Korasidis et al., 2022; Solé et al., 2022).

Crocodyliformes (*sensu* Benton & Clark, 1988) was no exception and experienced a significant turnover in the Cenozoic, initiated in the Late Cretaceous by the rise of the crown-group Crocodylia, "last common ancestor of *Gavialis gangeticus*, *Alligator mississippiensis*, and *Crocodylus niloticus* and all of its descendants" (sensu Brochu, 2003; Puértolas-Pascual et al., 2016). The latter group is indeed estimated to date back to ca. 100 Ma according to recent tip-dating studies employing different taxon and character sampling (morphology only, Turner et al., 2017; total-evidence, Lee & Lates, 2018; Darlim et al., 2022; see also Appendix 4.1), and included times of markedly higher regional diversity in the Paleogene compared to modern days (Mannion et al., 2015; de Celis et al., 2020; Scheyer et al., 2013; Solórzano et al., 2020).

Among crown lineages, Alligatoroidea (*sensu* Brochu, 2003) traditionally includes the oldest taxa (e.g., *Brachychampsa* spp., *Deinosuchus* spp., *Albertochampsa langstoni*, *Stangerochampsa mccabei*; Norell et al., 1994; Williamson, 1996; Wu, 1996; Brochu, 1999; Cossette & Brochu, 2020) and therefore sets a minimum age of the crown-group Crocodylia to ca. ~ 90 Ma in accordance with molecular studies (Oaks, 2011; Pan et al., 2021). The literal reading of the fossil record suggests that early alligatoroids rapidly dispersed out of North America after the K/Pg mass extinction, allowing the clade to reach a nearly global distribution by the end of the Paleogene (among others, Brochu, 1999;

Skutschas et al., 2014; Bronzati et al., 2015; Puértolas-Pascual, 2016; Iijima et al., 2016; Massonne et al., 2019; Rio & Mannion, 2021). Alligatoroidea became especially dominant in Europe by the late Eocene with the presence of the endemic genus *Diplocynodon* Pomel 1847, by far the most common crocodyliform and largely recognised as a monophyletic clade of early-branching alligatoroids based on the founding phylogenetic work of Brochu (1997, 1999) and all subsequent works expanding upon it (Martin, 2010; Martin et al., 2014; Macaluso et al., 2019; Massonne et al., 2019; Rio et al., 2020).

The taxonomic content of Alligatoroidea has however been subject to minor questioning following the extensive revisions and descriptions of new species in the last 25 years. More specifically, traditional stem-alligatorids such as *Deinosuchus* spp. and *Leidyosuchus canadensis* (Wu et al., 2001; Schwimmer, 2002; Cossette & Brochu, 2020) show contrasting morphologies with the oldest alligatoroids (e.g. *Brachychampsa* spp.; *Stangerochampsa mccabei*), which render the phylogenetic placement of the latter taxa increasingly unstable in recent phylogenies (Bona et al., 2018; Cossette & Brochu, 2018; Massonne et al., 2019; Walter et al., 2022).

In this context, *Diplocynodon* further complicates the picture, as a meaningful corpus of literature previously acknowledged shared morphologies with the stem-crocodylian *Borealosuchus* (Gilmore, 1910; Erickson, 1976; Brochu, 1997; Wu et al., 2001b and references therein), such as the presence of ventral armour made of bipartite osteoderms, the exclusion of the nasals from the external naris, or the similar occlusion pattern. This signal was however never recovered in phylogenetic analyses since the use of modern cladistics methods (Brochu, 1997, 1999; Martin et al., 2014; Rio et al., 2020; Rio & Mannion, 2021). Regarding the phylogenetic relationships of *Diplocynodon*, its early branching position within Alligatoroidea is moreover inconsistent with the relatively young stratigraphic distribution of the group in Europe, spanning from the late Paleocene to the Middle Miocene (Martin et al., 2014; Massonne & Böhme, 2022), as opposed to the strict Cretaceous age of all other early-branching alligatoroids (Wu et al., 2001; Schwimmer, 2002; Cossette & Brochu, 2020). The biogeographic origin of *Diplocynodon* is consequently puzzling, necessarily explained by a long ghost lineage of unsampled species extending back to the Late Cretaceous of North America (Brochu, 1999; Martin et al., 2014; Rio & Mannion, 2021). The first appearance date of *Diplocynodon* (*Diplocynodon* *remensis*, Martin et al., 2014) however coincides with a substantial input of American immigrant species in European faunas in the Paleocene (West & Dawson, 1978; Smith et al., 2006; Mayr, 2009; Rose, 2012; Macaluso et al., 2022), suggesting that one or more dispersals occurred prior to the late Paleocene. Based on geographical and paleobiological evidence (Brikiatis, 2014; De Bast & Smith, 2017), these dispersals would have been possible through the De Geer route (between North America and Eurasia, via present day Scandinavia), open during the Late Cretaceous / early Paleocene (early Maastrichtian to middle Danian, 70.8 Ma to ca. 63 Ma). Alternatively, through the Thulean route, open during two short late Paleocene intervals (57 and 56 Ma), but not congruent with the first occurrence of *Diplocynodon* considering the slightly older age of the type locality of *D. remensis* (Cernay, France; late Thanetian, MP6, 58.14 to 57.92 Ma; Legendre and Lévêque, 1997). The ingroup palaeobiogeographical history of *Diplocynodon* in Europe is however hampered by largely unresolved relationships, as illustrated by the number of different topologies previously published (Buscalioni et al., 1992; Brochu, 1999; Piras & Buscalioni, 2006; Martin, 2010; Delfino & Smith, 2012; Massonne et al., 2019; Rio et al., 2020; Rio & Mannion, 2021).

The first chapter of the present thesis investigates the evolutionary relationships of long-established early-branching alligatoroids through an expanded molecular-informed morphological phylogeny, and further explore implications for the body-size evolution and osmoregulation in the crown-group Crocodylia. The second chapter of the thesis reconsiders the taxonomic validity of accepted *Diplocynodon* species. This work further assesses the current state of the fossil record of the taxon through a detailed survey of all occurrences reported in two open databases. The third and final chapter is a reappraisal of the species *Diplocynodon darwini*, for which a modern description is critically lacking, despite representing a unique chance to study intraspecific variation in a Paleogene taxon reported from two localities with abundant material. Intraspecific variation between Messel and Geiseltal populations is here reported, together with general insights into the ontogenetic trajectory observed in the sample. Insights into morphological variability of some character states shared across *Diplocynodon* species are also provided. The ingroup evolutionary relationships are further tested after the taxa scores in two different eusuchian character-taxon datasets.

CHAPTER 1: Expanded phylogeny elucidates *Deinosuchus* relationships, crocodylian osmoregulation and body-size evolution

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1. Introduction

The history of Alligatoroidea, the total (stem + crown) group of extant alligators and caimans (Alligatoridae), can be traced back to the Late Cretaceous of North America. Previous phylogenies of extinct taxa implicitly suggest that the early evolution of the group was already characterised by high morphological disparity and complex biogeographic histories, implying rapid rates of evolution (Brochu, 1999, 2003; Cossette & Brochu, 2020; Rio & Mannion, 2021). Several early alligatoroids from the Late Cretaceous (e.g., *Brachychampsa* spp., *Albertochampsa langstoni*, *Stangerochampsa mccabei*) overall fit an expected ancestral body-plan for the group and were characterised by a relatively small size, short and blunt snout, overbite dental occlusion, enlarged 4th maxillary tooth, molariform posterior dentition, and an initial distribution restricted to Laramidia, the western part of North America once bisected by the extensive epicontinental Western Interior Seaway (WIS; Brochu, 1999, 2001). A putative alligatoroid has been reported from the Atlantic coast but its age postdates the existence of the WIS (Cosstette & Brochu, 2018). The absence of unambiguous alligatoroids in Appalachia, together with depositional environments (Erickson, 1972; Norell et al., 1994; Wu et al., 1996), imply a shared lack of saltwater tolerance with extant alligatorids (Taplin, 1988). In contrast, other species recovered as early diverging members of the group, like *Deinosuchus* spp. and *Diplocynodon* spp. resembled crocodyloids or stem-group crocodylians in having partly interfingering dental occlusion, an occlusal notch between the premaxilla and maxilla for the 4th dentary tooth, enlarged 4th and 5th maxillary teeth, narrower and longer snout, larger or even gigantic body-size, and transmarine distribution (Schwimmer, 2002; Rio &

Mannion, 2021). In addition to its extremely large body-size, the ‘terror-crocodile’ *Deinosuchus* (Erickson & Brochu, 1999) furthermore possessed highly derived morphological specializations (Cossette & Brochu, 2020) and, together with *Diplocynodon*, have also utilised coastal marine habitats (Wheatley, 2010; Venczel & Codrea, 2022; Kocsis et al., 2023). Moreover, the earliest alligatoroid record (~ 82 Ma) already includes both of these highly divergent morphotypes (*Deinosuchus* and *Brachychampsa sealeyi*; Williamson, 1996; Mohler et al., 2021), potentially implying a significantly earlier origin of the group. Most molecular divergence age estimates, however, do not suggest an earlier age than ~ 90 Ma (Oaks, 2011; Pan et al., 2021). *Diplocynodon* further complicates the picture with its early branching position within the group that is in turn conflicting with an endemic European distribution and comparatively late first appearance date (late Paleocene; Brochu, 1999; Rio & Mannion, 2021; Martin et al., 2014). Morphology, stratigraphic age, biogeography, and physiology are therefore markedly difficult to reconcile with alligatoroid phylogeny.

We present an expanded molecular-informed morphological phylogeny and find that character states previously diagnosing Alligatoroidea have a broader taxonomic distribution recovering both *Deinosuchus* and *Diplocynodon* as stem-crocodylians. The novel topology explains the geographic distribution of *Deinosuchus* with inferred salt tolerance, resolves the biogeographic history of *Diplocynodon*, and implies body-size reduction at the root of Alligatoroidea. In light of the resulting simpler biogeographic pattern, we hypothesise that the basal split of crown-group crocodylians, involving caiman and alligator ancestors, was triggered by extreme mid-Cretaceous sea level rise.

2. Material and Methods

2.1 *Phylogenetic analysis*

We expanded and combined previous morphological taxon-character datasets (Cossette & Brochu, 2020; Massonne et al., 2019; Stocker et al., 2021; Walter et al., 2022; Shan et al., 2021; Salas-Gismondi et al., 2015; Bona et al., 2018; Cossette, 2021) that are themselves expanded on previous works (Brochu, 1999, 2004, 2011; Brochu & Storrs, 2012). Our character/taxon dataset consists of 219 discrete morphological characters and 128 taxa, including taxa absent from other recent global datasets (e.g.

Deinosuchus spp., Orientalosuchina, *Diplocynodon remensis*, and *Borealosuchus griffithi*). Character definitions and scorings were managed in Mesquite version 3.7 (Maddison & Maddison, 2023). Multistate characters forming a morphocline were treated as ordered. Ordering, however, does not impact the position of *Diplocynodon*, *Leidyosuchus* or *Deinosuchus*. In total, 19 new taxa were added, 20 additional characters, and over 50 character scores were updated relative to the parent dataset (Massonne et al., 2019). For details of the dataset and analysis see Appendix 1.

The maximum parsimony analysis was performed in TNT 1.6 (Goloboff & Morales, 2023) using a manually implemented molecular scaffold (Darlim et al., 2022) based on the topology recovered by Oaks (Oaks, 2011): the scaffold constrains extant species relationships on the basis of molecular topology and allows fossil taxa to be placed within this topology based on morphological characters. Enforcing constraints enables the recovery of Longirostres, the consensual clade uniting *Gavialis gangeticus*, *Tomistoma schlegelii* and *Crocodylus niloticus* in accordance with molecular (Janke et al., 2005; Oaks, 2011; Lee & Yates, 2018) and some recent morphological topologies (Rio & Mannion, 2021). The parent datasets here combined and expanded, however, are unable to recover this clade and yet only few previous studies employed a molecular scaffold (Massonne et al., 2019; Walter et al., 2022; Darlim et al., 2022). It has been recently demonstrated that molecular scaffolds represent an appropriate alternative of total-evidence approaches for fossil crocodylian phylogenetic inference (Darlim et al., 2022). Nevertheless, the scaffold has apparently no impact on the phylogenetic position of *Deinosuchus, Diplocynodon* or *Leidyosuchus* in our analyses.

A first round of New Technology Search was performed as advised for large datasets (Goloboff et al., 2008), enabling all search algorithms (Sectorial search, XSS enabled; Ratchet; Drift; Tree fusing) and stabilising the consensus 5 times. A second round of New Technology Search was then conducted, but using the trees saved from RAM, disabling Sectorial searches. The consensus tree was obtained from trees recovered by the second round of calculation. Figs. 1 and 2 were created using the R package *strap* developed by Bell and Lloyd (Bell & Lloyd, 2015), using 1 Ma as minimum branch length, and using taxon ages from (Darliml et al., 2022) and sources reported in Appendix 1.3.

2.2 *Phylogenetic body-size analysis*

The estimation of body sizes of extinct species was undertaken using a Bayesian phylogenetic approach and the application of regressions based on head width (HW) and total body length (TL) measurements from extant crocodylians (O'Brien et al., 2019; Paiva et al., 2022). We expanded previous regression datasets (O'Brien et al., 2019; Paiva et al., 2022) by adding the extant *Osteolaemus osborni* and thus including a total of 25 species and 207 specimens. Head width, measured as the distance between the extremes of the quadrates, was collected using ImageJ (Schindelin et al., 2012) for 91 fossil and 16 extant taxa in our phylogenetic analysis (Supplementary Data 2.3, Table S1). For topological structure, we used the consensus tree obtained in the present study (Figs. 1-2; Fig. S1), including time calibration. This involved adding age information for all tips sourced from Darlim et al. (2022) and other references (Appendix 1.3). The calibration employed 5 million years as minimum branch lengths (*mbl* method; Laurin, 2004) in the *timePaleoPhy()* function of the *paleotree* package (Bapst, 2012) in R 4.3.1 (R Core Team, 2023).

Total body length was estimated through the BayesModelS method (Nunn & Zhu, 2014) for phylogenetic predictions, which adopts a Brownian motion model and employs a Monte-Carlo Markov-Chain (MCMC; Garland & Ives, 2000; Nunn & Zhu, 2014; O'Brien et al., 2019; Paiva et al., 2022). The phylogenetic signal values utilised by BayesModelS method were extracted from the *phytools* package (Revell, 2012) through *phylosig()* function. The entire protocol, data sources, along with additional details are available in Supplementary Data 2 (Appendix 1, Figshare repository), including packages such as *car* (Fox & Weisberg, 2018), *MASS* (Venables & Ripley, 2002), *caper* (Orme, 2018), *evomap* (Smaers & Mongle, 2014), and *rms* (Harell, 2017). A parsimony reconstruction of ancestral states was used to plot the discretised continuous values of mean total length in Mesquite (Maddison & Maddison, 2023) on the strict consensus tree (see Appendix 1, section 2). Temporal and taxic distribution of body size were visualised using R scripts using *ggplot2*, *deeptime* and *jpeg* packages.

2.3 *Figures*

All figures were produced using the free image editor GIMP (https://www.gimp.org/) and free vector graphics editor Inkscape (https://www.inkscape.org). The silhouette used for *Deinosuchus* in Figure 1, 2 and 3 was created based on the artwork of Andrey Atuchin under the Creative Common BY-SA 4.0 license (https://creativecommons.org/licenses/by-sa/4.0/). Remaining silhouettes used to illustrate clades and taxa in Figures 1 to 4 were sourced from PhyloPic (https://www.phylopic.org/ and are in the Public Domain except for *Gryposuchus* (https://www.phylopic.org/images/d4225b65-a520-42ae-b3ab-8725778a8403/gryposuchus-pachakamue); *Paleosuchus* (https://www.phylopic.org/images/9289a813-73ad-4644-b738-d9be619d8219/paleosuchus), and *Purussaurus* (https://www.phylopic.org/images/b7fedb04-759e-4f1a-b8bb-d0faefc64e75/purussaurus-neivensis) by Armin Reindl and are accessible for reuse under the Creative Commons BY-NC 3.0 license (https://creativecommons.org/licenses/by-nc/3.0/deed.en); and *Euthecodon*, by Smokeybjb (https://www.phylopic.org/images/a1e916c4-e020-4657-932b-d74ec6c08e0a/euthecodon-brumpti); *Crocodylus anthropophagus* by Nobu Tamura (vectorised by Julian Bayona, https://www.phylopic.org/images/c60b0e39-1437-4bb4-8940-f6da3d943adf/crocodylinae-anthropophagus); *Stomatosuchus* by Stanton F. Fink (vectorised by Julian Bayona, https://www.phylopic.org/images/f7d45c6d-e506-4826-8ffe-3f75d588d378/stomatosuchus-inermis); *Phosphatosaurus* by Nobu Tamura (vectorised by Julian Bayona, https://www.phylopic.org/images/13ff6eb0-a671-44d8-8a51-8b9f95d49403/dyrosaurus-phosphaticus) accessible for reuse under the Creative Commons BY-SA 3.0 Unported license (https://creativecommons.org/licenses/by-sa/3.0/). Crocodylian skull silhouettes in Figures 1 and 3 are original creations. Map in Figure 4 was modified after (Scotese, 2008). All other elements presented in Figures 1 to 4 are original creations.

3. Results

3.1 *Phylogenetic analysis*

Our maximum parsimony analysis recovered 506 most parsimonious trees (strict consensus tree reported in Figure 1, 2 and Supplementary Figure 1). The most unstable taxa (*Eocaiman* spp. *and Necrosuchus ionensis*) were pruned from the strict consensus tree to increase resolution (see Supplementary Figure 1 for their respective placement). Alligatoroidea is formed by Orientalosuchina and its sister-group Alligatoridae (total group of caimans and alligators). Globidonta, the stem-based lineage comprising *Alligator mississippiensis* and all crocodylians more closely related to it than to *Diplocynodon ratelii*[1], is here redundant with Alligatoroidea because *Diplocynodon* is recovered as a non-alligatoroid stem-crocodylian. In contrast to previous phylogenies (Brochu, 1999; and all subsequent expansions), *Leidyosuchus canadensis*, *Deinosuchus* spp., and *Diplocynodon* spp. form the stem-lineage of crown-group crocodyliforms (Figure 1). *Diplocynodon* spp. is recovered as a monophyletic clade, nested in a polytomic *Borealosuchus* group from North America. This polytomy is caused by the occasional recovery of *Borealosuchus griffithi* as a sister taxon to *Diplocynodon* spp. in some trees, sharing a hypapophyseal keel present up to the 12th vertebra and a greatly reduced quadratojugal spine. Unordering multistate characters has minimal impact on the global topology: some trees recover *Borealosuchus* and *Diplocynodon* as separate clades, with *Diplocynodon remensis* placed outside *Diplocynodon* spp., one node stemward from *Borealosuchus*.

The strict consensus tree recovers a basal polytomy within Alligatoridae formed by Alligatorinae, Caimaninae (including *Bottosaurus harlani*), and the North American Late Cretaceous taxa *Brachychampsa* spp., *Stangerochampsa mccabei*, and *Albertochampsa langstoni*. The latter have two alternative positions either in Alligatorinae or along stem-Alligatoridae.

3.2 *Phylogenetic body-size estimation*

In light of the novel topology, with *Deinosuchus* spp., *Leidyosuchus canadensis*, and *Diplocynodon* spp. removed from Alligatoroidea, all early representatives of this clade were relatively small-sized and we therefore wanted to test whether the origin of alligatoroids was characterised by phyletic dwarfing. In addition, we wanted to test the impact of the phylogenetic correction and the current topology on body-size estimates of *Deinosuchus* spp. relative to previous studies. Previous works addressing *Deinosuchus* body-length did not employ phylogenetic correction and instead included it in a regression of distantly related extant taxa (*Crocodylus porosus*, *Alligator mississippiensis*; Erickson & Brochu, 1999) with likely different body proportions (Brochu, 2001). Phylogenetic body-size estimates provide results that take into account the known or reconstructed proportions of close extant relatives (O'Brien et al., 2019). We here used the same individual of *D. riograndensis* as previous non-phylogenetic work (TMM 43620-1 (Erickson & Brochu, 1999; Schwimmer, 2002; see Appendix 1 section 2, and Appendix 1section 3 for the list of sources) but a skull width proxy (O'Brien et al., 2019) instead of skull/mandible length making the comparison only partly appropriate. However, skull width proxy has been argued to be more reliable as it is less influenced by differences in body proportions caused by a long snout, a trait present in species of *Deinosuchus* (O'Brien et al., 2019; Cossette & Brochu, 2020). Mean values of estimated body-length together with lowest and highest quantiles are provided in Appendix 1, and a parsimony ancestral state reconstruction of size bins is shown in Figure 3. We here divide body-sizes according to the following categories based on extant species: total length (TL) estimations of ca. 1.5 m and lower can be considered small size, representing the general body-size of some extinct species and exceptionally small individuals of extant species. Medium size category includes TL estimations between 1.5 and 4.0 m, and comprises all extant species. Large size category includes TL estimations between 4.0 and 7 m and includes large to maximal body length of extant species (e.g. *Crocodylus porosus*, *Gavialis gangeticus*; Whitaker & Whitaker, 2008). TL estimations above 7 m are considered gigantic and are only known in extinct species (Brochu & Storrs, 2012; Aureliano et al., 2015). The divergence of Alligatoroidea was coupled with size reduction with an ancestral body-length of 150–200 cm compared to 250–300 cm of the outgroup. Most Paleogene alligatoroids of North America retained a medium to small size or went through further shrinking including some taxa that are inferred to be relatively more terrestrial (Rauhe, 1995). Larger size independently evolved in the lineage containing extant *Alligator mississippiensis* and its extinct Miocene relatives, as well as extant *Melanosuchus niger* and a clade of South American Miocene caimanines, involving independent gigantism in *Purussaurus* spp. and *Mourasuchus amazonensis* according to the present topology (Figure 3). Species of the stem-crocodylian *Deinosuchus* acquired giant sizes although our estimates give shorter, and possibly more realistic, total body length compared to previous work (Erickson & Brochu, 1999). The detailed results of the analysis are available in Supplementary Data 2.3.

4. Discussion

4.1 *Stem-crocodylian affinities of Deinosuchus can explain transmarine distribution through saltwater tolerance*

Expansions and modifications implemented in the present morphological taxon-character matrix included the merging of published data subsets, addition of characters and character states, rigorous redefinitions of select characters, homology reassessments and update of select character state scores, addition of taxa, and the inclusion of a molecular scaffold in the phylogenetic analysis (see Appendix 1.1 and 1.2). Our maximum parsimony analysis resulted in a topology where several taxa previously considered to represent stem-alligatorids (i.e., all studies descending from that of Brochu (1999), e.g. Whitaker & Whitaker, 2008; Brochu & Storrs, 2012; Martin et al., 2014; O'Brien et al., 2019; Massonne et al., 2019; Cossette & Brochu, 2020; Rio & Mannion, 2021; Stocker et al., 2021), such as *Deinosuchus* spp., *Leidyosuchus canadensis*, and *Diplocynodon* spp., are reinterpreted as stem-group crocodylians, regardless of the addition of the molecular scaffold (Figure 1). The placement of these taxa along stem-crocodylians is more consistent with their plesiomorphic morphology relative to other alligatoroids (Brochu, 1999), their stratigraphic and geographic distribution, and the fact that *Diplocynodon* shares a number of remarkable derived traits with the stem-crocodylian *Borealosuchus*. We detail our arguments below. Some of our results are congruent with recent published analyses using different datasets: some but not all analyses of Groh et al. (2020) employing quantitative characters recovered *Diplocynodon* spp. and *Leidyosuchus canadensis* as stem-crocodylians (Groh et al., 2020) and Rio and Mannion (2021) recovered a paraphyletic *Diplocynodon* sister to the lineage of Longirostres also using quantitative characters in some of their analyses. Muscioni et al. (2023), based on a more similar dataset to that of the present study, found *Diplocynodon*, *Leidyosuchus canadensis*, as well as *Deinosuchus riograndensis* in a polytomy with Crocodylia.

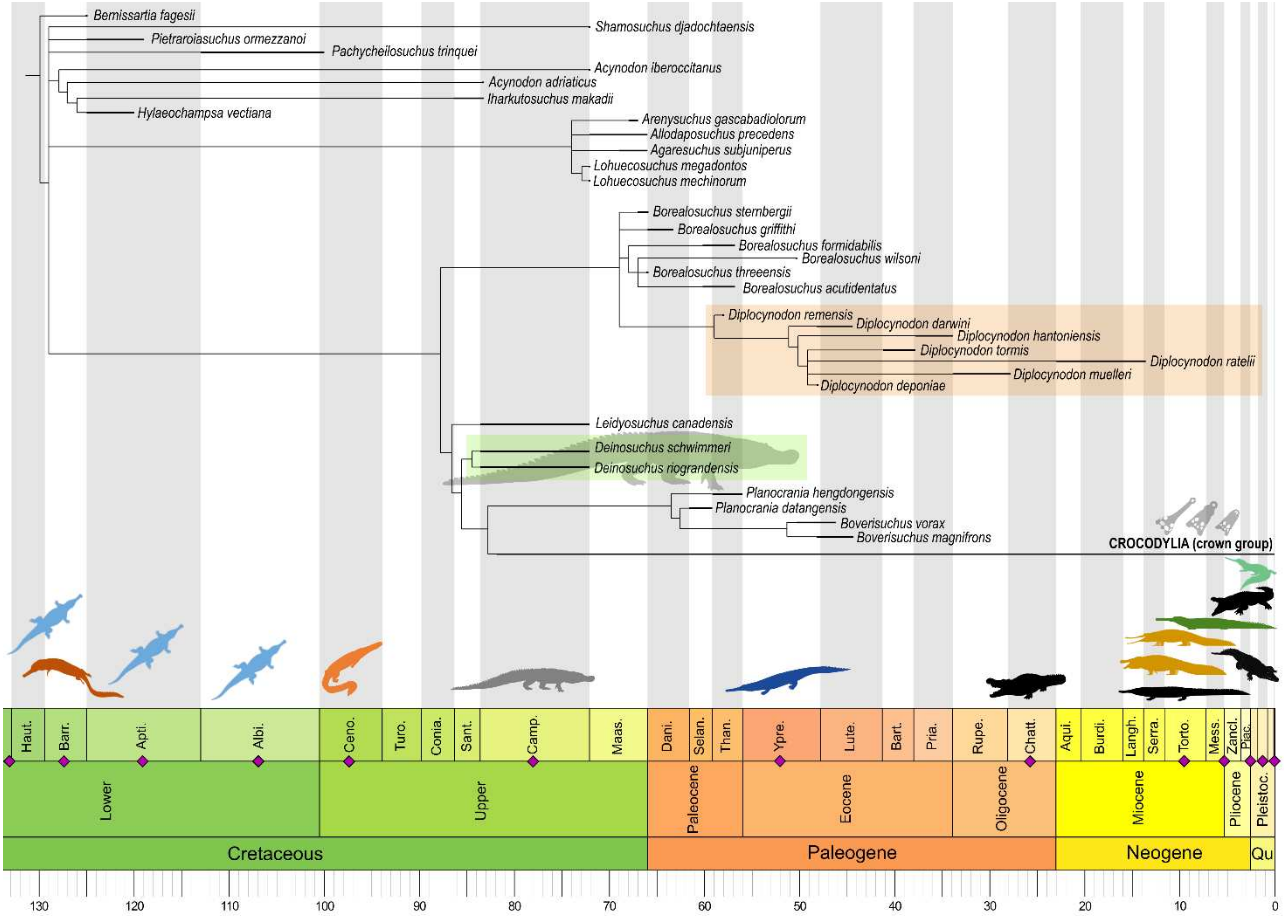


Figure 1: Reduced time calibrated strict consensus tree of the maximum parsimony analysis showing the position of *Deinosuchus* spp., *Leidyosuchus canadensis*, and *Diplocynodon* spp. as stem-crocodylians. *Borealosuchus griffithi* has two alternative positions, either as sister to *Diplocynodon* spp. or an early diverging placement within *Borealosuchus* spp. (Supplementary Data 1 “Walter et al_[TNT]”). Purple diamonds and silhouettes correspond to known occurrences of very large to giant (≥ 7) crocodyliforms. Each of the illustrated taxa is associated with high-productivity wetland or marine habitats (see Appendix 1.3 Table S1 for a list of taxa and sources). Ages are in Ma.

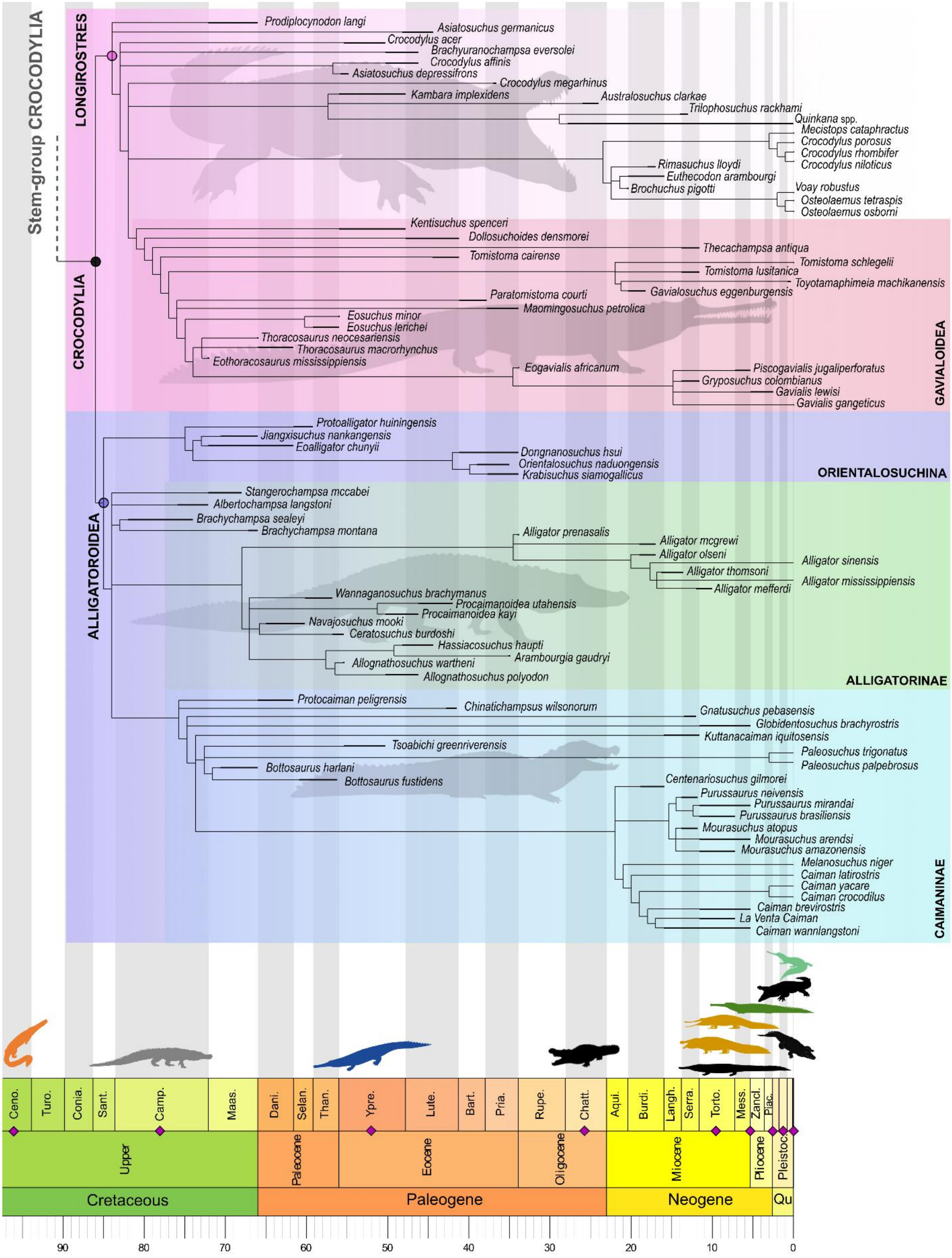


Figure 2: Reduced time calibrated strict consensus tree of maximum parsimony analysis showing the phylogeny of Crocodylia (i.e. crown-group) including Alligatoroidea. Purple diamonds and silhouettes correspond to known occurrences of very large to giant (≥ 7) crocodyliforms. Each of the illustrated taxa is associated with high-productivity wetland or marine habitats (see Appendix 1.3 Table S1 for a list of taxa and sources). Ages are in Ma.

Species of *Deinosuchus* from the Late Cretaceous (Campanian) coastlines of the North American Western Interior Seaway (WIS) and Atlantic have been considered among the largest crocodyliforms of all time with a body length previously estimated around 10 m (Cossette & brochu, 2020; Erickson & Brochu, 1999; Colbert et al., 1954; Farlow et al., 2005). Bite mark evidence suggests their diet even included large dinosaurs (Schwimmer, 2002; Riveira-Sylva et al., 2009; Schwimmer & Harell, 2010). The first phylogeny including *Deinosuchus* (Brochu, 1999) found this taxon as an early diverging member of total-group Alligatoridae. All subsequent works, including a recent comprehensive revision of *Deinosuchus* (Cossette & Brochu, 2018), confirmed this placement despite marked morphological contrast relative to contemporaneous early alligatoroids, such as *Brachychampsa* (Williamson, 1996; Mohler et al., 2021). These differences include gigantic size, several traits associated with a secondarily elongated snout (Cossette & Brochu, 2020), subequal 3rd and 4th dentary fangs in confluent alveoli, or the largest maxillary teeth being the 4th and 5th, which variously represent plesiomorphies and homoplasies. Moreover *Deinosuchus* had a transmarine distribution unlike Cretaceous alligatoroids during the existence of the WIS (Brochu, 1999; Cossette & Brochu, 2018; Cossette & Brochu, 2020)

The phylogeny herein, on the other hand, finds *Deinosuchus schwimmeri* and *D. riograndensis* outside Alligatoroidea, along the stem-lineage of crown-group crocodyliforms (Crocodylia). In other words,, *Deinosuchus* was neither a 'greater alligator' (Shiltuizen, 1999), or a 'terror crocodile' (Erickson & Brochu, 1999). Our expanded dataset is overlapping in taxon and character sample with previous studies including *D. schwimmeri* and *D. riograndensis* (Brochu, 1999; Brochu & Storrs, 2012; Massonne et al., 2019) and our character state scorings follow the latest work updating this taxon (Cossette & Brochu, 2020). The more stemward position in our study is largely due to the addition of two key Paleocene taxa to the dataset, *Diplocynodon remensis* and *Borealosuchus griffithi,* which resulted in the placement of *Diplocynodon* spp., *Deinosuchus* spp. and *Leidyosuchus canadensis* as stem-crocodylians in our analysis. These three taxa share the above listed differences from true early alligatoroids (except large body size) and their stem-crocodylian placement is retained even with the removal of the molecular scaffold from our analysis. *Deinosuchus* is excluded from Crocodylia by lacking the following traits among others: an incisive foramen that abuts the toothrow; a single largest maxillary alveolus that is the 5th, and a frontoparietal suture that makes a modest entry into the supratemporal fenestrae. Some previous alligatoroid synapomorphies are now optimised as crocodylian plesiomorphies (Appendix 1.2). This novel stem-crocodylian position of *Deinosuchus* spp. is consistent with its early stratigraphic age (early Campanian), plesiomorphic morphology, and would also imply less homoplasies (Cossette & Brochu, 2020; e.g. character 71:0 was convergent with *Borealosuchus* but here optimised as a plesiomorphy for Crocodylia). Species of *Deinosuchus* nevertheless still share convergent characters with long-snouted taxa (Cossette & Brochu, 2020) even in the current topology. Scoring *Deinosuchus riograndensis* in a different dataset (Rio & Mannion, 2021) resulted in a relatively deeply nested position within Alligatoroidea, but we nevertheless find this highly doubtful due to the particularly poor stratigraphic fit of this topology and the ambiguous synapomorphies uniting Alligatoroidea, some of which are present only in a few of the ingroup taxa whereas others are present in many outgroup taxa as well (Appendix 1.2).

Deinosuchus as a stem-crocodylian is furthermore more consistent with its biogeographic distribution on both sides of the Western Interior Seaway (WIS) in contrast to early members of true early alligatoroids restricted to the West until the retreat of the seaway (Cossette & Brochu, 2018). Cossette & Brochu (2020) recently proposed that species of *Deinosuchus* were allopatric with *D. riograndensis* distributed along the western coast of the WIS (Laramidia), whereas *D. schwimmeri* along the eastern and Atlantic coasts (Appalachia). The authors suggested that speciation in the clade occurred through vicariance, during the opening phase of the WIS, separating *Deinosuchus* ancestral populations. The main rationale behind this was due to the supposed alligatoroid affinity of *Deinosuchus* with extant relatives lacking lingual salt glands, which would render them incapable of osmoregulation and prolonged saltwater exposure required for crossing the extensive WIS (Schwimmer, 2002; Jackson et al., 1996; Grigg et al., 1998; Elsey, 2005; Lehmann et al., 2024; Roberts & Kirschbaum, 1995). The herein proposed stem-crocodylian position, however, no longer infers lack of osmoregulation and may explain the distribution of *Deinosuchus* through dispersal across the WIS. Saltwater tolerance is inferred to be plesiomorphic for Longirostres (e.g. Rio & Mannion, 2021; Vélez-Juarbe et al., 2007) and may well have been plesiomorphic for Crocodylia as many stem-group taxa close to the crown appear to be euryhaline (Wheatley, 2005). These include marine thoracosaurs (recovered as stem-crocodylians in tip-dated phylogenies; Lee & Yates, 2018), potentially *Diplocynodon*, occasionally recovered from marginal marine settings (Venczel & Codrea, 2022; Kocsis et al., 2023), and *Deinosuchus* itself, which is mostly recorded from estuarine or nearshore habitats such as coastal plains, deltas or platform contexts (Schwimmer, 2002). Moreover, stable isotope analysis of carbon and oxygen from eastern *Deinosuchus* tooth enamel samples suggest consumption of seawater or marine prey (Wheatley, 2005), the latter also supported by bite mark evidence of predation on nearshore marine turtles (Schwimmer, 2002). The simultaneous disappearance of *Deinosuchus* from the fossil record (supposed extinction) with the draining of megawetlands along the WIS and Atlantic coasts (including complete retreat of the former) later during the Cretaceous is furthermore consistent with a lifestyle linked to coastal habitats (Markwick, 1998; Dennis et al., 2013). *Borealosuchus* may serve as an additional example for salt-tolerant stem-crocodylians as it is known to co-occur with *Deinosuchus* in the Moorville Chalk of Alabama, a marginal marine setting (McCormack, 2019). Taking this data together, our parsimony ancestral state reconstruction, including data from this study, implies that the presence of saltwater tolerance (osmoregulation) may have been plesiomorphic for Crocodylia (Figure 4) and simply retained in species of *Deinosuchus*. This does not mean that osmoregulation was necessarily achieved through the presence of lingual salt glands. Saltwater tolerance, possibly including lingual salt glands, were subsequently lost in alligatoroids and *Gavialis* (Taplin & Grigg, 1989). A recent review suggested that salt tolerance may have been present in early alligatoroids (Stout, 2024) as previous phylogenies left it ambiguous whether salt glands (with no known osteological correlates) were already lost in stem- or in crown-group alligatoroids only (Brochu, 1999). The topology of the present study, however, implies the loss of effective osmoregulation (possibly including lingual salt glands) in the stem-lineage as all early true alligatoroids in the new phylogeny come from freshwater deposits (Erickson, 1972; Norell & Clark, 1994; Wu, 1996; Figure 4).

Morphological differences in western *Deinosuchus riograndensis* and eastern *D. schwimmeri* are relatively minor except for body size with known specimens of the western taxon being considerably larger (Cossette & Brochu, 2020). If speciation took place, dispersal is more consistent with the novel phylogeny than vicariance. Isolation would have been maintained through the episodic nature of the dispersal due to the significant width of the seaway. A literal reading of the fossil record would imply an east to west dispersal as eastern records are so far somewhat older (Schwimmer, 2002), but this simply may be a sampling bias in the fossil record of *Deinosuchus*.

4.2 *Body-size estimation of Deinosuchus and evolution of gigantism in crocodyliforms*

Previous work estimated the total body-length of *Deinosuchus* spp. between ca. 8 and 12 m (up to 12 m, Schwimmer, 2002; 7.67 and 10.640 m, Farlow et al., 2005; and 7.73 to 8.13 m, Iijima et al., 2016). Total body-length has been shown to more strongly correlate with head-width than with cranial length given the variability of rostral proportions among crocodylians (Paiva et al., 2022). Because *Deinosuchus* has a relatively long snout (Cossette & Brochu, 2020), previous approaches (Schwimmer, 2002; Erickson & Brochu, 1999) may have overestimated the total length of this taxon, as they based their regression on shorter-snouted taxa, *Alligator mississippiensis* and *Crocodylus* spp. Our method of estimation differs from that of previous studies in employing a skull width proxy (O'Brien et al., 2019) instead of femur (Farlow et al., 2005), mandible (Schwimmer, 2002; Erickson & Brochu, 1999) or vertebra (Schwimmer, 2002; Iijima et al., 2016) and furthermore includes a phylogenetic correction to bypass the use of a unique extant proxy (e.g., *Alligator mississippiensis*, *Crocodylus porosus*) as body size proportions show strong phylogenetic structuring in crocodylians (O'Brien et al., 2019). The phylogenetic approach, however, is still only sampling living crocodylians, a fraction of past morphological diversity, and body proportions of extinct taxa, particularly those (but not only) outside the clade may have significantly differed (including *Deinosuchus*). This implies that, following O'Brien et al. (2019), outer quartile estimates should be considered for taxa showing "sufficient biological evidence to presume that body size should be meaningfully greater or lesser than the mean estimate (e.g., terrestrial versus fully aquatic denizens, tail, or head size atypically large or small in a given taxon)". Concerning the present estimate, we consider the 97.5 percentile estimate (7.66 m total length for *Deinosuchus riograndensis* and 6.37 m for *Deinosuchus schwimmeri*; see Appendix 1.6) more realistic than the mean (5.80 m for *Deinosuchus riograndensis* and 4.83 m for *Deinosuchus schwimmeri*). Our reasoning is that the 97.5 percentile estimates lie between the conservative mean of our estimates and previous non-phylogenetic estimations using cranial length. Our estimate of *D. riograndensis* is based on the skull of the same individual as in Schwimmer (2002; 9.8 m) and Erickson and Brochu (1999; 8.43 to 9.10 m) who, however, both used the length of the lower jaw of the specimen. Furthermore, previous applications of phylogenetic body-size estimations systematically found lower mean estimates compared to non-phylogenetic methods (O'Brien et al., 2019; Paiva et al., 2022; Engelman, 2023). The maximal size of *D. riograndensis* was, nevertheless, likely larger than even our 97.5 percentile estimates as evidenced by the larger size of the holotype specimen (AMNH 3073) compared to the specimen used in our study (TMM 43620-1).

Very large to gigantic body size (here defined as ≥ 7 m total length) has repeatedly evolved during the history of crocodyliforms and represents a wide range of taxa across the phylogenetic tree known from the Cretaceous to the present Britton et al., 2012; Godoy et al., 2019; Martin et al., 2019; Gearty & Payne, 2020; Figures 1 and 2). Previous work has underlined the importance of aquatic to semi-aquatic lifestyle (Godoy et al., 2019) and temperature (Lakin et al., 2020; Stockdale & Benton, 2021) in driving large body-size in crocodyliforms, but the triggers of extreme sizes across clades have not been explicitly addressed. We propose that *Deinosuchus* exemplifies an ecological pattern that has been universally characteristic of giant crocodyliforms and their ecosystems. Species of *Deinosuchus* were inhabitants of a marginal mega-wetland along the WIS and the Atlantic east coast, sustaining other extremely large megafauna species during highly favourable mean annual temperatures for growth (Schwimmer, 2002; Markwick, 1998). Other species of giant crocodyliforms (e.g. *Rhamphosuchus*, *Phosphatosaurus*, *Sarcosuchus*, *Crocodylus porosus*; for a complete list, see Appendix 1.3 Table S1) are/were likewise associated with extraordinarily productive and spatially extensive warm marine or wetland ecosystems including other megafauna. A proposed relationship of extreme body-size and ecosystem productivity is well in accordance with a global analysis of phanerozoic animals, excluding crocodyliforms, which found that the critical factor for gigantism is an unusually highly structured ecosystem in which productivity imposes only exceptionally low limits to sustain extraordinary body-size (Vermeij, 2016). Favourably constant warm temperatures (Markwick, 1998), an evolutionary shift to rapid growth rates early in ontogeny (Britton et al., 2012), and elevated long-term ecosystem productivity can be therefore considered key for the evolution of gigantism in crocodyliforms. The existence of very large, ~ 7 m long crocodylians in the present and Pleistocene icehouse conditions (*Crocodylus porosus*, Britton et al., 2012; *C. thorbjarnarsoni*, Brochu & Storrs, 2012; *Crocodylus* sp., Delfino & de Vos, 2014) suggests that, contrary to what the literal reading of the fossil record implies, a world with enormous crocodyliforms may have been rather the norm than the exception in the last ~130 million years.

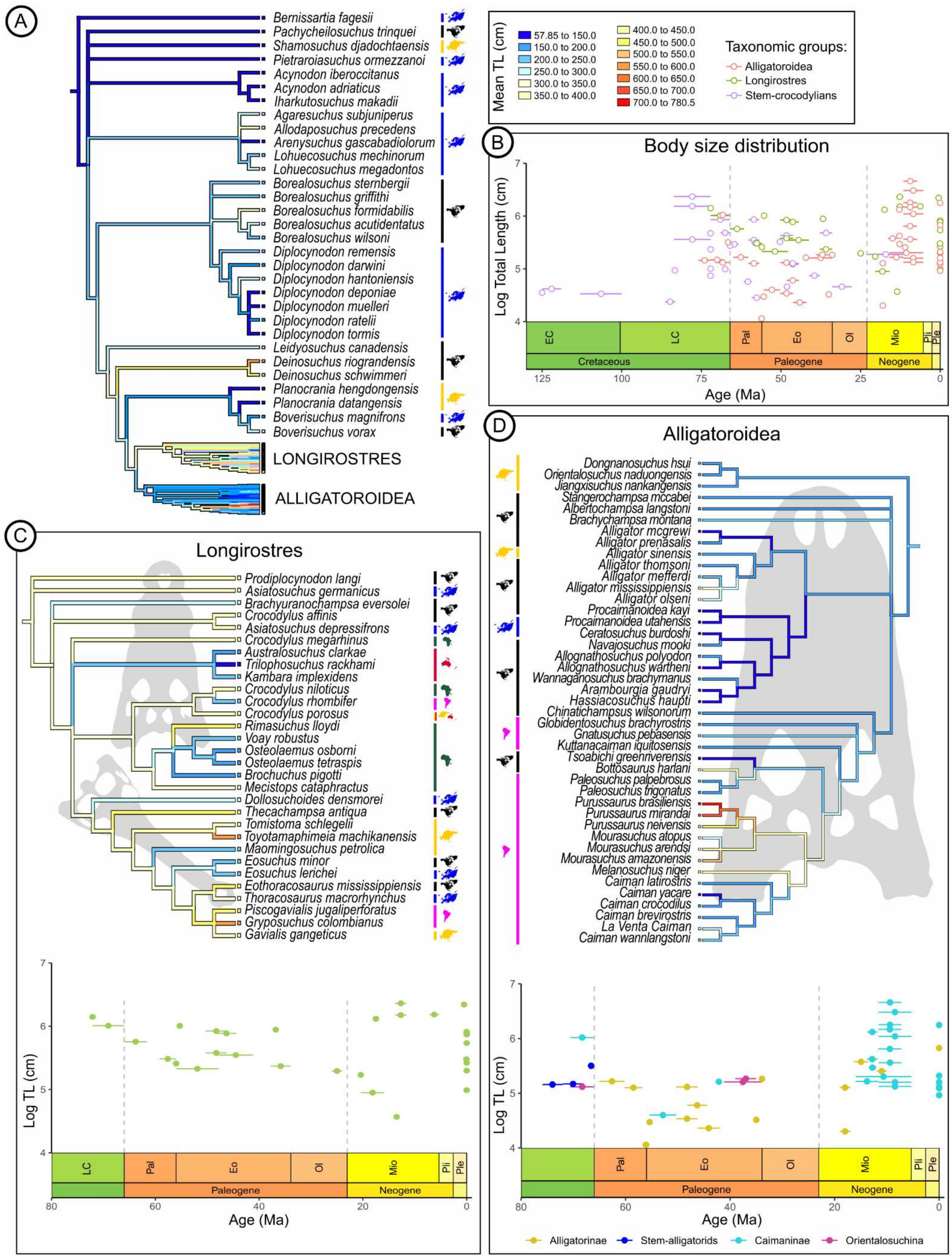


Figure 3: Parsimony ancestral state reconstruction of the phylogenetic mean total length estimations (Appendix 1.6) plotted on the strict consensus tree using equal branch length. A: stem- and crown-group Crocodylia; B: body size distribution of all taxa against geological time; C: Longirostres and body size distribution of the group through time; D: Alligatoroidea and body size distribution of the group through time. Ages are in Ma.

4.3 *Systematics of Diplocynodon and implications for Euramerican paleobiogeography*

Another novel aspect of the phylogeny presented in our study is the placement of the European Cenozoic *Diplocynodon* outside Crocodylia in a monophyletic group with species of North American *Borealosuchus* (Figure 1; *B. griffithi* has two alternative positions within the clade). This novel result is largely the impact of the addition of the geologically earliest known species of *Diplocynodon*, *D. remensis* (late Paleocene) as well as the early Paleocene *Borealosuchs griffithi* to our dataset. Pre-cladistic work has long acknowledged the high morphological similarities between *Diplocynodon* and *Borealosuchus* (Gilmore, 1910; Mook, 1960; Erickson, 1976; Rauhe & Rossmann, 1995) but this signal was never recovered in phylogenetic analyses (e.g. Brochu, 1999; Rio & mannion, 2021; Martin et al., 2014; Brochu & Storrs, 2012; Massonne et al., 2019; Walter et al., 2022; Brochu, 1997; Wu et al., 2001; Rio et al., 2020). Several plesiomorphies of *Diplocynodon* are shared with *Borealosuchus* and *Deinosuchus* but are absent in typical alligatoroids (e.g., long snout, confluent 3rd and 4th dentary alveoli, 4th and 5th maxillary alveoli equal in size; notch between premaxilla and maxilla in adults). A key character previously placing *Diplocynodon* in Alligatoroidea is the presence of a premaxillary-maxillary pit (instead of a notch) for the reception of the dentary fang early in ontogeny. The notch seen in adult *Diplocynodon* (the inferred plesiomorphic condition for Crocodylia) is secondary, developed later in ontogeny due to abrading occlusion (Brochu, 1999). However, the early ontogenetic pit is not confirmed for all species of *Diplocynodon* and more importantly, the condition remains unknown for *Borealosuchus* spp. and other stem-crocodylians (Brochu, 1997, 1999). The taxonomic distribution of the early ontogenetic premaxillary-maxillary pit is therefore ambiguous and might diagnose a more inclusive clade. On the other hand, some of the shared traits between *Diplocynodon* and *Borealosuchus* are derived and include the presence of ventral armour made of bipartite osteoderms (otherwise only known in *Tsoabichi greenriverensis* and extant caimanines; Brochu, 2010), the exclusion of the nasals from the external naris, unequal anterior processes of the surangular, and the presence of occlusion pits between the 7th and 8th maxillary alveoli. Indeed, our phylogeny optimises these three character states as synapomorphies uniting the clade *Diplocynodon* + *Borealosuchus*.

This topology has far better stratigraphic fit for species of *Diplocynodon* and *Borealosuchus* compared to previous phylogenies: for the first time, we recover the oldest species (i.e. the late Paleocene *D. remensis* and the Late Cretaceous *B. sternbergii*) of each clade as also the earliest branching taxa. Although the early Paleocene *Borealosuchus griffithi* has an unresolved position in our phylogeny, several of our most parsimonious trees place this species as the sister taxon of *Diplocynodon* spp. Under this particular topology, *Borealosuchus* is paraphyletic and the ghost lineage of nearly 20 Myrs inferred by previous phylogenies (with *Diplocynodon* spp. as early branching alligatoroid) are reduced to ca. 6 Myrs. Notably, *Diplocynodon remensis* and *Borealosuchus griffithi* both share the derived trait of a shallow recess on the medial wall of the premaxillary-maxillary notch (Martin et al., 2014), a character yet to be included in a phylogeny and explored for other species of *Diplocynodon* and *Borealosuchus*. A (*Borealosuchus* spp. (*B. griffithi* + *Diplocynodon* spp.)) clade is implying a single dispersal from North America to Europe during the Paleocene. The earliest known occurrence of *Diplocynodon* in the late Paleocene of Europe (*Diplocynodon remensis*, Martin et al., 2014) may underestimate the timing of the dispersal since a high number of North American species immigrated via Greenland and Scandinavia to Europe during the early and middle Paleocene using the De Geer route (West & Dawson, 1978; Smith et al., 2006; Mayr, 2009; Boyer et al., 2012; Rose, 2012; de Bast & Smith, 2017; Macaluso et al., 2022; Legendre & Lévêque, 1997; Briakitis, 2014). In light of the herein recovered stem-crocodylian status of *Diplocynodon*, a dispersal through a marine route cannot be excluded. A comprehensive revision of Paleogene *Borealosuchus* may contribute to testing or further refining these hypotheses.

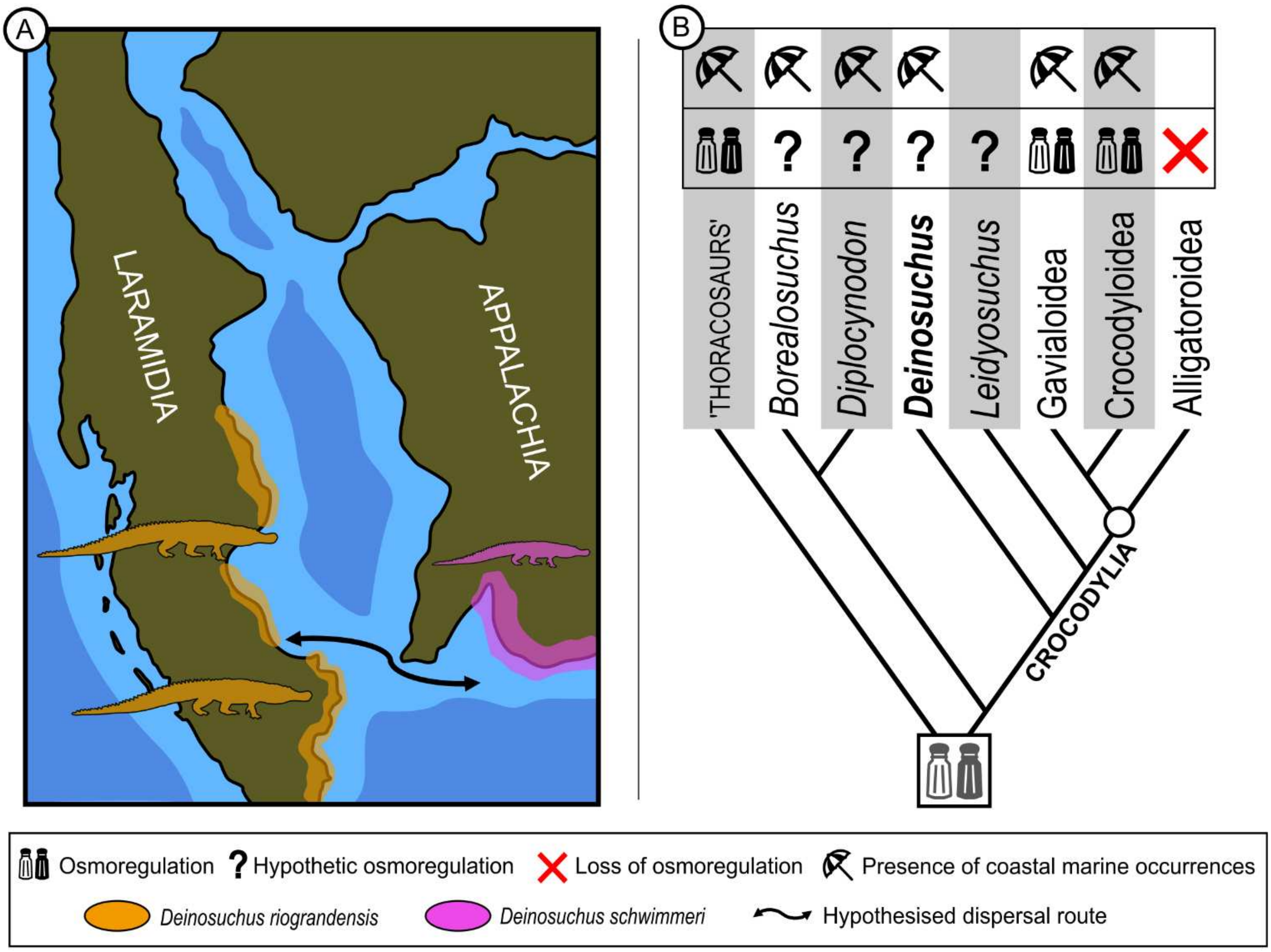


Figure 4. A: Distribution of *Deinosuchus riograndensis* and *D. schwimmeri*[3] during the Campanian around the Western Interior Seaway (WIS). B: parsimony ancestral state reconstruction (equal branch length) of osmoregulation in Crocodylia and close relatives using presence/absence of salt glands, stable isotopes, and coastal marine occurrences as proxies [Schwimmer, 2002; Wheatley, 2010; Venczel & Codrea, 2022; Kocsis et al., 2023; Mohler et al., 2021; Jackson et al., 1996; Grigg et al., 1998; Elsey, 2005; Lehmann et al., 2024; Roberts & Kirschbaum, 1995; Vélez-Juarbe et al., 2007; Markwick, 1998; McCormack, 2019; Burke et al., 2024]. The topology is from the present study except for 'thoracosaurs' for which we follow a more appropriate tip-dated work [Lee & Yates, 2018]. The analysis suggests potential plesiomorphic saltwater-tolerance for *Deinosuchus* and Crocodylia with early loss in Alligatoroidea. The distribution of *Deinosuchus* may be explained by dispersal across the WIS. Map is redrawn from [Scotese, 2008], early to late Campanian. Distribution of *Deinosuchus* spp. follows [Cossette & Brochu, 2020; Schwimmer, 2002; Mohler et al., 2021] and references therein.

4.4 *Implications for crocodyliform extinction across the Eocene/Oligocene cooling*

Our topology has implications for phylogenetic patterning of high crocodyliform extinction rates across the cooling climate of the Eocene/Oligocene transition in North America and Europe (Markwick, 1998). Previous phylogenies implied that all crocodyliform survivors in terrestrial ecosystems were alligatoroids, including *Diplocynodon* (e.g. Brochu, 1999; Brochu, 2004; Kotsakis et al., 2004; Delfino & Smith, 2012; de Celis et al., 2020; Seghetti et al., 2022). In contrast, the topology herein suggests a survival pattern less structured by phylogeny: in Europe, the stem-crocodylian *Diplocynodon* spp., whereas in North America, the alligatorine lineage leading to *Alligator* spp. crossed the transition (Walter et al., 2022; Brochu, 2010). In contrast, the herein proposed sister-taxon of *Diplocynodon*, the North American *Borealosuchus* did not survive into the Oligocene (with the last occurrence known from the middle Eocene; *Borealosuchus wilsoni* (Rio & Mannion, 2021, Brochu, 1997). This divergent survival pattern may be best explained by independent cold adaptation in *Diplocynodon* and the lineage leading to *Alligator*. It has been previously proposed that following global cooling, shrinking habitats led to increased competition between large and small-bodied crocodylians and selective extinction of small-sized taxa (Godoy et al., 2019). An alternative explanation consistent with our body-size analysis, at least for alligatoroids, is that small-sized lineages evolved large body-sizes during the Neogene without selective extinction of small taxa.

4.5 *Early alligatoroid evolution*

The most important difference relative to previous datasets is the sampling of the key taxa *Diplocynodon remensis*, *Borealosuchus griffithi*, and *Deinosuchus* spp. in the present work and these additions are largely responsible for the changes in topology. In contrast to previous global phylogenies (Brochu, 1999; Cossette & Brochu, 2020; Rio & Mannion, 2021; O'Brien et al., 2019; Brochu & Storrs, 2012; Massonne et al., 2019; Stocker et al., 2021; Walter et al., 2022, Brochu, 2011; Shan et al., 2021), the analysis herein advocates a less inclusive alligatoroid clade (Figure 2). Under this topology, previously recovered synapomorphies for Alligatoroidea, including *Deinosuchus* (e.g. foramen aëreum set in from the margin of the retroarticular process, occlusion of anterior dentary teeth lingual to maxillary teeth, quadratojugal spine located between the posterior and superior angles of the infratemporal fenestra; see Cossette and Brochu, 2020) are reoptimized to diagnose a more inclusive clade. The earliest representatives of Alligatoroidea are herein restricted to only a few taxa from the Late Cretaceous of North America (*Brachychampsa* spp., *Stangerochampsa mccabei*, and *Albertochampsa langstoni*; Norell et al., 1994; Wu et al., 1996, Williamson, 1996), here recovered either as representatives of stem Alligatoridae or the early branching Alligatorinae (total group of *Alligator* spp.). Both alternatives would make the name Globidonta (Brochu, 1999) redundant with Alligatoroidea. This restricted taxonomic composition has a better stratigraphic fit owing to the removal of the stratigraphically old and morphologically specialised *Deinosuchus*. It also implies less homoplasy and eliminates the phenetic contrast with taxa previously inferred as early branching alligatoroids. In turn, taxa replaced as stem-crocodylians are arranged in a topology with a better stratigraphic fit, such as *Diplocynodon* and *Borealosuchus* (see above).

Almost all Cretaceous alligatoroids, under the novel topology, share a relatively reduced body-size compared to other non-alligatoroid crocodylians, suggesting phyletic dwarfism (Gould & McFadden, 2004) early during the evolution of the group (Figure 3). An exception is *Brachychampsa montana*, which retains a body-size comparable to the ancestral condition of Crocodylia. *Bottosaurus harlani* is another large-sized early putative alligatoroid (Cossette & Brochu, 2018) but its affinity with the group has been questioned (Walter et al., 2022). Additionally, all share a typical short and blunt snout, full overbite dental occlusion, a caniniform 4th maxillary tooth, crushing posterior dentition, a North American Laramidian distribution, and freshwater habitat. The only exceptions in our topology are representatives of Late Cretaceous–Paleogene Orientalosuchina that are here recovered as the earliest diverging alligatoroids and are characterised by plesiomorphies including a 5th maxillary caniniform tooth, a notch between the premaxilla-maxilla for the reception of the 4th dentary tooth, as well as a strictly Asian distribution (Massonne et al., 2019; Shan et al., 2021; Martin & Lauprasert, 2011; Wang et al., 2016; Li et al., 2019). The global phylogenetic relationships of Orientalosuchina, however, has been unstable and studies variously placed them in stem-group Alligatoridae (Massonne et al., 2019; Walter et al., 2022; Shan et al., 2021; Wu et al., 2023), Crocodyloidea (Wang et al., 2016; Li et al., 2019; Wu et al., 2023; Wu et al., 2018), Caimaninae (Walter et al., 2022, under equal weighting), and Australian Mekosuchinae (Ristevski et al., 2023). The alligatoroid position of Orientalosuchina in our phylogeny is not well supported since most synapomorphies uniting the two groups are unknown in most orientalosuchines and the outgroup (Appendix 1.2 for the list of alligatoroid synapomorphies and trees). Additionally, their endemic Asian distribution is in contrast with that of all other early alligatoroids and would imply an early dispersal to Asia during the Late Cretaceous, a route otherwise poorly supported (Massonne et al., 2019).

Except for Orientalosuchina, the simplified paleobiogeographic pattern inferred by our topology is consistent with a vicariant divergence between Alligatoroidea and its sister-clade, Longirostres (Crocodylidae + Gavialidae; Oaks, 2011). Most early and living representatives of Longirostres have an Asian origin and/or distribution (Rio & Mannion, 2021), whereas all definite early alligatoroids are North American. The age of this divergence has been estimated into the early Late Cretaceous (ca. 90–100 Mya; Oaks, 2011; Pan et al., 2021; Lee & Yates, 2018; Darlim et al., 2022) coinciding with a period of extreme sea level increase culminating in the highest sea level during the entire Mesozoic and Cenozoic eras (90–94 Mya, Turonian; Olde et al., 2015). Exceptionally high sea level may have isolated North American and Asian ancestral stem-crocodylians by posing a wide marine barrier, even for saltwater tolerant species, across Beringia. In contrast, warm climate would have instead favoured high latitude faunal connections during the Turonian (Cretaceous thermal maximum; Moriya, 2011) and is therefore unlikely to have driven divergence. Based on our topology, we can infer that alligatoroids, as a freshwater clade in the interior of the continent, secondarily lost lingual salt glands and associated osmoregulation ability early during their evolution. Our parsimony body-size analysis recovers a minimum of 20% reduction in total body length (TL) at the root of Alligatoroidea, involving a shrinkage from 200–250 cm to 150–200 cm. This reduction reaches up to 40% (from 200–250 cm to < 150 cm) when early alligatorines such as *Ceratosuchus burdoshi* are considered (Figure 3). Low body-size disparity and shrinking early in the evolution of the group is a novel finding of this study as previous body-size analyses employed different topologies (i.e. not accommodating molecular topologies in the phylogenetic framework, placing *Diplocynodon* and *Leidyosuchus* as early alligatoroids, and excluding

Deinosuchus from the sample; Gearty & Payne, 2020; Godoy & Turner, 2020; Godoy et al., 2019). Small body size was broadly retained during the Paleogene and gigantic forms only evolved in the Neogene among caimanines (*Purussaurus* and *Mourasuchus* from South America). In addition, large size (3–4 m) independently evolved in the lineage of extant *Alligator mississippiensis*. Godoy et al. (2019) proposed that Cenozoic Crocodylia body-size progressively increased in response to selective extinction of smaller-bodied taxa due to global cooling-induced habitat loss and associated increased competition. However, as we demonstrate here, in alligatoroids at least, there were no large-bodied taxa before the Neogene and instead, small-bodied taxa may have simply evolved into large-bodied ones. In line with this, Miller-Camp & Brochu (2018) suggested that small-sized Paleogene specialists with crushing dentition evolved into larger-sized generalists in the Neogene, although we note that a specialised morphology may not be necessarily associated with narrow niche (Darlim et al., 2023). Under our topology, we detect a minor body-size increase in *Alligator* following the Eocene/Oligocene extinction of all other North American crocodylians (Hutchison, 1992; de Celis et al., 2020).

CHAPTER 2: Assessing the waste-basket status of *Diplocynodon* through quantitative and taxonomic analysis of fossil occurrences

To be submitted as: Walter J. D., Macaluso L., Rabi M., Martin J. & Delfino M. Assessing the waste-basket status of *Diplocynodon* through quantitative and taxonomic analysis of fossil occurrences.

1. Introduction

The European fossil record of Eusuchia during the early Cenozoic greenhouse shows an exceptionally diverse fauna, including large generalist forms such as *Asiatosuchus* spp., short-snouted alligatorines (*Allognathosuchus* and *Hassiacosuchus*), two unrelated terrestrial hypercarnivores, and a mid-sized generalist, *Diplocynodon* (Hastings & Hellmund, 2017; Rio & Mannion, 2021). This high diversity is in contrast with the period immediately preceding the global cooling of the Eocene/Oligocene (33.9 Ma; de Celis et al., 2020) transition, by which time European crocodyliformes already experienced a severe diversity decline (Martin, 2010; Mannion et al., 2015). *Diplocynodon* however maintained a continuous presence in Europe from the late Paleocene to the Middle Miocene, offering a rich and widespread record (Berg, 1966; Buscalioni et al., 1992; Martin et al., 2014; Rio et al., 2020; Rio & Mannion, 2021). The extinction of *Diplocynodon* was previously hypothesised as a result of the global cooling occurring in the Middle Miocene, shortly after dispersal of the taxon from central to south Europe (Böhme, 2003).

The recent research focus on the group allowed the revision of previously described species and to test the phylogenetic relationships of *Diplocynodon*, largely recognising a monophyletic clade of early-branching alligatoroids (Brochu, 1999; Martin, 2010; Martin et al., 2014; Macaluso et al., 2019; Rio et al., 2020; Rio & Mannion, 2021) or stem-group crocodylians (see discussion in Martin et al., 2014; Walter et al., 2025). The successive revisions and erections of species have however overlooked the genus diagnosis, therefore setting lengthy combinations of morphological characters to discriminate taxa. As a result, previous studies suggest that species-level taxonomy of *Diplocynodon* is not well-established, and highly incongruent stratigraphic fits are commonly recovered in phylogenies (Martin, 2010; Delfino & Smith, 2012; Martin et al., 2014; Rio & Mannion, 2021). Knowledge of speciation mechanisms in the clade is consequently impoverished: allopatry due to climate or tectonics-induced geographic isolation, or even sympatry as in the case proposed for *Diplocynodon darwini* Ludwig, 1877 and *Diplocynodon deponiae* Frey, Laemmert & Ries, 1987 from Messel (Delfino & Smith, 2012) may have taken place in the evolutionary history of the group.

Since Pomel (1847) erected the genus based on the crocodylian remains found in Saint-Gérand-le-Puy, Cenozoic crocodylian material was repeatedly attributed to *Diplocynodon*. As such, it might today be considered as a waste–basket taxon, given that it shares with other waste–basket taxa (Plotnick & Wagner 2006) an early date of first description and a stratigraphically extended fossil record. To test this possible status, we herein quantitatively and qualitatively review the nature of the occurrences and of the material attributed to *Diplocynodon* through a survey of the literature cited by two open online palaeontological databases.

Furthermore, the current study revisits the ingroup taxonomy of *Diplocynodon*, assessing whether the currently established species are morphologically distinct, and presents updated and concise diagnoses of the genus and of the valid species. A dichotomous key of the valid species was subsequently built to favour future straightforward identifications.

2. Material and Methods

We performed a complete material survey of *Diplocynodon* for the total number of occurrences found in two online databases, namely The Paleobiology Database (PBDB; https://paleobiodb.org) and fosFARbase (Böhme & Ilg, 2003). The database outputs for *Diplocynodon* were retained and checked to remove overlapping occurrences. The supporting literature cited for each of them was then cross checked to categorise the nature of the reference to *Diplocynodon* (*Diplocynodon* sp. or species level, either simply mentioned, described and/or figured, see below). Occurrences that could not be corroborated in the cited literature were deleted, as the information provided could not be verified. Second, the type of material for each occurrence was assessed by scoring the presence of different types of specimen categories: articulated specimens, cranial and/or postcranial elements. The terminology used for the survey mainly follows Uhen et al. (2023) and are explained as follows:

- ‘occurrence’ refers to the presence of a taxon per locality;
- ‘evidence’ refers to a description (including osteological element) and/or figure(s) of the specimen(s)
- ‘cited/mentioned’ refers to a simple citation of a taxon without evidence (e.g. in a faunal list).

The complete list of occurrences, taxonomic identifications (including the updated attributions following the taxonomic revision presented in this study), calculations, references, and list of all specimens studied first hand is provided Appendix 1. The supplementary references list is reported in Appendix 2.3.

3. Results

The complete list of described species of *Diplocynodon* is reported in Table 1, and the revised validity and diagnostic characters are expanded in the following Systematic Palaeontology section. In total, 169 occurrences were qualified as usable after removal of overlapping and uninformed entries in both databases (see Figure 1 for a summary of the results). A majority of this sample actually includes concrete evidence of *Diplocynodon* occurrence (60.9%). Attributions at species level rank represent nearly half of the total number of occurrences (45%), of which only one third report one or more articulated specimens (32.8%). Most occurrences providing evidence report disarticulated material (88.3%), comprising teeth and osteoderms as their main components. Regarding the distribution of the material over geological ages, the record is underrepresented in the Paleocene (1.7%) and largely dominated by Miocene remains (59.8%).

4. SYSTEMATIC PALAEONTOLOGY

Crocodyliformes Hay, 1930 (*sensu* Benton & Clark, 1988)

Eusuchia Huxley, 1875 (*sensu* Brochu, 2003)

Crocodylia Gmelin, 1789 (*sensu* Brochu, 2003)

Diplocynodon Pomel, 1847

Emended diagnosis:

Diplocynodon is a medium-sized crocodyliform characterised by the unique combination of the following characters:

– the presence of paired canines both on the dentary (3rd + 4th teeth) and the maxillary (4th + 5th teeth);

– the 3rd and 4th dentary alveoli are confluent;

– the 3rd and 4th dentary alveoli occlude in a pit early in ontogeny;

– the ventral shield consists of bipartite osteoderms;

– the iliac blade is rounded and ventrodorsally deep.

Comments:

Pomel (1847: 383) names the genus *Diplocynodon* in a short note briefly describing the confluence of the 3rd and 4th dentary teeth: "[…] the third and fourth mandibular teeth, very close, very strong and nearly equal, protrude the upper jaw together in a cavity located at the junction between the maxillary and intermaxillary; the teeth are also less numerous than in extant species. We can call them *Diplocynodon*." We hereby propose an emended diagnosis of *Diplocynodon* based on characters consistently recognised in founding taxonomical works, recent studies and personal observations. These morphological traits were previously included in nearly all *Diplocynodon* species diagnoses, complicating the interspecific identification. *Diplocynodon* is today only unambiguously found in the Cenozoic of Europe. Early studies attributed material from North America (*Diplocynodon stuckeri*;

Mook, 1960) or Asia (Efimov, 1988; Liu & Chen, 1993), but were later reattributed to other taxa or considered too fragmentary to be confidently referred to *Diplocynodon* (Brochu, 1999).

Species	**Authorship**	**Historical synonymies**	**Possible synonyms**	**References**	**Age**
Diplocynodon remensis	Martin et al., 2014	-	-	Martin et al., 2014	Thanetian
Diplocynodon deponiae	Frey et al., 1987	*Baryphracta deponiae*	-	Delfino & Smith, 2012	Lutetian
Diplocynodon darwini	Ludwig, 1877	*Alligator darwini*	-	Berg, 1966	Lutetian
		Crocodilus ebertsi	-		
		Diplocynodon hallense	-	Kuhn, 1938	
				Rauhe & Rossmann, 1995	
Diplocynodon tormis	Buscalioni et al., 1992	-	-	Buscalioni et al., 1992	Lutetian / Bartonian
Diplocynodon elavericus	Martin, 2010	-	-	Martin, 2010	Priabonian
Diplocynodon hantoniensis	Wood, 1846	*Alligator hantoniensis*	-	Rio et al., 2020	
		Crocodilus hastingsiae	-	Owen, 1848	
Diplocynodon kochi	Venczel & Codrea, 2022	-	-	Venczel & Codrea, 2022	Priabonian
Diplocynodon gervaisi	Gervais, 1859	-	-	Gervais, 1859	Rupelian
Diplocynodon muelleri	Kälin, 1936	*Hispanochampsa muelleri*	-	Piras & Buscalioni, 2006	Rupelian
		Diplocynodon guerini	-	Bataller, 1941	
		Diplocynodon marini	-	Bataller, 1941	
		-	*Diplocynodon monsvialensis*	Macaluso et al., 2019	
		-	*Diplocynodon dalpiazi*		
Diplocynodon levantinicum	Huene & Nikoloff, 1963	-	-	Massonne & Böhme, 2022	Chattian
Diplocynodon ratelii	Pomel, 1847	*Crocodilus ratelii*	-	Pomel, 1846	Aquitanian
Diplocynodon ungeri	Prangner, 1855	*Enneodon ungeri*	-	Martin & Gross, 2011	Langhian
		Diplocynodon styriacus	-	Thenius, 1955	
		Diplocynodon steineri	-	Thenius, 1955	
Diplocynodon buetikonensis	von Meyer, 1845	*Crocodilus bütikonensis*	-	Berg, 1966	Tortonian

Table 1: List of valid taxa ordered according to their age (from the oldest to the youngest) including authorship, historical synonymies, possible synonyms, and essential references.

Ingroup taxonomy

Valid taxa (ordered alphabetically)

Diplocynodon darwini (Ludwig, 1877)

(Plate 2)

Type material:

Table I–XVI in Ludwig (1877)

Type locality:

Grube Messel (Darmstadt, Germany).

Geological stage and age:

Middle Eocene, early Lutetian (MP 11), 47 Ma.

Diagnosis:

Diplocynodon darwini belongs to *Diplocynodon* by the unique combination of characters diagnosing the genus (presented above).

It differs from all other *Diplocynodon* species by the combination of the following characters:

- presence of a linear sulcus on the prefrontal, along the anteromedial margin of the orbit;
- lack of osteoderms coverage on posterior section of the tail (i.e. the posterior two-thirds);
- the orbital margin flush with the circumscribing bones surface.

This species is further characterised by:

- a retention of the pterygoid-ectopterygoid flexure (shared with *D. deponiae* and *D. hantoniensis*).

Comments:

Diplocynodon darwini was erected by Ludwig (1877) on the basis of disarticulated material from the locality of Messel. It was originally subdivided in two separate species, *Alligator darwini* and *Crocodilus ebertsi*, based on subtle variation in dental ornamentation. Personal observation of multiple specimens not available at the time of the species erection did not reveal such discrimination: available specimens shared similar dentition, cranial and postcranial skeletal organisation. We thus hereby agree with Rauhe & Rossmann (1995) and later works in considering both taxa to belong to a single species. Our investigation also involved specimens of *Diplocynodon hallense* (Kuhn, 1938), housed in the collections of the Geiseltalmuseum (Halle, Germany). We hereby agree with Berg (1966) in invalidating *D. hallense*, as no evident morphologies distinguish the Geiseltal population from the Messel population at species level. Comparison of the two populations however revealed intraspecific variation (including ontogenetic) in *D. darwini*, and that may also occur in congeneric species. These include: 1) length of mandibular symphysis (reaching the 3rd and up to the posterior end of the 4th dentary alveolus), size of the medial jugal foramen, presence of a premaxillary-maxillary notch, or confluence of the 4th and 5th maxillary alveoli.

While *Diplocynodon darwini* is currently recognised from the localities of Messel and Geiseltal, its distribution may have been more widespread: unstudied material currently attributed to Crocodylia indet. or *Diplocynodon* sp. was recovered from various Eocene localities in Europe (e.g. Dormaal, Maransart or Eckfeld). This material, if pertaining to *Diplocynodon darwini*, would extend the time range and geographical distribution of the species.

Diplocynodon deponiae (Frey, Laemmert & Riess, 1987)

(Plate 1B)

Type material:

SMF ME 899 (holotype), a complete skeleton exposed in left lateral and ventral views.

Type locality:

Messel Pit (Darmstadt, Germany).

Geological stage and age:

Middle Eocene, early Lutetian (MP 11), 47 Ma.

Diagnosis:

Diplocynodon deponiae belongs to *Diplocynodon* by the unique combination of characters diagnosing the genus (presented above). It differs from all other *Diplocynodon* species by the combination of the following characters:

- a relatively small body-size (ca. 1 m in total length);
- a complete armour coverage extending on limbs, body and tail;
- choanae placed approximately in the middle of the pterygoids;
- a significant overhang of the supratemporal fenestrae by dermal bones of the skull roof;
- external naris circumscribed by a thin ridge.

This species is further characterised by:

- a retention of the pterygoid-ectopterygoid flexure throughout ontogeny (shared with *D. darwini* and *D. hantoniensis*);
- very blunt posterior dentary and maxillary teeth (shared with *D. hantoniensis*).

Comments:

The species was first erected by Frey, Laemmert & Riess (1987) under the genus and species name *Baryphracta deponiae*. It was later recombined into *Diplocynodon deponiae* by Delfino & Smith (2012) based on newly prepared specimens housed in the Institut Royal des Sciences Naturelles de Belgique in Brussels. We amended the previous diagnosis of Delfino & Smith (2012) to discard characters shared among all species where known, and further specify characters shared with *D. hantoniensis* and *D. darwini* but no other species.

Diplocynodon deponiae differs noticeably phenotypically from its congeneric species, bearing several characters found in combination in extant dwarf crocodylian species at maturity: a reduced total length, supratemporal fenestrae closed or nearly closed, and an extensive armour coverage (Clarac et al., 2024). These characters were previously described by Delfino & Smith (2012) and are confirmed in the present study after first-hand study of several specimens (JDW pers.obs.). Found solely in the locality of Messel (Germany), *Diplocynodon deponiae* may well represent a dwarf species of *Diplocynodon*. The species may have evolved derived characters related to dwarfism to maximise niche partitioning with

Diplocynodon darwini and/or other large crocodylians such as *Asiatosuchus* found in the same locality (Morlo et al., 2004; Smith et al., 2024).

Diplocynodon hantoniensis (Wood, 1846)

(Plate 1G)

Type material:

NHMUK OR 25166 (holotype), a complete snout.

Type locality:

Hordwell Cliff (Hampshire, United–Kingdom).

Geological stage and age:

Upper Eocene, early Priabonian (MP 17), 37 Ma.

Diagnosis:

Diplocynodon hantoniensis belongs to *Diplocynodon* by the unique combination of characters diagnosing the genus (presented above). It differs from all other *Diplocynodon* species by the combination of the following characters:

- premaxillary surface posterolateral to external naris with a deep notch;
- short anterior ectopterygoid process, which forms the medial wall of the posteriormost maxillary alveolus, before veering medially to the suborbital fenestra;
- broad preorbital ridge on the lacrimal.

This species is further characterised by:

- a retention of the pterygoid–ectopterygoid flexure throughout ontogeny (shared with *D. darwini* and *D. deponiae*);
- very blunt (“globular” in Rio et al., 2020) posterior dentary and maxillary teeth (shared with *D. deponiae*).

Comments:

The validity of *Diplocynodon hantoniensis* was reassessed and confirmed by Rio et al. (2020), who redescribed and referred additional material in their recent revision of the species, including several complete skulls and disarticulated skull elements, postcranial material consisting of vertebrae and limb bones, and osteoderms. The diagnosis of *Diplocynodon hantoniensis* by Rio et al. (2020) was slightly modified here to specify characters shared with *D. deponiae* and *D. darwini* but not with the other species.

The general proportions of known specimens of *Diplocynodon hantoniensis* make it one of the largest species in the group, potentially explained by a better preservation in volume and higher degree of maturity of the individuals. A nearly complete skull of comparable size and shape from the Oligocene of Dordogne (France) was described and referred to *Diplocynodon* cf. *hantoniensis* by Vignaud et al. (1996). However, following comments of Rio et al. (2020) and after first-hand observation of a cast of the specimen (JDW pers. obs.), we advise a referral to *Diplocynodon* sp. pending restudy of the specimen.

Diplocynodon kochi Venczel & Codrea, 2022

(Plate 1H)

Type material:

UBB V.1453 (holotype), a nearly complete skull.

Type locality:

Cluj-Mănăștur former limestone quarry, Cluj-Napoca (Transylvania, Romania).

Geological stage and age:

Upper Eocene, early Priabonian (MP 17), 37 Ma.

Diagnosis:

Diplocynodon kochi belongs to *Diplocynodon* by the unique combination of characters diagnosing the genus (presented above). It differs from all other *Diplocynodon* species by the combination of the following characters:

- lateral carotid foramen opens dorsal to basisphenoid at maturity;
- posterior series of maxillary (12th–16th) and dentary (14th–19th) teeth and alveoli are mediolaterally compressed;
- the 1st, 2nd and 3rd premaxillary alveoli are placed closer to each other than to the 4th and 5th.

<u>Comments</u>:

Additional material was referred to *Diplocynodon kochi* by Venczel (2023), including postcranial elements, previously unknown for the species and not preserved in the holotype. The assignment of this undiagnostic material (e.g. UBB V 1005, 1006: femurs; and 1007: a vertebra) to the latter species relies on their co–occurrence in the same stratigraphic unit.

We amended the diagnosis of *Diplocynodon kochi* in light of new insights in intraspecific variation of *Diplocynodon* spp. and detailed comparison with published revisions of other species. Characters diagnostic at generic level were removed from the diagnosis.

Previous autapomorphies were also amended: enlarged and procumbent 1st dentary teeth are also present in *D. darwini*, *D. hantoniensis* and *D. ratelii*, therefore not autapomorphic for *D. kochi*. Additionally, the recess on the parietal medial wall does not appear any different from the condition seen in most *Diplocynodon* species which bear an open supratemporal fenestra where the parietal forms a medial shelf and is slightly concave on its lateral wall. The 'recess' described in *D. kochi* is rather likely the effect of the modest overhang of the parietal over the anteromedial corner of the supratemporal fenestra coupled with dorsoventral compression of the braincase. Furthermore, the preorbital ridge described by Venczel & Codrea (2022) rather appears like a step between the dorsal level of the lacrimal and the dorsal level of the anterolateral corner of the orbit due to dorsoventral compression on this part of the skull. Virtually all crocodylians bear a variably pronounced preorbital ornamentation on the lacrimal, usually linear and running along the lacrimal dorsal surface. The condition in *Diplocynodon* spp. is very modest to absent. One character state is here newly added to the diagnosis, as it differs from the condition seen in all other congeneric species: the 1st, 2nd and 3rd premaxillary teeth are placed closer to each other than to the 4th and 5th.

Diplocynodon levantinicum Huene & Nikoloff, 1963

Type material:

NMNHS 31-1 (lectotype), cast of a right dentary fragment.

Type locality:

Nadeshda (Dimitrovgrad, Bulgaria), Chattian (late Oligocene).

Geological stage and age:

Upper Oligocene, early Chattian (MP 27), 26 Ma.

Diagnosis:

Diplocynodon levantinicum belongs to *Diplocynodon* by the unique combination of characters diagnosing the genus (presented above). It differs from all other *Diplocynodon* species by the combination of the following characters:

- a lingual foramen for the articular artery situated entirely on the surangular;
- a long suborbital fenestra reaching the level of the eighth maxillary alveolus;
- an occlusion pit in line with the tooth row posterior to the 14th dentary alveolus.

Comments:

Massonne & Böhme (2022) recently revised *Diplocynodon levantinicum* based on new and previously published specimens by Huene & Nikoloff (1968). The authors proposed an updated late Oligocene age for the material and confirmed the species validity. We hereby amended the previous diagnosis of Massonne & Böhme (2022) by discarding characters shared among all species, where known, and retaining characters bearing a different condition from other *Diplocynodon* species.

Diplocynodon muelleri (Kälin, 1936)

(Plate 1D)

Type material:

NMB Spa 4 (holotype), NMB Spa 73 (paratype).

Type locality:

El Talladell (Lleida, Spain).

Geological stage and age:

Lower Oligocene, Rupelian (MP 23), 31–29 Ma.

Referred material:

Complete list provided by Piras & Buscalioni (2006).

Diagnosis:

Diplocynodon muelleri belongs to *Diplocynodon* by the unique combination of characters diagnosing the genus (presented above). It differs from all other *Diplocynodon* species by the combination of the following characters:

- splenial excluded from mandibular symphysis, and with anterior tip passing dorsal to Meckelian groove;
- orbital contour anteriorly notched;
- lateral edges of palatines with anterior projections into suborbital fenestrae.

Comments:

Piras & Buscalioni (2006) provided a new combination of the taxon *Hispanochampsa muelleri* Kälin 1936 into *Diplocynodon muelleri*: a handful of specimens from Spain were newly referred to the species and the species diagnosis was amended. The latest revision of the Oligocene crocodylians from Monteviale by Macaluso et al. (2019) attributed the local specimens to *Diplocynodon* cf. *muelleri*, as no significant differences could be put forward to justify the presence of a separate species in the Italian locality. The definitive attribution to *D. muelleri* was prevented by both the uncertain distinction between the two Spanish species *D. muelleri* and *D. tormis* at that time, and by the longer extension of the mandibular symphysis of the Monteviale *Diplocynodon*, that would have eventually distinguished it from *D. muelleri*. In light of the first-hand variation observed in *D. darwini*, we argue for the intraspecific nature of the mandibular symphysis length in *Diplocynodon* species, that can vary from the level of the 3rd dentary alveolus to reaching the posterior edge of the 4th. This variation is actually known in crocodylians: the character coding for the length of the mandibular symphysis is actually used in various eusuchian morphological datasets (e.g. Brochu, 1999, and subsequent works; Rio & Mannion, 2021), and regard the variation described above as a single state for eusuchian taxa. We therefore refute the use of this character to separate *D. muelleri* from other *Diplocynodon* species. If the Monteviale material has to be referred to the same taxon as the Spanish material (referred to *D. muelleri*), then the taxon would take the name *Diplocynodon monsvialensis* comb. nov. based on nomenclature priority rules (ICZN, 1999).

However, crucial to this matter is the ambiguity of the diagnostic characters of the Spanish species retained in the present work:

a. The dorsal projection of the anterior tip of the splenial relative to the Meckelian groove is only briefly mentioned by Piras & Buscalioni (2006), without reference to any precise specimen showing this condition. Our first-hand observation of NMB Spa 4 (holotype) did not allow us to confirm this condition, as the mandibular rami are strongly twisted and damaged on the relevant region. NMB Spa 73 (paratype) on the other hand preserves the right mandible with its medial surface, but the anterior tip of the splenial is broken off: the sutural mark however indicates exclusion from the mandibular symphysis, with the tip placed ventrally to the Meckelian groove. One cannot exclude that Piras & Buscalioni (2006) based their observations on specimens that are not figured and/or specifically referred, other than the types, making their interpretations irreproducible as to now. The condition in *Diplocynodon* from Monteviale is rather unclear, as most specimens either do not preserve the relevant region, or the splenial tip is largely obscured because of the mandibular occlusion. A thorough reassessment of this character in both specimen samples is in order to clarify the appropriate morphology.

b. The orbital contour anteriorly notched is apparent in both *D. muelleri* and the Monteviale *Diplocynodon*, but this could be a taphonomic artefact caused by dorsoventral compression during diagenesis. As a matter of fact, the most severely compressed specimens of *D. darwini* from Messel and Geiseltal show a similar anteriorly notched orbital outline, contra less deformed skulls.
c. Similarly to point (a), the anterior projections of the lateral edges of the palatines into the suborbital fenestrae are only mentioned in the diagnosis of the taxon. No specimens are referred by the authors to corroborate this condition. This character, defined by Brochu (1999; character 106), describes an evident and thin flange protruding in the anteromedial corner of the suborbital fenestra. This morphology cannot be assessed in the holotype of *D. muelleri*, but the right palatine (although distorted) seems to project slightly in the fenestra. Like other diagnostic characters, future research should focus on the reassessment of this morphology in both the material referred to *D. muelleri* and specimens from Monteviale.

Diplocynodon ratelii Pomel, 1847 (type species of the genus)

(Plate 1E-F)

Type material:

MHNH F BR 4020 (holotype), a fragmented skull.

Type locality:

Saint-Gérand-le-Puy (Allier, France).

Geological stage and age:

Lower Miocene, early Aquitanian (MN1), ca. 23–22 Ma.

Diagnosis:

Diplocynodon ratelii belongs to *Diplocynodon* by the combination of characters diagnosing the genus (presented above). It differs from all other *Diplocynodon* species by the unique following character:

- the nasals contact the posterior margin of the external nares;
- the snout remains comparably narrow throughout ontogeny (shared with *D. ungeri*).

Comments:

Diplocynodon ratelii, type species of *Diplocynodon*, is recorded in several Miocene localities across Europe. Pomel (1846) originally referred material from Saint-Gérand-le-Puy to *Crocodilus ratelii*, mentioning the abundance of osteoderms. Reference to the species is actually absent in Pomel (1847) where the author erected the genus *Diplocynodon* in a brief note (see above comments on *Diplocynodon* spp.). Only later Pomel (1853:123) provides a more complete description of the species, referred to *D. ratelii* in the latter work: "1. *Diplocynodus ratelii*, Pom. Skull with a nearly straight shape up to the anterior third of the orbits, where it forms an obtuse and right angle beyond the skull region. The latter resembles the true crocodiles one much more than the one of caimans, because of the development of its temporal fossae, nearly as large as in the Nile species. The skull is, as a whole, less large posteriorly than in alligators, and less constricted anteriorly than in crocodiles. The head never exceeds 0.32 to 0.33 [meter], and the species is small". Vaillant (1872) revised the latter material and gives a complete description of new specimens (referred to *Crocodilus gracilis*). *Crocodilus gracilis* is today considered a junior synonym of *Diplocynodon ratelii*, following more formal diagnoses from Berg (1966) and subsequent studies (e.g. Brochu, 1999; Brinkmann & Rauhe, 1998). Despite a fossil record that has become increasingly richer since the earliest works, a thorough redescription and update of the taxon diagnosis is critically lacking. Future studies on this matter should include the several recent finds from other European localities (Diaz-Araez et al., 2016; Lujàn et al., 2019; Chroust et al., 2021).

Diplocynodon remensis Martin, Smith, de Lapparent de Broin, Escuillié & Delfino, 2014

(Plate 1I)

Type material:

MHNH F BR 4020 (holotype), a fragmented skull.

Type locality:

Mont de Berru (Champagne, France).

Geological stage and age:

Upper Paleocene, late Thanetian (MP 6), 57 Ma.

Diagnosis:

Diplocynodon remensis belongs to *Diplocynodon* by the combination of characters diagnosing the genus (presented above). It differs from all other *Diplocynodon* species by the combination of the following characters:

- presence of two parallel ridges creating a recess on the lateral wall of the premaxillary notch;
- splenial participation in the mandibular symphysis.

Comments:

The oldest taxon, *Diplocynodon remensis*, is the only species of *Diplocynodon* recognised from the Paleocene (Thanetian). The material referred by Martin et al. (2014) from the Mont de Berru locality consists of one complete and two partial skulls, along with numerous disarticulated remains (cranial and postcranial). We confirm the reproducibility of the taxon diagnosis here and did not alter it. Paleocene localities with vertebrate assemblages (e.g. Hainin, Belgium; Walbeck, Germany) are relatively rare in Europe and so far did not yield any additional and identifiable *Diplocynodon* remains.

Diplocynodon ungeri (Prangner, 1845)

(Plate 1A)

Type material:

UMJ 1774 (holotype), a partial rostrum.

Type locality:

Vordersdorf and Schönegg (Styria, Austria).

Geological stage and age:

Middle Miocene, early Langhian (MN5), ca. 16–15 Ma.

Diagnosis:

Diplocynodon ungeri belongs to *Diplocynodon* by the combination of characters diagnosing the genus (presented above). It differs from all other *Diplocynodon* species by the combination of the following characters:

- the anterior process of the palatine is thin (laminar);
- the snout remains comparably narrow throughout ontogeny (shared with *D. ratelii*).

Comments:

Diplocynodon ungeri was erected by Martin & Gross (2011) as a new combination of specimens from the Miocene of Styria (Austria), previously referred to the previously described species *Enneodon ungeri*, *Diplocynodon* (*Crocodilus*) *styriacus* and *Diplocynodon* (*Crocodilus*) *steineri*. Additional material from France (Bézian, Ginsburg & Bulot, 1997) was referred to *Diplocynodon ungeri* by the authors, including a complete skull. The latter specimen however shows a significant contact between the anterior process of the nasals and the posterior region of the external nares, diagnostic character of *D. ratelii* and absent in *D. ungeri*. Given the clear presence of this character in the skull from Bézian, the specimen should rather be attributed to *D. ratelii*. Other Miocene localities in Europe yielded material attributed to *D. ungeri* (or indicated as *D. styriacus*), but on the basis of isolated elements not identifiable beyond the genus if not family level. Additional crocodylian remains were previously reported in the southeast of Europe (Gračanica, Bosnia; Vasilyan, 2020), geographically close to the region of Styria (Austria), but the initial identification needs further testing (D. Vasilyan pers. com.).

Invalid species of Diplocynodon

Diplocynodon buetikonensis von Meyer (1855)

Type material:

PIMUZ, a fragmented skull and mandible with osteoderms.

Type locality:

Lindenberg, Büttikon (Canton Aargau, Switzerland).

Geological stage and age:

Upper Miocene, Tortonian (MN 9–12), ca. 11.6–7.2 Ma.

Comments:

The holotype and only specimen referred to *Diplocynodon buetikonensis* was dated to the Tortonian (Late Miocene) according to Berg (1966). In the latter work, the author pointed out the uncertain presence of the diagnostic paired canines on the dentary of *Diplocynodon.* An additional noticeable difference is the occurrence of longer than wide dorsal osteoderms, feature that is absent in the taxon. The anterior part of the snout in very narrow, with a larger incisive foramen compared to other congeneric taxa. We consider the evidence too weak in order to refer the species to *Diplocynodon*.

Diplocynodon elavericus Martin, 2010

Type material:

Rhinopolis B3, a fragmented skull and mandible with osteoderms.

Type locality:

Domérat (Allier, France).

Geological stage and age:

Upper Eocene, middle Priabonian (MP 18–20), ca. 36–34 Ma.

Comments:

Diplocynodon elavericus is based on a fragmented skull, a mandible and few osteoderms. Elongated quadrate rami and a pterygoid–palatine suture located at the posterior angle of the suborbital fenestra are presented as autapomorphies by Martin (2010). These characters however cannot be confidently recognised in the specimens Rhinopolis B3:

- the length of the quadrate rami does not differ from the condition seen in other mature *Diplocynodon* (e.g. *D. hantoniensis*, NHMUK OR 30392; or *D. remensis*, CE 0001);
- the palatine–pterygoid suture intersects the suborbital fenestra at the posteromedial medial margin in all other *Diplocynodon*, but the pterygoids appear severely fractured at this level, obscuring the actual extent of the pterygoids relative to the posterior margin of the fenestrae. Comparing the right and left suborbital fenestrae, one could interpret the suture to be placed at the posteromedial corner on the right side, whereas it can be interpreted more anteriorly on the left side.

No additional material is referred to *Diplocynodon elavericus*, but as noted by Martin (2010), *Diplocynodon* cf. *hantoniensis* (from the early Oligocene of Dordogne, France; Vignaud et al., 1996) is also similar in size and shape (see comments in the previous section on *D. hantoniensis*). Both *Diplocynodon* cf. *hantoniensis* and *Diplocynodon elavericus* however differ from *Diplocynodon hantoniensis* by the shape of the sutural contact between the ectopterygoid and maxilla, and the absence of circumscribing ridge around the supratemporal fenestrae and orbits. We therefore consider that, given the current state of the art, *Diplocynodon elavericus* cannot be confidently considered as a valid species of *Diplocynodon*. We advise reference to Rhinopolis B3 as *Diplocynodon* sp. pending future comparative studies and/or discovery of additional material.

Diplocynodon gervaisi Gervais, 1859

Type material:

Osteoderms, an isolated hemimandible and a fragmentary skull.

Type locality:

Ronzon (Haute-Loire, France).

Geological stage and age:

Lower Oligocene, early Rupelian (MP 21), 33.5 Ma.

Comments:

Diplocynodon gervaisi (or *Saurocainus gervaisii*) is mentioned and figured by Gervais (1859: plate 57, Fig. 4) without providing any description or diagnosis for the taxon, but citing Aymard (1856) as a reference. Berg (1966) summarised the situation and provided a short description of two specimens from the same locality, previously illustrated by Zittel (1885:697): a skull, curated in the paleontological collections of the University of Münich (Germany; plate 2, Fig. 11 in Berg, 1966), and a partial hemimandible (Rz 33) housed at the Natural History Museum of Basel, Switzerland. As a matter of fact, additional postcranial disarticulated specimens are curated at the Natural History Museum of Bern, Switzerland (L. Macaluso pers. obs.) In the absence of original diagnosis and description, *Diplocynodon gervaisi* is considered a nomen dubium and *Saurocainus gervaisii* a nomen nudum. The specimens referred to the species should be regarded as *Diplocynodon* sp. pending further description.

Diplocynodon kintyktshensis Efimov, 1988

Type material

A fragmentary skull roof and an isolated osteoderm.

Type locality:

No precise locality is given. The material was discovered in the Kintykche Formation cropping out in the northern Priaralie region (Kazakhstan).

Geological stage and age:

Middle Miocene (no further indications).

Comments:

The absence of an adequate diagnosis, figure and more detailed description of the material published by Efimov (1988) lead researchers to disregard *Diplocynodon kintyktshensis* as a valid species. We advise referring to the specimens of this locality as Crocodylia indet. given the absence of diagnostic characters pertaining to *Diplocynodon*, as well as the apparent conservative morphology of the different elements. This conclusion was also drawn by Kurochkin et al. (2015).

Diplocynodon tormis Buscalioni, Sanz & Casanovas, 1992

Type material:

IPS 36361 (= IPS 9001, holotype), ST-7066 and ST-344 (paratypes).

Type locality:

Salamanca province (Duero basin, Spain).

Geological stage and age:

Middle-Upper Eocene, Bartonian (MP14-16), ca. 41–38 Ma.

Comments:

We herein consider *Diplocynodon tormis* as invalid after the direct revision of the referred and figured material by Buscalioni, Sanz & Casanovas (1992). This is motivated by the following observations:

1) The diagnosis of *Diplocynodon tormis* is based on the paratypes STUS 344 and ST 7066 , as the holotype does not preserve the posterior region of the skull; the paratypes and described material however do not differ in their morphologies from other *Diplocynodon* species.
2) First-hand study of the holotype of *Diplocynodon tormis* (IPS 36361) revealed that diagnostic features of *Diplocynodon* are undoubtedly different or absent from the latter specimen, such as the absence of a double pairs of canines, 4th and 5th dentary alveoli not being confluent, and an unknown condition for ventral osteoderms (paired or "bipartite" in *Diplocynodon*, but not preserved in the specimen here).
3) further differences between IPS 36361 and all other *Diplocynodon* species are evident: a frontoparietal suture that does not enter the supratemporal fenestrae, the posterior dentary and maxillary teeth are severely compressed mediolaterally and bear well-defined striations, and an

inconsistent ornamentation of the parietal between IPS 36361 and STUS 344 (and other species).

4) the dermoccipital projects backwardly, as described by Buscalioni & Sanz (1992) for STUS 344, but the occipital condyle is not obscured in dorsal view (as previously defined in the diagnosis); this can be verified in Figure 1B of Serrano-Martinez et al. (2019), while the condyle is cropped in Figure 1E.

We advise referring to all previously referred specimens as *Diplocynodon* sp. pending new comparative study of the material.

5. Discussion

5.1 *The most common crocodylian in the Cenozoic of Europe*

With 446 total entries (128 entries in PBDB and 318 in fosFARbase, counting overlapping occurrences, i.e. presence of a taxon per locality), *Diplocynodon* is one of the most frequently occurring crocodylian in the Cenozoic of Europe. In comparison, the larger crocodylian *Asiatosuchus* is only recorded 62 times (32 entries in PBDB and 30 in fosFARbase), or 90 times for *Tomistoma* spp. (29 entries in PBDB and 61 in fosFARbase). Notably, only *Crocodylus* spp. shows a higher count than *Diplocynodon* with a combined count of 515 occurrences (385 entries in PBDB and 130 in fosFARbase), with ~50% of these occurrences being younger than the Middle Miocene, and nearly all certainly not represent the genus as currently defined (Delfino et al., 2007; Delfino et al., 2020). The dominating record of *Diplocynodon* is firstly a quantitative consequence of its unmatched survivorship (in Eusuchia) throughout the Cenozoic, as more material could statistically be fossilised, but also a result of the qualitative appreciation of the specimens that lead to the waste-basket status of the taxon discussed later.

Our global review of *Diplocynodon* spp. occurrences was carried out with 169 occurrences fulfilling the criteria for the material survey (overlaps between both databases as well as entries unsupported by the literature were discarded), which represents 37.9% of the original total occurrences count. The results show that 39.1% of the latter 169 occurrences are solely based on a simple citation of the genus in the literature (i.e. material is neither described nor figured; Figure 1A). This corpus of literature consists of faunal lists for localities or specialised articles focusing on other vertebrate groups that only mention the presence of *Diplocynodon* without stating the type of material, and/or why it is attributed to the taxon.

Occurrences supported by evidence are based on articulated and disarticulated material in the literature. Articulated material is reported in 34% of the supported occurrences, and 10.7% including multiple articulated specimens (Fig. 1A). On the other hand, disarticulated material is reported in 88.3% of these occurrences with evidence. Frequent in the case of crocodylians, isolated teeth are the most commonly recovered elements when it comes to reports including disarticulated material (70.3%). Old teeth are regularly shed and replaced during the animal's life (polyphyodonty), therefore statistically more likely to be discovered in the sediments, in addition to their higher resistance to alteration processes (Frey & Monninger, 2010). It is moreover worth noticing that one fifth of the reports of *Diplocynodon* disarticulated material are based on teeth alone (20.9%). Besides teeth, osteoderms are also highly represented in the sample, being present in 50.5% of occurrences reporting disarticulated material, and can be diagnostic if belonging to the ventral armour (characterised by a bipartite structure in *Diplocynodon*). Most reports of osteoderms however critically lack a specification of the type elements, including their count, in their descriptions and/or figures.

Regarding the taxonomic identification, *Diplocynodon* sp. represents 55% of the total number of occurrences, but nearly half of these occurrences lack evidence and are only based on simple citations (52.7%; Figure 1B). The remaining *Diplocynodon* sp. identifications are in majority based on medium-size disarticulated material (93.9%). It appears evident from our survey that *Diplocynodon* has been commonly used as a 'wastebasket taxon' that can include any indeterminate specimen bearing a generalist morphology. Less than half of the occurrences report material referred at species rank, among which 22.3% lack descriptions and figures, therefore rendering any identification irreproducible. Species occurrences citing informative literature are largely based on disarticulated material (53.9%), before relying on material including one articulated specimen (19.7%) or more abundant articulated remains (13.1%).

As such, most published studies attribute fragmentary, disarticulated crocodylian material to *Diplocynodon*, only in rare cases relying on diagnostic characters (in the latter cases a separate species is usually erected). It is necessary to stress-out here the importance of cautious taxonomic attribution, as a biased taxonomy can have a direct negative impact on larger scale diversity studies, through a series of escalating interpretations. First, attributing non-diagnostic and conservative material to the species level artificially encourages additional attribution of non-diagnostic material by the way of comparative anatomy, since vaguely similar elements can be included. When repeated enough times for a majority of the species, this cycle prevents an accurate reconstruction of the phylogenetic relationships in the group because of the high overlapping morphological variation of each character in the taxa. The genus definition therefore becomes a combination of morphological traits that encompass all species, but that may not be strictly applicable case by case. Second, this phenomenon introduces an abundance bias in the fossil record, making a particular taxon more common than the others, while this was not necessarily true from an ecological point of view. Third, it can mislead taxonomical research priorities, because there are virtually less chances for new information to be gained from specimens attributed to an abundant form. To remedy to the issues inherent to this practice, we advise consistent referral to the higher Linnean classification category in the case of tentative attribution of morphologically conservative material, such as teeth or osteoderms for crocodylians (unless specifically distinct such as bipartite osteoderms in *Diplocynodon*). At the cost of sample size, palaeobiogeographical reconstructions for a given taxon should be done using only the better supported occurrences that include valid evidence.

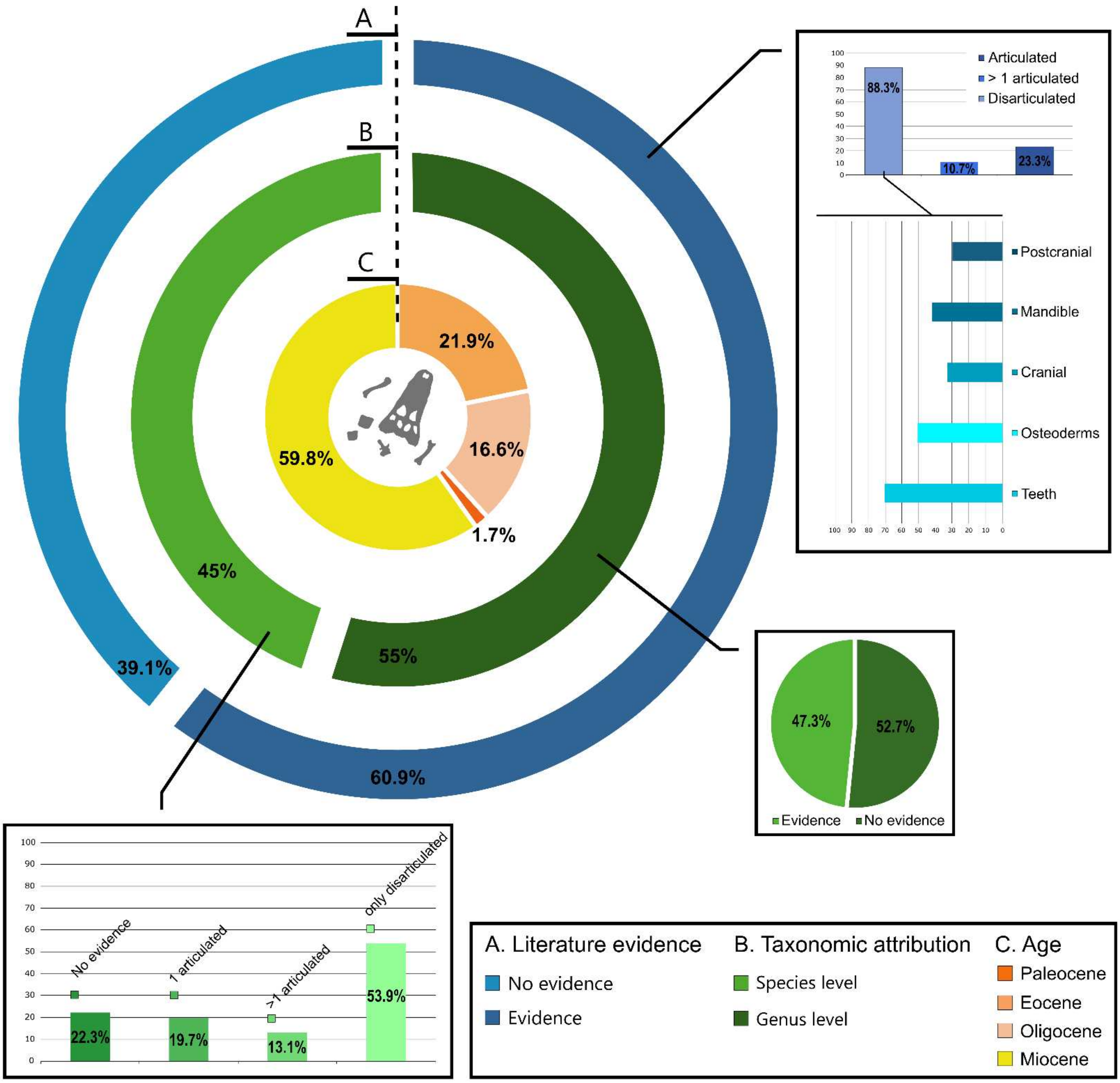


Figure 1: Combined graphics of *Diplocynodon* occurrences distribution in the Cenozoic. A, evidence ratios in the supporting literature. B, taxonomic attributions. C, age distribution.

5.2 *Revised taxonomic diagnoses and diversity*

As far as the valid species are concerned, the present paper provides a complete revision of their diagnoses. According to recommended taxonomic practices, an effective diagnosis would need to be as concise as possible in order to allow straightforward identifications of specimens at hand (among others Mayr, 1969; Dubois et al., 2021; Borkent, 2021). The literature concerning *Diplocynodon* reveals that taxonomic studies of the taxon either erect new species or refrain to refer the material (even if well-preserved and/or abundant) to an already published species, preferring an open nomenclature (Bengston, 1988; and see Appendix 2). Indeed, there are no report of studies that definitely attribute newly described material to an already published species, if not from a comparable geological age and area (the only exception being *D. darwini* reported from Messel and Geiseltal Lagerstätten). This phenomenon might be largely caused by previous convoluted and redundant diagnoses that rendered species-level identifications difficult to make, hampering paleobiogeographic and evolutionary relationships assumptions. The revised diagnoses are herein summarised in a comprehensive dichotomous key, to facilitate the identifications of *Diplocynodon* remains (Figure 2). As a general trend, many features listed in previous diagnoses were characters common to most (if not all) *Diplocynodon* species, or part of intraspecific variation. These characters are herein implemented in the revised diagnosis of the genus, where they better pertain.

The possible phylogenetic affinities of *Diplocynodon* and *Borealosuchus* pointed out by Walter et al. (2025; see Chapter 1) raises the additional question of the presence of the latter genus in Europe and the former in North America. Incomplete specimens bearing characters shared by both groups are classically assigned to each genus on the basis of their geographical origin (i.e. *Diplocynodon* for Eurasia and *Borealosuchus* for North America). May the two taxa be closely related, the recurrent practice of geography-based attributions introduces a bias in the fossil record that leads to circular reasoning in paleobiogeographical interpretations. A thorough reappraisal of the morphology and taxonomy of *Borealosuchus* is critical in this context in order to allow future straightforward identifications of both taxa in North America and Europe.

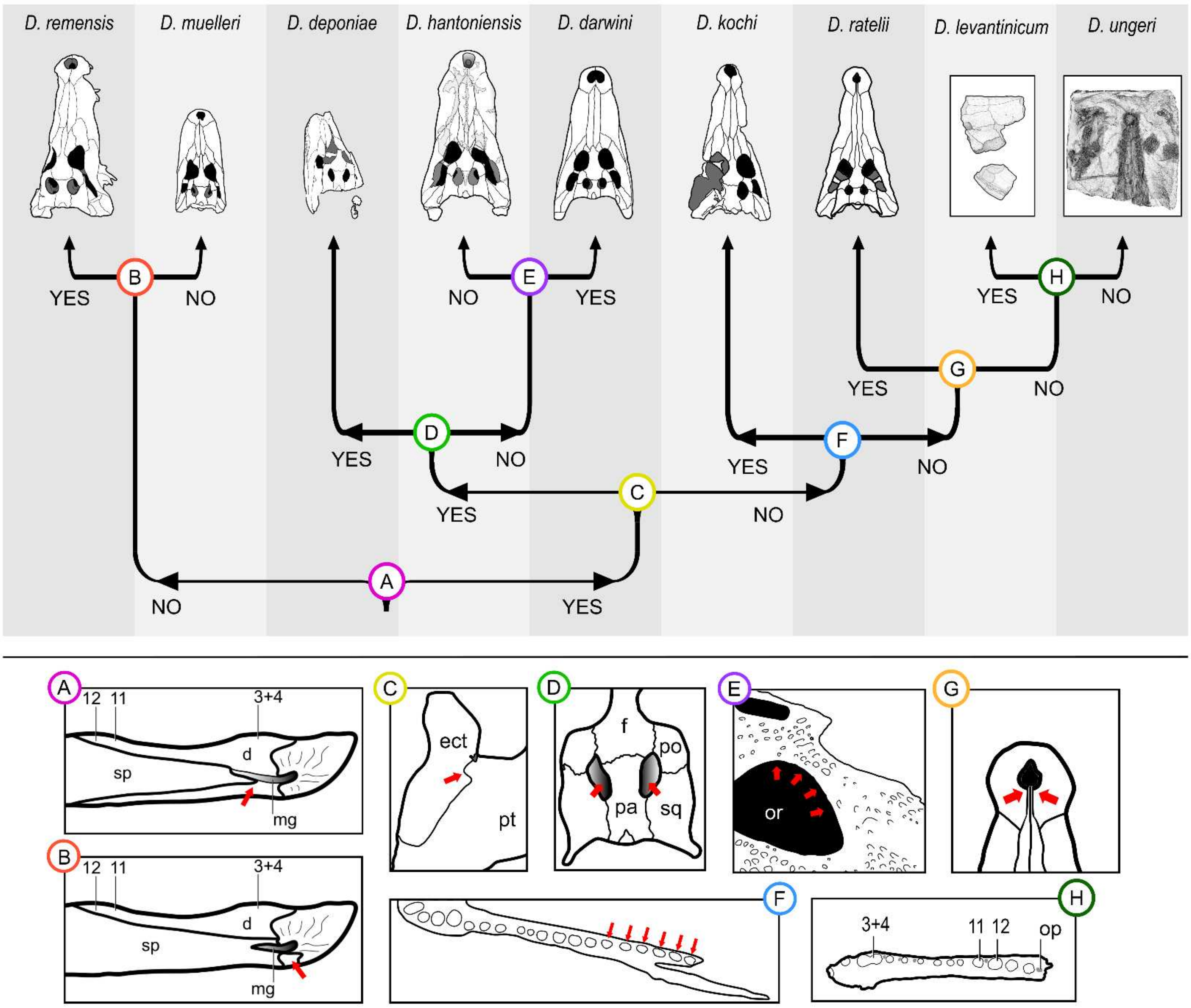


Figure 2: Dichotomous key for *Diplocynodon* (species order does not represent ingroup phylogenetic relationships). A, exclusion of the splenial from the mandible symphysis with its anterior tip passing ventral to the Meckelian groove; B, presence of a splenial symphysis; C, retention of the ectopterygoid-pterygoid flexure at maturity; D, dermal bones of skull roof overhang the rim of supratemporal fenestra at maturity; E, absence of upturned orbital margins; F, posterior dentary teeth (caudal to 14th) are laterally compressed; G, nasals protrusion in the posterior margin of the external nares; H, presence of an occlusion pit posterior to the 14th dentary alveolus.

The taxonomic revision of *Diplocynodon* spp. conducted herein invalidates the species *Diplocynodon elavericus* and *Diplocynodon tormis* (to be added to the list of Paleogene invalid taxa; see Table 1). The characters proposed for the diagnosis of the former species currently do not allow to confidently distinguish it from the larger specimens of the other congeneric species. Concerning *D.*

tormis, its description is mainly based on the holotype, whose morphology significantly diverges from the diagnostic characters of the genus (see above for the list of diagnostic characters).

Our revision therefore concludes on nine valid species in the Paleogene out of the eleven previously proposed: *D. darwini*, *D. deponiae*, *D. hantoniensis*, *D. kochi*, *D. levantinicum*, *D. muelleri*, *D. ratelii*, *D. remensis* and *D. ungeri*.

The Eocene epoch shows the highest diversity with four species (Figure 3), including the unique case of co–occurrence of two *Diplocynodon* taxa in a restricted geographical area (*Diplocynodon darwini* and *Diplocynodon deponiae* in the Lutetian age locality of Messel). It is one of the rare examples of syntopic extinct species (Scheyer et al., 2013; Wilson & Parker, 2023), which may well have been achieved by the dwarfism and acquisition of a derived posterior dentition in *Diplocynodon deponiae*, and the latter can reflect the occupation of a specialised ecological niche as in the case of *Acynodon adriaticus* (Delfino et al., 2008), *Gnatusuchus pebasensis* (Salas-Gismondi et al., 2015) or *Alligator munensis* (Darlim et al., 2023).

In the Oligocene, several occurrences argue for the presence of *Diplocynodon* aside from *D. levantinicum* and *D. muelleri* (see Appendix 2.1). Brinkmann & Rauhe (1998) published a nearly complete specimen from Oligocene horizons of Céreste (southern France) that they attributed to *Diplocynodon* cf. *ratelii*. This attribution is rather uncertain given the incomplete description and figures of the specimen, in addition to the absence of a catalogue number. *Diplocynodon ratelii*, the type species of *Diplocynodon*, was erected by Pomel (1847) on the basis of Miocene specimens from Saint-Gérand-le-Puy (Allier, France), and most of the material attributed to the taxon was found in strata of approximately the same age (Diaz Araez et al., 2017; Chroust et al., 2021). A thorough study of potentially well-preserved *Diplocynodon* specimens (currently unpublished) from France (JDW pers. obs.) may eventually confirm the presence of *Diplocynodon ratelii* in the Oligocene, or possibly extend the paleobiogeographic range of the two valid species being currently recorded in this epoch (Figure 3; *D. muelleri*, Spain; *D. levantinicum*, Bulgaria).

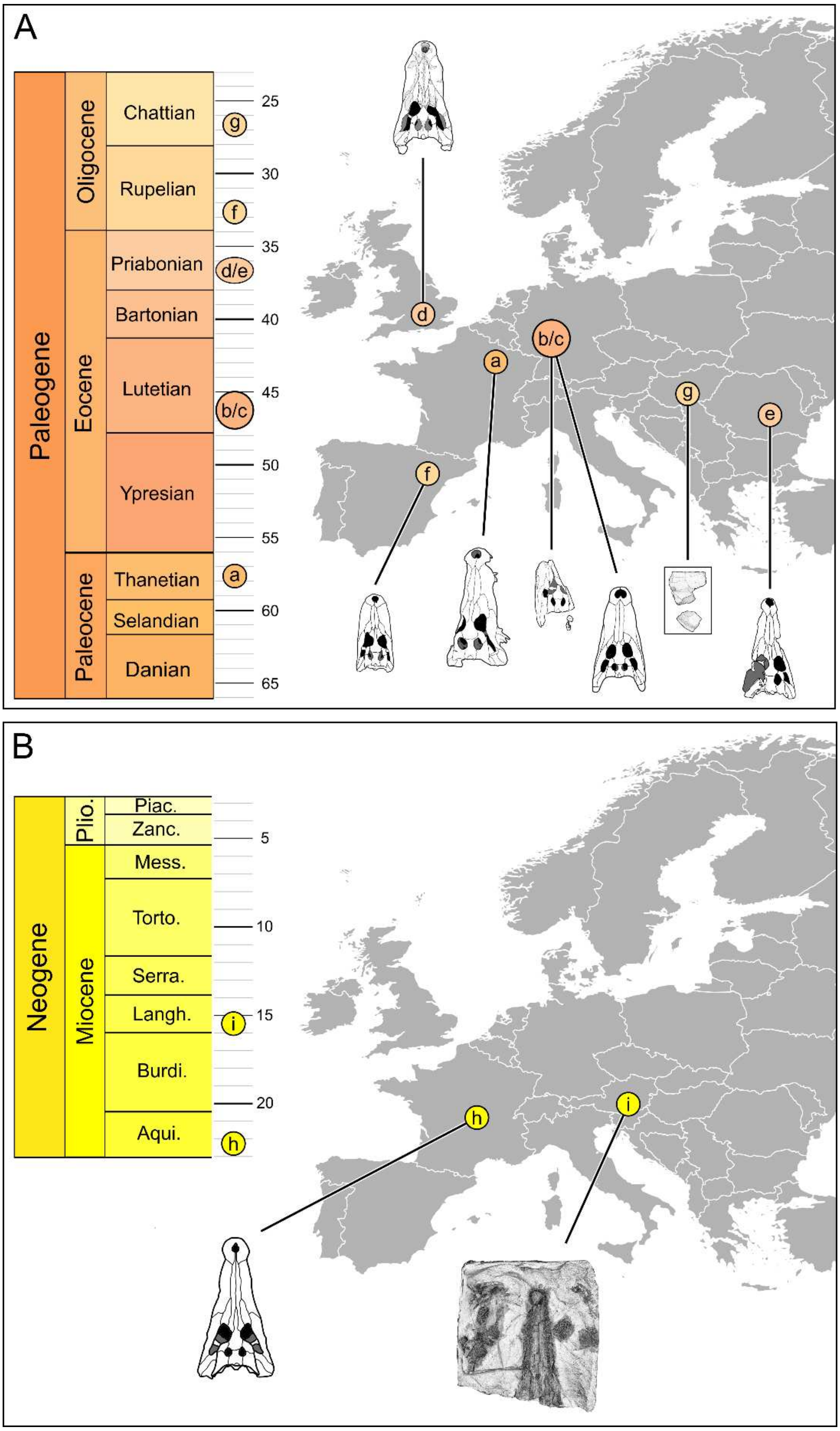


Figure 3: Spatiotemporal distribution of *Diplocynodon* in the Cenozoic. A, Paleogene: a. *Diplocynodon remensis* (after Martin et al., 2014); b. *Diplocynodon deponiae* (after Delfino & Smith, 2012); c. *Diplocynodon darwini* (after Ludwig, 1877); d. *Diplocynodon hantoniensis* (after Rio et al., 2020); e. *Diplocynodon kochi* (after Venczel & Codrea, 2022); f. *Diplocynodon muelleri* (after Piras & Buscalioni, 2006); g. *Diplocynodon levantinicum* (after Massonne & Böhme, 2022). B, Neogene: h. *Diplocynodon ratelii*; i. *Diplocynodon ungeri* (after Martin & Gross, 2011).

The diversity of *Diplocynodon* in the Neogene is in contrast with the Paleogene peak, consisting of the two species, *D. ratelii* and *D. ungeri* from the Early and Middle Miocene respectively (Figure 3). According to the PBDB and fosFARbase databases, the number of Miocene occurrences however largely dominates the record (Figure 1C). The critical lack of a modern osteological description of *D. ratelii* however prevents attribution of isolated material to the species when new material is not found in correlated geological layers. Reappraisal of specimens with indeterminate and/or debatable taxonomic attribution has the potential of enhancing the study of morphological variation in greater details, and further investigate whether *D. ratelii* and *D. ungeri* were co-occurring geographically during a given time period. According to the current state of the fossil record, the extinction of *Diplocynodon* in the Early to Middle Miocene appears clear, as no valid attributions with identifiable evidence have ever been reported later than the Langhian.

Plate 1

Type material of valid *Diplocynodon* species. A. *Diplocynodon ungeri* (UMJ 1774, holotype); B. *Diplocynodon deponiae* (SMF-Me 899, holotype) ; C. *Diplocynodon levantinicum* (NMNHS 31-1; lectotype); D. *Diplocynodon muelleri* (NMB Spa 4, holotype); E / F. *Diplocynodon ratelii* (MNHN SG 539 / original illustration of the holotype by Pomel, 1847 – specimen); G. *Diplocynodon hantoniensis* (NHMUK OR 25166, holotype); H. *Diplocynodon kochi* (UBB V. 1453, holotype); I. *Diplocynodon remensis* (MNHN F BR 4020, holotype); scale

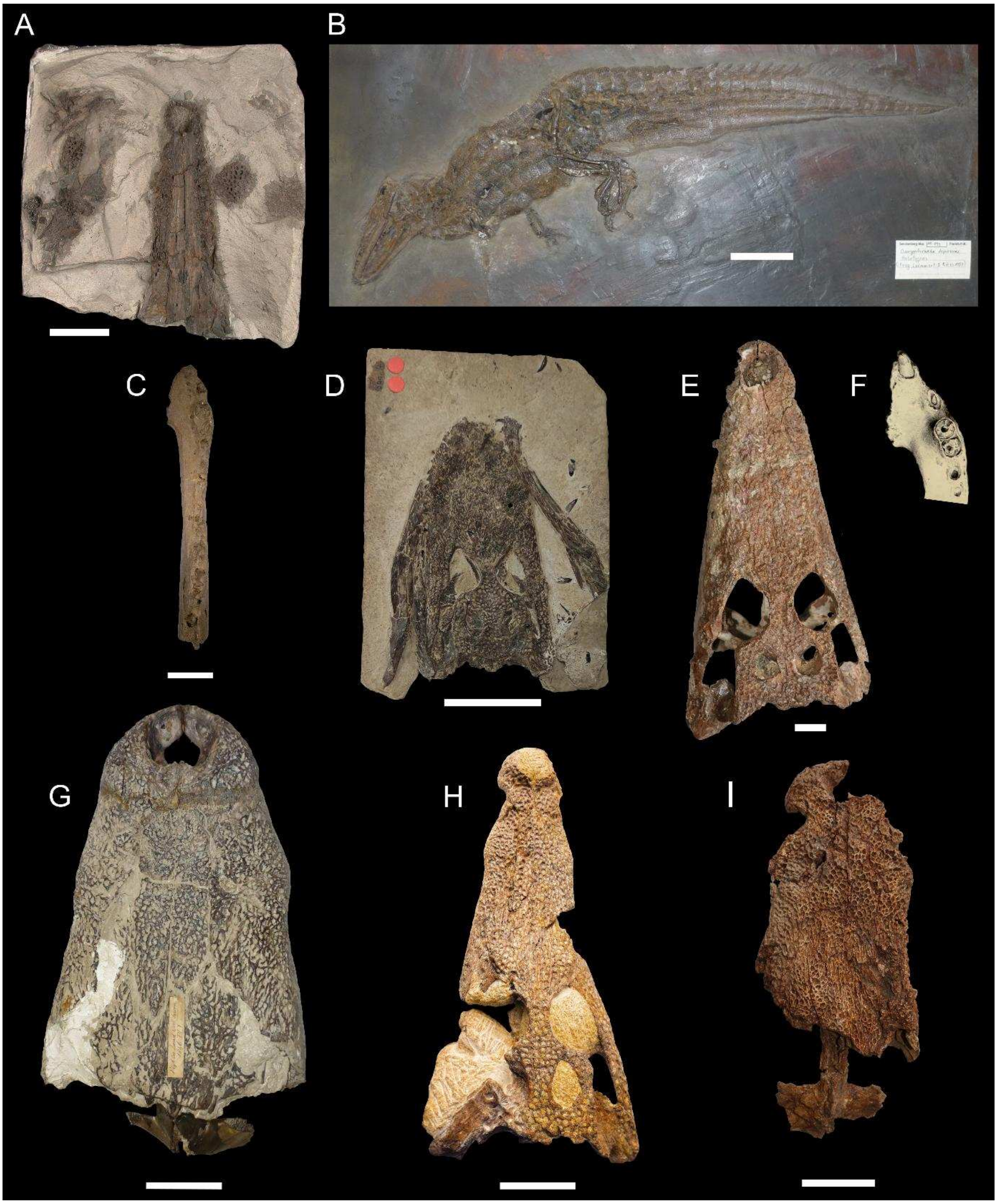
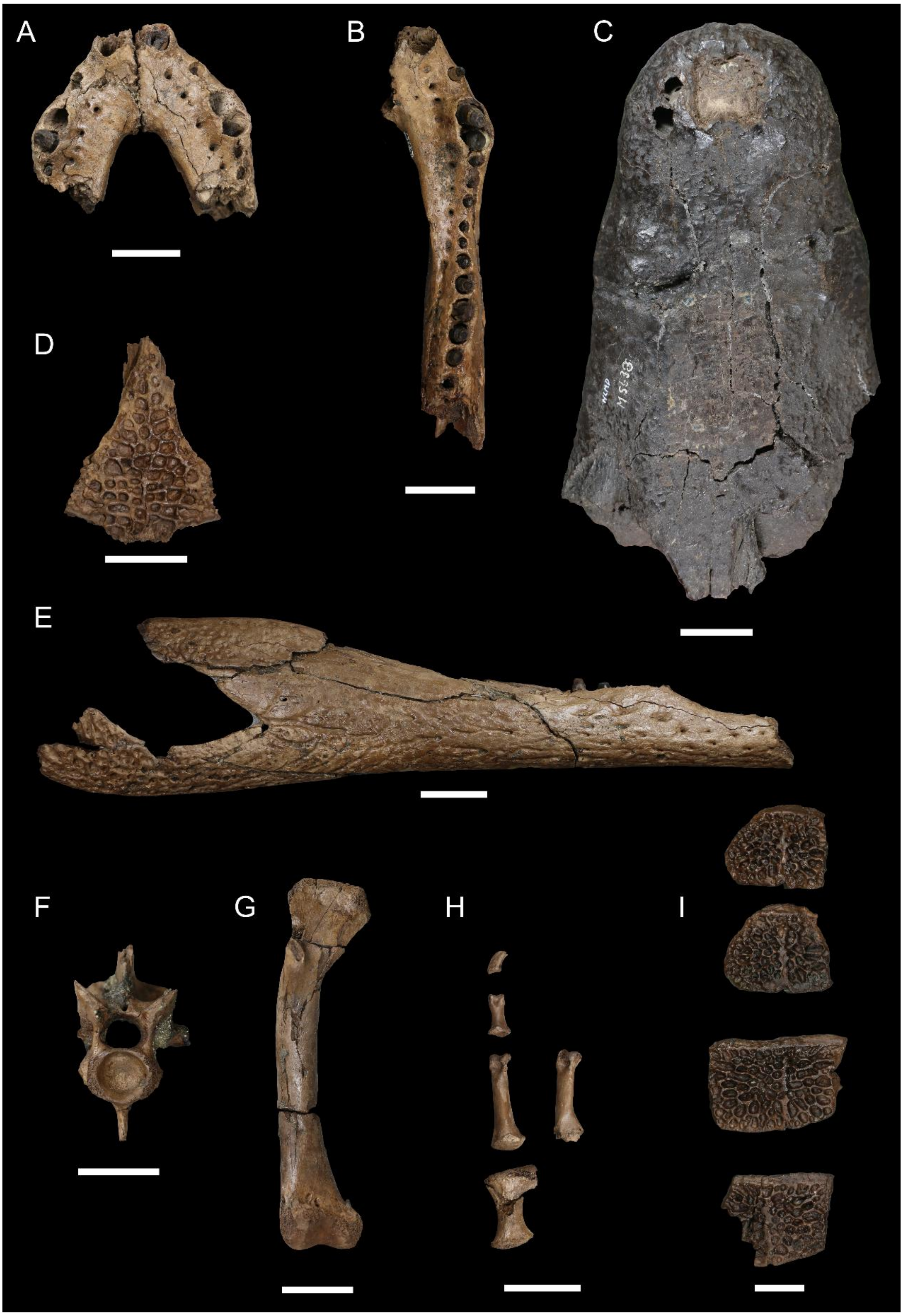


Plate 2

Selected type material of *Diplocynodon darwini*. A, HLMD-Me 5366; B, HLMD-Me 5360 (lectotype); C, HLMD-Me 5638; D, HLMD-Me 5348; E, HLMD-Me 5361; F, HLMD-Me 6004; G, HLMD-Me 5902; H, HLMD-Me 3033; I, HLMD-Me 6015; scale bars = 2 cm.



CHAPTER 3: Redescription of *Diplocynodon darwini* from the middle Eocene of Germany and evolutionary relationships in the group

1. Introduction

European crocodyliform faunas of the early Paleogene greenhouse were particularly diverse, including several members of the crown clades Longirostres and Alligatoroidea. Notably, the fossil record of the mid-sized generalist taxon *Diplocynodon* is particularly extensive (see Chapter 2 and references therein). The taxon was previously also reported from the Paleogene of North America (*Diplocynodon stuckeri* Mook 1960), before the specimen was synonymised with the 'Northern Crocodile' *Borealosuchus*, currently known from six species ranging from the Late Cretaceous to the middle Eocene of North America (Gilmore, 1910; Mook, 1959; Erickson, 1996; Brochu, 1997; Wu et al., 2001a; Brochu et al., 2012; Lindblad et al., 2022). Both genera indeed share notable characters that might pertain to a common ancestor, though most eusuchian phylogenies currently place *Diplocynodon* spp. as a monophyletic group of early-branching alligatoroids (Martin et al. 2014; Massonne et al., 2019; Groh et al., 2020; Rio & Mannion, 2021) but see Chapter 1 (Walter et al. 2025; Chapter 1) for an alternative topology. Recent studies have extensively tested and discussed the interrelationships of the group but failed at retrieving any topological consensus (Brochu, 1999; Martin, 2010; Brochu et al., 2012; Delfino & Smith, 2012; Martin et al., 2014; Rio et al., 2020; Rio & Mannion, 2021).

The continuous presence of *Diplocynodon* in Europe from the late Paleocene to the middle Miocene produced a rich fossil record, from which numerous species were erected and seven currently considered valid (see Chapter 2). The taxon disparity was studied relatively recently through a series of revisions (Piras & Buscalioni, 2006; Martin, 2010; Martin et al., 2011, 2014; Delfino & Smith, 2012; Rio et al., 2020), with however the notable exception of the middle Eocene species *Diplocynodon darwini* Ludwig, 1877 from the Konservat-Lagerstätte of Messel (Germany).

The paratropical Lake Messel was an open and warm environment hosting a rich biodiversity, today fossilised in the pit's oil-shale layers (Schaal & Ziegler, 1988; Smith, 2021; Smith et al., 2024). Together with plants (Wilde, 2018) and invertebrates (Wedmann, 2018), several well-preserved vertebrates were recovered from the sediments, such as mammals (Franzen et al., 2009, 2015), birds (Mayr, 2017), fishes (Micklich, 2012) and crocodyliformes (Brochu & Miller-Camp, 2018). The latter are notable vertebrates found at the Messel Pit as they show an exceptional diversity for a single fossil site, including the two alligatorines *Allognathosuchus* and *Hassiacosuchus*, two unrelated terrestrial forms *Bergisuchus* (sebecosuchian) and *Boverisuchus* (planocraniid), the large sized crocodyloid *Asiatosuchus*, and the above-mentioned *Diplocynodon* (Chapter 1 and 2; Smith et al., 2018). Two separate *Diplocynodon* species are known from Messel: the medium-sized *Diplocynodon darwini* Ludwig, 1877 and the short-sized and heavily armored *Diplocynodon deponiae* (Delfino & Smith, 2012). Originally described as two separate species, *Diplocynodon darwini* today embodies the previously erected *Alligator darwini* Ludwig, 1877 (in honour of Charles Darwin), *Crocodilus ebertsi* Ludwig, 1877 and *Diplocynodon hallense* Kuhn, 1938 from Geiseltal (Germany). The validity and taxonomical status of the species was previously corroborated by Berg (1966), Rauhe & Rossmann (1995) and Brochu (1999) (see also Walter et al., Chapter 2), but the taxon critically lacks a modern reappraisal.

The present work aims at redescribing the species *Diplocynodon darwini* and report intraspecific variation between two distinct populations. We additionally provide here insights into morphological variability shared across *Diplocynodon* species. We further investigate the ingroup evolutionary relationships of *Diplocynodon* after the revision of the taxa scores in a eusuchian character-taxon dataset.

2. Geological settings

2.1 Messel Pit Konservat-Lagerstätte

The Messel Pit fossil site is located in the Hesse (Germany) region, north-east to the town of Darmstadt. This ancient Eocene lake formed after the initial creation of a maar consequently to earlier phreatomagmatic eruptions (Schulz et al., 2002; Mezger et al., 2013). Continuous input of sediments and biotic material in the crater slowly filled the anoxic bottom of the structure, where oil/bituminous shale layers developed in large volumes (Goth, 1990; Bauersachs et al., 2014; Moshayedi et al., 2020). A series of research drillings were performed between from 1993 to 2006 in order to precisely date the formation of the maar, rate, and duration of sedimentation (Mezger et al., 2013). The maar formation was dated to be around 48.2 Ma by Lenz & Wilde (2014; 2018), and independent evaluations of the laminated sediments provided an average sedimentation rate of 0.14 mm/yr (Mertz & Renne, 2005; Lenz & Wilde, 2014, 2018). The chronostratigraphy of the sediments was recently reassessed, indicating a deposition period between 48.06 Ma and 47.22 Ma with an average sedimentation rate of ~0.2 mm/yr (Kaboth-Bahr et al., 2024).

2.2 Geiseltal Konservät-Lagerstätte

The Geiseltal Lagerstätte is located in the Saxony-Anhalt (Germany) region, south to the town of Halle (Saale). The Geiseltal succession formed from marsh sediments and fluvial material (Krumbiegel et al., 1983) that deposited in dominant layers of siltstones and claystones of variable thickness, intruded by thinner lignite strata. The fossiliferous horizons are found in coal seams intercalated in the claystones and sandtstones beds (Haubold, 1989). Six lignite seams are recognised in Geiseltal, chronologically named lower lower coal or 'Untere Unterkohle' (LLC), lower middle coal or 'Untere Mittelkohle' (LMC), upper middle coal or 'Obere Mittelkohle' (UMC), upper sandstone/siltstone deposits or 'Oberes Hauptmittel' (UHM), lower upper coal or 'Untere Oberkohle' (LUC) and middle upper coal or 'Mittlere Oberkohle' (MUC; Lincke, 1977; Falk et al., 2022). The relative dating of these units was previously made by mean of mammal biochronology (Haubold & Hellmund, 1998; Franzen, 2005) and concludes to a total discontinuous span of ~ 6 Myrs in the Lutetian (Falk et al., 2022 Fig. 2), but otherwise challenged by taxonomical ambiguity for some key mammal species that consequently render biochronological correlations uncertain (see Ring et al., 2020).

Institutional abbreviations

GMH: Geiseltal Museum of Martin-Luther-University Halle-Wittenberg, Halle (Saale), Germany;

HLMD: Hessisches Landesmuseum Darmstadt, Darmstadt, Germany;

SMF: Senckenberg Museum Frankfurt, Frankfurt, Germany.

SYSTEMATIC PALEONTOLOGY

DIPLOCYNODONTINAE Brochu, 1999

DIPLOCYNODON Pomel, 1847

Type species: *Diplocynodon ratelii*, Pomel 1847

Diagnosis:

Diplocynodon is a medium-sized crocodyliform characterised by the unique combination of the following characters:

– the presence of paired canines both on the dentary (3rd + 4th teeth) and the maxillary (4th + 5th teeth);

– the 3rd and 4th dentary alveoli are confluent;

– the 3rd and 4th dentary alveoli occlude in a pit early in ontogeny;

– the ventral shield consists of bipartite osteoderms;

– the iliac blade is rounded and ventrodorsally deep;

DIPLOCYNODON DARWINI Ludwig, 1877

Alligator darwini Ludwig, 1877

Diplocynodon darwini Berg, 1966

Diplocynodon darwini Brochu, 1999

Diplocynodon darwini Walter, [Chapter 2]

Type material:

HLMD-Me 5360 (lectotype); HLMD-Me 3014, 3015, 3012, 3014, 3015, 3016, 3018, 3019, 3020, 3022, 3023, 3024, 3025, 3027, 3031, 3033, 3037, 3111, 3112, 3118, 3119, 3120, 3121, 3122, 3125, 5348, 5349, 5361, 5365, 5366, 5367, 5368, 5369, 5370, 5371, 5374, 5712, 5714, 5875, 5886, 5890, 5892, 5893, 5895, 5896, 5902, 5903, 5905, 5907, 5908, 5909, 5910, 5911, 5912, 5919, 5925, 6001, 6002, 6003, 6004, 6005, 6006, 6007, 6008, 6011, 6012 (paralectotypes).

Synonyms:

Crocodilus ebertsi Ludwig, 1877; *Diplocynodon hallense* Kuhn, 1938

Referred material:

An exhaustive list of specimens cited in the text is provided here (complete list of all the specimens studied first-hand is provided in Appendix 4): GMH XXXVI-524-1966; HLMD-Me 233, HLMD-Me 236, HLMD-Me 4423, HLMD-Me 5317, HLMD-Me 5349, HLMD-Me 5364, HLMD-Me 5368, HLMD-Me 5369, HLMD-Me 5605, HLMD-Me 5875, LMD-Me 5890, HLMD-Me 5907; HLMD-Me 5919; HLMD-Me 6001, HLMD-Me 6002, HLMD-Me 6004, HLMD-Me 6005, HLMD-Me 6006, HLMD-Me 6007, HLMD-Me 6008, HLMD-Me 6012, HLMD-Me 6015, HLMD-Me 6018, HLMD-Me 6026, HLMD-Me 6044, HLMD-Me 7500, HLMD-Me 7571, HLMD-Me 10262, HLMD-Me 10496, HLMD-Me 10876, HLMD-Me 13729, HLMD-Me 14600, HLMD-Me 14926, HLMD-Me 16990, HLMD-Me 20336; SMF-Me 213, SMF-Me 896, SMF-Me 898, SMF-Me 900, SMF-Me 1137, SMF-Me 1341, SMF-Me 2748, SMF-Me 3780 and SMF-Me 10876.

Diagnosis:

Diplocynodon darwini belongs to *Diplocynodon* by the unique combination of characters diagnosing the genus (presented above).

It differs from all other *Diplocynodon* species by the combination of the following characters (Appendix 3, Figure S3):

- presence of a linear sulcus on the prefrontal, along the anteromedial margin of the orbit
- lack of osteoderms coverage on posterior section of the tail (i.e. the posterior two-thirds)
- the orbital margin flush with the circumscribing bones surface

This species is further characterised by:

- a retention of the pterygoid-ectopterygoid flexure (shared with *D. deponiae* and *D. hantoniensis*)

Description

General preservation

The description presented here is largely based on the exceptionally complete and well-preserved juvenile to adult specimens from Messel HLMD-Me 233, HLMD-Me 236, HLMD-Me 5317, HLMD-Me 7500, HLMD-Me 10262, HLMD-Me 10496, HLMD-Me 13729, HLMD-Me 14600, HLMD-Me 16990, HLMD-Me 20336, SMF-Me 213, SMF-Me 896, SMF-Me 898, SMF-Me 900, SMF-Me 1137, SMF-Me 1341, SMF-Me 2748, SMF-Me 3780 and SMF-Me 10876. Figures 2, 3, 9 and Figures S1 and S2 in Appendix 3 illustrate complete specimens on slabs. Deformation is generally characterised by dorsoventral compression: typically, the dorsal surfaces of the skull table and the rostrum are approximately at the same level. This results in a slight increase of the width proportions of the elements.

Complete specimens from Geiseltal however show further rework, as shown by general disarticulation of the limbs and full torsion of axial elements. The majority of the specimens are prepared, allowing 2D first-hand observation (or 3D for disarticulated and some exceptional articulated specimens). More rare specimens are still partly embedded in matrix and therefore not informative for the present description.

Skull

General shape:

The complete sample of specimens consists of three ontogenetic stages: juveniles, sub-adults and adults. Adult skulls are profusely ornamented and morphologically comparable to most other *Diplocynodon* species. The skull table is planar and the lateral edges of the rostrum are broadly parallel, exhibiting a partial overbiting dentition. The supratemporal and suborbital fenestrae are moderately large, similar in proportions to the morphology shown by *D. hantoniensis*. The orbit medial margins are flush with the surrounding bones surface.

Premaxilla:

The premaxillae are preserved in most of the complete individuals. They enclose the naris dorsally and, in the case of the most mature specimens, appear as an evident circumscribing swelling. This is similar to *D. hantoniensis*, although the latter species bears notches located posterodorsally to the nares (Rio et al., 2020). The posterior edge of the external nares variably bears a reduced indentation that projects into the trapezoidal opening of adult individuals of *D. darwini*. The posterior process of each premaxilla separates the nasal from the maxilla for a short distance, and reaches posteriorly to the level of the 2nd to 3rd maxillary alveoli. The premaxilla-maxilla suture intersects the lateral edge of the rostrum at the level of notch receiving the 4+5th dentary teeth. The premaxillae are profusely ornamented on their dorsal surface.

In palatal view, the premaxilla-maxilla suture is nearly straight, starting laterally from the interalveolar space between the 5th premaxillary and 1st maxillary alveolus, and intersecting the inter-premaxillary suture in a perpendicular line. Adult and juvenile specimens have five premaxillary teeth, among which the 3rd and 4th are equally the largest, comparable in size to the 3rd and 4th maxillary ones. The 2nd alveolus is positioned closer to the 3rd than to the 1st, consequently to the presence of a large reception pit for the 1st dentary tooth lateral to the 1st premaxillary alveolus. The incisive foramen is rather small and tear-dop shaped. A series of foramina punctures the bone immediately lingual to the alveoli.

Maxillae:

The maxillae are large rostral bones, contacting nasals medially for most of their length. Posteromedially, they contact the prefrontals and lacrimals. There, the suture is linear, no posterior maxillary process intrudes into the lacrimal. The ornamentation is similar to the premaxillae, without canthi rostralii nor elevated anterior boss. An evident festoon forms dorsally at the level of the 4th and 5th alveolus, making the maxillae appear broader on the rostrum. Immediately posteriorly, the lateral edge of the rostrum is gently concave. In palatine view, the maxillae meet medially and form the anterior corner of the suborbital fenestrae. The specimen HLMD-Me 5364 was sectioned sagittaly during preparation, allowing to confirm the absence of caecal recesses, otherwise autapomorphic of *Crocodylus*. Regarding the dentition, a maximum of 19 alveoli was noted in the most complete specimens (e.g. HLMD-Me 7500, Figure 2). The bone is usually carved into a notch anterior to the 1st alveolus by the dentary canines (3rd + 4th teeth). The 4th and 5th maxillary alveoli are comparable in size and the largest of the toothrow. The completeness of the septum between the latter two alveoli varies among individuals, occasionally making both alveoli confluent. The concavity of the toothrow is noticeable from the level of the 6th alveolus in ventral view, and the toothrow becomes straight again posterior to the 8th alveolus. The 6th, 7th and 8th alveoli are further separated from each other than observed for the rest of the toothrow: notable occlusion pits at this level result from a local in-line occlusion with dentary teeth. Some specimens show a nearly in-line occlusion up to the 10th maxillary alveoli, with occlusion pits overlapping the alveoli necks.

Nasal:

The nasal separates the premaxillae anteriorly and are excluded from the external nares. The anteriormost tip ends at or nearly at the level of the premaxilla-maxilla notch. The anteroventral tips of the nasals occasionally pierce and intrudes into the nares due to the dorsoventral compression of the rostrum. Posteriorly, the nasal successively contacts the lacrimal and prefrontal laterally. The frontal anterior process separates the nasals medially for a short distance. The dorsal surface of the nasals is smoother than the surrounding bones: ornamenting pits are shallow and lengthened, nearly absent.

Jugal:

The jugal forms the ventral margin of the orbit and contacts the quadratojugal posteroventrally. It contacts the maxilla anteriorly in a broad convex suture running up to the lacrimal medially. The jugal process of the postorbital bar insets from the lateral margin, forming a shallow sulcus at the base of the bar. Anterior to the latter process, the medial jugal foramen is preserved in most complete isolated specimens, but its size differs among specimens. This variation is consistent across ontogenetic stages, as both juvenile and adult individuals appear to possess a large, medium or small foramen. Furthermore, some specimens bear up to two foramina, the second being consistently small. A large medial jugal foramen is also observed in *D. remensis* (Martin et al., 2014), *D. ratelii* (JDW pers. obs.) and variably in *D. hantoniensis* (Rio et al., 2020). Both the number and size of the foramina are not consistently similar on the left and right side of the skull.

In palatal view, the jugal contacts the ectopterygoid anteromedially at the level of the postorbital bar. The lateral jugal surface bears a similar ornamentation to the maxilla and premaxilla externally, while the medial surface is smooth.

Lacrimal:

The lacrimal forms the anterior margin of the orbit. It is bordered along its entire length by the maxilla anterolaterally and the nasal medially. As in all *Diplocynodon* species, the lacrimal is longer than the prefrontal and contacts the nasal medially immediately anterior to the prefrontal (Figure 1, 2 and 3).

Canthi rostrali and preorbital ridges are absent from the dorsal surface. In adult individuals, the lacrimal bears a more pronounced ornamentation than in other adjacent bones, taking the shape of a pitted shallow boss resulting from the pneumatization of the bone by the lacrimal duct opening on the anterior wall of the orbit.

Prefrontal:

The prefrontal forms the anteromedial margin of the orbits, contacting the lacrimal anterolaterally and the frontal and nasals posteromedially and anteromedially respectively. Prefrontals do not contact each other, being separated by the frontal anterior process and by the posterior processes of the nasals. A noticeable groove runs along the orbital margin (Figure 1, 2 and 3). This groove stops immediately anterior to the prefrontal-frontal suture and does not cross the inter-orbital bar. Most crocodilians, including *Diplocynodon*, bear variable ornamental features on the prefrontal surface: these features often take part in the formation of an interorbital bridge which, in the most derived cases, create a complete "spectacle" (e.g. *Caiman crocodilus*). The morphology observed in *Diplocynodon darwini* instead does not bear comparable structure, and the groove is strictly restricted to the prefrontal and does not uplift the anteromedial edge of the orbit.

Frontal:

The frontal is a robust bone forming the interorbital bar and anteromedial area of the skull table. Anterior to the orbits, the frontal separates the nasals posterior tips buy sending a thin "v" shaped process, and no "step" is present as opposed to *Diplocynodon hantoniensis*. Posteriorly, it forms the anteromedial corner of the supratemporal fenestrae by contacting the postorbital laterally and the parietal posteriorly through linear sutures. The ornamented surface is restricted to the skull table area, while the anterior process is usually devoid of grooves or pits (Figure 1 and 2). The lateral edges forming the orbital margins flush with the skull surface, or only slightly uplifted in the most mature specimens. There is no interorbital bridge or "spectacle" crossing transversely on the frontal in *Diplocynodon darwini*, as in most congeneric species with the exception of *Diplocynodon hantoniensis*. In the latter species, Rio et al. (2020) noticed a minimal step occurring on the frontal of the least mature specimens. In ventral view, the interorbital section of the frontal is excavated to receive the anterodorsal region of the cerebrum. Few specimens, among which HLMD-Me 10262 (Figure 3) preserved palpebrals: a single reduced, ossification is preserved in each orbit, similar to *Alligator mississippiensis*.

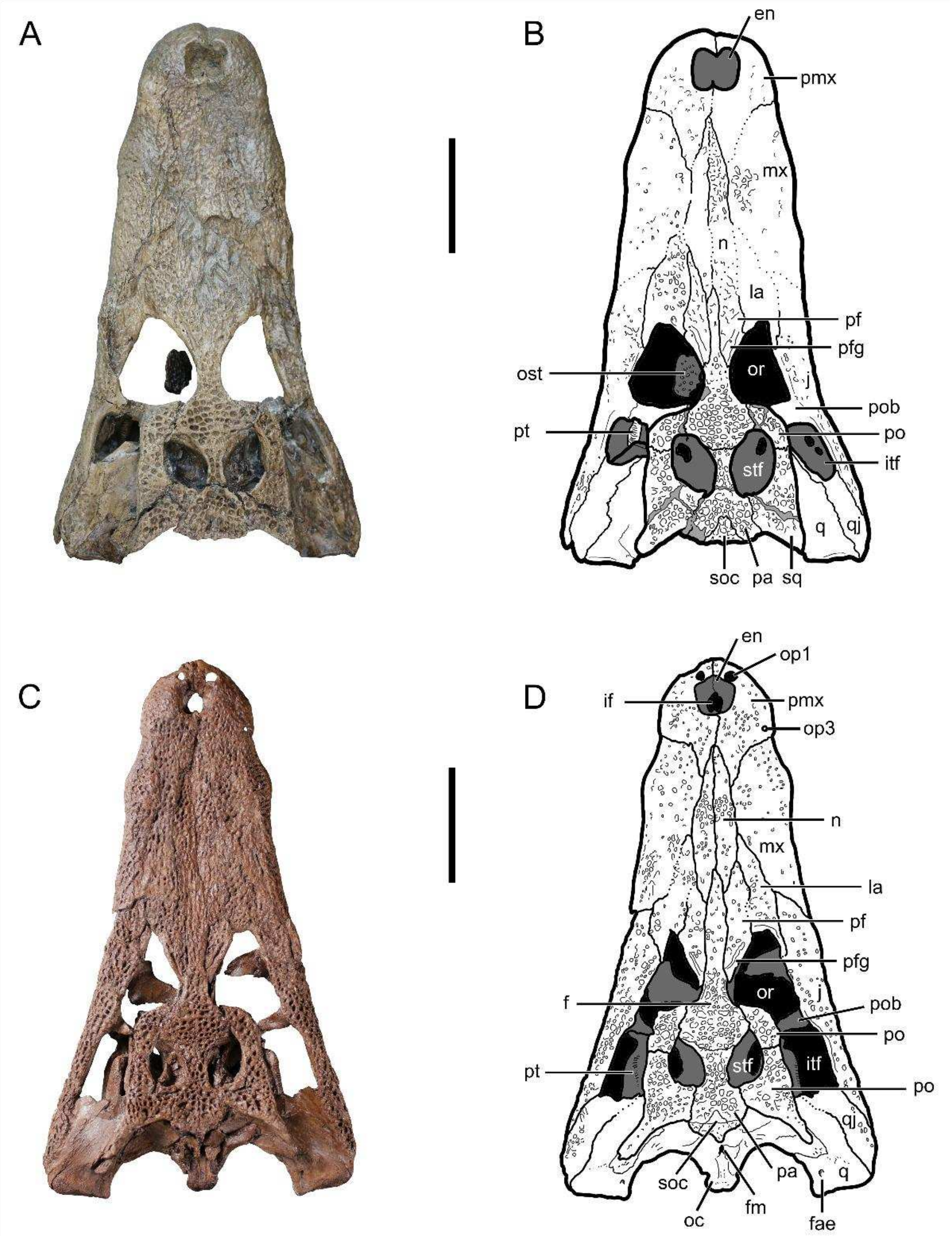


Figure 1: Skulls of *Diplocynodon darwini* (HLMD-Me 900, A-B, Messel; GMH XXXVI-524-1966, C-D, Geiseltal). Abbreviations: en, external naris; f, frontal; fae, foramen aërum; fm, foramen magnum; if, incisive foramen; itf, infratemporal fenestra; j, jugal; la, lacrimal; mx, maxilla; n, nasal; oc, occipital condyle; op1-3, occlusion pit for dentary tooth 1-3; or, orbit; ost, osteoderm; pa, parietal; pf, prefrontal; pfg, prefrontal groove; pmx, premaxilla; po, postorbital; pob, postorbital bar; pt, pterygoid; soc, supraoccipital; sq, squamosal; stf, supratemporal fenestra. Scale bars = 5 cm.

Postorbital:

The postorbital forms the anterolateral corner of the skull table, contacting the frontal medially, the squamosal posteriorly, and the jugal anteroventrally through the postorbital bar. The latter bar is rather thin and circular in cross-section, formed for most of its length by the postorbital which contacts the jugal process medially near its base. The ornamentation is well developed on the dorsal surface. One foramen pierces the anterior surface of the postorbital anterolateral corner in several specimens.

Parietal:

The parietal is a solid central bone of the skull table, contacting the frontal anteriorly along a mediolateral concavo-convex suture. The latter enters deeply into the supratemporal fenestrae laterally, before shifting anterolaterally on the medial wall of the supratemporal fossa, preventing any contact with the postorbital (Figure 1). The lateral edges of the parietal only minimally overhang the supratemporal fenestra and the medial wall of the fenestra is imperforate. The anteromedial corner of the supratemporal fenestrae are smoothly tapering anteriorly and flush with the skull surface. Most skulls preserving the posterior wall of the supratemporal fenestra display the parietal approaching the squamosal ventrally but not contacting it. Anteriorly, the parietal-laterosphenoid suture is horizontal. The dorsal surface of the parietal is planar and bears shallow pits and grooves.

Squamosal:

The squamosals form the posterolateral corners of the skull table, contacting the postorbital anteriorly and the parietal medially. There is no medial contact with the supraoccipital. The lateral edges of the squamosals are straight and parallel in mature specimens. Along the lateral surface of the bone, a subparallel dorsal and ventral rim bound the squamosal groove. Immediately ventral, the squamosal forms the dorsal and posterodorsal edge of the external auditory meatus. From this point, the squamosal contacts the quadrate along a dorsoventral linear suture. The squamosal prongs contact the paroccipital processes of the exoccipitals ventrally for a short distance. The squamosal dorsal surface is planar and ornamented with pits and grooves of similar size than on the parietal and postorbital.

Supraoccipital:

The supraoccipital forms the medial posterior edge of the skull table and is enclosed by the parietal anteriorly and laterally. The bone is triangular in shape both in dorsal and posterior view, and is minimally exposed on the skull table in the largest specimens. The posterior edge of the supraoccipital is convex and slightly exceeds the posterior margin of the skull, giving the latter a slight concavo-convex outline in dorsal view. The posterior surface of the supraoccipital bears an evident sagittal crest erecting dorsally from the short dorsal overhang and fading ventrally into the posterior wall before reaching the sutural contact with the exoccipitals. Furthermore, the posterior wall surface of the supraoccipital bears two lateral processes that project slightly posteriorly, comparably to the sagittal crest. These processes are visible in dorsal view in some specimens, more specifically juveniles and subadult specimens (Figure 3B). Similar processes are also recovered in *Diplocynodon hantoniensis* (Rio et al., 2020). The ornamentation of the bone is often formed by two reduced and sagittally symmetrical grooves on the posteromedial region, surrounded by common shallow pits.

Quadrate:

The quadrate is the main bone of the ramus articulating with the lower jaw. Anteromedially, it sutures with the squamosal, preventing the exoccipital to be exposed laterally posterior to the external auditory meatus. At this level, the quadrate-squamosal suture flares dorsally along the straight posterior margin of the meatus. The quadratic ramus is rather long, as is the paroccipital process, which approaches the condyle. The quadrate foramen aëreum is located on the posteromedial part of the ramus, and is exposed on the dorsal surface of the latter. In posterior view, the quadrate condyle appears relatively large, with the dorsal and ventral edges being roughly parallel. Most specimens bear a medial hemicondyle that is slightly medioventrally directed, but the shape of the condyle may be subject to variation relative to the expansion of the medial notch (see character 118 and 119 in Rio & Mannion, 2021 for a discussion). A thin anteroposteriorly directed crest is visible in ventral view, as the attachment surface for the posterior mandibular adductor muscle.

Quadratojugal:

The quadratojugal reaches the dorsal angle of the infratemporal fenestra and contacts the postorbital. The latter bone sends a short process ventrally into the quadratojugal. The quadratojugal forms the posterior angle of the infratemporal fenestra and sends a thin dorsal projection that contacts the postorbital, preventing contact between the quadrate and the postorbital. As in other *Diplocynodon* species, the spina quadratojugalis is extremely reduced to completely absent. In rare specimens it takes the shape of a rounded knob placed at mid-height between the posteroventral and dorsal angles of the fenestra, comparable to *Leidyosuchus canadensis* (Wu, 2001). Anteriorly, the quadratojugal contacts the jugal along an anterodorsally directed linear suture. The posterolateral surface of the quadratic ramus is entirely hidden by the quadratojugal.

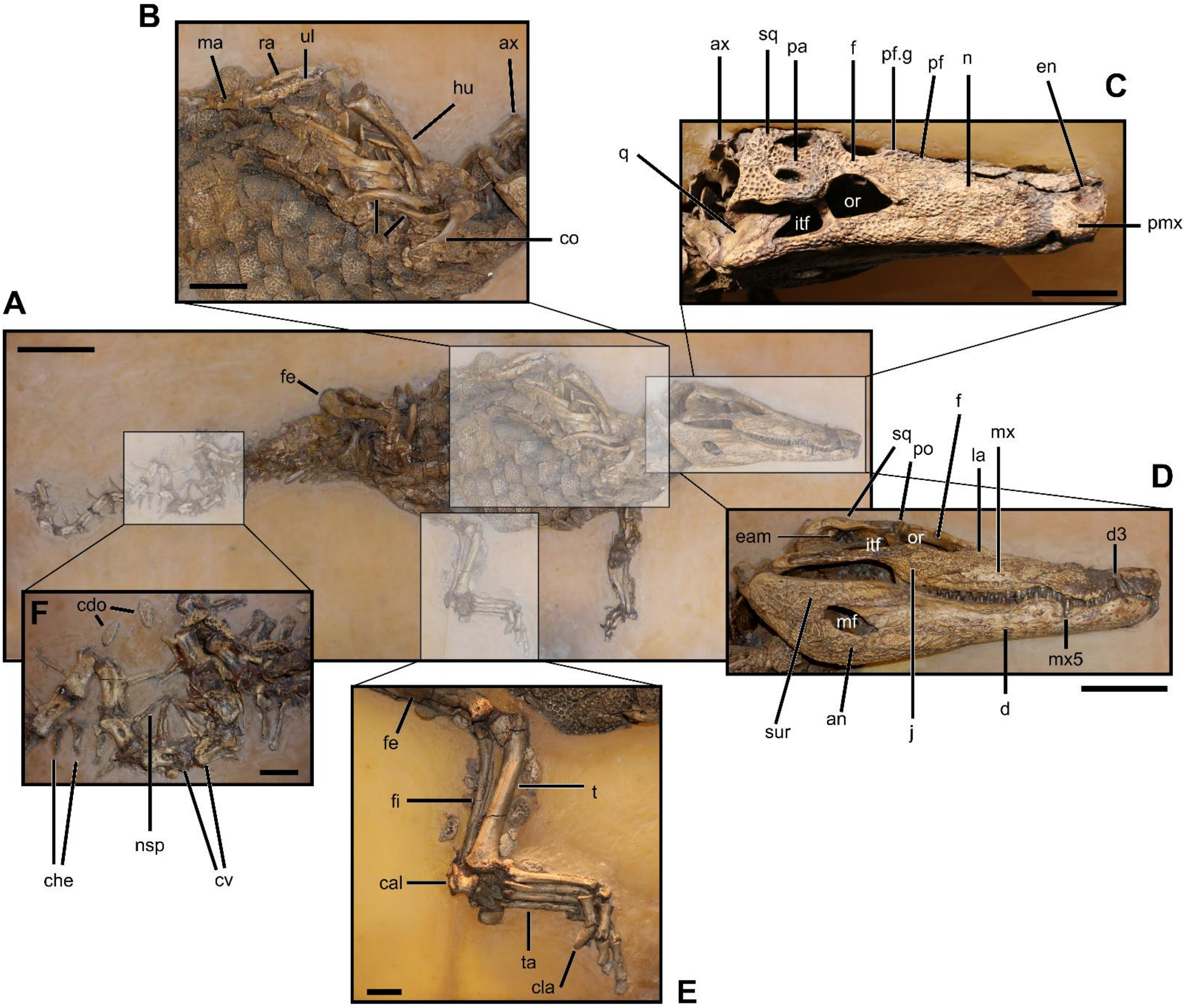


Figure 2: Articulated adult specimen of *Diplocynodon darwini*. A, HLMD-Me 7500 exposed ventrolaterally (scale bar = 10 cm); B, close-up view of thoracic region and pectoral girdle (scale bar = 5 cm). C-D, close-up view of the skull in dorsal and lateral views (scale bars = 5 cm); E, close-up view of the left hindlimb in medial view (scale bar = 2 cm); F, close-up view of the ultimate caudal vertebrae bearing osteoderms (scale bar = 2 cm). Abbreviations: an, angular; ax, axis; cal, calcaneum; cdo, caudal dorsal osteoderms; ch, choanae; che, chevrons; cla, claw; co, coracoid; cv, caudal vertebra; d, dentary; d3, dentary tooth 3; eam, external auditory meatus; en, external naris; f, frontal; fe, femur; fi, fibula; hu, humerus; itf, infratemporal fenestra; j, jugal; la, lacrimal; ma, metacarpals; mf, mandibular fenestra; mx, maxillary; mx5, maxillary tooth 3; n, nasal; nsp, neural spine; or, orbit; pa, parietal; pf, prefrontal; pf.g, prefrontal groove; pmx, premaxillary; po, postorbital; pt, pterygoid; q, quadrate; ra, radius; sq, squamosal; sur, surangular; t, tibia; ta, metatarsals; ul, ulna.

Palatine:

The palatines are long bones forming the medial border of the suborbital fenestrae. It contacts the pterygoid posteriorly along a mediolateral suture located at a short distance anterior to the posteromedial corner of the fenestra. Anteriorly, the palatine process projects up to the level of the 9th maxillary alveolus, and its tip is convex. There is a reduced lateral projection of the palatine along anteromedial margin of suborbital fenestra. The anterior process of the palatine however shows variation among the two populations: individuals from Messel locality bear a rounded bilobate suture with the maxilla, while Geiseltal specimens (where preserved) have a wider angled "V" shaped process. This process terminates slightly anterior to the suborbital fenestra, not further rostrally than 2 alveoli. The suborbital fenestra is devoid of palatine shelves, either anteromedially or posteromedially.

Ectopterygoid:

Only a few specimens preserve the ectopterygoid, even fewer in situ. The ectopterygoid approaches the medial wall of the last two maxillary alveoli, but does not contact the toothrow. The shape of the anterior suture is however unknown as the relevant area is not sufficiently well-preserved in any specimen. HLMD-Me 7571 and SMF-Me 898 were found with a sutural surface indicating a flexure in the ectopterygoid-pterygoid contact. This morphology is newly recognised in *Diplocynodon darwini*, and was recently acknowledged in two other *Diplocynodon* species, namely *Diplocynodon deponiae* and *Diplocynodon hantoniensis*. Posteriorly, the ectopterygoid stops before reaching the posterolateral tip of the pterygoid flange.

Pterygoid:

The pterygoid contacts the palatine anteriorly and the ectopterygoid anterolaterally. The bone is dorsoventrally long and forms the posterior and posterolateral margins of the suborbital fenestra. The pterygoid encloses entirely the choanae which is located further posteriorly from the level of the posterior margin of the suborbital fenestra. The lateral surface of the pterygoid is expanded dorsoventrally and ruguous. The dorsal surface of the pterygoids could not be observed because of the absence of 3D specimens. The choanae, where preserved, are heart-shaped resulting from a short invagination in its anterior margin and projects posteroventrally. The posterior margin of the choanae is positioned slightly anterior to the posterior margin of the pterygoid. The internal cavity of the choanae is septate and the septum remains recessed within the choanae is unknown. The anterior and lateral margins of the choanae are slightly upturned, but the degree varies among specimens, most presumably because of deformation. This morphology is also observed in *Diplocynodon deponiae* and *Diplocynodon hantoniensis*, but differs from the "neck" seen in osteolaemines which circumscribes the entire choanae. As in *Diplocynodon hantoniensis* and *Diplocynodon remensis*, thin crests directed anterolaterally are found lateral to the choanae.

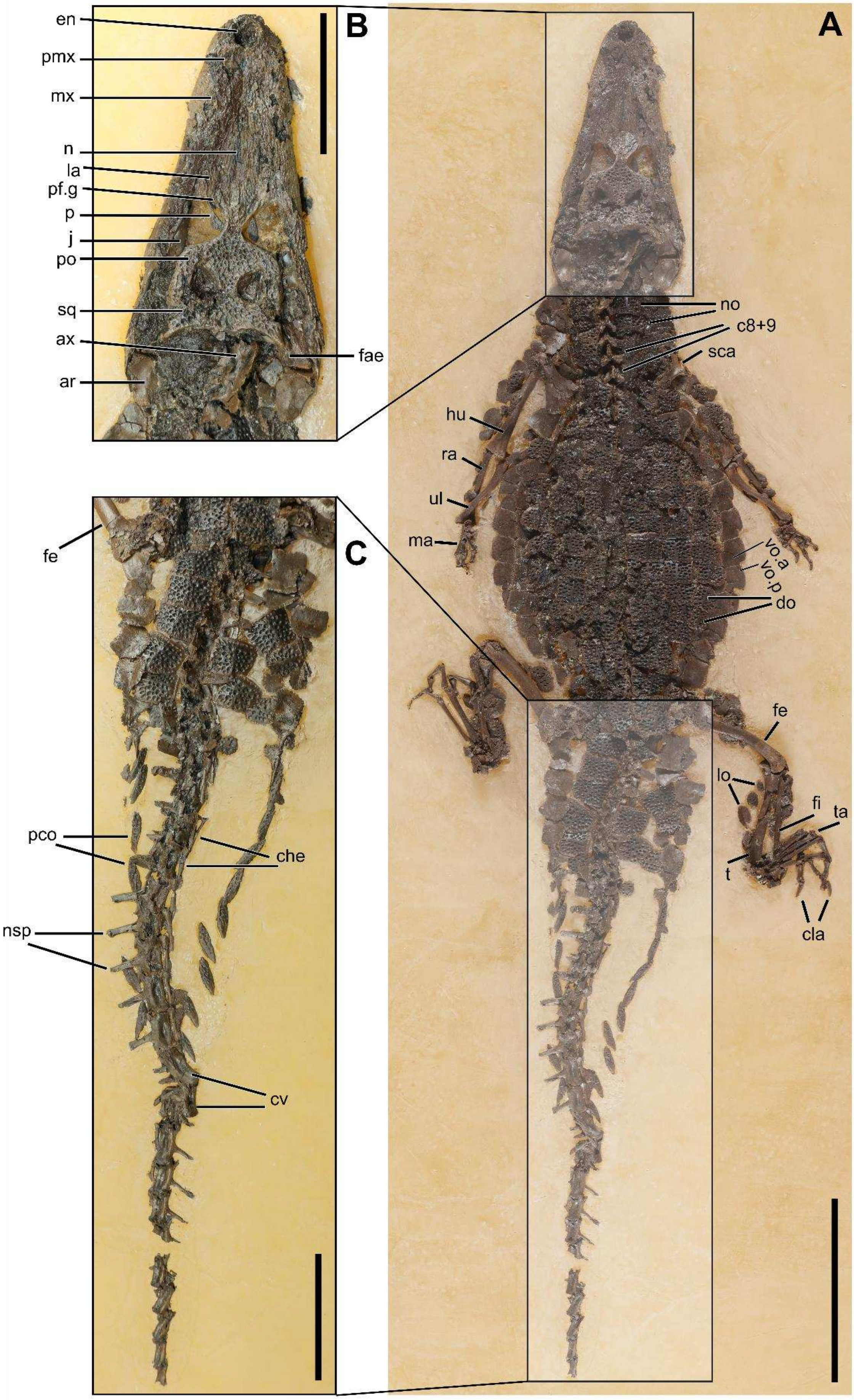
Exoccipital:

The exoccipital is exposed in posterior view and partially visible in dorsal view. The paroccipital process of the exoccipital sutures dorsally with the squamosal. Its lateral process is short and does not extend to the articular border of the quadrate condyle, without any projection in the paroccipital process. The exoccipital does not project far ventrally and does not contact the basioccipital tubera. The foramen magnum is oval in shape, bordered by the exoccipital dorsally and basioccipital ventrally. The ventrolateral surface of the exoccipital hosts several cranial foramina, the largest being the metotic foramen, located laterally at the level of the foramen magnum. The ventral portion of the exoccipital (otoccipital) is oriented vertically at maturity.

Basioccipital and *basisphenoid*:

Two isolated basicranium specimens were used to describe the following morphologies (HLMD-Me 5368, 5369). The basioccipital forms the ventral part of the skull in posterior view, immediately and ventral to the exoccipital. The exoccipital-basioccipital suture passes ventral to the lateral carotid foramen that is distinctly separated from the metotic foramen, located further ventrally. The lateral edges of the basioccipital are ventrally parallel and converge ventrally. A shallow concavity shapes the ventral margin of the basioccipital but is not comparable to the extreme state found in gavialoids. The basioccipital tubera is slender and does not contact the exoccipital. Ventrally, the median eustachian foramen opens close to the basisphenoid-basioccipital suture. The lateral Eustachian canals open dorsolaterally to the median foramen. A short sagittal and thin crest runs dorsoventrally along the medial surface of the basioccipital ventral plate.The basisphenoid is exposed ventrally for a short distance in posterior view and hidden in ventral view. Most basicranium bones are consistently crushed in well-preserved specimens due to the common dorsoventral compression. The precise organisation between the basisphenoid and the surrounding bones could therefore not be observed and assessed.

Figure 3 (see below): Articulated sub-adult specimen of *Diplocynodon darwini*. A, HLMD-Me 10262 exposed dorsally (scale bar = 10 cm); B, close-up view of the skull in dorsal view (scale bar = 5 cm); C, close-up view of the ultimate caudal vertebrae bearing osteoderms (scale bar = 5 cm). Abbreviations: ar, articular; ax, axis; cal, calcaneum; ch, choanae; che, chevrons; cla, claws; co, coracoid; cv, caudal vertebra; d, dentary; d3, dentary tooth 3; eam, external auditory meatus; en, external naris; f, frontal; fae, foramen aërum; fe, femur; fi, fibula; hu, humerus; itf, infratemporal fenestra; j, jugal; la, lacrimal; ma, metacarpals; mf, mandibular fenestra; mx, maxillary; mx5, maxillary tooth 3; n, nasal; no, nuchal osteoderms; nsp, neural spine; or, orbit; pa, parietal; pco, posterior caudal osteoderms; pf, prefrontal; pf.g, prefrontal groove; pmx, premaxillary; po, postorbital; pt, pterygoid; q, quadrate; ra, radius; sca, scapula; sq, squamosal; sur, surangular; t, tibia; ta, metatarsals; ul, ulna.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Mandible

Dentary and dentition:

The dentary (Figure 4) forms most of the mandible length and hosts the complete toothrow. In lateral view, its dorsal surface is largely linear, with gentle concavity between the 4th and 10th alveoli. The dentary symphysis varies in length, but never reach further posteriorly than the level of the 4th alveolus. In medial view, the dorsal lobe of the symphyseal surface projects further posteriorly than the ventral counterpart.

The 1st dentary alveolus and tooth are generally projecting anterodorsally in *Diplocynodon darwini*, but the degree of projection can vary significantly, including strong procumbence in some specimens. As in all *Diplocynodon*, the 3rd and 4th alveoli are enlarged and confluent. This primitive morphology is shared with *Bernissartia fagesii*, *Borealosuchus* spp., *Leidyosuchus canadensis* and *Deinosuchus* spp. The alveoli are noticeably reduced in size immediately posterior to the 4th until the 11th and 12th which are similar in size to the 3rd and 4th. In lateral view, both pairs sit slightly higher than the rest of the toothrow.

Dentary and maxillary teeth occlude in a partial interlocking pattern. The 3rd and 4th dentary teeth form a pair of canines that occlude in a pit early in ontogeny, that later develops into a notch in adult specimens after carving the premaxilla-maxilla lateral surface. Posteriorly, the interalveolar space is enlarged between the 6th-7th, 7th-8th, and variably 8th-9th alveoli, for the in-line reception of the corresponding maxillary teeth. The dentary toothrow remains straight posterior to the 9th alveolus, and the respective teeth occlude lingually on the maxilla. All mandibular alveoli and teeth are circular in cross-section, with a very modest mediolateral compression for the ones posterior to the 12th alveolus. The first 13 dentary teeth are generally conical and acute, each bearing a distal and mesial carina. Posterior to the 13th dentary tooth, the teeth are slightly blunter and exhibit a ventral an easily identifiable constriction at the level of the crown-root contiguity.

Splenial:

The splenial runs along the medila surface of the dentary for most of its length. The dorsal edge of the bone is linear. The medial surface of the splenial is smooth and devoid of foramen for the cranial nerve V anteriorly. The splenial is excluded from the mandibular symphysis as in all *Diplocynodon* species except *Diplocynodon remensis*, in which the splenial participates in the symphysis. In *Diplocynodon darwini*, the anterior-most tip of the splenial is located ventral to the Meckelian groove. In the posterior region, the splenial contacts the angular and coronoid but does not separate the latter bones.

Coronoid: The coronoid is unfortunately lost in most specimens, or only fragmentary in some isolated mandibles. The coronoid contacts the splenial anteriorly: the sutural contact with the latter bone is perforated by the small foramen intermandibularis medius.

Angular:

The angular contacts the dentary anteriorly through a long ventral process reaching the mandible midlength, and the surangular dorsally from the posterior margin of the external mandibular fenestra up to the posterolateral tip of the retroarticular process (HLMD-Me 5349). The angular is ornamented by pits and shallow grooves on its lateral surface, but shows no eversion of the ventrolateral margin.

Surangular:

The surangular forms the posterodorsal corner of the jaw. It contacts the dentary anteriorly beyond the posterodorsal corner of the external mandibular fenestra, and the angular ventrally at the posterior margin of the latter fenestra. The latter suture intersects the articular medially, dorsal to its ventral tip. Medially, the surangular-articular suture is straight, running anteroposteriorly along the contact surface of both elements, and is perforated by the lingual foramen for the articular and alveolar nerve (HLMD-Me 5349). Laterodorsally, the surangular sends a short projection that nearly reaches the dorsal tip of the lateral wall of the glenoid fossa. The surangular posterior process does not reach the posterior tip of the retroarticular process, and is instead pinched out. In dorsal view, two sub-equal processes extend anteriorly on either side of the surangular foramen. Similarly to the angular, the lateral surface of the surangular is ornamented with pits and grooves.

Articular:

The articular sutures with the surangular and angular laterally along all its length. Posterodorsally, the retroarticular process projects posterodorsally and level with or exceeds the dorsal height of the posterior edge of the articular fossa in lateral view. The foramen aërum opens dorsolaterally on the medial margin of the articular (or "inset"). As in *Diplocynodon hantoniensis*, a thin ridge erects from the foramen aërum neck and projects posteriorly for a short distance before fading into the smooth dorsal surface of the articular fossa.

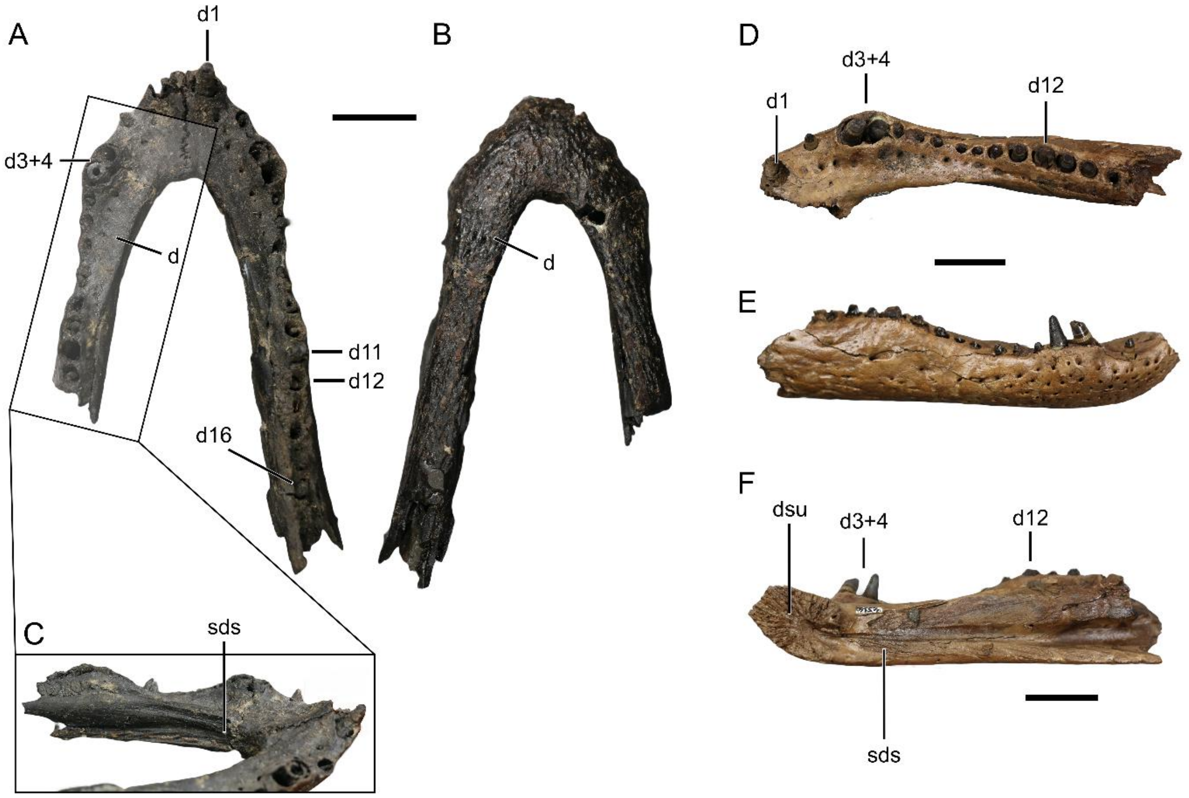
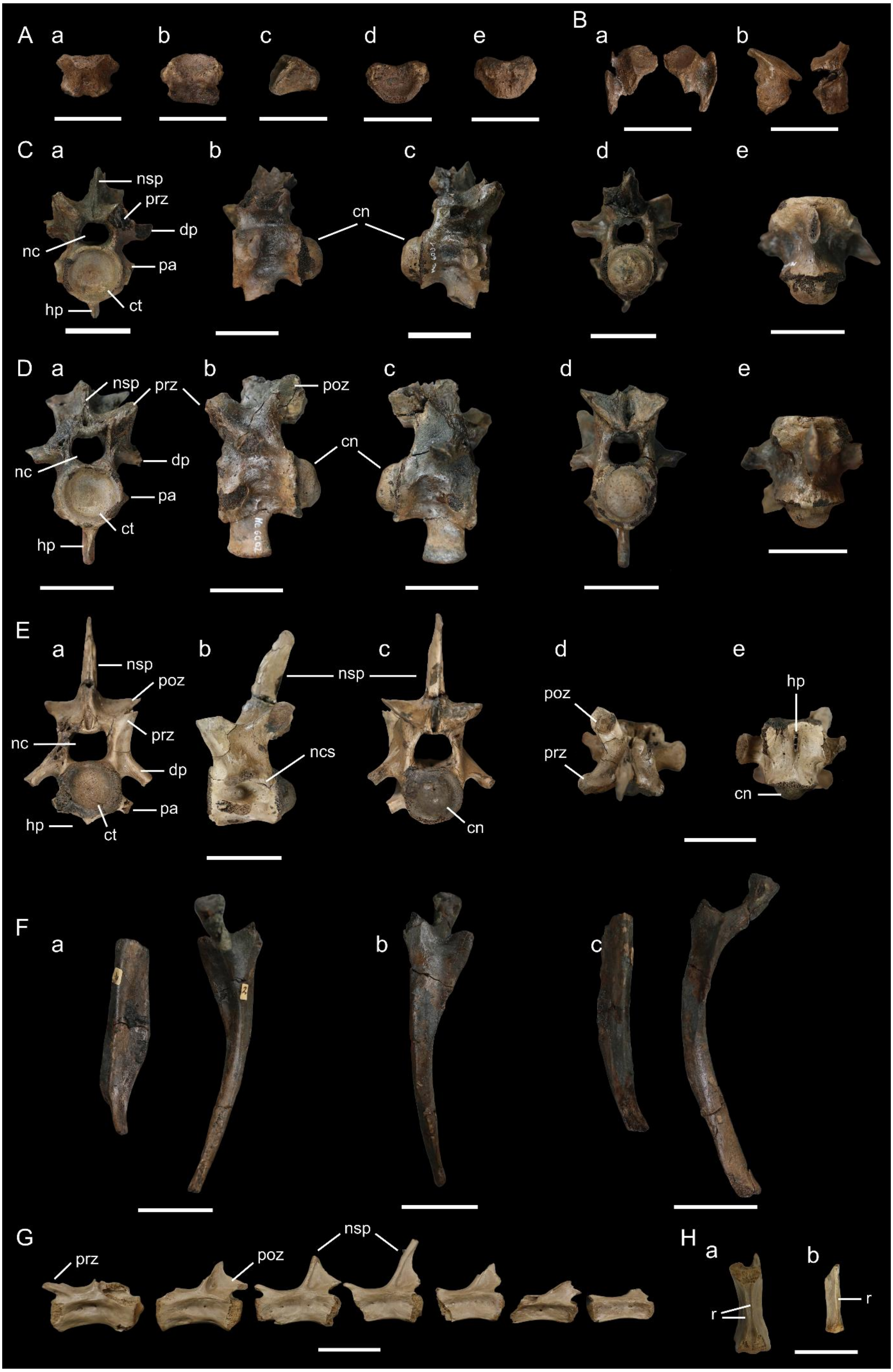


Figure 4: Lower jaw (HLMD-Me 4423; A-C) and right dentary (HLMD-Me 5360, lectotype; D-F) of *Diplocynodon darwini*. A, dorsal view; B. ventral view; C, dorsomedial view of the left dentary ramus; D, dorsal view; E, lateral view; F, medial view. Abbreviations: d, dentary; d1, d 3+4, d11, d12, d16, dentary alveolus position on the dentary; dsu, dentary symphysis surface; sds, splenial-dentary sutural surface. Scale bars = 2 cm.

Postcranial

Postcranial material of *Diplocynodon darwini* is well-preserved in complete and articulated specimens. Accurate observation of axial elements is however rendered difficult by the preservation of most complete specimens on slabs (in ventral or dorsal views), as well as the extensive osteoderm coverage. Description of the postcranial elements mostly rely on the multiple specimens exposed on slabs (Figure 2, 3, 6, 9 and Figures S1 and S2 in Appendix 3) and rare disarticulated bones (see Appendix 4 for a complete list of specimens).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<u>*Figure 5*</u>: Disarticualted axial elements of *Diplocynodon darwini*. A, atlas intercentrum (HLMD-Me 5890); a, ventral view; b, dorsal view; c, left lateral view; d, anterior view;, e, posterior view; B, atlantal ribs (HLMD-Me 5890); a, dorsal view; b, ventral view (lateral edge on top); C, cervical vertebrae (HLMD-Me 6001); a, anterior view; b, left lateral view; c, right lateral view; d, posterior view; e, ventral view; D, cervical vertebrae (HLMD-Me 6002); a, anterior view; b, left lateral view; c, right lateral view; d, posterior view; e, ventral view; E, posterior cervical vertebrae (HLMD-Me 6044); a, anterior view; b, left lateral view; c, posterior view; d, dorsal view; e, ventral view; F, anterior left dorsal ribs; a, anterior view; b, posterior view; c, medial view; G, series of 7 posterior caudal vertebrae; H, posterior caudal vertebrae presented in (G) in ventral view (note the width reduction); a, anterior vertebrae; b, posterior vertebrae. Abbreviations: cn, condyle; ct, cotyle; dp, diapophysis; hp, hypapophysis; nc, neural canal; ncs, neurocentral suture; nsp, neural spine; pa, parapophysis; poz, postzygapophysis; prz, prezygapophysis; r, ridge.

Proatlas, atlas and atlas intercentrum:

The proatlas and atlas were not observable in any complete individual, nor part of the disarticulated specimens. The atlas intercentrum is wedge-shaped (Figure 5A), condition shared with all non-alligatoroid crocodylians where preserved.

Axis:

The axis is preserved in 2 specimens illustrated here, HLMD-Me 7500 (Figure 2) and HLMD-Me 10262 (Figure 3). The neural spine is dorsoventrally high along its entire length, and its dorsal edge is horizontal up to its posterior tip. The position and morphology of the hypapophysis or axial ribs could not be determined in any of the specimens.

Cervical vertebrae:

Most cervical vertebrae were observable in dorsal or dorsolateral views (Figure 5C-E; HLMD-Me 6004/05/06/07/08, HLMD-Me 6026, HLMD-Me 6044). All isolated cervical vertebrae are procoelous and bear a prominent hypapophysis, when preserved. The respective position of each cervical can be assessed in complete specimens, but only in dorsal or ventral views. The neural spine of the 3rd cervical vertebra is anteroposteriorly longer than the one of other cervicals, relatively to the centrum length. Posteriorly, the anterior extent of the hypapophysis of the 7th to 9th cervical vertebrae does not project further anteriorly than the ventral anterior margin of the centrum. The 8th and 9th cervicals are equal in length.

Dorsal vertebrae:

Dorsal vertebrae are preserved in most specimens, but are often covered by the dorsal shield, obscuring their exact location on the axial column. Most dorsal vertebrae have two medial foramina on the dorsal surface of the centrum, separated by a thin sagittal crest, visible through the neural canal. The neural spine is successively shifted posteriorly along the dorsal column: the 1st dorsal vertebra bears a neural spine located at mid-length in lateral view, while the last dorsal vertebra bears a neural spine located close to the posterior edge of the neural arch.

Sacral vertebrae:

As for all other crocodylians and eusuchians, *Diplocynodon darwini* has two sacral vertebrae. Their centrum is robust and slightly wider than other vertebrae. The wide ribs suture strongly to the lateral surface of the centrum. HLMD-Me 6012 are the only disarticulated sacral vertebrae available for three dimensional view, but are too poorly preserved to assess the respective extent of sacral ribs capitulum.

Caudal vertebrae:

The first caudal vertebra is biconvex in *Diplocynodon darwini* (HLMD-Me 10496), as in all extant crocodylians and most fossil eusuchians where known. All subsequent caudal vertebrae are procoelous. The centrum becomes progressively thinner mediolaterally along the tail and bear a shallow concavity on its lateral surface. This concavity becomes evident in the last vertebrae, making the ventral surface of the centrum look constricted, and two thin ridges appear prominent on the ventrolateral surface of the centrum (HLMD-Me 6018; Figure 5G).

Transverse processes are present on caudal vertebrae until caudal vertebra 15. Articular surfaces for the chevrons are all fused in dorsal vertebrae posterior to the first caudal vertebra, visible in complete well-preserved specimens (HLMD-ME 10496, SMF Me 1137, SMF Me 1341, SMF Me 2748). The neural spine is located on the posterior part of the neural arch dorsal surface and projects posterodorsally. The postzygapophyses fuse into a single postzygapophysis in the posterior caudal vertebrae. This unique postzygapophysis is connected to the neural spine with a thin bony 'veil' (see Figure 5G).

Pectoral girdle:

Except from the most complete specimens, two scapulae (HLMD-Me 5905 and 5906) and three fragmentary isolated coracoids are preserved (HLMD-Me 5886, 5911 and 5912). The scapula and the coracoid are slender bones. The scapula bears a thin deltoid crest, but the blade itself is uniformly wide along its length. The articular facet of the coracoid is broad relative to the shaft width and ends in a pointed process anteriorly. The coracoid is pierced by a large foramen on its dorsomedial surface, anterior to the glenoid fossa (Figure 6Bb).

Forelimb:

The humerus is only slightly contorted, comparable to *D. hantoniensis* (Rio et al., 2020). The proximal margin of the deltopectoral crest emerges noticeably from the proximal end of the bone. Only a single scar for the attachment of the M. teres major and M. dorsalis scapulae was observed.

The ulna is relatively slender with a wide and rounded olecranon process. The proximal diaphysis is straight. The morphology of metacarpals in crocodylians is very conservative and do not, to our current knowledge, present any diagnostic differences across genera. The distal region of the forelimb comprises 5 digits among which number III being the longest (Figure 2, 3 and 6).

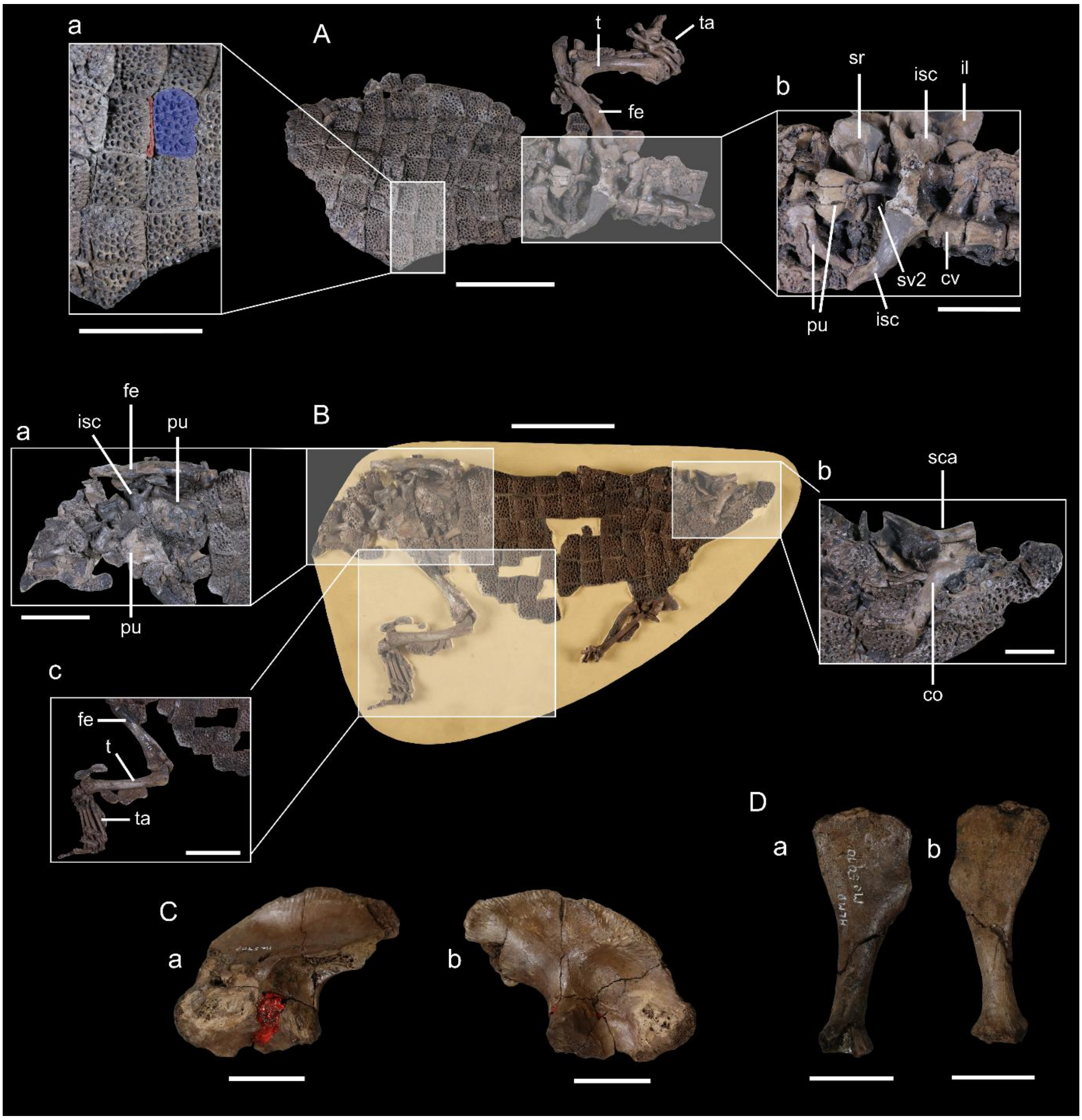


Figure 6: Articulated axial elements of *Diplocynodon darwini*. A, trunk region with pelvic girdle in ventral view (HLMD-Me 5605, scale bar = 10 cm); a, close-up view of the bipartite ventral osteoderms (anterior element in red, posterior element in blue, scale bar = 5 cm); b, close-up view of the pelvic girdle and first caudal vertebræ (scale bar = 5 cm); B, trunk region with pectoral and pelvic girdles in ventrolateral view (HLMD-Me 5605, scale bar = 10 cm); a, close-up view of the pelvic girdle and first caudal vertebrae (scale bar = 5 cm); b, close-up view of the pectoral girdle (scale bar = 2 cm); c, close-up view of the left hindlimb (scale bar = 5 cm); C, right ilium (HLMD-Me 5907, scale bar = 2 cm); a, dorsal view; b, medial view; D, left pubis (HLMD-Me 5910, scale bar = 2 cm); a, ventral view; b, dorsal view. Abbreviations: co, coracoid; cv, caudal vertebra; fe, femur; il, ilium; isc, ischium; pu, pubis; sr, sacral rib; sv2, sacral vertebra 2; t, tibia; ta, metatarsals.

Pelvic girdle:

The pelvic girdle is composed by the articulation of the ilium, ischium and pubis. The ilium preacetabular process is acute and pointed anteriorly. The dorsal margin of the latter bone is rounded and devoid of indentation. Diagnostic of *Diplocynodon*, the dorsoventral height of the postacetabular process is deep and projects posteriorly (HLMD-Me 5875; Figure 6C).

Hindlimb:

The hindlimb is generally longer than the forelimb (Figure 2, 3, 6 and 9). The femur has a reduced sulcus on its medial surface, ventral to the proximal epiphysis. The tibia and fibula are slightly curved bones and show no differences with the same bones described for other *Diplocynodon* species. As for metacarpals, the morphology of metatarsals in crocodylians is very conservative and do not, to our current knowledge, present any significant differences across genera.

Osteoderm coverage:

The dorsal shield is composed of six osteoderms in the nuchal region, and 6 middle transverse rows on the trunk at maturity. Midline dorsal osteoderms are rectangular in shape, bearing a well-defined but smooth median keel and an articular facet that is anterolaterally expanded (Figure 8A). Diagnostic of *Diplocynodon darwini*, caudal osteoderms only cover the anterior third of the tail (Figure 2, 3 and 9). No clear pattern was observed to explain the termination of the coverage, but it however seems that osteoderms are always absent posterior to ~ 1 to 3 vertebrae caudal to the ultimate vertebra bearing a transverse process. The caudal osteoderm coverage however does not evolve throughout ontogeny, as immature individuals already show a partially armoured tail (Figure 9). The ventral armor is made of bipartite osteoderms, diagnostic of the genus (Figure 3, 7, 8; Figure S1 in Appendix 3). The short anterior and squared posterior elements are connected through a straight mediolateral suture. The anterior element slides almost entirely under the anterior osteoderm (Figure 8D).

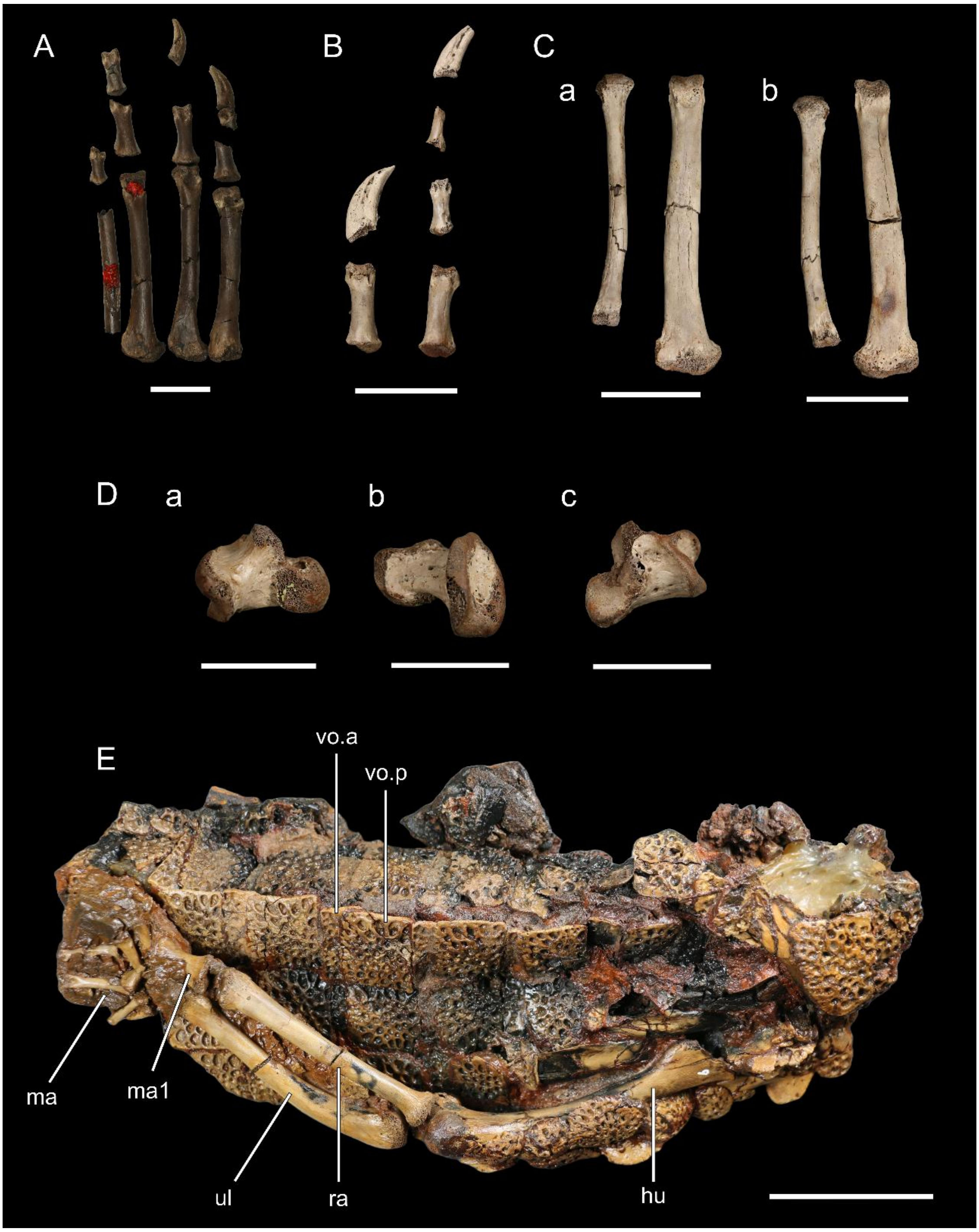


Figure 7: Disarticulated hindlimb elements and articulated forelimb of *Diplocynodon darwini*. A, right metatarsals and claws (HLMD-Me 5919, scale bar = 2 cm); B, ultimate left metatarsals (HLMD-Me 14926, scale bar = 2 cm); Ca-b, first left metatarsals (HLMD-Me 14926, scale bar = 2 cm); a, dorsal view; b, ventral view; Da-c, right calcaneum (HLMD-Me 14926, scale bar = 2 cm); a, ventral view (anterior part pointing to the left); b, dorsal view (anterior part pointing to the left); c, lateral view (anterior part pointing to the right). E, isolated articulated forelimb with anterior ventral osteoderms (HLMD-Me 14926b, scale bar = 5 cm). Abbreviations: hu, humerus; ma, metacarpal; ma1, metacarpal 1; ra, radius; ul, ulna; vo.a, anterior element of the ventral bipartite osteoderm; vo.p, posterior element of the ventral bipartite osteoderm.

Other

Gastroliths are often found among ventral osteoderms. In a large majority of cases, the gastroliths composition is dominated by smooth quartzite specimens white. One can hypothesise that the latter type of liths were intentionally selected for their hardness (as these represent the ultimate rock remains saved from erosion when reaching lowlands) and/or more easily distinguished in turbid environments by their colour.

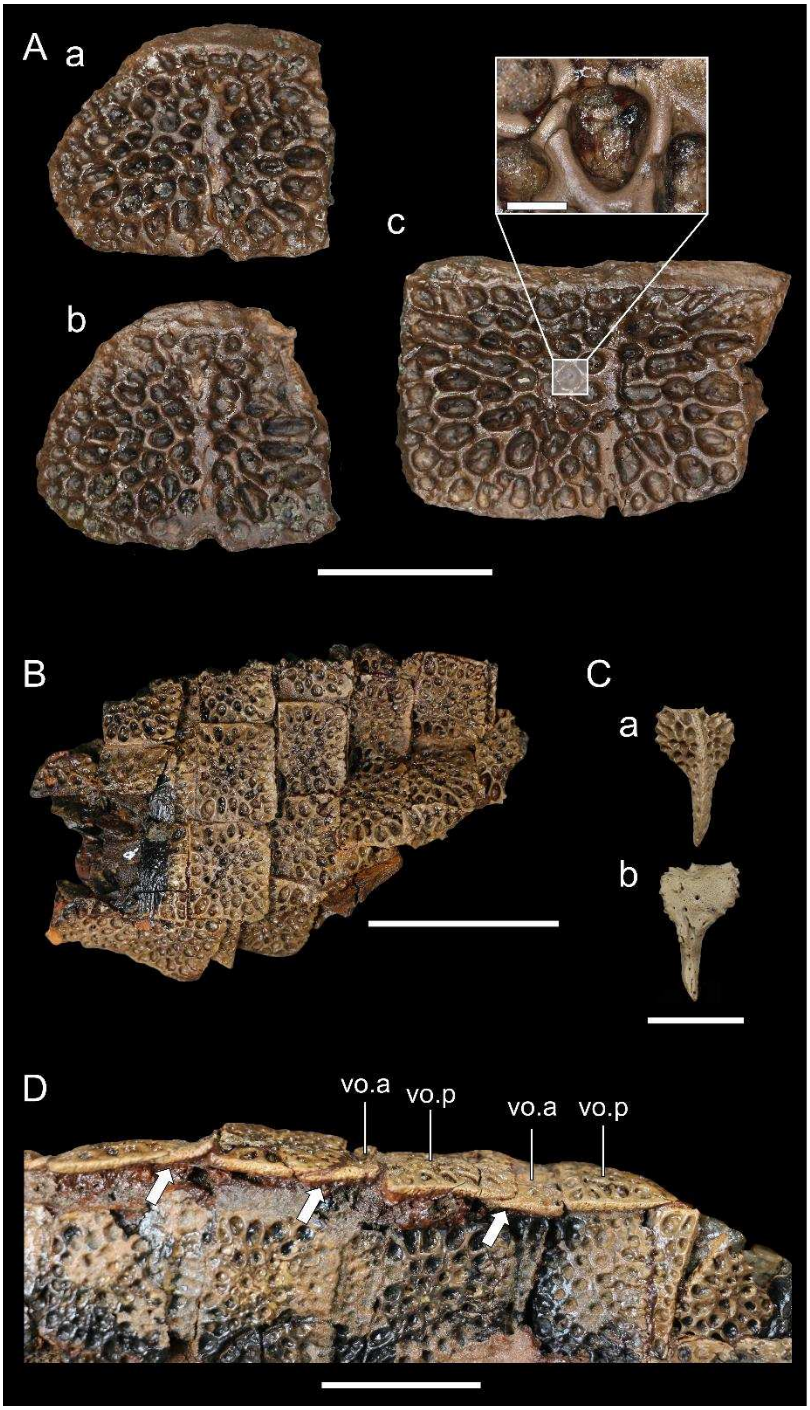


Figure 8: Disarticulated dorsal osteoderms and isolated section of ventral armor of *Diplocynodon darwini*. Aa-c, anterior dorsal osteoderms (HLMD-Me 6015, scale bar = 2 cm); a-b, left lateral dorsal osteoderms; c, anterior (right) medial dorsal osteoderm with a close-up of one of the pit (scale bar = 2 mm). B, isolated section of the ventral armor made of bipartite osteoderms (HLMD-Me 14926d, scale bar = 5 cm); Ca-b, posterior caudal dorsal osteoderm (HLMD-Me 6018, scale bar = 2 cm); a, dorsal view; b, ventral view; D, lateral view of the ventral osteoderms overlap organisation (arrows point at the anterior element covered by the successive posterior element, HLMD-Me 14926b, scale bar = 3 cm). Abbreviations: vo.a, anterior element of the ventral bipartite osteoderm; vo.p, posterior element of the ventral bipartite osteoderm.

Ontogeny

First-hand study of specimens from different ontogenetic classes (e.g. Figure 2, 3 and 9) allowed to identify a number of character states that evolve throughout ontogeny. These can be here used as a relative way to assess a given specimen's ontogenetic stage. These morphologies are as follows:

1. As recognised for other *Diplocynodon* species, the 4th dentary tooth occludes into a pit located between the premaxilla and maxilla early in ontogeny in *D. darwini*. In a majority of mature individuals, the canines eventually pierce through the dorsal surface of the bones and carve the original pit into an evident notch.
2. Juvenile specimens bear a thin crest circumscribing the external nares. This character is lost in mature specimens, where the dorsal surface of the narial opening is smooth. A narial crest is however known in adult specimens of *D. deponiae*, which may indicate a retention of the juvenile state in later ontogenetic states in this species.
3. The external nares opening projects dorsally early in ontogeny and progressively projects anterodorsally as the aperture changes shape (see point X).
4. The general skull shape evolves from an anteriorly tapering rostrum in juveniles to a stouter aspect in adults, with the maxilla lateral edges being parallel for most of their length. Posterior to the premaxillary-maxillary notch.
5. Morphological maturity in *Diplocynodon darwini* may have been acquired late in ontogeny. A majority of the cervical vertebrae studied in hand with a size comparable to adult elements showed a partially opened neurocentral suture, as also noted for *Diplocynodon hantoniensis* (Rio et al., 2020 fig. 14). Moreover, the scapula-coracoid complex is often preserved with the two constituting bones being disarticulated, which hints at a late closure of the synchrondrosis.
6. The dentition of young individuals consists of sharp pointed teeth, nearly all equal in size. Throughout ontogeny, the canines become evidently developed, while the posterior teeth become increasingly blunt caudal to the 12th. The morphology however differs from *D. hantoniensis* and *D. deponiae* in which these teeth become more blunt (see Chapter 2).

7. In juveniles, the supraoccipital appears relatively larger, both in size and exposure on the dorsal surface of the skull. The supraoccipital may have a slower growth rate than surrounding bones during ontogeny, preserving its shape and size, slowly turning out to be modestly exposed in mature individuals.
8. The shape of the external nares evolves throughout ontogeny. The lateral sides of the external nares are broadly convex in the youngest individuals. The shape later evolves in a square in larger individuals identified as sub-adults. The external nares finally open and is flush with the premaxillae surface anteriorly. This gives the nares a trapezoidal shape in the largest individuals identified as adults.
9. Juvenile teeth are thinly striated (Figure 9), but this striation disappears throughout ontogeny as the enamel thickens.

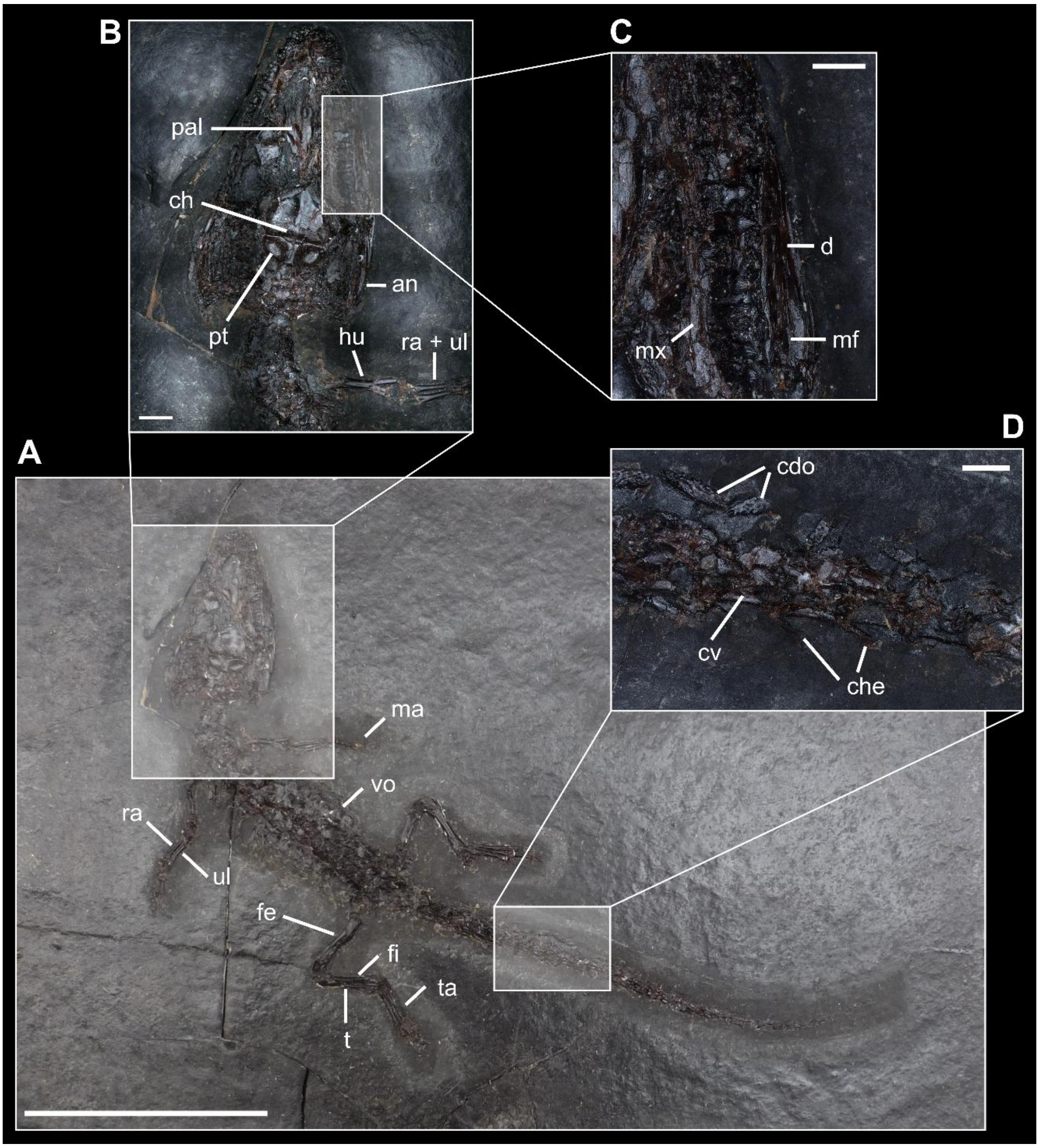


Figure 9: Articulated juvenile specimen of *Diplocynodon darwini*. A, HLMD-Me 5317 exposed dorsally (scale bar = 5 cm); B, close-up view of the skull region (the skull table and braincase were not preserved, scale bar = 4 mm); C, close-up view of the fragmentary right dentary and maxillary (scale bar = 2 mm); D, close-up view of the ultimate caudal vertebrae bearing osteoderms (scale bar = 2 mm). Abbreviations: an, angular; cdo, caudal dorsal osteoderms; ch, choanae; che, chevrons; cv, caudal vertebra; d, dentary; fe, femur; fi, fibula; hu, humerus; ma, metacarpals; mf, mandibular fenestra; mx, maxillary; pt, pterygoid; ra, radius; t, tibia; ul, ulna.

3. Phylogenetic analyses

3.1 Methods

The ingroup evolutionary relationships of *Diplocynodon* were tested using a modified version of two datasets:

1) Chabrol et al. (2024), expanded upon Rio & Mannion (2021); consisting of 26 continuous and 304 discrete morphological characters, among which 36 multistates characters are treated as ordered. Two versions of the dataset were used to run the analyses, one consisting of the quantitative characters treated continuously, and a second consisting of the quantitative characters treated discretely. Modifications of the dataset consists of changes previously implemented by Walter et al. (2025, Supplementary information; see Appendix 1) in Rio & Mannion (2021), and rescoring *Diplocynodon darwini* and other valid *Diplocynodon* species already present in the dataset (following Chapter 2).
2) Walter et al. (2025; [Chapter1]), expanded upon Massonne et al. (2019); consisting of 219 discrete morphological characters, among which 11 multistates characters are treated as ordered. Modifications of the dataset consists of changes in the scoring of *Diplocynodon darwini* and other valid *Diplocynodon* species for corresponding characters modified in Chabrol et al. (2024).

The six most completely known and valid *Diplocynodon* species (see Chapter 2) served as operational taxonomic units (OTUs) to run two separate sets of parsimony phylogenetic analyses, using *Bernissartia fagesii* as an outgroup. The analyses were performed in TNT 1.6 (Goloboff & Catalano, 2008) under equal weighting and extended implied weighting (EIW3; k-value = 3), following Ezcurra et al. (2024, Table 2) for the choice of the k value. Given the reduced number of OTUs (7), the Traditional Search algorithm was used to obtain starting trees (Goloboff et al., 2008), with a number of replications set to 1000. A second round of search was run using only the starting trees (saved from RAM) in order to retrieve the final most parsimonious trees (MPTs). Figures 10-12 present the different consensus trees obtained from MPTs of each analysis set. The complete list of modifications and data files ([.tnt] for TNT 1.6) are provided in Appendix 3.

4. Results

The phylogenetic analyses yielded different results depending on the dataset and algorithms employed.

Parsimony analysis of the modified Walter et al. (2025) under EW recovered 4 MPT (tree length 88). The strict consensus tree is largely unresolved, recovering a polytomy between four branches: the sister taxa *Diplocynodon darwini* + *Diplocynodon hantoniensis*, the sister taxa *Diplocynodon deponiae* + *Diplocynodon muelleri*, *Diplocynodon ratelii*, and *Diplocynodon remensis* (Figure 10Aa). A majority of the trees however recover *Diplocynodon ratelii* as the sister taxon to *Diplocynodon deponiae* + *Diplocynodon muelleri*, as well as *Diplocynodon remensis* being the earliest branching species (Figure 10Ab). The analysis under EIW recovered the same results from 4 MPTs of tree length 1.75, with the same topologies calculated by the strict and majority consensus trees (Figure 10Ba, b).

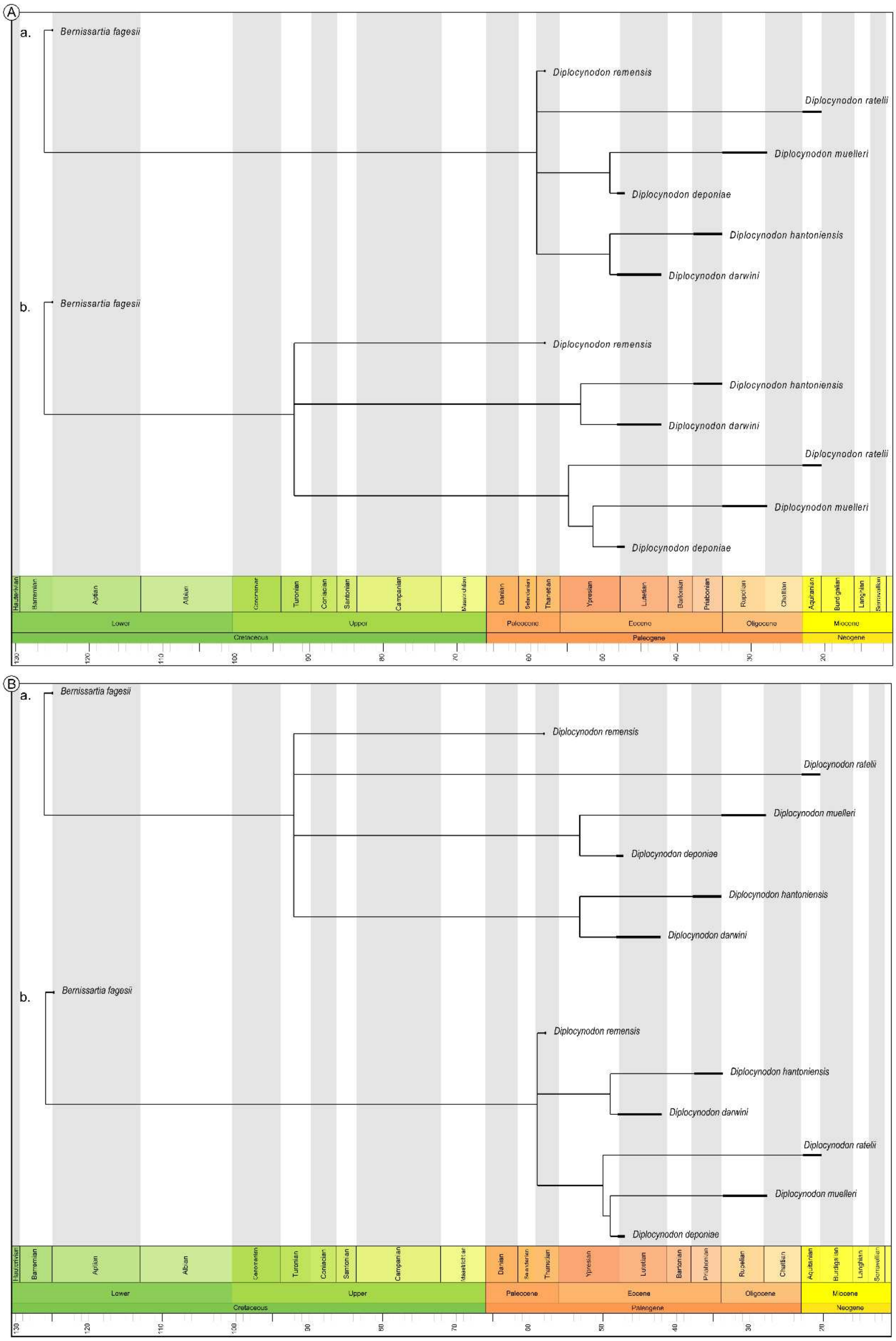


Figure 10: Consensus trees obtained using the modified dataset of Walter et al. (2025; Chapter 1). A, equal weighting strategy; a, strict consensus tree; b, majority consensus tree. B, extended implied weighting strategy (k = 3); a, strict consensus tree; b, majority consensus tree.

The analyses of the modified dataset of Chabrol et al. (2024) recovered different topologies. The EW analysis of the version treating quantitative characters continuously (Figure 11) recovered a single MPT (tree length of 11,830.794). *Diplocynodon remensis* is the earliest branching species, with *Diplocynodon muelleri*, *Diplocynodon ratelii*, *Diplocynodon hantoniensis*, *Diplocynodon deponiae* and *Diplocynodon darwini* successively recovered in more derived positions. The analysis of the same version of the dataset under EIW (k=3) provided a single MPT as well (tree length of 469.14159), but of a different topology: two sister groups are formed, respectively by *Diplocynodon muelleri* + *Diplocynodon hantoniensis*, and *Diplocynodon darwini* + *Diplocynodon ratelii* + *Diplocynodon deponiae*.

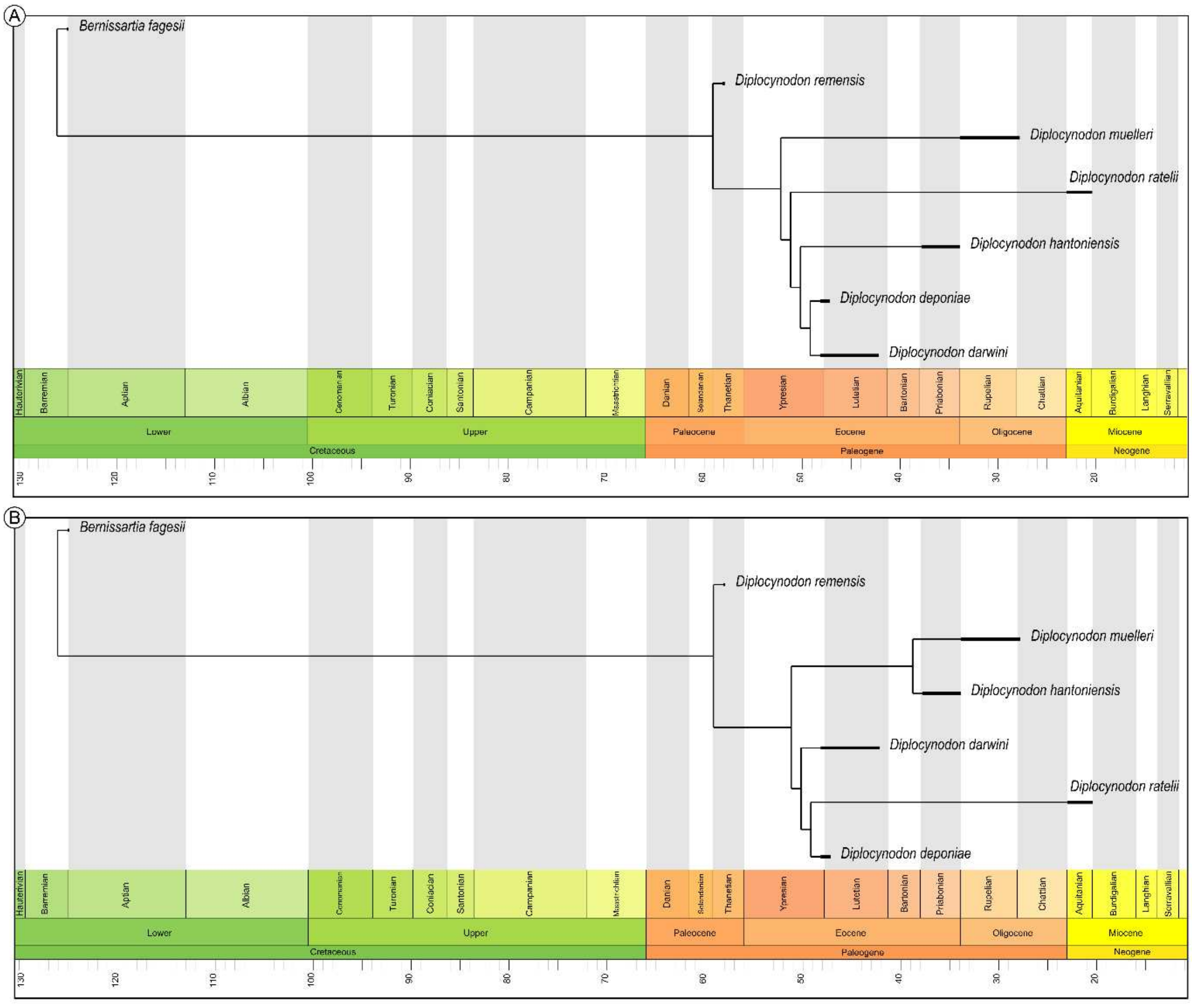


Figure 11: Consensus trees obtained using the modified dataset of Chabrol et al. (2024), continuous and discrete characters. A, equal weighting strategy, B, extended implied weighting strategy (k = 3).

Alternatively, the EW analysis of the version treating quantitative characters discretely (Figure 12) recovered 7 MPTS (tree length of 123). The strict consensus of the sample of MPTs results in a complete polytomy (Figure 12Aa), but the majority consensus tree shows that most trees present a topology where *Diplocynodon deponiae* + *Diplocynodon darwini* is the earliest branching group, sister to a polytomy involving *Diplocynodon remensis*, *Diplocynodon ratelii*, and *Diplocynodon mulleri* + *Diplocynodon hantoniensis* (Figure 12Ab). The EIW analysis of this same version of the dataset recovered a single MPT (tree length of 4.99448; Figure 12B), of the same topology as the EIW analysis of the continuous version of the dataset (Figure 11B).

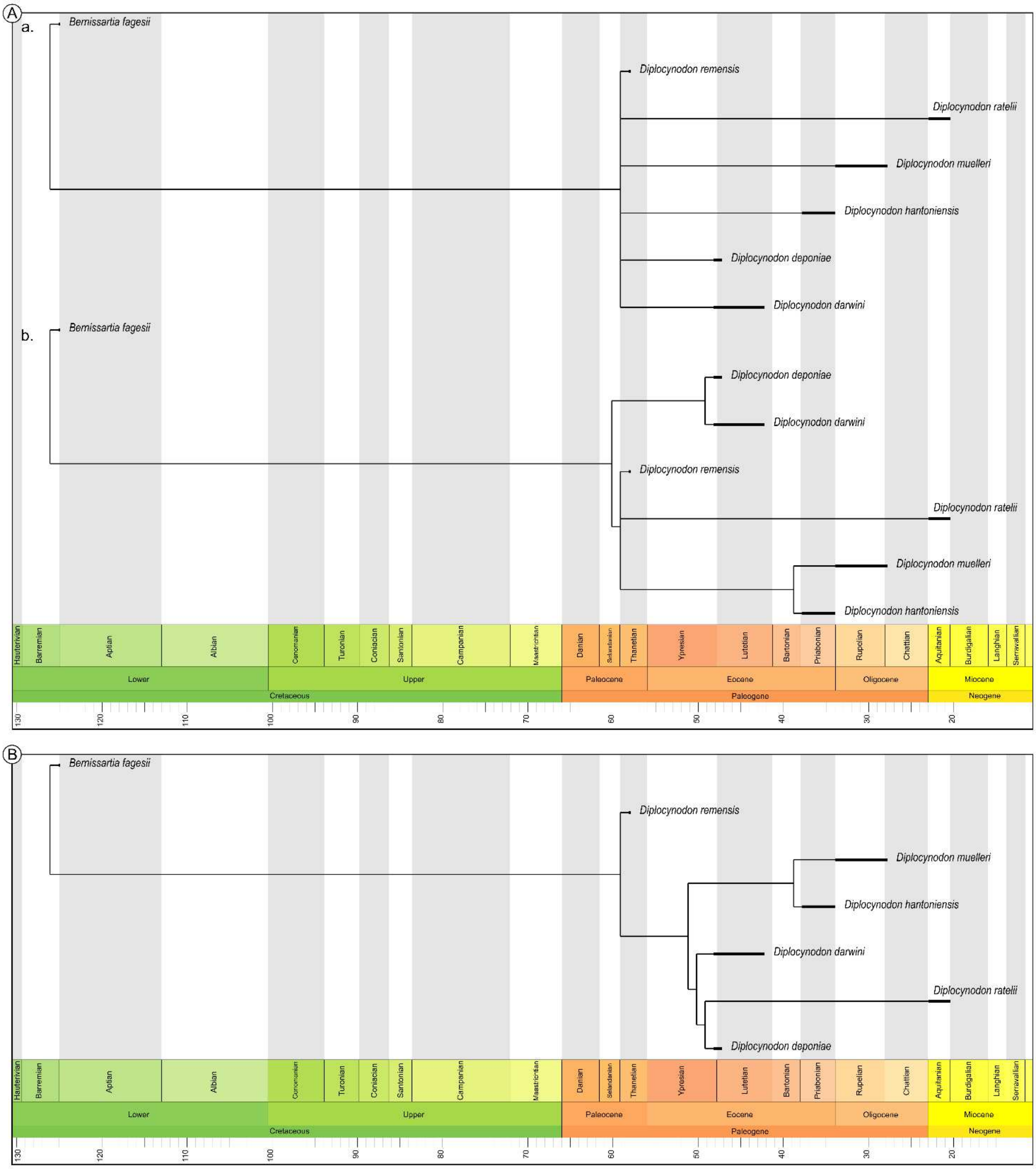


Figure 12: Consensus trees obtained using the modified dataset of Chabrol et al. (2024), discrete and rediscretised characters. A, equal weighting strategy; a, strict consensus tree; b, majority consensus tree. B, extended implied weighting strategy (k = 3).

5. Discussion

5.1 Diplocynodon darwini *as two distinct populations*

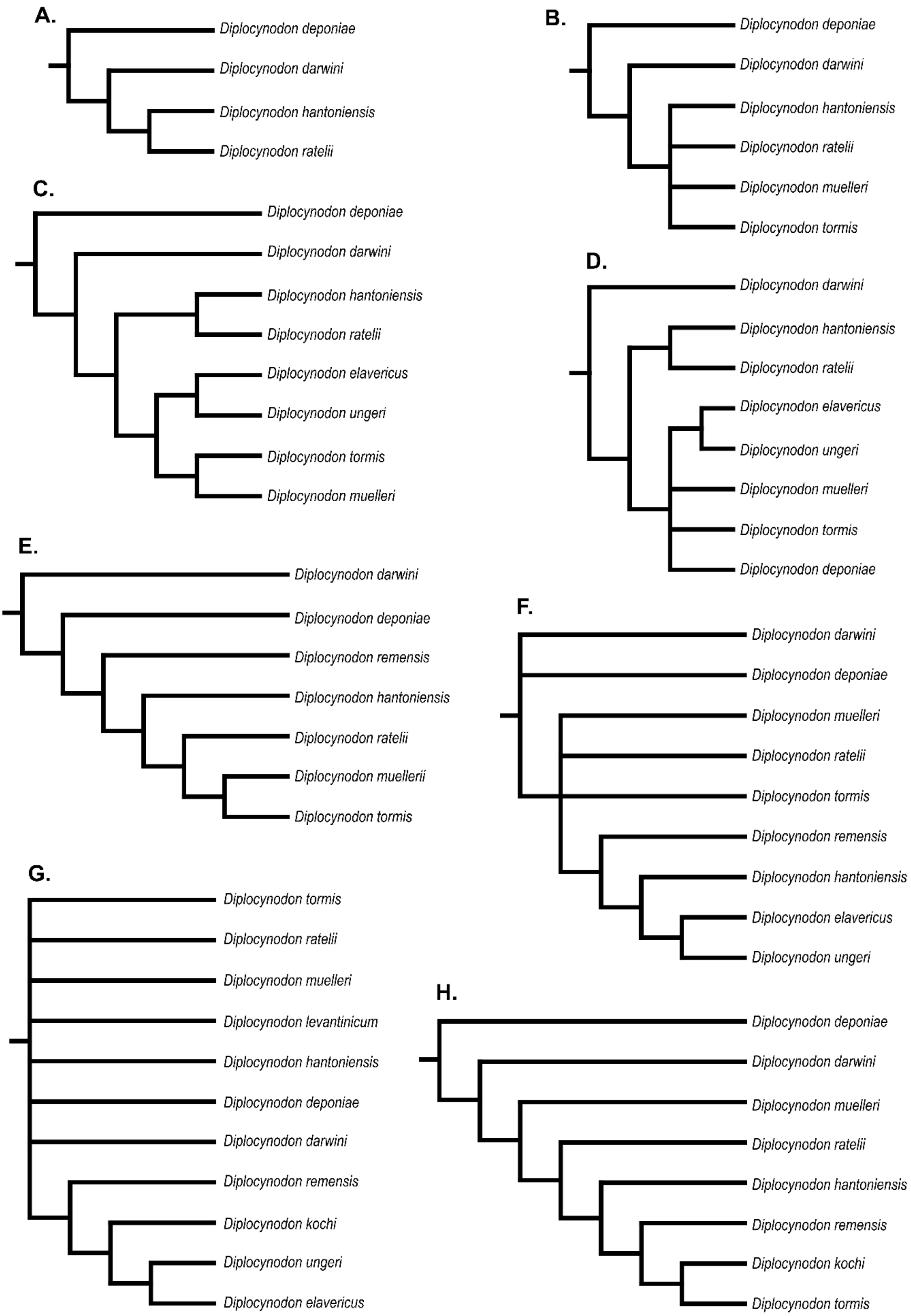
Observed differences between the populations from Messel (Darmstadt, Germany) and Geiseltal (Halle, Germany) pertain to the individuals general body-size, skull shape, and variability in some character states. While the sample from Geiseltal is largely represented by small-sized individuals of a generally gracile appearance and pointed skull (ca. ~ 20 cm in skull length), the population from Messel locality consists of larger individuals with more sturdy skulls (ca. ~ 25–30 cm in skull length).

This apparent difference can be tentatively explained by ontogenetic niche partitioning. As observed for several extant species such as *Crocodylus niloticus* (Behangana et al., 2020) or *Crocodylus moreletii* (Platt et al., 2006), crocodylian populations tend to partition their habitats by ontogeny for a combination of reasons including reduction of intraspecific competition, differing dietary habits, or predator avoidance (Tucker, 1997). Commonly, juveniles are inhabiting shallow woody vegetations and river margins microhabitats to both feed and avoid predators, including conspecific adult individuals. Sub-adults, on the other hand, occur in a wider range of microhabitats, from shallow areas to open water ways. Adults, finally, are most often found in riverbeds and occasionally on the margins for nesting (e.g. pools and or burrows). By comparison, the fossil samples of Geiseltal and Messel sites match this pattern: the swampy paleoenvironment of Geiseltal sheltered a majority of juveniles to sub-adult individuals, while the open paleolake of Messel comprised a majority of adults. This hypothesis is partly supported by Hastings & Hellmund (2017) whose results preclude the predation of medium to large-sized vertebrates by *Diplocynodon* in Geiseltal, but instead suggest a diet comparable to extant sub-adult crocodylians (fish, molluscs, or small mammals and reptiles). The taphonomical and subsequent fossilisation processes that took place in the Konservat-Lagerstätten sites of Messel and Geiseltal captured the local ontogenetic classes of the respective populations.

5.2 Ingroup relationships of Diplocynodon

Results from the different parsimony analyses performed in our study did not agree upon a consensual topology of *Diplocynodon* species interrelationships. This uncertainty is well documented in the literature, as nearly all previous studies recovered distinct phylogenies (Figure 13), usually expanding upon the common parent dataset of Brochu (1999). Rio & Mannion (2021) however introduced a newly built character-taxon matrix and employed different phylogenetic approaches to investigate eusuchian evolutionary relationships, but their results did not grant any consistency regarding the interrelationships of *Diplocynodon*, instead recovering the genus as a paraphyletic group in their preferred topology contra previous studies (but see Groh et al., 2020).

Figure 13 (below): Contrasting topologies (strict consensus trees) of *Diplocynodon* ingroup based on previously published studies: A. from Brochu, 1999; B. from Piras & Buscalioni, 2006; C. from Martin & Gross, 2011; D. from Delfino & Smith, 2012; E. from Martin et al., 2014; F. from Rio et al., 2020; G. from Massonne et al., 2022; H. from Venczel & Codrea, 2022.


A.
Diplocynodon deponiae
Diplocynodon darwini
Diplocynodon hantoniensis
Diplocynodon ratelii
B.
Diplocynodon deponiae
Diplocynodon darwini
Diplocynodon hantoniensis
Diplocynodon ratelii
Diplocynodon muelleri
Diplocynodon tormis
C.
Diplocynodon deponiae
Diplocynodon darwini
Diplocynodon hantoniensis
Diplocynodon ratelii
Diplocynodon elavericus
Diplocynodon ungeri
Diplocynodon tormis
Diplocynodon muelleri
D.
Diplocynodon darwini
Diplocynodon hantoniensis
Diplocynodon ratelii
Diplocynodon elavericus
Diplocynodon ungeri
Diplocynodon muelleri
Diplocynodon tormis
Diplocynodon deponiae
E.
Diplocynodon darwini
Diplocynodon deponiae
Diplocynodon remensis
Diplocynodon hantoniensis
Diplocynodon ratelii
Diplocynodon muellerii
Diplocynodon tormis
F.
Diplocynodon darwini
Diplocynodon deponiae
Diplocynodon muelleri
Diplocynodon ratelii
Diplocynodon tormis
Diplocynodon remensis
Diplocynodon hantoniensis
Diplocynodon elavericus
Diplocynodon ungeri
G.
Diplocynodon tormis
Diplocynodon ratelii
Diplocynodon muelleri
Diplocynodon levantinicum
Diplocynodon hantoniensis
Diplocynodon deponiae
Diplocynodon darwini
Diplocynodon remensis
Diplocynodon kochi
Diplocynodon ungeri
Diplocynodon elavericus
H.
Diplocynodon deponiae
Diplocynodon darwini
Diplocynodon muelleri
Diplocynodon ratelii
Diplocynodon hantoniensis
Diplocynodon remensis
Diplocynodon kochi
Diplocynodon tormis

Nevertheless, two patterns can be noted from previous phylogenies and results obtained herein, broadly congruent with the stratigraphical data (Figure 10-13; Brochu,1999; Piras & Buscalioni, 2006; Martin & Gross, 2011; Delfino & Smith, 2012; Martin et al., 2014; Rio et al., 2020; Venczel & Codrea, 2022 ; Massonne & Böhme, 2022).

First, the Eocene taxa from Messel *D. darwini* and *D. deponiae* are branching relatively early within *Diplocynodon*. This is the case in the oldest phylogenies including only a few species (Figure 13A-C) as well as for studies following the reappraisal of *D. deponiae* by Delfino & Smith (2012; Figure 13D and subsequent trees). The relative completeness may play a decisive role here for *D. darwini*, as it is the best sampled and most completely scored taxon in the group (see Table 1), therefore setting the primitive condition for nearly all morphological characters. On the other hand, *D. deponiae* is the least complete taxon in our datasets (~ 50%; see Table 1) and bears a noticeably different morphotype from all other *Diplocynodon* species, which always implies a deeply nested (but poorly supported) or basal (dictated by exclusion) phylogenetic placement, as recovered in our results (Figure 10-12). These alternative positions were previously recovered by most phylogenies (Figure 13; Groh et al., 2020; Rio & Mannion, 2021).

Species	**mW**	**mC**
Diplocynodon darwini	83.0	81.2
Diplocynodon deponiae	49.8	47.9
Diplocynodon hantoniensis	79.5	79.4
Diplocynodon muelleri	58.0	44.2
Diplocynodon ratelii	79.9	79.4
Diplocynodon remensis	70.3	61.5

Table 1. Scoring completeness per species in the datasets used for phylogenetic analyses presented in the chapter. mW: modified Walter et al. (2025) dataset. mC: modified Chabrol et al. (2024) dataset Values are in %.

Second, a central issue in the investigation of interrelationships of *Diplocynodon* relies on whether *D. remensis*, *D. darwini* or *D. deponiae* is the earliest-branching taxon. *D. remensis* has commonly been recovered in a relatively crownward position since its erection (Figure 13E-H; Groh et al., 2020; Rio & Mannion, 2021), inconsistent with its old age (late Thanetian; Martin et al., 2014). The stratigraphically early appearance of the taxon combined to shared character states with *Borealosuchus* (Martin et al., 2014; Rio et al., 2020; Walter et al., 2025, Chapter 1) would justify its placement at the root of the group but is not yet consensually recovered in phylogenetic analyses. The taxon was only recently recovered as the most basal *Diplocynodon* species in equal-weighting analyses (see discussion in Rio & Mannion, 2021), and is also retrieved in the majority of our consensus trees, more specifically from analyses under EIW (Figure 10-12).

5.3 The diversification and geographical distribution of Diplocynodon *in the European Paleogene greenhouse context*

Diplocynodon exhibits a discontinuous paleogeographical distribution across the Paleogene and Neogene periods of Europe. The literal interpretation of the stratigraphic data from fossil evidence suggests that the first appearance date of *Diplocynodon* is the late Paleocene of northeastern France (Martin et al., 2014; this thesis, Chapter 2). The Paleocene epoch represents a critical period in crocodylian evolution, characterised by the recovery and diversification of various lineages following the Cretaceous-Paleogene extinction event (Jouve & Jalil, 2020).

The subsequent Eocene epoch witnessed a distinct diversification of *Diplocynodon*, with four species spread across Europe. The earliest species of this epoch, namely *Diplocynodon darwini* and *Diplocynodon deponiae*, are reported from the fossil sites of Messel and Geiseltal in Germany. Only a few million years later appears *Diplocynodon hantoniensis* from southern United-Kingdom, and so far the northernmost specific occurrence of a *Diplocynodon* species (see Chapter 2). The warm, subtropical climates that prevailed during the Eocene provided ideal conditions for the proliferation of crocodyliforms, notably *Diplocynodon* appears to have thrived in various freshwater environments, including rivers, lakes, and swamps. This diversification coincided with a period of elevated global temperatures, commonly referred to as the Early Eocene Climatic Optimum (Wing et al., 2010; Huber et al., 2017), which may have facilitated the dispersal and sustainability of thermophilic reptiles across higher latitudes. The presence of *Diplocynodon* in middle Eocene localities, such as the Ikovo locality in Ukraine, alongside crocodylians and turtles with similarities to those from Western Europe, may suggest the existence of a single European biogeographical zone during this time, distinct from that of Asia (Kuzmin & Zvonok, 2021).

The Oligocene epoch marked a period of significant climatic and environmental change, with a gradual cooling trend leading to more temperate conditions in Europe, which had an impact on the distribution of *Diplocynodon* while reading the fossil record literally. The genus persisted in Europe throughout the Oligocene, but its range appears to have contracted southwards compared to the Eocene, possibly due to the changing climate, geography, and emergence of new competitors. During the following Miocene epoch, *Diplocynodon* experienced further changes in its distribution, with a gradual decline in its eastern range.

Refining the paleobiogeographical distribution of *Diplocynodon* at the species level is, in the current state of the fossil record, hampered by taxonomical uncertainties. As discussed in Chapter 2, *Diplocynodon* sp. is widespread across Europe throughout the Cenozoic, but definite species occurrences are rare and usually local. Directing taxonomical research efforts towards revising known material attributed to Diplocynodon sp. is thus necessary, as it may 1) confirm or refute genus occurrences, and 2) possibly provide new occurrences of known species, consequently extending the temporal and geographical ranges of these taxa.

GENERAL CONCLUSION AND FUTURE PERSPECTIVES

The novel topology presented in the first chapter of this thesis better resolves the early biogeographic history of *Diplocynodon* and biogeographic distribution of *Deinosuchus*, infers possible salt tolerance for stem-crocodylians and at the root of Crocodylia, and implies a body-size reduction at the root of Alligatoroidea. A basal split of crown-group crocodylians is hypothesised in light of the resulting simpler biogeographic pattern, triggered by extreme mid-Cretaceous sea level rise.

Regarding the ingroup relationships of *Diplocynodon*, morphological diagnoses of currently known species often included shared and/or irreproducible characters, hampering specific delimitation. The first taxonomic revision of the group since its inclusion in modern phylogenetics is presented herein and invalidates the species *Diplocynodon elavericus* and *Diplocynodon tormis*. An identification key is provided along with the taxonomic revision to assist researchers in future identifications of the valid species. Moreover, the quantitative review of the fossil record of *Diplocynodon* reveals the waste-basket status of the taxon, whose reasons and implications are discussed, including recommendations for better taxonomic practices.

The reappraisal of the species *Diplocynodon darwini* updates the current knowledge of the species morphology by recognising two distinct populations from Messel and Geiseltal respectively. Morphological variation of some characters in the taxon is described, including ontogenetic evolution, and insights into morphological variability across *Diplocynodon* species are provided. The ingroup evolutionary relationships are additionally tested in two eusuchian character-taxon datasets and compared to previously published phylogenies. The results, congruent with previously published topologies, indicate the absence of consensus.

The exceptionally long survivorship of *Diplocynodon* in Europe however raises new questions with respect to results and conclusions of the thesis. Three central future perspectives can be drawn:

1) The extinction of the sister-group *Borealosuchus* in the middle Eocene of North America seems rather sudden compared to *Diplocynodon*, while both groups lived under similar paleolatitudes.

A possible hypothesis would be the lower physiological tolerance of *Borealosuchus* (implied by a comparably larger body-size than most species of *Diplocynodon*) to the global increase of mean temperatures in the context of pre-Paleocene/Eocene Thermal Maximum (PETM). A handful of studies have explored the potential influence of latitudinal distribution and mean temperatures on ectotherms physiology (Lindeman, 2008; Pincheira-Donoso et al., 2008), among which the first study regarding crocodylians demonstrated a positive correlation between latitude and body-mass in females based on extant taxa (Lakin et al., 2020). Such question however requires an initial complete systematics and taxonomic revision of *Borealosuchus*, in order to test the current species validity, and refine stratigraphic and biogeographical ranges.

2) The interrelationships of *Diplocynodon* species currently suffers from insufficiently informed scoring in datasets. Research efforts on the group should aim at improving the overall completeness of taxon scoring in existing datasets, especially for species nearing 50% of missing entries. In this regard, CT data has the potential to allow investigation of unknown characters, otherwise inaccessible to the naked eye (e.g. because of the extensive osteoderm coverage in *Diplocynodon deponiae*). Species including few articulated cranial materials would also benefit from the methods as to optimise the amount of morphological information retrieved from limited sample.
3) From a larger point of view, macroevolutionary interpretations for Crocodylia based on combined DNA (either directly implemented in datasets or in the form of a scaffold) and morphological data are congruent among them (see contribution to the work of Darlim et al. (2022) provided in Appendix 4.1). These methods may represent the most efficient way to take molecular informed topologies into account while investigating evolutionary relationships of crown-groups.

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The following works were published or accepted for publication during the candidate's doctoral period (see Appendix 5 for the complete articles):

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APPENDICES

APPENDIX 1: Supplementary information and data for Chapter 1

The appendix (present document) is the main additional material file associated with the manuscript and phylogenetic analyses.

All the data regarding Chapter 1 is accessible under the following Figshare repository link: https://doi.org/10.6084/m9.figshare.27901317.v1

The folder ‘Supplementary Data 1’ contains the character-taxon dataset used for the phylogenetic analyses as well as the TNT files.

The folder ‘Supplementary Data 2’ contains all the primary data, code and files used to determine the body size estimates (folders 1. and 2.), along with the raw data and results (folder 3.).

1. Changes applied to the dataset of Massonne et al. (2019)

For our phylogenetic analysis, we modified the dataset of Massonne et al. (2019), which in turn is based on Brochu (1999, 2004), Brochu & Storrs (2012), Wang, Sullivan & Liu (2016), Cossette & Brochu (2018), and Li, Wu & Rufolo (2019). In order to update and increase the taxon-character sample of Massonne et al. (2019), we combined it with the datasets of Gismondi et al. (2015), Bona et al. (2018), Cossette (2021), Shan et al. (2021), Stocker et al. (2021), and Walter et al. (2022), including the addition of 20 characters, 14 character states, and 17 taxa. We furthermore added the taxa *Diplocynodon remensis* and *Borealosuchus griffithi* and removed four characters due to irreproducibility, intraspecific variability or redundancy with the added character states. The complete list of characters is available in part [4] of the present document. The expanded dataset now includes a total of 219 characters and

128 taxa. See Supplementary Data 1 folder for nexus and tnt files and part [2] of the present document and Methods of the main manuscript for details of the analysis.

1.1 List of taxa added to the dataset of Massonne et al. (2019)

The following 19 taxa were added to the parent dataset (see [3] for sources):

- *Albertochampsa langstoni* Erickson, 1972
- *Borealosuchus griffithi* Wu, 2001
- *Bottosaurus fustidens* Cossette, 2021
- *Caiman wannlangstoni* Salas-Gismondi, Flynn, Baby, Tejada-Lara, Wesselingh & Antoine, 2015
- *Chinatichampsus wilsonorum* Stocker, Brochu & Kirk, 2021
- *Deinosuchus schwimmeri* Cossette & Brochu, 2020
- *Diplocynodon remensis* Martin, Smith, de Lapparent de Broin, Escuillié & Delfino, 2014b
- *Dongnanosuchus hsui* Shan, Wu, Sato, Cheng & Rufolo, 2021 (replacing the incomplete taxon "Maoming alligatoroid"; Skutschas et al. 2014, Massonne et al. 2019)
- *Eocaiman itaboraiensis* Pinheiro, Fortier, Pol, Campos & Bergqvist, 2013
- *Eocaiman palaeocenicus* Bona, 2007
- *Gnatusuchus pebasensis* Salas-Gismondi, Flynn, Baby, Tejada-Lara, Wesselingh & Antoine, 2015
- *Kuttanacaiman iquitosensis* Salas-Gismondi, Flynn, Baby, Tejada-Lara, Wesselingh & Antoine, 2015

- *Caiman brevirostris* Souza Filho, 1987
- *Mourasuchus amazonensis* Price, 1964
- *Mourasuchus arendsi* Bocquentin Villanueva, 1984
- *Necrosuchus ionensis* Simpson, 1937
- *Protocaiman peligrensis* Bona, Ezcurra, Barrios & Blanco, 2018
- *Purussaurus brasiliensis* Barbosa-Rodrigues, 1892
- *Purussaurus mirandai* Aguilera, Riff & Bocquentin-Villanueva, 2006

1.2 List of omitted taxa

A total of 4 taxa were removed from the dataset:

- *Asiatosuchus nanlingensis* Young, 1964

  This taxon was omitted due to its incompleteness (Shan et al., 2021).

- *Culebrasuchus mesoamericanus* Hastings et al., 2013

  This taxon was omitted due to its poor preservation and further studies are required before it can be reintroduced into the phylogeny (see Stocker et al., 2021).

- *Melanosuchus fisheri* Medina, 1976.

  The taxon was considered to be a *nomen dubium* (Bona et al., 2017).

- *Orthogenysuchus olseni*, Mook 1924

  This taxon was omitted due to its poor preservation and need for osteological revision (see Stocker et al., 2021 and Walter et al., 2022).

1.3 List of updates and modifications of scores

39. Number of contiguous dorsal osteoderm rows:

Diplocynodon hantoniensis: 1 > ?

We are unaware of a complete dorsal shield preserved for this species. The character is therefore rescored as (?).

46. Alveoli size of dentary teeth: 3rd and 4th same size and confluent (0), 4th larger than 3rd and separate (1), 3rd and 4th nearly same size and separate (2).

Diplocynodon deponiae: ? > 0

Diplocynodon deponiae, as all other *Diplocynodon* species, has confluent 3rd and 4th dentary alveoli (Delfino & Smith, 2012, Fig.4). The character is therefore rescored as (0).

47. Anterior dentary teeth strongly procumbent (0) or project anterodorsally (1).

Eocaiman cavernensis: 1 > 0

The anterior dentary teeth are procumbent in the only known specimen (AMNH FARB 3158). This is also apparent in Godoy et al. (2021 figs. 1, 8) and the condition is not different from other taxa scored for this state in the dataset. To make the scorings consistent, we therefore rescore *E. cavernensis* as (0).

49. Dentary gently curved (0), deeply curved (1), or linear (2) between fourth and tenth alveoli.

Dongnanosuchus hsui: 0 > 1

The lower jaw of *D. hsui* is preserved in occlusion. In Shan et al. (2021 fig. 6 1), the curvature nevertheless looks deeper than in *J. nankangensis* (state 0 - Li et al., 2019 fig. 6 c), and more similar to the stronger curvature of *O. naduongensis* (state 1 - Massonne et al., 2019 fig. 8a). The character is therefore rescored as (1).

50. Largest dentary alveolus immediately caudal to fourth is (0) 13 or 14, (1) between 11 and 14 and a series behind it, (2) 11 or 12, (3) no differentiation, (4) behind 14, (5) 10.

Bottosaurus harlani: 1 > 2

Massonne et al. (2019) changed the scoring of this species from 2 to 1 but this was apparently a misinterpretation.Based on Cossette & Brochu (2018 fig. 5) and personal observation, the condition is clearly state (2).

58. Process of splenial separates angular and coronoid (0) or no splenial process between angular and coronoid (1).

Globidentosuchus brachyrostris: ? > 1

No splenial process is visible between the angular and coronoid (Scheyer & Delfino, 2016 fig. 9). The character is therefore rescored as (1).

59. Angular-surangular suture contacts external mandibular fenestra at posterior angle at maturity (0) or passes broadly along ventral margin of external mandibular fenestra late in ontogeny (1).

Globidentosuchus brachyrostris: 1 > 0

The angular-surangular suture reaches the external mandibular fenestra posteriorly (Scheyer & Delfino, 2016 fig. 9). The character is therefore rescored as (0).

60. Surangular, relative length of the anterior processes: equal (0); subequal (1).

Borealosuchus formidabilis: ? > 1

Diplocynodon deponiae: 1 > ?

Diplocynodon tormis: 1 > ?

Borealosuchus formidabilis is here scored (1) following Rio and Mannion (2021; in Appendix 2, Fig. 107). In *Diplocynodon deponiae* and *Diplocynodon tormis*, the relative extent of the surangular processes are incomplete (pers. obs.; Buscalioni et al., 1992; Delfino & Smith, 2012).

62. External mandibular fenestra absent (0) or present as narrow slit, no discrete fenestral concavity on angular dorsal margin (1) or present with discrete concavity on angular dorsal margin (2) or present and very large; most of foramen intermandibularis caudalis visible in lateral view (3).

Orientalosuchus naduongensis: 2 > 1

Orientalosuchus naduongensis has a very small external mandibular fenestra, noticeably reduced compared to closely related taxa. To account for this obvious difference, the character is rescored as (1).

Globidentosuchus brachyrostris: 1 > 3

The foramen intermandibularis caudalis is apparent in lateral view in Scheyer & Delfino (2016 fig. 9). The character is therefore rescored as (3).

65. Surangular-angular suture lingually meets articular at ventral tip (0) or dorsal to tip (1).

Bottosaurus harlani: ? > 1

We here follow the scoring of Cossette & Brochu (2018).

66. Surangular continues to dorsal tip of lateral wall of glenoid fossa (0) or truncated and not continuing dorsally (1).

Bottosaurus fustidens: 0 > ?

The limited preservation of the relevant specimen (TMM 40148-7; Cossette, 2021 fig. 5) does not allow assessment of the full extent of the surangular-articular suture. The glenoid fossa does not seem complete enough to detect a possible truncation. We here conservatively rescore the character as (?).

78. Teeth and alveoli of maxilla and/or dentary circular in cross-section (0), or posterior teeth laterally compressed (1), or all teeth compressed (2).

Dongnanosuchus hsuii: 0 > 1

There does not seem to be a difference in the posterior tooth morphology between *D. hsui* and *Orientalosuchus naduongensis* (scored (1)). In *D. hsui* (Shan et al., 2021 fig. 6.6), the posterior teeth are clearly longer than wide (laterally compressed). The character is therefore rescored as (1).

84. External naris (0) opens flush with dorsal surface of premaxillae or (1) circumscribed by thin crest.

Dongnanosuchus hsui: 1 > 0

The condition in *D. hsui* is not comparable to the thin crest around the naris as present in e.g. *Tsoabichi greenriverensis* (Brochu, 2010 fig. 3c) and appears as a thinner bulge instead, similar to *O. naduongensis* (without a notch posterolateral to the naris). The character is therefore rescored as (0).

Eocaiman cavernensis: 0 > ?

The external naris is not preserved in the only specimen unambiguously referred to this species (pers. obs.; Godoy et al., 2021 fig. 1). The character is therefore rescored as (?).

88. Incisive foramen completely situated far from premaxillary tooth row, at the level of the second or third alveolus (0) or abuts premaxillary tooth row (1) or projects between first premaxillary teeth (2).

Brachychampsa montana: ? > 0

The incisive foramen is located away from the toothrow (pers. obs.; Norell et al., 1994, fig. 1) as in other taxa scored for the corresponding state. The character is therefore rescored as (0).

Brachychampsa sealeyi: ? > 0

The incisive foramen is located away from the toothrow (Williamson, 1996, fig. 2) as in other taxa scored for the corresponding state. The character is therefore rescored as (0).

Albertochampsa langstoni: ? > 1

The incisive foramen abuts the toothrow (Erickson, 1972, fig. 2) as in other taxa scored for the corresponding state. The character is therefore rescored as (1).

We follow Stocker et al. (2021, ch. 89) who rescored this character due to what may have been a transcription error in one of their parent datasets.

90. Dentary tooth 4 occludes in notch between premaxilla and maxilla early in ontogeny (0) or occludes in a pit between premaxilla and maxilla; no notch early in ontogeny (1).

The definition of character 90 specifies early ontogenetic stage since a pit may develop into a notch during ontogeny in some taxa. Massonne et al. (2019) noticed that several taxa with a premaxillary-maxillary notch in the adult stage was scored for this character, even though the early ontogenetic stage is not actually known (in the absence of subadult specimens). In order to fix this, Massonne et al. (2019) added a new character (ch. 194 of the present study) that only considers the adult condition. To avoid double weighting of the same morphology, Massonne et al. (2019) rescored all taxa with no known subadult specimens as unknown for character 90. For few taxa, however, Massonne et al. (2019) incorrectly assumed that the juvenile condition was known, which we here correct by updating the following taxa:

Acynodon iberoccitanus: 1 > ?

Allodaposuchus precedens: 1 > ?

92. Largest maxillary alveolus is 3 (0), 5 (1), 4 (2), 4 and 5 are same size (3), 6 (4), or maxillary teeth homodont (5), or maxillary alveoli gradually increase in diameter posteriorly toward penultimate alveolus (6).

Bottosaurus fustidens: 2 > ?

In the maxillae referred to this species (TMM 40148-7; Cossette, 2021; fig. 4 and TMM 41336-16; Cossette, 2021; fig. 7B), the size of the 5th alveolus is not fully discernible, thereby making an adequate comparison to that of the 4th impossible. The character is therefore rescored as (?).

97. Antorbital fenestra present (0) or absent (1).

Globidentosuchus brachyrostris: ? > 1

An antorbital fenestra is absent in this taxon (Hastings et al., 2016, fig. 4).

112. Anterior face of palatine process rounded or pointed anteriorly (0) or notched anteriorly (1).

Eocaiman cavernensis: ? > 0

The anterior palatine process is pointed in AMNH FARB 3158 (pers. obs.; Godoy et al., 2021, fig. 4) and instead of medially, it is laterally notched. The morphology differsfrom the notched condition of e.g. *Paleosuchus palpebrosus*. The character is therefore rescored as (0).

115. Palatine process generally broad anteriorly (0) or in form of a thin wedge (1).

Chinatichampsus wilsonorum: 1 > 0

Based on Stocker et al. (2021, fig. 5) the anterior palatine process is round and broad instead of forming a thin wedge. We assume this was a typographical error in Stocker et al (2021). The character is therefore rescored as (0).

119. Lateral edges of palatines parallel posteriorly (0) or flare posteriorly, producing shelf (1).

Diplocynodon darwini: 0 > 1
Diplocynodon deponiae: 0 > 1
Diplocynodon hantoniensis: 0 > 1
Diplocynodon muelleri: 0 > 1
Diplocynodon ratelii: 0 > 1

In Massonne et al. (2019) the definition of ch. 119 was misinterpreted and this error is corrected here.

124. Internal choana not septate (0) or with septum that remains recessed within choana (1) or with septum that projects out of choana (2).

We follow Stocker et al. (2021, ch. 125) who rescored this character due to what may have been a transcription error in one of their parent datasets.

128. Prefrontals separated by the frontals and nasals, anterior process of frontal extending far anterior to the anterior margin of the orbit (0) prefrontals separated by the frontal and nasals, anterior process of frontal around the same level or posterior to the anterior margin of the orbit (1) or prefrontals meet medially, anterior process of frontal around the same level or posterior to the anterior margin of the orbit (2).

Albertochampsa langstoni: ? > 1

The anterior process of the frontal is in line with the orbit (Erickson; 1972 fig. 1).

130. Anterior tip of frontal (0) forms simple acute point or (1) forms broad, complex sutural contact with the nasals.

Deinosuchus schwimmeri: 2 > 1

This character was previously scored with state (2) by Shan et al. (2021), but the character includes two states only. The character is therefore rescored as (1).

139. Quadratojugal spine presence: prominent (0); greatly reduced or absent (1).

Diplocynodon tormis: 1 > ?

Diplocynodon tormis does not preserve a complete lower temporal fenestra, lacking most elements posterior to the jugal in the most complete specimen (IPS-9001, pers. obs.). Other referred specimens by Buscalioni et al. (1992) consist of skull elements not pertaining to or not preserving the area of interest (see also Serrano-Martinez et al., 2019 for a description of another specimen, STUS-344). The authors also mentioned disarticulated material attributed to *Diplocynodon tormis* but without further description, figures or inventory numbers. Since the score appears to be irreproducible, we rescore this character as unknown (?).

140. Quadratojugal spine position: low, near posterior angle of fenestra (0); high, between posterior and superior angles of fenestra (1).

Diplocynodon tormis: 1 > ?

See justification under ch. 139.

148. Caudal margin of otic aperture not defined and gradually merging into the exoccipital (0) or smooth and continuous with the paraoccipital process (1) or caudal margin of otic aperture inset (2).

Diplocynodon tormis: 2 > ?

See justification under ch. 139.

150. Frontoparietal suture concavoconvex (0) or linear (1) between supratemporal fenestrae.

Globidentosuchus brachyrostris: 1 > ?

In Hastings et al. (2016, fig. 4), the frontoparietal suture cannot be clearly followed. The scores of Massonne et al. (2019) and Walter et al. (2022) are contradicting. We here therefore prefer caution over the scoring of this character and rescore it as unknown (?).

163. Prootic on external wall of braincase is extensively exposed (0); largely obscured by the quadrate and laterosphenoids externally (1).

Eoalligator chunyii: 1 > ?

Specimens of *Eoalligator chunyii* do not preserve the prootic (Wang, 2016; Wu et al. 2018). The extent of its exposure relative to the quadrate and laterosphenoid therefore cannot be assessed.

196. If largest dentary alveolus is between 11th and 14th and a series behind it, is it the (0) 11th, (1) 12th, or (2) 13th or 14th.

Bottosaurus harlani: 1 > (-)

After rescoring character 50 for this taxon (see above), character 196 is no longer applicable. The character is therefore scored as (-).

202. Ventral premaxilla-maxilla suture short and ends posteriorly before the 3rd maxillary alveoli (0) or elongated and extends or exceeds the 3rd maxillary alveoli (1). [added from Stocker et al. (2021)]

Brachychampsa montana: 0 > 1

In *B. montana* the premaxilla-maxilla suture is strongly bowed posteriorly due to the large incisive foramen. The suture reaches the level of the fourth maxillary tooth (pers. obs.; Gilmore, 1911 pl. 27; Norell et al. 1994 fig. 1). The character is therefore scored as (1).

204. Lateral edge of the skull table at the level of the postorbital-squamosal suture situated laterally or at the same level as (0), or medially to (1) the quadrate condyle in dorsal view at maturity. [added from Stocker et al. (2021)]

Boverisuchus vorax: 1 > 0

In *B. vorax*, the lateral edge of the skull table at the level of the postorbital-squamosal suture reaches the level of the medial quadrate condyle (Langston, 1975 fig.1; Brochu, 2012 fig. 3). The character is therefore scored as (0).

207. Interorbital bridge narrower to equivalent (0), or broader (1) than the width of the orbit. [added from Stocker et al. (2021)]

Boverisuchus vorax: 0 > 1

In *B. vorax*, the interorbital bridge is wide, broader than the width of the orbit (pers. obs.; Langston, 1975 fig.1; Brochu, 2012 fig. 3). The character is therefore scored as (1).

215. Dentary teeth series behind alveoli 12-13 are pointed to slightly blunt (0); globular, different in size among them (1); globular, at least four subequal in size (2), molariform multicusped (3) or absent (4). [added from Stocker et al. (2021)]

Bottosaurus harlani: 1 > 0

In *B. harlani*, posterior teeth behind the 12th are slightly blunt rather than being globular (Cossette & Brochu, 2018 fig. 5) and resemble the corresponding teeth of e.g. *O. naduongensis* more than the condition of e.g. *Ceratosuchus burdohsi* (state 1). In order to remain consistent with the scores and morphology of other taxa, we rescore *B. harlani* as (0).

1.4 Deleted characters

Character 1 of Massonne et al. (2019)

Ventral tubercle of proatlas: more than one-half (0), or no more than one-half (1) the width of the dorsal crest. [OMITTED]

The definition of this character is imprecise regarding the angle of view necessary to score the morphology of the tubercles. A few fossil taxa were scored for this character in the parent dataset, but their scoring was irreproducible. Moreover, Sookias (2020; supplementary) evaluated the character as non-robust in his review of crocodylian morphological characters, based on a different dataset using the same version of the character (Narváez et al., 2015). The author specifies that the variation indicated by the scorings could not be observed for extant taxa. Given the uncertainty of the morphological variation and irreproducibility of the scoring distribution, we omit this character from the present analysis.

Character 194 of Massonne et al. (2019)

Nasal bone does (0) or does not (1) reach to the height of the orbita. [OMITTED]

This character was introduced in Massonne et al. (2019) and by updating ch.128 of the present dataset with an additional state (after Salas-Gismondi et al. 2015), this morphology is already included and makes ch. 194 redundant.

Character 197 of Massonne et al. (2019)

Sutural contact of the exoccipitals dorsal to the foramen magnum (0) long, at least half the height of the foramen magnum, (1) short, shorter than half the height of the foramen magnum, or (2) no sutural contact between the exoccipitals. [OMITTED]

This character was introduced in Massonne et al. (2019). In occipital view, the supraoccipital is generally triangular but its ventral extension differs among taxa. In e.g. *Acynodon iberoccitanus* Buscalioni, Ortega & Vasse 1997, the supraoccipital nearly prevents contact between the exoccipitals (Martin, 2007 fig. 2), whereas in *Leidyosuchus canadensis* Lambe, 1907, the ventral supraoccipital process is short, allowing a long contact between the exoccipitals (Wu et al. 2001, fig. 3). However, we find that in most taxa, the condition is intermediate or the variation is continuous. In addition, fossil skulls are commonly crushed. We therefore omit this character from the present analysis.

Character 199 of Massonne et al. (2019)

Intersupratemporal bar (0) as or near as broad as the supratemporal fenestra, (1) at least twice as broad as the supratemporal fenestra, (2) around half the broadness of the supratemporal fenestra or (3) constricted, less than half the broadness of the supratemporal fenestra. [OMITTED]

This character was introduced in Massonne et al. (2019). While the extreme conditions are straightforward (broad bar in caimanines with small or nearly closed supratemporal fenestrae versus a constricted bar in gavialines with large fenestrae), variation is continuous in most other taxa. Furthermore, the character is partly correlating with ch. 209.

2. Additional data, results and discussion of phylogenetic analyses

2.1 Phylogenetic analysis of the modified Massonne et al. (2019) dataset

The character-taxon dataset (nexus and tnt files) is in Supplementary Data 1. The complete list of characters is provided in section [4] of the present document. Strict consensus tree is provided in Figure S1.


Bernissartia fagesii
Pachycheilosuchus trinquei
Pietraroiasuchus ormezzanoi
Shamosuchus djadochtaensis
Acynodon iberoccitanus
Acynodon adriaticus
Hylaeochampsa vectiana
Iharkutosuchus makadii
Agaresuchus subjuniperus
Allodaposuchus precedens
Arenysuchus gascabadiolorum
Lohuecosuchus mechinorum
Lohuecosuchus megadontos
Allodaposuchidae
Borealosuchus griffithi
Borealosuchus sternbergii
Borealosuchus formidabilis
Borealosuchus acutidentatus
Borealosuchus threeensis
Borealosuchus wilsoni
Borealosuchus
Diplocynodon remensis
Diplocynodon darwini
Diplocynodon hantoniensis
Diplocynodon deponiae
Diplocynodon muelleri
Diplocynodon ratelii
Diplocynodon tormis
Diplocynodon
Leidyosuchus canadensis
Deinosuchus riograndensis
Deinosuchus schwimmeri
Deinosuchus
Planocrania hengdongensis
Planocrania datangensis
Boverisuchus magnifrons
Boverisuchus vorax
Planocraniidae
Asiatosuchus germanicus
Prodiplocynodon langi
Brachyuranochampsa eversolei
Crocodylus acer
Asiatosuchus depressifrons
Crocodylus affinis
Crocodylus megarhinus
Australosuchus clarkae
Kambara implexidens
Quinkana spp
Trilophosuchus rackhami
Mecistops cataphractus
Crocodylus porosus
Crocodylus niloticus
Crocodylus rhombifer
Rimasuchus lloydi
Brochuchus pigotti
Euthecodon arambourgi
Voay robustus
Osteolaemus osborni
Osteolaemus tetraspis
Crocodyloidea
Kentisuchus spenceri
Dollosuchoides densmorei
Thecachampsa antiqua
Tomistoma cairense
Tomistoma lusitanica
Tomistoma schlegelii
Gavialosuchus eggenburgensis
Toyotamaphimeia machikanensis
Maomingosuchus petrolicus
Paratomistoma courti
Eosuchus lerichei
Eosuchus minor
Eothoracosaurus mississippiensis
Thoracosaurus macrorhynchus
Thoracosaurus neocesariensis
Eogavialis africanum
Gavialis gangeticus
Gavialis lewisi
Gryposuchus colombianus
Piscogavialis jugaliperforatus
Gavialoidea
LONGIROSTRES
CROCODYLIA (crown group)
Protoalligator huiningensis
Eoalligator chunyii
Jiangxisuchus nankangensis
Dongnanosuchus hsui
Krabisuchus siamogallicus
Orientalosuchus naduongensis
Orientalosuchina
Albertochampsa langstoni
Stangerochampsa mccabei
Brachychampsa montana
Brachychampsa sealeyi
Alligator mcgrewi
Alligator prenasalis
Alligator olseni
Alligator sinensis
Alligator mefferdi
Alligator mississippiensis
Alligator thomsoni
Procaimanoidea utahensis
Procaimanoidea kayi
Navajosuchus mooki
Ceratosuchus burdoshi
Allognathosuchus wartheni
Allognathosuchus polyodon
Wannaganosuchus brachymanus
Hassiacosuchus haupti
Arambourgia gaudryi
Alligatorinae
Chinatichampsus wilsonorum
Protocaiman peligrensis
Globidentosuchus brachyrostris
Gnatusuchus pebasensis
Kuttanacaiman iquitosensis
Tsoabichi greenriverensis
Bottosaurus fustidens
Bottosaurus harlani
Paleosuchus palpebrosus
Paleosuchus trigonatus
Centenariosuchus gilmorei
Mourasuchus amazonensis
Mourasuchus arendsi
Mourasuchus atopus
Purussaurus neivensis
Purussaurus brasiliensis
Purussaurus mirandai
Melanosuchus niger
Caiman latirostris
Caiman crocodilus
Caiman yacare
Caiman brevirostris
Caiman wannlangstoni
La Venta Caiman
Caimaninae
ALLIGATOROIDEA
◆ Eocaiman cavernensis
Eocaiman itaboraiensis
Eocaiman paleocenicus
◇ Necrosuchus ionensis
Constraint topology:
Gavialis gangeticus
Tomistoma schlegelii
Mecistops cataphractus
Osteolaemus osborni
Osteolaemus tetraspis
Crocodylus porosus
Crocodylus rhombifer
Crocodylus niloticus
Alligator mississippiensis
Alligator sinensis
Paleosuchus palpebrosus
Paleosuchus trigonatus
Melanosuchus niger
Caiman latirostris
Caiman crocodilus
Caiman yacare

Figure S1.

Pruned strict consensus of 506 most parsimonious trees (tree length = 1185) from the parsimony analysis of the modified Massonne et al. (2019) dataset employing a molecular backbone constraint following Darlim et al. (2022) and Oaks (2011). *Borealosuchus griffithi* has two alternative positions, either as sister to *Diplocynodon* spp. or an early diverging placement within *Borealosuchus* spp. (orange triangle; see Supplementary Data 1, "Walter et al_[TNT]" for the tnt file). Alternative positions of pruned taxa (*Eocaiman* spp. and *Necrosuchus ioensis*) are furthermore indicated.

List of synapomorphies recovered for Alligatoroidea

4. Atlas intercentrum shape: wedge-shaped (0); or plate-shaped (1).

0 > 1

38. Dorsal midline osteoderms shape: rectangular (0); or nearly square (1).

0 > 1

50. Largest dentary alveolus caudal to fourth: 13 or 14 (0); 13 and 14 and series behind it (1); 11 or 12 (2); no differentiation (3); behind 14 (4); 10 (5); 11 and series behind it (6); or 12 and series behind it (7).

2 > 1

58. Splenial process: separates angular and coronoid (0); or no process between angular and coronoid (1).

0 > 1

121. Choana projecting at maturity: posteroventrally (0); or anteroventrally (1).

0 > 1

131. Ectopterygoid extension at postorbital bar: extends along medial face of postorbital bar (0); or stops abruptly ventral to postorbital bar (1).

0 > 1

139. Quadratojugal spine appearance: prominent at maturity (0); or greatly reduced or absent at maturity (1).

0 > 1

List of synapomorphies recovered for Crocodylia

17. Third cervical vertebra (first postaxial) with prominent hypapophysis (0) or lacks prominent hypapophysis (1).

1 > 0

26. Proximal edge of deltopectoral crest emerges smoothly from proximal end of humerus and is not obviously concave (0) or emerges abruptly from proximal end of humerus and is obviously concave (1).

0 > 1

80. Naris projects anterodorsally (0) or dorsally (1) or posterodorsally (2). [modified by Cossette & Brochu (2020)]:

0 > 1

88. Incisive foramen completely situated far from premaxillary tooth row, at the level of the second or third alveolus (0) or abuts premaxillary tooth row (1) or projects between first premaxillary teeth (2).

0 > 1

92. Largest maxillary alveolus is 3 (0), 5 (1), 4 (2), 4 and 5 are same size (3), 6 (4), or maxillary teeth homodont (5), or maxillary alveoli gradually increase in diameter posteriorly toward penultimate alveolus (6).

3 > 1

149. Frontoparietal suture deeply within supratemporal fenestra; frontal prevents broad contact between postorbital and parietal (0) or suture makes modest entry into supratemporal fenestra at maturity; postorbital and parietal in broad contact (1) or suture on skull table entirely (2).

0 > 1

List of synapomorphies for Alligatoroidea recovered in Cossette & Brochu (2020)

60 (1): Anterior processes of the surangular are equal to subequal.

69 (1): Foramen aerum of articular set in from the margin of retroarticular process.

91 (0): All dentary teeth occlude lingual to maxillary teeth.

130 (1): Anterior tip of frontal forms broad, complex sutural contact with the nasals.

140 (1): The quadratojugal spine is high, between posterior and superior angles of infratemporal fenestra.

176 (1): Quadrate foramen aëreum on dorsal surface.

2.2 Phylogenetic analyses using a modified version of the Rio & Mannion (2021) dataset

In order to test the phylogenetic position of *Deinosuchus* and *Diplocynodon* spp., we performed a parsimony analysis on an alternative dataset using a modified version of Rio and Mannion (2021) [Supplementary Data 2, "Walter-RM" files]. Modifications are detailed below.

We added the following taxa:

Deinosuchus riograndensis Colbert & Bird, 1954

Borealosuchus griffithi Wu, 2001

We modified the scores of the following taxa:

32. Rostral ornamentation, morphology of the transverse orbital ridge (i.e. spectacle): low, lacking a posterior fossa (0); tall, with deep posterior fossa (1).

Diplocynodon remensis: 1 > 0

The ridge is low in *Diplocynodon remensis*, preserved in both the holotype MHNH F BR 4020 and specimen CE0001.

87. Supratemporal fenestra, posterior wall: quadrate forms entire ventral margin of orbitotemporal canal (no parietal-squamosal contact) (0); quadrate partially forms ventral margin of orbitotemporal canal (parietal and squamosal narrowly separated) (1); quadrate excluded from ventral margin of orbitotemporal canal (parietal and squamosal in contact) (2).

Diplocynodon hantoniensis: 1 > (?)

In the juvenile specimen NHMUK OR 25170a, the parietal and squamosal are in contact in the posterior wall of the supratemporal fenestra (2) in contrast to the (1) scoring of Rio & Mannion (2021). Moreover, the left and right squamosal-quadrate sutures in NHMUK OR30393 (Rio et al., 2020; fig. 30) appear different on each side, and might represent independent cracks. In this case, the parietal-quadrate sutures indicated on the figure may actually correspond to the squamosal-parietal contact.

Diplocynodon darwini: 1 > (?)

Direct observation of a large sample of specimens, including those cited in Rio & Mannion (2021), reveals that the material referable to this species is dorsoventrally compressed and we were unable to reproduce the previous scoring of this character. We here conservatively score this taxon as unknown (?).

142. Premaxilla, posterior extent on palate, relative to number of maxillary alveoli, in ventral view: 0 (0); 1 (1); 2 (2); 3 (3); 4 (4); 5 or more (5).

Diplocynodon darwini: ? > (0)

Based on specimen GMH XXXVI 524 1966, the premaxilla does not even extend up to the 1st maxillary alveolus.

241. Surangular, relative length of the anterior processes: unequal, ventral process <75% anteroposterior length of dorsal process (measured from surangular foramen) (0); sub-equal, ventral process >= 75% length of dorsal process (1).

Diplocynodon hantoniensis: 1 > 0

This scoring was likely erroneously entered in the previous version of the dataset, as state 1 is clearly recognisable in fig. 9D from Rio et al. (2020).

Diplocynodon muelleri: 1 > (?)

Piras & Buscalioni (2006) described this morphology as follows "In its anterior dorsal suture with the dentary, the surangular probably bears two subequal anterior processes. This feature is also seen in the holotype and in a specimen from the Tàrrega Museum". Direct observation of the holotype and paratype however did not allow assessment of this feature, as the surangular is fragmentary in NMB-Spa 4., and occlusion of the jaws obscures the morphology in NMB-Spa. 73. The alternative specimen of the Tàrrega Museum is not precisely referred, figured nor described, making the previous scoring irreproducible. We therefore adopt a more cautious scoring, here (?).

Diplocynodon ratelii: 1 > 0

The processes are unequal in the specimen MNHN SG 599, we therefore rescore the character as (0).

Diplocynodon remensis: 1 > 0

Based on Martin et al. (2014, fig.5; specimen CE0001), the processes are unequal. We therefore rescore the character as (0).

248. Articular, position of foramen aëreum: at medial margin of retroarticular process (0); inset from medial margin of retroarticular process (1).

Borealosuchus formidabilis: 0 > 1

Erickson (1976) describes the alligatoroid condition observed on the single specimen preserving this feature (SMM P74.24.6).

Results

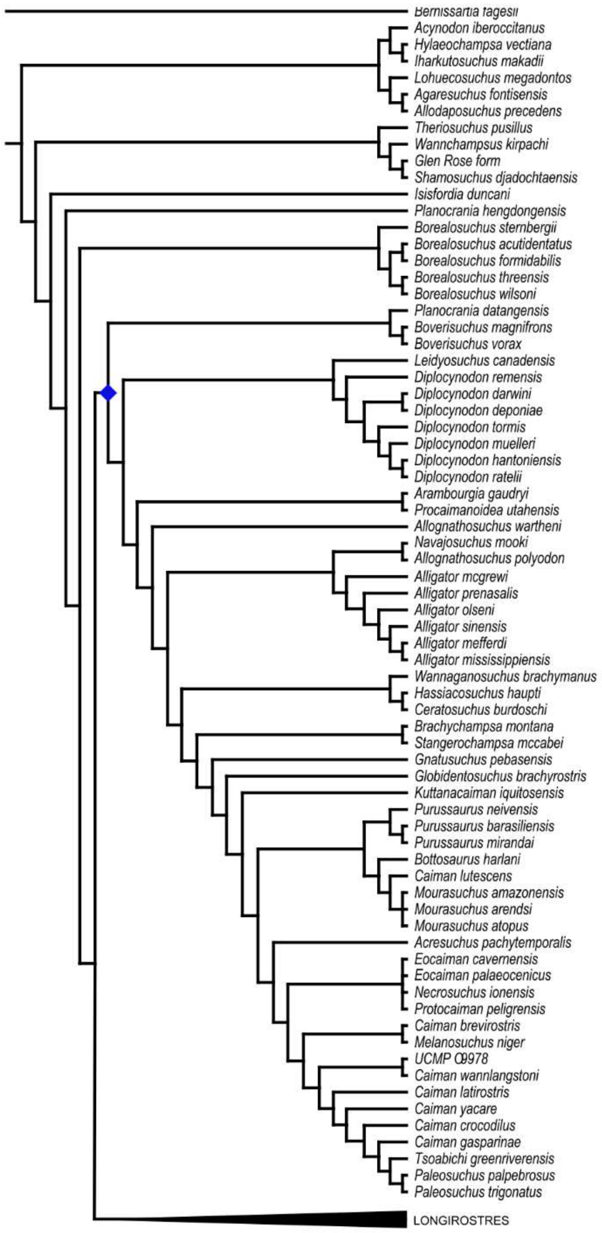
Parsimony analyses of the modified Rio & Mannion (2021) dataset were ran in TNT 1.6. We performed a first round of Traditional Search using 1000 replicates of Wagner trees, followed by a second round of Tree Bisection Reconnection (TBR) using trees saved from the first round, with 10 saves per replication.

Equal weighting parsimony analyses in TNT are as follows:

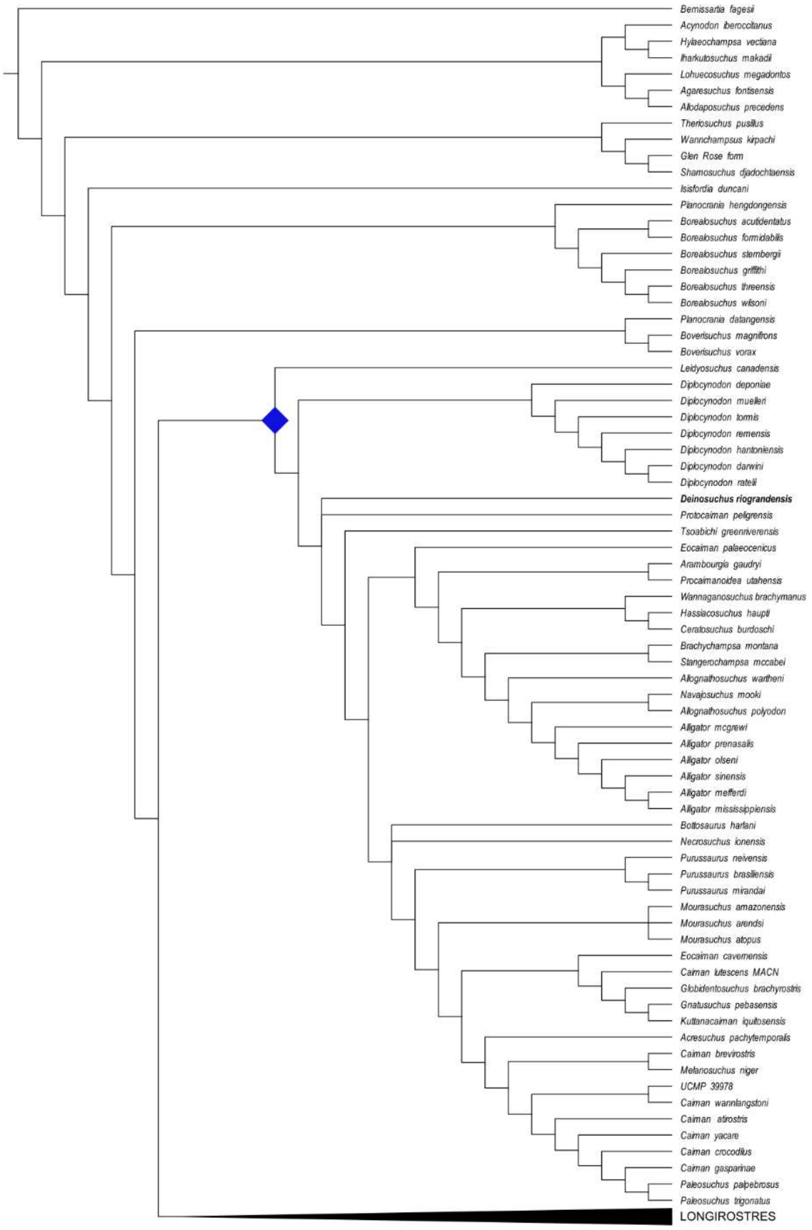
Continuous + discrete dataset (equivalent to analysis 1.1 in Rio & Mannion, 2021)

- 8 MPTs were recovered from the analysis, with a tree length of 225,845.239 (Fig. S2).
- *Diplocynodon* and *Deinosuchus* are placed at the base of Alligatoroidea, but have a poor stratigraphic fit.
- *Diplocynodon* is monophyletic under this topology.
- *Leidyosuchus* is the earliest-branching alligatoroid.
- *Borealosuchus* is monophyletic under this topology. *Planocrania hengdongensis* is sister to the latter clade.
- Planocraniids are not recovered in Alligatoroidea under this topology, in contrast to Rio & Mannion (2021).
- 8 synapomorphies are recovered for Alligatoroidea
    - 1: 1.382-1.608 > 1.614–1.710 - Skull proportions, ratio of mediolateral rostrum width at the level of the anterior orbital margin, to mediolateral width across anterior margin of the cranial table.
    - 104: 0 > 1 - Quadratojugal, position of spina quadratojugalis: high, between posterior and dorsal angles of infratemporal fenestra.
    - 117: 0 > 1 - Quadrate, foramen aërum position on posterior quadrate ramus: on dorsal surface.

- 181: 2 > 0 - Ectopterygoid, morphology of posterior process on the medial jugal surface: acute, extends beyond level of posterior margin of postorbital bar.
- 195: 0 > 2 - Choanae, ornamentation of margins: elevated forming a wall which extends to the anterolateral (but not anterior) margins of the choanae.
- 217: 1 > 0 - Dentary, alveoli 3 and 4: confluent.
- 221: 1 > 0 - Mandibular symphysis, posterior extent, adjacent to number of full dentary alveoli: < 6.248: 0 > 1 - Articular, position of foramen aërum: inset from medial margin of retroarticular process.



6 MPTs; tree length 225, 142.3



8 MPTs; tree length 225, 845.239

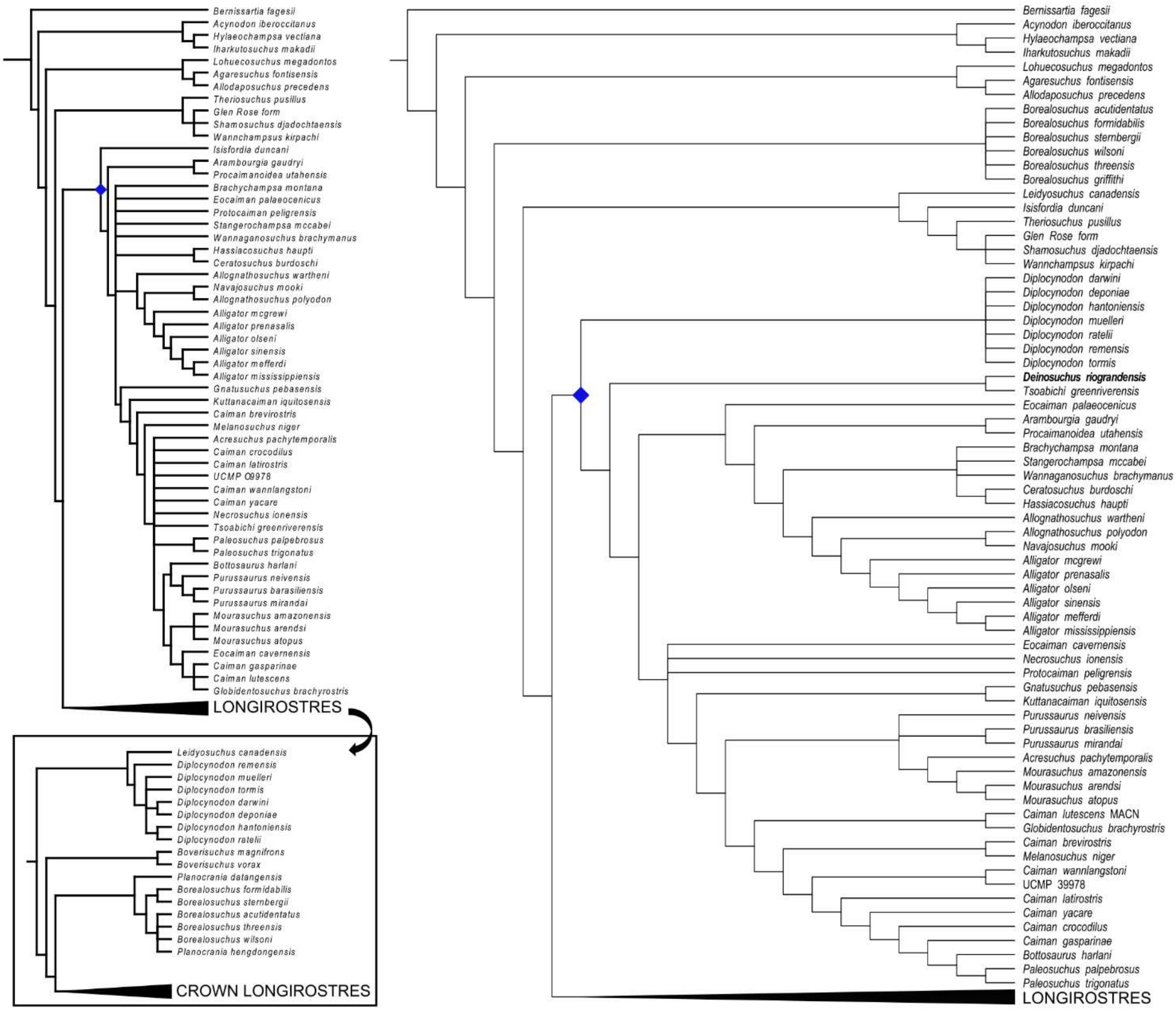
Figure S2.

Strict consensus tree of the Analysis 1.1 of Rio & Mannion (2021) continuous + discrete character dataset (left) and the modified dataset of Rio & Mannion (2021) used in the present study (right). Blue diamond denotes the node Alligatoroidea.

Re-discretised + discrete dataset (equivalent to analysis 2.1 in Rio & Mannion, 2021):

- number of MPTs > 99999, tree length of 2270 steps (Fig. S3).
- Similarly to the continuous + discrete version of the dataset, *Diplocynodon* and *Deinosuchus* are placed at the base of Alligatoroidea, contra Rio & Mannion (2021) result which recovered *Diplocynodon*, *Leidyosuchus* and *Borealosuchus* as early-branching Longirostres.
- *Diplocynodon* is monophyletic under this topology.
- *Deinosuchus* is recovered as a basal alligatoroid, placed one step crownward to *Diplocynodon*.
- *Leidyosuchus* is recovered as a ste-crocodylian under this topology. In contrast to Rio & Mannion (2021), *Isisfordia* is not recovered in Alligatoroidea, but forms a sister clade to crown-Crocodylia together with *Leidyosuchus* and other traditional early-branching eusuchians.
- 10 synapomorphies are recovered for Alligatoroidea:
    - 94: 0 > 1 - Orbit, dorsal profile of jugal forming posteroventral margin: posteroventrally sloping, gradually descending into the lower temporal bar.
    - 103: 0 > 1 - Quadratojugal, development of spina quadratojugalis (at maturity): greatly reduced or absent.
    - 104: 0 > 1 - Quadratojugal, position of spina quadratojugalis: high, between posterior and dorsal angles of infratemporal fenestra.
    - 152: 0 > 1 - Occlusion pattern, 4th dentary tooth occludes in a pit between premaxilla and maxilla; no notch early in ontogeny.

- 180: 0 > 1 - Ectopterygoid, dorsal extent along medial surface of postorbital bar: small, level with or ventral to level of ventral orbital margin.
- 222: 0 > 2 - Splenial, participation in symphysis: no participation.
- 267: 0 > 1 - Atlantal rib, dorsal margin shape: with prominent process.
- 283: 0 > 1 - Cervical rib 8, length in proportion to cervical rib 9: short, equal to or less than half the length of cervical rib 9.
- 294: 0 > 1 - Caudal vertebrae, articular surfaces of chevrons posterior to the first: completely fused.
- 330: 0 > 1 - Limb armour: densely covered in well-formed osteoderms.



>400,000 MPTs; tree length 2,279

>99,999 MPTs; tree length 2,270

Figure S3.

Strict consensus trees of the redescritised + discrete dataset modified from Rio & Mannion (2021). Left: Analysis 2.1 of Rio & Mannion (2021) parent dataset; Right: this study, modified dataset of Rio & Mannion (2021). Blue diamond denotes the node Alligatoroidea.

Discussion

- *Deinosuchus* is consistently recovered inside Alligatoroidea in the modified Rio & Mannion (2021) dataset, crownward to *Diplocynodon*. This, however, involves a poor stratigraphic fit since representatives of *Deinosuchus* are Campanian and the earliest *Diplocynodon* species is late Paleocene.
- As in previous phylogenies, the stratigraphic fit within *Diplocynodon* is poorly resolved. The oldest species, *Diplocynodon remensis* from the late Paleocene is recovered in a derived position and *Diplocynodon* is monophyletic. On the other hand, this stratigraphic incongruence is resolved in our preferred and alternative topology using the modified Massonne et al. (2019) dataset (Fig. S1; Figs. 1-2), which furthermore recognizes the unique shared derived traits of *Diplocynodon* and *Borealosuchus*.
- The synapomorphies of Alligatoroidea retrieved by these analyses are mostly ambiguous and are not unique to the clade.

3. Sources for taxa

Acynodon adriaticus: Delfino et al., 2008; MCSNT 57248; MCSNT 57032

Acynodon iberoccitanus: Martin, 2007; ACAP-FX1, ACAP-FX2, an ACAP-QR1, ACAP-M1343, ACAP-M260, ACAP-QR7

Agaresuchus subjuniperus: Puértolas-Pascual et al., 2014

Albertochampsa langstoni: Erickson, 1972; Norell et al., 1994;

Alligator mcgrewi: Schmidt, 1941; Brochu, 1999; AMNH FAM

7905, AMNH FAM 8700, AMNH 17090

Alligator mefferdi: Mook, 1941; Brochu, 1999; AMNH 7016

Alligator mississippiensis: O'Brien et al., 2019; Paiva et al., 2022;

Alligator olseni: White, 1942; Brochu, 1999; *Alligator prenasalis*: Brochu, 1999; AMNH 4994, YPM PU

13799, YPM PU 16273, YPM PU 14063

Alligator sinensis: Shan et al., 2013; Iijima et al., 2016; O'Brien et al., 2019; Paiva et al., 2022

Alligator thomsoni: Mook, 1923; Brochu, 1999

Allodaposuchus precedens: Delfino et al., 2008; Martin et al., 2016; PSMUBB V 438; MAFI Ob 3131

Allognathosuchus polyodon: Brochu, 2004b; AMNH 6049

Allognathosuchus wartheni: Brochu, 2004b; YPM PU 16989

Arambourgia gaudryi: Kälin, 1939; MNHN QU17155 (holotype)

Arenysuchus gascabadiolorum: Puértolas-Pascual, 2011

Asiatosuchus germanicus: Berg, 1966; Vasse, 1992; HLMD-Me 5345; GMH-XIV 420; GMH-XIV 4757a; GMH-XIV 4757

Asiatosuchus depressifrons: Delfino & Smith, 2009; Delfino et al., 2017; MNHN G 159, IRScNB IG 9912, IRScNB R 251, IRScNB R 253, IRScNB R 254

Australosuchus clarkae: Willis & Molnar, 1991;

Bernissartia fagesii: Buscalioni & Sanz, 1990; Sookias, 2020; Martin et al., 2020; IRScNB 1538

Borealosuchus acutidentatus: Sternberg, 1932; Lucas & Sullivan, 1986; Brochu, 1997;

Borealosuchus formidabilis: Erickson, 1976; Brochu, 1997; YPM 16242, YPM 16241, YPM 6512; photos from digital collection of SMM

Borealosuchus griffithi: Wu et al., 2001; Lindblad et al., 2022

Borealosuchus sternbergii: Gilmore, 1910; Brochu, 1997; photos from digital collection of USNM

Borealosuchus threensis: Brochu, 2012

Borealosuchus wilsoni: Mook, 1959; Brochu, 1997; Hester, 2018; AMNH 6050, AMNH 7637; photos from digital collection of USNM

Bottosaurus harlani: Cossette & Brochu, 2018;

Bottosaurus fustidens: Cossette, 2021;

Boverisuchus magnifrons: Rossmann, 1998; Brochu, 2012; all material in GMH, HLMD

Boverisuchus vorax: Langston, 1975; Rossmann, 1998; Brochu, 2012; YPM 249 (holotype),

Brachychampsa montana: Norell et al., 1994; Carpenter & Lindsey, 1980; Brochu, 1999; Sullivan & Lucas, 2003; AMNH 5032 (holotype)

Brachychampsa sealeyi: Williamson, 1996

Brachyuranochampsa eversolei: Zangerl, 1944; Mook, 1962; Brochu, 2000; AMNH FARB 6048

Brochuchus pigotti: Conrad et al., 2013

Caiman brevirostris: Fortier et al., 2014; Scheyer & Delfino, 2016

Caiman crocodilus: O'Brien et al., 2019; Paiva et al., 2022

Caiman latirostris: O'Brien et al., 2019; Paiva et al., 2022

Caiman wannlangstoni: Salas-Gismondi et al., 2015; Scheyer & Delfino, 2016

Caiman yacare: O'Brien et al., 2019; Paiva et al., 2022

Centenariosuchus gilmorei: Hastings et al., 2016; Stocker et al., 2021

Ceratosuchus burdoshi: Bartels, 1983; Brochu, 1999

Chinatichampsus wilsonorum: Stocker et al., 2021

Crocodylus acer: Mook, 1921; AMNH 7121

Crocodylus affinis: Mook, 1921; AMNH 1213, AMNH 1719, AMNH 6166, AMNH 16609, AMNH 16622, AMNH 6176, YPM 1352, YPM 265, YPM 266, YPM 246

Crocodylus megarhinus: Mook, 1927; Müller, 1927; Andrews, 2016; AMNH 5061, AMNH 5062

Crocodylus niloticus: O'Brien et al., 2019; Paiva et al., 2022

Crocodylus porosus: O'Brien et al., 2019; Paiva et al., 2022

Crocodylus rhombifer: O'Brien et al., 2019; Paiva et al., 2022

Deinosuchus riograndensis: Cossette & Brochu, 2020; AMNH 3073 (holotype)

Deinosuchus schwimmeri: Cossette & Brochu, 2020

Diplocynodon darwini: Ludwig, 1877; SMF-Me 896, SMF-Me 898, SMF-Me 900, SMF-Me 1137, SMF-Me 1289, SMF-Me 2748, SMF-Me 3780; HLMD-Me 233, HLMD-Me 236, HLMD-Me 5317, HLMD-Me 5349, HLMD-Me 5485, HLMD-Me 7492, HLMD-Me 7500, HLMD-Me 10262, HLMD-Me 10496, HLMD-Me 14600a; GMH-XXXVI 524; GMH 6077; SMNK-PAL 6517

Diplocynodon deponiae: Delfino & Smith, 2012; SMF-Me 899; SMF-Me 2609; HLMD-Me 147; HLMD-Me 8080; HLMD-Me 7496

Diplocynodon hantoniensis: Rio et al., 2020; Rio & Mannion, 2021; specimens in Rio et al. (2020)

Diplocynodon muelleri: Piras & Buscalioni, 2006; NMB-Spa 4 (holotype); NMB-Spa 73

Diplocynodon ratelii: MNHN-SG 599; MNHN 13728a; MNHN 13728b

Diplocynodon remensis: Martin et al., 2014b; MNHN-F-BR 4020 (holotype); MNHN-F-BR 13105; MNHN-F-BR 13106; MNHN-F-BR 13100; MNHN-F-BR 3501; CT-scan of CE 0001

Diplocynodon tormis: Buscalioni et al., 1992; IPS 36361 (holotype, IPS-9001 in Buscalioni et al., 1992; housed in ICP)

Dollosuchoides densmorei: Brochu, 2007

Dongnanosuchus hsui: Shan et al., 2021

Eoalligator chunyii: Wu et al., 2018; IVPP V.2716

Eocaiman cavernensis: Simpson, 1933; Godoy et al., 2021; AMNH 3158 (holotype)

Eocaiman itaboraiensis: Pinheiro, 2013

Eocaiman palaeocenicus: Bona, 2007

Eogavialis africanum: Andrews, 1901; Müller, 1927; YPM 6263;

Eosuchus lerichei: Delfino et al., 2005

Eosuchus minor: Brochu, 2006

Eothoracosaurus mississippiensis: Brochu, 2004a

Euthecodon arambourgi: Ginsburg, 1978

Gavialis gangeticus: O'Brien et al., 2019; Paiva et al., 2022;

Gavialis lewisi: Lull, 1944; YPM VP 3226

Gavialosuchus eggenbrugensis: Toula & Kail, 1885; Nicholl et al., 2020

Globidentosuchus brachyrostris: Scheyer et al., 2013; Scheyer & Delfino, 2016

Gnatusuchus pebasensis: Salas-Gismondi et al., 2015; Cidade et al., 2019; Rio & Mannion, 2021; photos from Rodolfo Salas-Gismondi

Gryposuchus colombianus: Salas-Gismondi et al., 2016

Hassiacosuchus haupti: HLMD-Me 4415; HLMD-Me-137; HLMD-Me 9119; HLMD-Me 6117; GMH-Ce-IV 6042

Hylaeochampsa vectiana: Clark, 1992; NHMUK R177

Iharkutosuchus makadii: Ösi, 2008; Ösi & Weishampel, 2009; material in MTM

Jiangxisuchus nankangensis: Li et al., 2019

Kambara implexidens: Salisbury, 1996

Kentisuchus spenceri: Brochu, 2007

Krabisuchus siamogallicus: Martin & Laupraset, 2010; Kr-C-006; Kr-C-007; Kr-C-010; Kr-C-012; Kr-C-015

Kuttanacaiman iquitosensis: Salas-Gismondi et al., 2015

La Venta Caiman: Langston, 1965

Leidyosuchus canadensis: Wu et al., 2001; Brochu, 1997; RTMP 86.221.01, RTMP 96.12.74

Lohuecosuchus mechinorum: Narvaez et al., 2015

Lohuecosuchus megadontos: Narvaez et al., 2015

Maomingosuchus petrolica: Shan et al., 2017

Mecistops cataphractus: O'Brien et al., 2019; Paiva et al., 2022

Melanosuchus niger: Vieira et al., 2016; O'Brien et al., 2019; Paiva et al., 2022

Mourasuchus amazonensis: Paiva et al., 2022

Mourasuchus arendsi: Paiva et al., 2022

Mourasuchus atopus: Paiva et al., 2022

Navajosuchus mooki: Lucas & Estep, 2000; Brochu, 2004b; AMNH 6780, AMNH 5186

Necrosuchus ionensis: Brochu, 2011; Cidade et al., 2019a

Orientalosuchus naduongensis: Massonne et al., 2019; GPIT/RE/09761; GPIT/RE/09730; GPIT/RE/09729; GPIT/RE/09784; GPIT/RE/09727

Osteolaemus osborni: O'Brien et al., 2019; Paiva et al., 2022

Osteolaemus tetraspis: O'Brien et al., 2019; Paiva et al., 2022

Pachycheilosuchus trinquei: Rogers, 2003

Paleosuchus palpebrosus: O'Brien et al., 2019; Paiva et al., 2022

Paleosuchus trigonatus: O'Brien et al., 2019; Paiva et al., 2022

Paratomistoma courti: Brochu, 2000

Pietraroiasuchus ormezzonai: Buscalioni et al., 2011

Piscogavialis jugaliperforatus: Kraus, 1998; Salas-Gismondi, 2016; SMNK 1282 PAL

Planocrania datangensis: Brochu, 2012; IVPP V5016

Planocrania hengdongensis: Brochu, 2012; IVPP V6074

Procaimanoidea kayi: Mook, 1941a; Wasserug & Hecht, 1967; Brochu, 1999

Procaimanoidea utahensis: Gilmore, 1946

Prodiplocynodon langi: Mook, 1941b; AMNH FARB 108

Protoalligator huiningensis: Wang et al., 2016; Massonne et al., 2019

Protocaiman peligrensis: Bona et al., 2018; Shan et al., 2021

Purussaurus brasiliensis: Aguilera, 2006; Paiva et al., 2022

Purussaurus mirandai: Aguilera, 2006; Scheyer et al., 2019; Paiva et al., 2022

Purussaurus neivensis: Paiva et al., 2022

Quinkana spp.*:* Molnar, 1981; Rossmann, 1998

Rimasuchus lloydi: Storrs, 2003

Shamosuchus djadochtaensis: Pol, 2009; Turner, 2015; AMNH FARB 6412

Stangerochampsa mccabei: Wu, 1996; digital collection of RTMP

Thecachampsa antiqua: Myrick, 2001; Weems, 2018

Thoracosaurus macrorhynchus: Koken, 1888; Voiculescu-Holvad, 2022; (Ca.)

Thoracosaurus neocesariensis: Voiculescu-Holvad, 2022

Tomistoma cairense: Müller, 1927

Tomistoma lusitanica:Antunes, 1961

Tomistoma schlegelii: O'Brien et al., 2019; Paiva et al., 2022

Toyotamaphimeia machikanensis: Kobayashi, 2006

Trilophosuchus rackhami: Willis, 1993; Ristevski et al., 2021

Tsoabichi greenriverensis: Brochu, 2010; Walter et al., 2022; SMNK-PAL 2333a; SMNK-PAL 2333b; SMNK-PAL 2334; AMNH FR 3666

Voay robustus: Brochu, 2007; Bickelmann & Klein, 2009; AMNH FR 3101; AMNH FR 3102; MNH FR 3103; AMNH FR 310; AMNH FR 3105

Wannaganosuchus brachymanus: Brochu, 1999; Erickson, 1982

Institutional abbreviatons:

ACAP: Association Culturelle, Archéologique et Paléontologique de l'Ouest Biterrois, Cruzy, France;

AMNH: American Museum of Natural History, New York, USA;

GMH: Geiseltal Museum of Martin-Luther-University Halle-Wittenberg, Halle (Saale), Germany;

GPIT: Geologisch-Paläontologisches Institut Tübingen, Tübingen, Germany;

HLMD: Hessisches Landesmuseum Darmstadt, Darmstadt, Germany;

IPS: Institut de Paleontologia Miquel Crusafont of Sabadell, Sabadell, Spain (= **ICP**; Institut Català de Paleontologia Miquel Crusafont);

IRScNB: Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium;

IVPP: Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China;

Kr-C: Sirindhorn Museum, Kalasin Province, Thailand;

MAFI: Magyar Állami Földtani Intézet, Hungarian Geological Institute, Budapest, Hungary;

MCSNT: Museo Civico di Storia naturale di Trieste, Trieste, Italy;

MNHM: Museum National d'Histoire Naturelle, Paris, France;

MTM: Magyar Természettudományi Múzeum, (Natural History Museum of Hungary), Budapest, Hungary;

NHMB: Naturhistoriches Museum Basel, Basel, Switzerland;

PSMUBB: Paleontology-Stratigraphy Museum, University Babes¸-Bolyai, Cluj-Napoca, Romania;

RTMP: Royal Tyrrell Museum of Palaeontology, Drumheller, Canada;

SMM: Science Museum of Minnesota, Saint Paul, Minnesota, USA;

SMNK: Staatliches Museum für Naturkunde Karlsruhe, Karlsruhe, Germany;

SMF: Senckenberg Museum Frankfurt, Frankfurt, Germany;

TMM: Texas Memorial Museum, Austin, Texas, USA;

USNM: United States National Museum, Smithsonian Institution, Washington DC, USA;

YPM: Yale Peabody Museum of Natural History, Yale University, New Haven, Connecticut, USA.

Table S1. List of extant and extinct gigantic crocodyliforms (≥ 7m in total length)

Age	Species	Source for body-size estimate and association with aquatic mega-ecosystems
Present	*Crocodylus porosus*	Britton et al., 2012
Pleistocene	Kali Gedeh *Crocodylus*	Delfino and De Vos, 2014; Sémah et al., 2010, 2016
Plio-Pleistocene	*Crocodylus thorbjarnarsoni*; *Euthecodon brumpti*	Brochu & Storrs, 2012; Brochu, 2020; Nutz et al., 2020
Mio-Pliocene	*Rhamphosuchus crassidens*	Head, 2001; More et al., 2016; Behrensmeyer et al., 2005; Martin, 2019
Mio-Pliocene	*Gryposuchus croizati*	Riff and Aguilera, 2008; Kern et al., 2020
Miocene	*Purussaurus brasiliensis*	Aureliano et al., 2015; Kern et al., 2020
Miocene	*Piscogavialis jugaliperforatus*	Kraus, 1998; Di Celma et al., 2016; Collareta et al., 2021
late Miocene	*Mourasuchus mirandai*	Aguilera et al. 2006; Kern et al., 2020
late Oligocene	*Astorgosuchus bugtiensis*	Martin et al., 2019
early Eocene	*Phosphatosaurus gavialoides*	Buffetaut, 1979
Campanian	*Deinosuchus riograndensis*	Erickson & Brochu, 1999; Schwimmer, 2002
Cenomanian	*Stomatosuchus inermis*	Stromer, 1925; Smith et al., 2001; Khalifa et al. 2008
Aptian–Albian	*Sarcosuchus imperator*	Sereno et al., 2001; Dridi, 2018
Early Cretaceous	*Chalawan thailandicus*	Buffetaut & Ingavat, 1980; Martin et al., 2014a

4. List of morphological characters

This list includes the characters in our analysis of the modified Massonne et al. (2019) matrix. The following eleven multistate characters form morphoclines and were therefore ordered in the phylogenetic analysis: 39, 48, 62, 81, 124, 149, 151, 154, 159, 193 and 203.

Character states were added to the following characters:

- 46, 48, 70, 79, 128, 137, and 156 (from Salas-Gismondi et al., 2015)
- 53, 80, 136, and 155 (from Cossette & Brochu, 2020)
- 151 and 159 (from Walter et al., 2022)
- 103 was adapted from the dataset of Rio & Mannion (2021)

The added states are highlighted in bold below and the characters were rescored.

(1) Fused proatlas boomerang-shaped (0), strap-shaped (1), or massive and block-shaped (2).

(2) Proatlas with prominent anterior process (0) or lacks anterior process (1).

(3) Proatlas has tall dorsal keel (0) or lacks tall dorsal keel; dorsal side smooth (1).

(4) Atlas intercentrum wedge-shaped in lateral view, with insignificant parapophyseal processes (0), or plate-shaped in lateral view, with prominent parapophyseal processes at maturity (1).

(5) Dorsal margin of atlantal rib generally smooth with modest dorsal process (0) or with prominent process (1).

(6) Atlantal ribs without (0) or with (1) very thin medial laminae at anterior end.

(7) Atlantal ribs lack (0) or possess (1) large articular facets at anterior ends for each other.

(8) Axial rib tuberculum wide, with broad dorsal tip (0) or narrow, with acute dorsal tip (1).

(9) Axial rib tuberculum contacts diapophysis late in ontogeny, if at all (0) or early in ontogeny (1).

(10) Anterior half of axis neural spine oriented horizontally (0) or slopes anteriorly (1).

(11) Axis neural spine crested (0) or not crested (1).

(12) Posterior half of axis neural spine wide (0) or narrow (1).

(13) Axis neural arch lacks (0) or possesses (1) a lateral process (diapophysis).

(14) Axial hypapophysis located toward the center of centrum (0) or toward the anterior end of centrum (1).

(15) Axial hypapophysis without (0) or with (1) deep fork.

(16) Hypapophyseal keels present on eleventh vertebra behind atlas (0), twelfth vertebra behind atlas (1), or tenth vertebra behind atlas (2).

(17) Third cervical vertebra (first postaxial) with prominent hypapophysis (0) or lacks prominent hypapophysis (1).

(18) Neural spine on third cervical long, dorsal tip at least half the length of the centrum without the cotyle (0) or short, dorsal tip acute and less than half the length of the centrum without the cotyle (1).

(19) Cervical and anterior dorsal centra lack (0) or bear (1) deep pits on the ventral surface of the centrum.

(20) Presacral centra amphicoelous (0) or procoelous (1).

(21) Anterior sacral rib capitulum projects far anteriorly of tuberculum and is broadly visible in dorsal view (0), or anterior margins of tuberculum and capitulum nearly in same plane, and capitulum largely obscured dorsally (1).

(22) Scapular blade flares dorsally at maturity (0) or sides of scapular blade subparallel; minimal dorsal flare at maturity (1).

(23) Deltoid crest of scapula very thin at maturity, with sharp margin (0) or very wide at maturity, with broad margin (1).

(24) Scapulocoracoid synchondrosis closes very late in ontogeny (0) or relatively early in ontogeny (1).

(25) Scapulocoracoid facet anterior to glenoid fossa uniformly narrow (0) or broad immediately anterior to glenoid fossa, and tapering anteriorly (1).

(26) Proximal edge of deltopectoral crest emerges smoothly from proximal end of humerus and is not obviously concave (0) or emerges abruptly from proximal end of humerus and is obviously concave (1).

(27) M. teres major and M. dorsalis scapulae insert separately on humerus; scars can be distinguished dorsal to deltopectoral crest (0) or insert with common tendon; single insertion scar (1).

(28) Olecranon process of ulna narrow and sub-angular (0) or wide and rounded (1).

(29) Distal extremity of ulna expanded transversely with respect to long axis of bone; maximum width equivalent to that of proximal extremity (0) or proximal extremity considerably wider than distal extremity (1).

(30) Interclavicle flat along length, without dorsoventral flexure (0) or with moderate dorsoventral flexure (1) or with severe dorsoventral flexure (2).

(31) Anterior end of interclavicle flat (0) or rod-like (1).

(32) Iliac anterior process prominent (0) or virtually absent (1).

(33) Dorsal margin of iliac blade rounded with smooth border (0) or rounded, with modest dorsal indentation (1) or rounded, with strong dorsal indentation (wasp-waisted; 2) or narrow, with dorsal indentation (3) or rounded with smooth border; posterior tip of blade very deep (4).

(34) Supraacetabular crest narrow (0) or broad (1).

(35) Limb bones relatively robust, and hind limb much longer than forelimb at maturity (0) or limb bones very long and slender (1).

(36) M. caudofemoralis with single head (0) or with double head (1).

(37) Dorsal osteoderms not keeled (0) or keeled (1).

(38) Dorsal midline osteoderms rectangular (0) or nearly square (1).

(39) Four (0), six (1), eight (2), or ten (3) contiguous dorsal osteoderms per row at maturity. (ORDERED)

(40) Nuchal shield grades continuously into dorsal shield (0) or differentiated from dorsal shield; four nuchal osteoderms (1) or differentiated from dorsal shield; six nuchal osteoderms with four central and two lateral (2) or differentiated from dorsal shield; eight nuchal osteoderms in two parallel rows (3).

(41) Ventral armor absent (0) or single ventral osteoderms (1) or paired ventral ossifications that suture together (2).

(42) Anterior margin of dorsal midline osteoderms with anterior process (0) or smooth, without process (1).

(43) Ventral scales have (0) or lack (1) follicle gland pores.

(44) Ventral collar scales not enlarged relative to other ventral scales (0) or in a single enlarged row (1) or in two parallel enlarged rows (2).

(45) Median pelvic keel scales form two parallel rows along most of tail length (0) or form single row along tail (1) or merge with lateral keel scales (2).

(46) Alveoli for dentary teeth 3 and 4 nearly same size and confluent (0), fourth alveolus larger than third, and alveoli are separated (1), **or 3 and 4 are nearly the same size and separated (2)**. [modified by Salas-Gismondi et al. (2015)].

(47) Anterior dentary teeth strongly procumbent (0) or project anterodorsally (1).

(48) Dentary symphysis extends to fourth or fifth alveolus (0), or sixth through eighth alveolus (1), **or eight to twelfth alveolus (2), or twelfth to sixteenth (3), beyond the sixteenth (4)**. [modified by Salas-Gismondi et al. (2015)]. (ORDERED)

(49) Dentary gently curved (0), deeply curved (1), or linear (2) between fourth and tenth alveoli.

(50) Largest dentary alveolus immediately caudal to fourth is (0) 13 or 14, (1) between 11 and 14 and a series behind it, (2) 11 or 12, (3) no differentiation, (4) behind 14, (5) 10.

(51) Splenial with anterior perforation for mandibular ramus of cranial nerve V (0) or lacks anterior perforation for mandibular ramus of cranial nerve V (1).

(52) Mandibular ramus of cranial nerve V exits splenial anteriorly only (0) or splenial has singular perforation for mandibular ramus of cranial nerve V posteriorly (1) or splenial has double perforation for mandibular ramus of cranial nerve V posteriorly (2).

(53) Splenial participates in mandibular symphysis; splenial symphysis adjacent to no more than five dentary alveoli (0) or splenial excluded from mandibular symphysis; anterior tip of splenial passes ventral to Meckelian groove (1) or splenial excluded from mandibular symphysis anterior tip of splenial passes dorsal to Meckelian groove (2) or deep splenial symphysis, longer than five dentary alveoli; splenial forms wide 'V' within symphysis (3) or deep splenial symphysis, longer than five dentary alveoli; splenial constricted within symphysis

and forms narrow ‘V’ (4) **or splenial reaches mandibular symphysis but does not touch other splenial** (5). [modified by Cossette & Brochu (2020)].

(54) Coronoid bounds posterior half of foramen intermandibularis medius (0) or completely surrounds foramen intermandibularis medius at maturity (1) or obliterates foramen intermandibularis medius at maturity (2).

(55) Superior edge of coronoid slopes strongly anteriorly (0) or almost horizontal (1).

(56) Inferior process of coronoid laps strongly over inner surface of Meckelian fossa (0) or remains largely on medial surface of mandible (1).

(57) Coronoid imperforate (0) or with perforation posterior to foramen intermandibularis medius (1).

(58) Process of splenial separates angular and coronoid (0) or no splenial process between angular and coronoid (1).

(59) Angular-surangular suture contacts external mandibular fenestra at posterior angle at maturity (0) or passes broadly along ventral margin of external mandibular fenestra late in ontogeny (1).

(60) Anterior processes of surangular unequal (0) or sub-equal to equal (1).

(61) Surangular with spur bordering the dentary toothrow lingually for at least one alveolus length (0) or lacking such spur (1).

(62) External mandibular fenestra absent (0) or present as narrow slit, no discrete fenestral concavity on angular dorsal margin (1) or present with discrete concavity on angular dorsal margin (2) or present and very large; most of foramen intermandibularis caudalis visible in lateral view (3). (ORDERED)

(63) Surangular-dentary suture intersects external mandibular fenestra anterior to posterodorsal corner (0) or at posterodorsal corner (1).

(64) Angular extends dorsally toward or beyond anterior end of foramen intermandibularis caudalis; anterior tip acute (0) or does not extend dorsally beyond anterior end of foramen intermandibularis caudalis; anterior tip very blunt (1).

(65) Surangular-angular suture lingually meets articular at ventral tip (0) or dorsal to tip (1).

(66) Surangular continues to dorsal tip of lateral wall of glenoid fossa (0) or truncated and not continuing dorsally (1).

(67) Articular-surangular suture simple (0) or articular bears anterior lamina dorsal to lingual foramen (1) or articular bears anterior lamina ventral to lingual foramen (2) or bears laminae above and below foramen (3).

(68) Lingual foramen for articular artery and alveolar nerve perforates surangular entirely (0) or perforates surangular/angular suture (1).

(69) Foramen aerum at extreme lingual margin of retroarticular process (0) or set in from margin of retroarticular process (1).

(70) Retroarticular process projects posteriorly (0) projects posterodorsally, **not higher than the posterior edge of the articular fossa (1), or projects posterodorsally higher than the posterior edge of the articular fossa (2)**. [modified by Salas-Gismondi et al. (2015)]

(71) Surangular extends to posterior end of retroarticular process (0) or pinched off anterior to tip of retroarticular process (1).

(72) Surangular-articular suture oriented anteroposteriorly (0) or bowed strongly laterally (1) within glenoid fossa.

(73) Sulcus between articular and surangular (0) or articular flush against surangular (1).

(74) Dorsal projection of hyoid cornu flat (0) or rod-like (1).

(75) Dorsal projection of hyoid cornu narrow, with parallel sides (0) or flared (1).

(76) Lingual osmoregulatory pores small (0) or large (1).

(77) Tongue with (0) or without (1) keratinized surface.

(78) Teeth and alveoli of maxilla and/or dentary circular in cross-section (0), or posterior teeth laterally compressed (1), or all teeth compressed (2).

(79) Maxillary and dentary teeth with smooth carinae (0) serrated (1), **or with neither carinae nor serrations (2)**. [modified by Salas-Gismondi et al. (2015)]

(80) Naris projects anterodorsally (0) or dorsally (1) **or posterodorsally (2)**. [modified by Cossette & Brochu (2020)]

(81) External naris bisected by nasals (0) or nasals contact external naris, but do not bisect it (1) or nasals excluded, at least externally, from naris; nasals and premaxillae still in contact (2) or nasals and premaxillae not in contact (3). (ORDERED)

(82) Naris circular or keyhole-shaped (0) or wider than long (1) or anteroposteriorly long and prominently teardrop-shaped (2).

(83) External naris of reproductively mature males (0) remains similar to that of females or (1) develops bony excrescence (ghara).

(84) External naris (0) opens flush with dorsal surface of premaxillae or (1) circumscribed by thin crest.

(85) Premaxillary surface lateral to naris smooth (0) or with deep notch lateral to naris (1).

(86) Premaxilla has five teeth (0) or four teeth (1) early in posthatching ontogeny.

(87) Incisive foramen small, less than half the greatest width of premaxillae (0) or large, more than half the greatest width of premaxillae (1) or large, and intersects premaxillary-maxillary suture (2).

(88) Incisive foramen completely situated far from premaxillary tooth row, at the level of the second or third alveolus (0) or abuts premaxillary tooth row (1) or projects between first premaxillary teeth (2).

(89) Dorsal premaxillary processes short, not extending beyond third maxillary alveolus (0) or long, extending beyond third maxillary alveolus (1).

(90) Dentary tooth 4 occludes in notch between premaxilla and maxilla early in ontogeny (0) or occludes in a pit between premaxilla and maxilla; no notch early in ontogeny (1).

(91) All dentary teeth occlude lingual to maxillary teeth (0) or occlusion pit between seventh and eighth maxillary teeth; all other dentary teeth occlude lingually (1) or dentary teeth occlude in line with maxillary toothrow (2).

(92) Largest maxillary alveolus is 3 (0), 5 (1), 4 (2), 4 and 5 are same size (3), 6 (4), or maxillary teeth homodont (5), or maxillary alveoli gradually increase in diameter posteriorly toward penultimate alveolus (6).

(93) Maxillary tooth row curved medially or linear (0) or curves laterally broadly (1) posterior to first six maxillary alveoli.

(94) Dorsal surface of rostrum curves smoothly (0) or bears medial dorsal boss (1).

(95) Canthi rostralii absent or very modest (0) or very prominent (1) at maturity.

(96) Preorbital ridges absent or very modest (0) or very prominent (1) at maturity.

(97) Antorbital fenestra present (0) or absent (1).

(98) Vomer entirely obscured by premaxilla and maxilla (0) or exposed on palate at premaxillary-maxillary suture (1).

(99) Vomer entirely obscured by maxillae and palatines (0) or exposed on palate between palatines (1).

(100) Surface of maxilla within narial canal imperforate (0) or with a linear array of pits (1).

(101) Medial jugal foramen small (0) or very large (1).

(102) Maxillary foramen for palatine ramus of cranial nerve V small or not present (0) or very large (1).

(103) Ectopterygoid, contact with maxillary toothrow, forming the medial wall of at least one maxillary alveolus: absent, ectopterygoid-maxilla suture anteromedially orientated and separated from toothrow margin (0); absent, ectopterygoid-maxilla suture parallel and adjacent to medial toothrow margin (1); present (2) (modified by Rio & Mannion, 2021).

(104) Maxilla terminates in palatal view anterior to lower temporal bar (0) or comprises part of the lower temporal bar (1).

(105) Penultimate maxillary alveolus less than (0) or more than (1) twice the diameter of the last maxillary alveolus.

(106) Prefrontal dorsal surface smooth adjacent to orbital rim (0) or bearing discrete knob-like processes (1).

(107) Dorsal half of prefrontal pillar narrow (0) or expanded anteroposteriorly (1).

(108) Medial process of prefrontal pillar expanded dorsoventrally (0) or anteroposteriorly (1).

(109) Prefrontal pillar solid (0) or with large pneumatic recess (1).

(110) Medial process of prefrontal pillar wide (0) or constricted (1) at base.

(111) Maxilla has linear medial margin adjacent to suborbital fenestra (0) or bears broad shelf extending into fenestra, making lateral margin concave (1).

(112) Anterior face of palatine process rounded or pointed anteriorly (0) or notched anteriorly (1).

(113) Anterior ectopterygoid process tapers to a point (0) or forked (1).

(114) Palatine process extends (0) or does not extend (1) significantly beyond anterior end of suborbital fenestra.

(115) Palatine process generally broad anteriorly (0) or in form of thin wedge (1).

(116) Lateral edges of palatines smooth anteriorly (0) or with lateral process projecting from palatines into suborbital fenestrae (1).

(117) Palatine-pterygoid suture nearly at (0) or far from (1) posterior angle of suborbital fenestra.

(118) Pterygoid ramus of ectopterygoid straight, posterolateral margin of suborbital fenestra linear (0) or ramus bowed, posterolateral margin of fenestra concave (1).

(119) Lateral edges of palatines parallel posteriorly (0) or flare posteriorly, producing shelf (1).

(120) Anterior border of the choana is comprised of the palatines (0) or choana entirely surrounded by pterygoids (1).

(121) Choana projects posteroventrally (0) or anteroventrally (1) at maturity.

(122) Pterygoid surface lateral and anterior to internal choana flush with choanal margin (0) or pushed inward anterolateral to choanal aperture (1) or pushed inward around choana to form neck surrounding aperture (2) or everted from flat surface to form neck surrounding aperture (3).

(123) Posterior rim of internal choana not deeply notched (0) or deeply notched (1).

(124) Internal choana not septate (0) or with septum that remains recessed within choana (1) or with septum that projects out of choana (2). (ORDERED)

(125) Ectopterygoid-pterygoid flexure disappears during ontogeny (0) or remains throughout ontogeny (1).

(126) Ectopterygoid extends (0) or does not extend (1) to posterior tip of lateral pterygoid flange at maturity.

(127) Lacrimal makes broad contact with nasal; no posterior process of maxilla (0) or maxilla with posterior process within lacrimal (1) or maxilla with posterior process between lacrimal and prefrontal (2).

(128) Prefrontals separated by **the** frontals and nasals, **anterior process of frontal extending far anterior to the anterior margin of the orbit (0), prefrontals separated by the frontal and nasals, anterior process of frontal around the same level or posterior to the anterior margin of the orbit (1)** or prefrontals meet medially, **anterior process of frontal around the same level or posterior to the anterior margin of the orbit** (2). [modified by Salas-Gismondi et al. (2015)]

(129) Lacrimal longer than prefrontal (0), or prefrontal longer than lacrimal (1), or lacrimal and prefrontal both elongate and nearly the same length (2).

(130) Anterior tip of frontal (0) forms simple acute point or (1) forms broad, complex sutural contact with the nasals.

(131) Ectopterygoid extends along medial face of postorbital bar (0) or stops abruptly ventral to postorbital bar (1).

(132) Postorbital bar massive (0) or slender (1).

(133) Postorbital bar bears process that is prominent, dorsoventrally broad, and divisible into two spines (0) or bears process that is short and generally not prominent (1).

(134) Ventral margin of postorbital bar flush with lateral jugal surface (0) or inset from lateral jugal surface (1).

(135) Postorbital bar continuous with anterolateral edge of skull table (0) or inset (1).

(136) Margin of orbit flush with skull surface (0) or dorsal edges of orbits upturned (1) or orbital margin telescoped (2) **or anterior margins of orbit telescoped (3)**. [modified by Cossette & Brochu (2020)]

(137) **Anterior margin of orbit not upturned**, ventral margin gently circular (0) **or anterior margin upturned, ventral margin gently circular (1)**, **or anterior margin upturned**, ventral margin with a prominent notch (1). [modified by Salas-Gismondi et al. (2015)]

(138) Palpebral forms from single ossification (0) or from multiple ossifications (1).

(139) Quadratojugal spine prominent at maturity (0) or greatly reduced or absent at maturity (1).

(140) Quadratojugal spine low, near posterior angle of infratemporal fenestra (0) or high, between posterior and superior angles of infratemporal fenestra (1).

(141) Quadratojugal forms posterior angle of infratemporal fenestra (0) or jugal forms posterior angle of infratemporal fenestra (1) or quadratojugal-jugal suture lies at posterior angle of infratemporal fenestra (2).

(142) Postorbital neither contacts quadrate nor quadratojugal medially (0) or contacts quadratojugal, but not quadrate, medially (1) or contacts quadrate and quadratojugal at dorsal angle of infratemporal fenestra (2) or contacts quadratojugal with significant descending process (3).

(143) Quadratojugal bears long anterior process along lower temporal bar (0) or bears modest process, or none at all, along lower temporal bar (1).

(144) Quadratojugal extends to superior angle of infratemporal fenestra (0) or does not extend to superior angle of infratemporal fenestra; quadrate participates in fenestra (1).

(145) Postorbital-squamosal suture oriented ventrally (0) or passes medially (1) ventral to skull table.

(146) Dorsal and ventral rims of squamosal groove for external ear valve musculature parallel (0) or squamosal groove flares anteriorly (1).

(147) Quadrate and squamosal not in contact on the external surface of the skull, posteriorly to the external auditory meatus (0) or quadratosquamosal suture extends dorsally along caudal margin of the external auditory meatus (1) or extends only to the caudoventral corner of the external auditory meatus (2).

(148) Caudal margin of otic aperture not defined and gradually merging into the exoccipital (0) or smooth and continuous with the paraoccipital process (1) or caudal margin of otic aperture inset (2).

(149) Frontoparietal suture deeply within supratemporal fenestra; frontal prevents broad contact between postorbital and parietal (0) or suture makes modest entry into supratemporal fenestra at maturity; postorbital and parietal in broad contact (1) or suture on skull table entirely (2). (ORDERED)

(150) Frontoparietal suture concavoconvex (0) or linear (1) between supratemporal fenestrae.

(151) Supratemporal fenestra with fossa; dermal bones of skull roof do not overhang rim at maturity (0), **or parietal overhangs the rim at maturity (1), or postorbital, squamosal and parietal overhang the rim at maturity (2)**, or fenestra is closed at maturity (3). [modified by Walter et al. (2022)] (ORDERED)

(152) Shallow fossa at anteromedial corner of supratemporal fenestra (0) or no such fossa; anteromedial corner of supratemporal fenestra smooth (1).

(153) Medial parietal wall of supratemporal fenestra imperforate (0) or bearing foramina (1).

(154) Parietal and squamosal widely separated by quadrate on posterior wall of supratemporal fenestra (0) or parietal and squamosal approach each other on posterior wall of supratemporal fenestra without actually making contact (1) or parietal and squamosal meet along posterior wall of supratemporal fenestra (2). (ORDERED)

(155) Skull table surface slopes ventrally from sagittal axis (0) or planar (1) **or skull table surface slopes ventrally towards sagittal axis at maturity, lateral elements planar (2)** at maturity. [modified by Cossette & Brochu (2020)]

(156) Squamosal **on skull table** is horizontal or nearly so (0), or upturned to form a **posterolateral** discrete horn (1), **or producing a high transversely oriented eminence at the posterior margin (2) late in ontogeny**. [modified by Salas-Gismondi et al. (2015)]

(157) Mature skull table with broad curvature; short posterolateral squamosal rami along paroccipital process (0) or with nearly horizontal sides; significant posterolateral squamosal rami along paroccipital process (1).

(158) Squamosal does not extend (0) or extends (1) ventrolaterally to lateral extent of paraoccipital process.

(159) Supraoccipital exposure on dorsal skull table **absent (0), small (1)**, large (2), or large such that parietal is excluded from posterior edge of table (3). [modified by Walter et al. (2021)] (ORDERED)

(160) Anterior foramen for palatine ramus of cranial nerve VII ventrolateral (0) or ventral (1) to basisphenoid rostrum.

(161) Sulcus on anterior braincase wall lateral to basisphenoid rostrum (0) or braincase wall lateral to basisphenoid rostrum smooth; no sulcus (1).

(162) Basisphenoid not exposed extensively (0) or exposed extensively (1) on braincase wall anterior to trigeminal foramen.

(163) Extensive exposure of prootic on external braincase wall (0) or prootic largely obscured by quadrate and laterosphenoid externally (1).

(164) Laterosphenoid bridge comprised entirely of laterosphenoid (0) or with ascending process or palatine (1).

(165) Capitate process of laterosphenoid oriented laterally (0) or anteroposteriorly (1) toward midline.

(166) Parietal with recess communicating with pneumatic system (0) or solid, without recess (1).

(167) Significant ventral quadrate process on lateral braincase wall (0) or quadrate-pterygoid suture linear from basisphenoid exposure to trigeminal foramen (1).

(168) Lateral carotid foramen opens lateral (0) or dorsal (1) to basisphenoid at maturity.

(169) External surface of basioccipital ventral to occipital condyle oriented posteroventrally (0) or posteriorly (1) at maturity.

(170) Posterior pterygoid processes tall and prominent (0) or small and project posteroventrally (1) or small and project posteriorly (2).

(171) Basisphenoid thin (0) or anteroposteriorly wide (1) ventral to basioccipital.

(172) Basisphenoid not broadly exposed ventral to basioccipital at maturity; pterygoid short ventral to median eustachian opening (0) or basisphenoid exposed as broad sheet ventral to basioccipital at maturity; pterygoid tall ventral to median eustachian opening (1).

(173) Exoccipital with very prominent boss on paroccipital process; process lateral to cranioquadrate opening short (0) or exoccipital with small or no boss on paroccipital process; process lateral to cranioquadrate opening long (1).

(174) Lateral eustachian canals open dorsal (0) or lateral (1) to medial eustachian canal.

(175) Exoccipitals terminate dorsal to basioccipital tubera (0) or send robust process ventrally and participate in basioccipital tubera (1) or send slender process ventrally to basioccipital tubera (2).

(176) Quadrate foramen aerum on mediodorsal angle (0) or on dorsal surface (1) of quadrate.

(177) Quadrate foramen aereum is small (0), comparatively large (1), or absent (2) at maturity.

(178) Quadrate lacks (0) or bears (1) prominent, mediolaterally thin crest on dorsal surface of ramus.

(179) Attachment scar for posterior mandibular adductor muscle on ventral surface of quadrate ramus forms modest crests (0) or prominent knob (1).

(180) Quadrate with small, ventrally-reflected medial hemicondyle (0) or with small medial hemicondyle; dorsal notch for foramen aerum (1) or with prominent dorsal projection between hemicondyles (2) or with expanded medial hemicondyle (3).

(181) Iris (0) greenish/yellowish or (1) brown.

(182) Two or more (0) or one (1) row of postoccipital osteoderms.

(183) Fewer than eight (0) or eight to 14 (1) or more than 14 (2) paired midline scale rows.

(184) Ectopterygoid maxillary ramus forms less than (0) or more than (1) two-thirds of lateral margin of suborbital fenestra.

(185) Ectopterygoid maxillary ramus terminates at lateral margin of suborbital fenestra (0) or lateral to it, with maxilla separating the ectopterygoid from fenestra for short distance.

(186) Palatine-maxillary suture intersects suborbital fenestra at its anteromedial margin (0) or nearly at its anteriormost limit (1).

(187) Frontal lacks (0) or bears (1) prominent midsagittal crest between orbits.

(188) All cervical neural spines anteroposteriorly broad (0) or posterior neural spines thin and rod-like (1).

(189) Largest premaxillary tooth is the second (0), the third (1) or the fourth (2) or the third and fourth similarly largest (3) or all similarly same in size (4) or the fourth and fifth similarly largest (5) or the first four similarly equal in size (6)

(190) Dorsal surface of the surangular is smooth (0), or bears a large sulcus next to the anterior half of the glenoid fossa (1).

(191) ‘U’-shaped depression of the frontal at the point of maximum constriction between the orbits: absent (0); present (1).

(192) Skull in lateral view relatively flat (0) or formed like a wedge **and trapezoid in shape** (1).

(193) Anterior process of jugal extends anterior (0), lies at the same level as (1), or well posterior to the anterior process of frontal (2). (ORDERED)

(194) Notch between the premaxilla and maxilla present (0) or absent (1) in adult individuals.

(195) Anterior maxillary teeth without (0) or with (1) ridges on their lateral surface

(196) If largest dentary alveolus is between 11th and 14th and a series behind it, is it the (0) 11th, (1) 12th, or (2) 13th or 14th.

(197) Surangular-angular suture lingually originates (0) near the ventral border of the external mandibular fenestra, (1) near the dorsal border of the external mandibular fenestra and straight, (2) near the dorsal border of the external mandibukar fenestra and bowed.

(198) If supraoccipital exposure on skull table is large or very large, is it (0) trapezoid, (1) triangular, or (2) block-shaped.

(199) Edge of the maxillary tooth alveoli lower or at the same level than the space between toothrow (0) or edge of maxillary tooth alveoli higher than the space (1). [added from Stocker et al. (2021)]

(200) Ventral border of exoccipital convex and ventrally projected, hiding the posterior opening of the cranioquadrate passage from the occipital view (0), or straight, sharpen or smoothly convex and does not hide the posterior opening of the cranioquadrate passage from the occipital view (1). [added from Stocker et al. (2021)]

(201) Occipital surface sloped, visible in dorsal view (0), or vertical or not visible in dorsal view (1) at maturity. [added from Stocker et al. (2021)]

(202) Ventral premaxilla-maxilla suture short and ends posteriorly before the 3rd maxillary alveoli (0) or elongated and extends or exceeds the 3rd maxillary alveoli (1). [added from Stocker et al. (2021)]

(203) Less than 18 teeth (0), 18 to 22 teeth (1), or more than 22 teeth (2) on maxilla. [added from Stocker et al. (2021)] (ORDERED)

(204) Lateral edge of the skull table at the level of the postorbital-squamosal suture situated laterally or at the same level as (0), or medially to (1) the quadrate condyle in dorsal view at maturity. [added from Stocker et al. (2021)]

(205) Frontal ends at the same level or posterior (0) or extends well anterior (1) to the anterior extension of the prefrontal. [added from Stocker et al. (2021)]

(206) Maxilla posterior process without tooth, short or absent (0), or long, longer than the distance between the three last teeth (1) in ventral view. [added from Stocker et al. (2021)]

(207) Interorbital bridge narrower to equivalent (0), or broader (1) than the width of the orbit. [added from Stocker et al. (2021)]

(208) Supratemporal fenestra longer than wide or rounded, posterior bar of supratemporal fenestra thick (0), or wider than long, posterior bar of supratemporal fenestra thick (1), or wider than long, posterior bar thin (2) at maturity. [added from Stocker et al. (2021)]

(209) Presence (0), or absence (1) of a medial crest on the basioccipital. [added from Stocker et al. (2021)]

(210) Absence (0), or presence (1) of a posterior dentary process between splenial and angular on the ventral side. [added from Stocker et al. (2021)]

(211) Dorsal margin of the articular on the retroarticular process largely visible in lateral view (0), or slightly or not visible in lateral view (1). [added from Stocker et al. (2021)]

(212) Posterior margin of the orbit anterior to the posterior margin of the suborbital fenestra (0), or posterior or at the same level than the posterior margin of the suborbital fenestra (1) measured at the level of the postorbital-frontal suture in the orbital margin. [added from Stocker et al. (2021)]

(213) Basioccipital-exoccipital process ventral to occipital condyle (basioccipital plate) with parallel or ventrally convergent sides (0) or ventrally divergent sides (1) in posterior view. [added from Stocker et al. (2021)]

(214) Absence (0) or presence (1) of a smooth medial depression ventral to the basioccipital and posterior to the medial Eustachian foramen. [added from Stocker et al. (2021)]

(215) Dentary teeth series behind to alveoli 12-13 are pointed to slightly blunt (0); globular, different in size among them (1); globular, at least four subequal in size (2), molariform multicusped (3) or absent (4). [added from Stocker et al. (2021)]

(216) First four alveoli in the dentary are the same size or smaller than other dentary alveoli (0) or are the largest within the dentary (1). [added from Stocker et al. (2021)]

(217) Orbits longer than wide (0) or wider than long to rounded (1) late in ontogeny. [added from Stocker et al. (2021)]

(218) The series composed by the last three premaxillary teeth diverge posteriorly to paraxial (0) or tend to converge posteriorly, straight among them (1). [added from Stocker et al. (2021)]

(219) Dentary, level of the first and fourth alveoli: lower than the level of the eleventh and twelfth alveoli (0); equal to higher than the level of the eleventh and twelfth alveoli (1). [added from Stocker et al. (2021)].

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6. Table: Data and Results from the phylogenetic body-size analysis

Table of estimations provided by the phylogenetic body-size analysis for each taxon, from the minimum (min) to maximum (max). Head width (HW) measurements are also provided, together with the specimen number (Specimen no).

Taxon	HW (cm)	min	2,5 %q	25% q	median	mean	75% q	97,5 %q	max	Specimen no
Acynodon adriaticus	10.62	90.84773786	107.1695963	107.1695963	143.5075338	143.996534	159.4599734	196.6380757	239.2845519	MCSNT 57248
Acynodon iberoccitanus	11.05	91.04536223	108.3220288	108.3220288	149.115877	148.9342368	164.8552601	202.4341242	265.6748491	ACAP FX1
Agaresuchus subjuniperus	25.44	175.3544208	211.863594	211.863594	289.7710601	289.7403362	320.3545447	391.9837853	521.8083361	MPZ 2012 288
Albertochampsa langstoni	14.3	120.0488187	141.4643117	141.4643117	175.859688	175.9050826	188.1907183	220.0400082	250.3879851	SMM P67 153
Alligator mcgrewi	5.08	49.59273307	58.07304824	58.07304824	74.42226953	74.56146148	81.07254494	94.59894359	113.7722018	AMNH 7303
Alligator mefferdi	20	169.0077848	193.9798612	193.9798612	225.7380026	226.1304462	238.019466	266.5424553	298.2788951	AMNH 7016
Alligator olseni	13.78	123.3023183	140.0748925	140.0748925	165.940881	165.581843	175.6404739	194.4613046	208.5121404	MCZ 1887
Alligator prenasalis	16.78	142.351768	160.9827928	160.9827928	194.6075628	194.3679452	206.8050853	235.2858945	287.0034178	SDSM 243
Alligator thomsoni	24.64	199.6276285	223.1176766	223.1176766	264.4636939	264.1510818	279.8011438	315.8116492	370.8761906	TMM 31219233

Allodaposuchus precedens	34.76	224.0997411	278.0270156	278.0270156	373.8681886	374.8181444	416.2254768	503.2208762	695.8054252	MMS VBN 12 10A
Allognathosuchus polyodon	13.6	111.0377527	131.2208363	131.2208363	167.1821733	167.4307924	182.3485326	212.2309886	257.7611823	AMNH 6049
Allognathosuchus wartheni	6.12	57.19844072	68.66506418	68.66506418	88.06634823	88.24887149	95.63010556	112.7049397	137.6817341	YPM-PU 16989
Arambourgia gaudryi	6.43	58.19665254	70.68526131	70.68526131	91.80491892	91.85328184	100.3070156	119.6765434	144.938035	MNHN QU 17155
Arenysuchus gascabadiolorum	10.86	86.21643762	106.4599005	106.4599005	146.6237186	146.6114506	163.8346843	199.3999756	254.1860834	ELI 1
Asiatosuchus depressifrons	37.3	242.7705291	306.5976081	306.5976081	403.6861004	403.8691681	442.5751421	531.6778265	647.3601774	IRSNB R251
Asiatosuchus germanicus	32.4	184.7599022	268.3597312	268.3597312	357.771504	358.7937974	395.8097086	478.5514973	643.6047432	HLMD-Me 5345
Australosuchus clarkae	15.33	116.8721448	150.0757148	150.0757148	200.9853527	201.2559275	222.6503027	274.279842	378.1453133	QM F16788
Bernissartia fagesii	6.25	63.74081936	75.13379684	75.13379684	94.5856969	94.54442928	102.6680041	118.4333822	143.6325711	IRSNB R46
Borealosuchus acutidentatus	21.45	132.5429517	181.8415303	181.8415303	252.8230188	252.4177878	281.3738037	342.51585	460.2952813	NMC 8544
Borealosuchus formidabilis	34.83	189.1874576	265.0662443	265.0662443	371.2249998	372.8922154	415.9813411	513.8869093	683.3110702	SMM P75 22 29

Borealosuchus griffthi	19.52	118.3912063	172.1508502	172.1508502	234.6925284	234.1640853	261.5204229	322.0646013	413.2177796	UALVP 40955
Borealosuchus sternbergii	18.87	120.0922741	170.5965029	170.5965029	228.436506	228.8130346	254.4119966	311.4755219	413.8128298	USNM 6533
Borealosuchus wilsoni	20.56	132.1065103	173.7266535	173.7266535	245.2979885	244.0784409	273.3324921	338.8943265	468.1910897	AMNH 7637
Bottosaurus harlani	43.79	277.4291851	342.391031	342.391031	411.7649118	412.3498077	438.2175035	503.4433572	602.0986596	NJSM 11265
Boverisuchus magnifrons	12.47	89.52031135	120.8178901	120.8178901	163.8699935	163.8366476	181.9056348	220.8643944	267.9759758	GMH XXXVI 274
Boverisuchus vorax	24.04	158.0132478	204.964543	204.964543	277.9325846	277.6410951	307.9952176	375.7216906	467.991545	FMNH PR399
Brachychampsa montana	21.93	161.2640011	196.7822894	196.7822894	247.7339681	247.4683794	266.5837708	315.1816979	366.0222456	UCMP 133901
Brachyuranochampsa eversolei	21.9	162.3604651	194.7089196	194.7089196	263.3842286	263.5528196	291.2769005	355.2287546	463.1636287	CM 9372
Brochuchus pigotti	15.98	136.4423653	157.2532311	157.2532311	187.9534821	187.9109522	199.3341097	227.9154873	257.5266671	Conrad et al. 2013
Caiman brevirostris	14.6	112.0372223	137.0878137	137.0878137	168.257054	168.9631622	182.0605291	208.6337194	268.9593228	UFAC 5388
Caiman wannlangstoni	18.24	139.7259909	162.795926	162.795926	202.7008972	202.0311585	218.2479774	249.7591829	301.8751328	MUSM 2377

Ceratosuchus burdoshi	3.65	35.4767958	44.68994271	44.68994271	58.43663788	58.50272139	64.32735327	78.20282419	91.24780195	FMNH P15576
Chinatichampsus wilsonorum	15.43	119.0407739	141.629539	141.629539	184.7898783	184.9651351	202.3134144	241.7786793	279.5382831	TMM 45911-1
Crocodylus affinis	33.72	234.1156009	279.7717695	279.7717695	371.5172945	373.1753276	410.7730321	492.2350005	639.1700053	YPM 1345
Crocodylus megarhinus	34	208.8932694	278.3943493	278.3943493	379.1505798	377.9904261	421.678363	514.3991383	668.4587974	AMN 5061
Deinosuchus riograndensis	60.4	381.5733731	434.5537917	434.5537917	580.5383708	580.9382704	643.8295137	766.7644828	1050.914204	TMM 43620-1
Deinosuchus schwimmeri	48	315.0157061	366.9186804	366.9186804	483.6960092	483.2804238	533.662985	637.4602595	764.720199	MMNS VP-256
Diplocynodon darwini	13.49	93.30454521	123.394793	123.394793	174.385706	174.0537687	195.0705622	247.9400187	312.3784732	SMF-Me 900
Diplocynodon deponiae	7.23	54.86261887	75.52042391	75.52042391	106.0454133	105.6965254	119.2785804	148.3318008	199.9450568	SMF-Me 2609
Diplocynodon hantoniensis	25.61	160.7094465	206.4573621	206.4573621	292.092825	291.948468	330.2980696	416.1431867	588.6125879	NHMUK OR 30392
Diplocynodon muelleri	7.23	45.35732307	73.68233883	73.68233883	105.8340274	105.5891306	119.3508736	152.7234187	185.3236114	Spa-4
Diplocynodon ratelli	15.45	98.43911201	134.925111	134.925111	193.4808446	194.0971881	221.0526811	277.8044392	415.6592521	MNHN SG 539

Diplocynodon remensis	20.21	135.0790529	176.3449574	176.3449574	240.0152739	241.5020893	267.9699725	334.1507921	409.2538182	MNHN F BR 13105
Diplocynodon tormis	9.4	68.58152284	90.56500435	90.56500435	130.6519647	130.2402609	146.5515802	182.7467668	254.6346682	IPS-9001
Dollosuchoides densmorei	20.4	171.6090194	193.1499735	193.1499735	255.488859	255.9201362	280.4641925	332.8532948	399.6415818	IRSNB 1748
Dongnanosuchus hsui	14.95	114.9911162	140.0913102	140.0913102	184.3681743	184.7381811	203.376975	247.158695	343.6990965	DM000001-F000001
Eosuchus lerichei	17.68	165.3067034	193.7056826	193.7056826	241.4112591	242.3922841	262.7359008	307.5860601	344.6963279	IRSNB R48
Eosuchus minor	16.05	142.9383739	176.6337719	176.6337719	223.089628	223.5478819	242.1782922	281.9039592	336.0459463	USNM 299730
Eothoracosaurus mississippiensis	39.78	337.5003872	381.1751239	381.1751239	470.56182	469.7806122	502.9616247	577.8001601	665.3050214	MSU 3293
Euthecodon arambourgi	11.23	104.5742278	119.2839919	133.0328817	141.4357221	141.7082786	150.619042	169.3162448	195.6862119	KNM-LT 23177
Globidentosuchus brachyrostris	15.34	118.6455145	135.5441288	135.5441288	183.574774	183.5882197	203.5794699	250.7903283	321.8962323	AMU-CURS-222
Gnatusuchus pebasensis	21.6	140.4030184	178.6705144	178.6705144	241.8640086	241.2330767	268.3307264	320.8331223	426.364726	MUSM-990
Gryposuchus colombianus	41.82	398.2913026	484.7407274	484.7407274	581.027154	579.7582002	614.9447045	698.8869176	802.2319311	IGM 184696

Hassiacosuchus haupti	8.95	76.08913777	90.90603537	90.90603537	119.7806711	119.5352697	130.9885471	154.9510012	194.3427482	HLMD-Me 1435
Iharkutosuchus makadii	5.06	46.15976171	59.33938972	59.33938972	79.79490758	79.63983939	87.97420508	106.6488379	137.369355	MTM 2006 52 1
Jiangxisuchus nankangensis	13.4	115.6187116	134.7099418	134.7099418	168.6841605	169.1363629	182.2518765	215.3682527	255.6921268	IVPP V 19125
Kambara implexidens	15.94	126.3187703	158.8961763	158.8961763	207.5346757	207.0062034	226.0849304	271.0593062	366.7047485	QMF29662
Kuttanacaiman iquitosensis	15.82	105.8359283	131.8683002	131.8683002	183.6991317	184.1357693	203.6494671	251.3625911	329.2942661	MUSM-1490
La venta Caiman	24.88	178.9159118	209.5926278	209.5926278	259.9481613	259.5052632	280.6650655	318.3636539	424.5697916	UCMP-39978
Leidyosuchus canadensis	21.69	133.1925417	193.7083908	193.7083908	256.8001526	257.0037866	282.6710698	337.7622754	422.7710134	CMN 8543
Lohuecosuchus mechinorum	17.25	131.053543	155.996909	155.996909	213.8272604	213.0729111	235.7272073	288.5700948	397.9720872	MDE CM 616
Lohuecosuchus megadontos	25.18	164.7697337	214.5501239	214.5501239	289.3362065	288.8003511	320.008947	392.4681978	481.5137276	HUE 02920
Maomingosuchus petrolicus	15.66	143.6691536	168.580122	168.580122	217.8027725	216.8689247	235.9767113	275.1953816	341.1173392	DM F0001
Mourasuchus amazonensis	59	348.9159839	401.2314882	401.2314882	521.6027037	521.1354631	571.5335666	673.602683	863.4341829	DGM-526-R

Mourasuchus arendsi	45.2	290.3281166	325.6990257	325.6990257	418.5522565	420.6089325	459.3606862	541.0960586	666.5421558	CIAAP-1297
Mourasuchus atopus	27	185.6575201	221.0557344	221.0557344	276.9687083	277.5963518	300.7658868	353.197996	424.0642711	UCMP-38012
Navajosuchus mooki	15.4	128.0376143	148.7790177	148.7790177	184.9310042	185.0416195	199.5752188	232.5551435	283.8536491	AMNH 6780
Orientalosuchus naduongensis	16.1	114.785769	147.0701534	147.0701534	195.4126596	195.5957877	215.0410993	261.1462673	342.4668924	GPIT RE 09761
Pachycheilosuchus trinquei	6.07	61.49019193	70.75776959	70.75776959	91.68600181	91.83694905	99.93462818	119.0096818	149.0710197	SMU 75281-75286
Pietraroiasuchus ormezzanoi	6.81	70.44102479	78.35749169	78.35749169	100.7186859	100.9205164	109.4169397	129.9094915	156.7229707	PC-1
Piscogavialis jugaliperforatus	33.42	337.8839503	397.2161287	397.2161287	484.1955904	483.949469	517.5061777	593.0491777	666.8611248	SMNK PAL 1282
Planocrania datangensis	8.08	71.23747158	85.1179914	85.1179914	115.5830137	115.6067095	127.4382445	155.8818325	196.6528817	IVPP V5016
Planocrania hengdongensis	5.53	50.64539127	62.95435794	62.95435794	85.286514	85.4557667	94.87653143	116.9593321	141.9681022	IVPP V6079
Procaimanoidea kayi	6.56	60.68169261	72.74080861	72.74080861	93.57741946	93.46493289	101.9940697	121.5840424	140.7227263	CM 9600
Procaimanoidea utahensis	5.31	47.94235268	59.62026565	59.62026565	78.49624117	78.54685542	86.25088353	103.1458426	117.0748054	USNM 15996

Prodiplocynodon langi	37.88	258.7116254	314.5360431	314.5360431	402.9178713	404.1172595	444.1098768	524.7979246	604.940862	IMG 5557
Purussaurus brasiliensis	98	535.0774282	595.9300069	595.9300069	783.054438	781.309559	860.5425503	1028.097609	1382.171601	UFAC-1403
Purussaurus mirandai	78.6	438.1777876	492.5415482	492.5415482	655.1702498	654.9233747	718.9251677	855.4977208	1212.291645	CIAAP-1369
Purussaurus neivensis	50.1	314.7471739	359.9038533	359.9038533	457.5453604	457.9250579	498.59193	587.9088568	701.5597102	UCMP-39704
Rimasuchus lloydi	47.75	322.1398064	365.8506581	365.8506581	452.8752849	451.1408064	482.8384575	552.1658237	604.4546023	KNM ER 1682
Shamosuchus djadochtaensis	9.25	72.07593819	97.45099525	97.45099525	128.6660482	128.537494	141.1343057	170.1546114	213.3213292	IGM 100/1195
Stangerochampsa mccabei	14.48	105.1803896	140.0767673	140.0767673	178.3246415	177.8523575	192.8415833	222.6003602	254.0844563	RTMP.86.61.1
Thecachampsa antiqua	44.01	289.0367552	351.3299279	351.3299279	483.7119724	483.833817	540.7332124	670.862899	817.6562841	USNM 25243
Thoracosaurus macrorhynchus	24.5	199.5762154	259.2780543	259.2780543	318.5589574	317.4914295	339.9009597	388.7723278	446.9291682	RGM 12458
Toyotamaphimeia machikanensis	50.76	419.848967	477.9980922	477.9980922	571.425292	570.8307961	606.7399152	683.9600305	793.7691944	MOUF0000I
Trilophosuchus rackhami	6.2	54.3807941	70.20573684	70.20573684	97.40454948	97.08344723	108.048995	133.9503891	239.7420934	QMF16856

Tsoabichi greenriverensis	7.44	66.60564018	80.10620721	80.10620721	99.82537707	100.0408978	108.2387002	126.1878276	141.9847748	TMM.42509-1
Voay robustus	22.37	166.0536416	199.4634302	199.4634302	239.164924	239.1444552	254.007229	288.9195948	327.2853277	MCZ 1006
Wannaganosuchus brachymanus	13.26	112.8204618	129.5786028	129.5786028	165.3276892	164.7851246	178.0973908	204.6850693	280.9088853	SMM P76.28.247

7. Dataset: Walter et al., primary dataset (.tnt)

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xread 'Data saved from TNT'

219 128

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Borealosuchus_sternbergii
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Caiman_latirostris
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Caiman_wannlangstoni
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Caiman_yacare
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Crocodylus_porosus
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Crocodylus_rhombifer
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Diplocynodon_hantoniensis
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???00120?0?001??1300?0100?1000001?0?000000101100010100010111100?110100?012
010101101010??0?1??010011?010001???000012100?0????011001?000001100?00?1

Diplocynodon_muelleri
???????????????????1?01??1??????4?0?10??21???01002??2?????0?120??100??100?
???00120?1000?011300001000100000????00000111110000010001?1?1100?110??0?02?
01010110101????????0100110010001????000??000210???01??0100000???????0??

Diplocynodon_ratelii
?????0??????000???010?00?1111001400?10??21???01002101?????00120000011?101?
???00110?00001011300001000101000?00?00000011110001010001011110 0?1?01001011
00010110101000001?10100110010001???000012000?00???011001000000110000001

Diplocynodon_remensis
???0100?????????0001000001111???400?10??20???01002000?????00020?00011?001?
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Diplocynodon_tormis
???????????????????1????????????????10???????01?021?1?????0??2?00?????1???
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01010110101?0???1?001?0110010001???0000???0010?????11??1??000???00?????

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Dollosuchoides_densmorei
01???0???111010?0001?0?001111??1?00??????????1120???0?????000200?0??0201??
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Dongnanosuchus_hsui
?????????????????????????????????????????????1101???0????????????????1????
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20000010112??0??????10011000001????0000?20001000?0011001000000??00000?1

Eoalligator_chunyii
010?????????000?????????????????????1??????????0?11?[12]????????????10?01?0
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12??0?0010112?????????1???1?00?003????????11?????0?0??1??????0??1????0???

Eocaiman_cavernensis
?????????????????????????????????????????????10000??2?????01120???????????
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Eocaiman_itaboraiensis
?????????????????????????????????????????????1?1????2?????????????????????
??????????????????????????????????????????????????????????????????????????
??????????????????????????????????????????????????????????????????????0

Eocaiman_palaeocenicus
?????????????????????????????????????????????11120??2?????0??20?????11????
??????????????????????????????????????????????????????????????????????????
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Eogavialis_africanum
???????1?????11???010??????????0?????????0????1122??03?????10?20000??2101?
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Eosuchus_lerichei
?????0??????01???01???????1?????????0????????1122???3??????????????????0??
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2001000010?1????????10?01?101003???000012?00000???10100000000??010000?1

Eosuchus_minor
?????0???0??111???01?00?0?01???0000?000??0???1122??0300?0000?20?000002100?
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Eothoracosaurus_mississippiensi
?????0????????????01??000????????00?00???0????122???3??????0?0???00?021?0?
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00010?001?10????????100010000000???000016000200???1001101?010?1010001?1

Euthecodon_arambourgii
????????????????????????????????????????????????????0??????????????????1??
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Gavialis_gangeticus
20000000?001111011010000000111000000?0000000011323003000000002000000021000
100001301000001025?0001000000000000000001010010000011000000012200001000111
11010000101000000000121010100000001001013000200?0?1001201112110011001?1
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Gavialis_lewisi
??????????????????010?????????????????????????22???3??????0?200000??2?0??
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??0?000010100?????0012101010000???00101???????????0???011101??011??1??

Gavialosuchus_eggenburgensis
??????????????????1??
???00120?0000?1?240000100??0?000???00?0101001000?012000?0?1110?0??????1?2
21010?10101????????11???10000003???0000??00?0????0110010?010??00?????

Globidentosuchus_brachyrostris
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1????0012??000??0??200001???1?00?0?????0???0?11?????1?2???1?1100??????0?0
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Gnatusuchus_pebasensis
??2020?12000?01111201000011001?
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20211?10103?????1??0100110210001?????????????????011001000000110040101

Gryposuchus_colombianus
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Hassiacosuchus_haupti
01?1?0?1?????1????01?000?1111?????0??11?11???11110?0?????01?20??0??11101?
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20010210100????????01???10010001???00001?0011101??011?00000001???100?1

Hylaeochampsa_vectiana
??0??
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Iharkutosuchus_makadii
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Jiangxisuchus_nankangensis
??????????????????010???????????????????????1100?[01]01?????0[01]021???????
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101111000010111?????????100110000001???0000?1?0?000?1?01100100000??01000?
1

Kambara_implexidens
?????0?????????????01?????11????1100?10???1???1102101?????0012000110?011?
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Kentisuchus_spenceri
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Krabisuchus_siamogallicus
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Kuttanacaiman_iquitosensis
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La_venta_Caiman
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Leidyosuchus_canadensis
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Lohuecosuchus_mechinorum
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Lohuecosuchus_megadontos
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Maomingosuchus_petrolica
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Mecistops_cataphractus
0?001001?000010000011100111112012000111101101111041010100010020001110201?1
00100120000001002100001000101000110100001011010001010000011111000010111012
2001001010101110101111001000000300?11101?000100?0?0110010000001100000?1

Melanosuchus_niger
01111001?1?0010000010101111110011000111221210110021121010111120110201100 1?
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21211210103000101100100110210001002000012000110??2011001000000110000001

Mourasuchus_amazonensis
???????????????????????????????????????????????0??????????????????????????
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Mourasuchus_arendsi
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Mourasuchus_atopus
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Navajosuchus_mooki
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2?0102101010????1??010??10010001???0000120001102??01100?000000?1001000?

Necrosuchus_ionensis
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???00???
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Orientalosuchus_naduongensis
???1????????000???01?0?0????????1[14]0??[01]1???1???110111?1[02]??0101?111110?
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000?1

Osteolaemus_osborni
?1?00001?0010101000111001111201110011111110111002101010000012000011010111
00110110000101002100011000102000110110010010010200010000011111010010101012
2131001011101110101111011000000310000001??00?0????011001?0000?1100??0?1

Osteolaemus_tetraspis
?1?00001?0010101000111001111201110011111110111002101010001012000011010111
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21310010111011101011110110000003110000001?000?00?0?0110010000001100000?1

Pachycheilosuchus_trinquei
???????????????0?01?00010?10??000??10???0???11?03?????????1?0????????????
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Paleosuchus_palpebrosus
00111111?010010101010001111112113000111321120110021222111?11120110201100?0
11110110000101010200001000000000110001000111111011110001111111011102011022
21?1?21010200010110010011021000111100001?000210?0101100100000?110000001

Paleosuchus_trigonatus
00111111?01001010001000111111211300011132112011002122211111112011020110010
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21?1?21010200010110010011021000110100001?000?10?010110010000000110000001

Paratomistoma_courti
???0??20?000001010?
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20010000101 0?1000?101?0?100??00???????0??1?01???0???1???1?000?1?00?????

Pietraroiasuchus_ormezzanoi
????????????????????1?000??0???????0?10021????111?3???????????10????????00???
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Piscogavialis_jugaliperforatus
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20010000201?0?1?0?0?12??1?10?000????010???00200?0?1001201102???01?001?1

Planocrania_datangensis
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Planocrania_hengdongensis
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Procaimanoidea_kayi
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Procaimanoidea_utahensis
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Prodiplocynodon_langi
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Protoalligator_huiningensis
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Protocaiman_peligrensis
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Purussaurus_brasiliensis
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Purussaurus_mirandai
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Purussaurus_neivensis
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Quinkana_spp
???11?0???1?????????????????1?????21010?0000?1?[02][15]00[01]0?000100000????0?0?????????????100?0111?10?002011101221010010102?11101?11??01?000???1????????????0?00???0??0?????????????????

Rimasuchus_lloydi
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Shamosuchus_djadochtaensis
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000?0?00????????????0?10?00??00??????011?000010???0???00000000?0010?0??

Stangerochampsa_mccabei
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Thecachampsa_antiqua
2000000??001010?0001101011?1??11?0?00???1???1122???4?100????2000031??01?0
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200100101000??00???11100100?2003???000013??0?0????01?00110000??000??0??

Thoracosaurus_macrorhynchus
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Thoracosaurus_neocesariensis
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Tomistoma_cairense
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Tomistoma_lusitanica
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Tomistoma_schlegelii
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0010012000000110210000101010000011010001001001000001100001111100000110101 2
2101001010101100101111001000000311100001300000 0?0?0110010000000100000?1

Toyotamaphimeia_machikanensis
0100100??111111001011000111111101100?00???1?????22??04?????10020?0000??0100
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Trilophosuchus_rackhami
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Tsoabichi_greenriverensis
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212?1?101?2??????????????????100?????????0?300001???10????10?00???????0001

Voay_robustus
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Wannaganosuchus_brachymanus
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Ccode

  -[/1  0      -[/1  1      -[/1  2      -[/1  3      -[/1  4
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  -[/1  60     +[/1  61     -[/1  62     -[/1  63     -[/1  64
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  +[/1  80     -[/1  81     -[/1  82     -[/1  83     -[/1  84
  -[/1  85     -[/1  86     -[/1  87     -[/1  88     -[/1  89
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  -[/1  95     -[/1  96     -[/1  97     -[/1  98     -[/1  99
  -[/1  100    -[/1  101    -[/1  102    -[/1  103    -[/1  104
  -[/1  105    -[/1  106    -[/1  107    -[/1  108    -[/1  109
  -[/1  110    -[/1  111    -[/1  112    -[/1  113    -[/1  114
  -[/1  115    -[/1  116    -[/1  117    -[/1  118    -[/1  119
  -[/1  120    -[/1  121    -[/1  122    +[/1  123    -[/1  124
  -[/1  125    -[/1  126    -[/1  127    -[/1  128    -[/1  129
  -[/1  130    -[/1  131    -[/1  132    -[/1  133    -[/1  134
  -[/1  135    -[/1  136    -[/1  137    -[/1  138    -[/1  139
  -[/1  140    -[/1  141    -[/1  142    -[/1  143    -[/1  144
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  -[/1  145    -[/1  146    -[/1  147    +[/1  148    -[/1  149
  +[/1  150    -[/1  151    -[/1  152    +[/1  153    -[/1  154
  -[/1  155    -[/1  156    -[/1  157    +[/1  158    -[/1  159
  -[/1  160    -[/1  161    -[/1  162    -[/1  163    -[/1  164
  -[/1  165    -[/1  166    -[/1  167    -[/1  168    -[/1  169
  -[/1  170    -[/1  171    -[/1  172    -[/1  173    -[/1  174
  -[/1  175    -[/1  176    -[/1  177    -[/1  178    -[/1  179
  -[/1  180    -[/1  181    -[/1  182    -[/1  183    -[/1  184
  -[/1  185    -[/1  186    -[/1  187    -[/1  188    -[/1  189
  -[/1  190    -[/1  191    +[/1  192    -[/1  193    -[/1  194
  -[/1  195    -[/1  196    -[/1  197    -[/1  198    -[/1  199
  -[/1  200    -[/1  201    +[/1  202    -[/1  203    -[/1  204
  -[/1  205    -[/1  206    -[/1  207    -[/1  208    -[/1  209
  -[/1  210    -[/1  211    -[/1  212    -[/1  213    -[/1  214
  -[/1  215    -[/1  216    -[/1  217    -[/1  218
;
cnames
{0 Fused_proatlas_shape boomerang-shaped strap-shaped block-shaped;
{1 Proatlas_process with_anterior_process without_anterior_process;
{2 Proatlas_dorsal_keel with_dorsal_keel without_dorsal_keel;
{3 Atlas_intercentrum_shape wedge-shaped plate-shaped;
{4 Dorsal_margin_of_atlantal_rib_process smooth dorsal_process;
{5 Atlantal_ribs_lamina without_lamina with_lamina;
{6 Atlantal_ribs_articular_facets without_facets with_facets;
{7 Axial_rib_tuberculum_tip broad_dorsal_tip acute_dorsal_tip;
{8 Axial_rib_tuberculum_diapophysis contact_late_in_ontogeny contact_early_in_ontogeny;
{9 Axis_neural_spine_shape horizontal_anteriorly slopes_anteriorly;
{10 Axis_neural_spine_ crested not_crested;
{11 Posterior_half_of_axis_neural_spine_ wide narrow;
{12 Axis_neural_arch_ lacks_diapophysis bears_diapophysis;
{13 Axial_hypapophysis_location _center_of_centrum anterior_end_of_centrum;
{14 Axial_hypapophysis_shape without_deep_fork with_deep_fork;
{15 Hypapophyseal_keels_presence 11th_vertebra_behind_atlas
12th_vertebra_behind_atlas 10th_vertebra_behind_atlas;
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{16 Third_cervical_vertebra_hypapophysis prominent not_prominent;

{17 Neural_spine_on_third_cervical long short;

{18 Cervical_and_anterior_dorsal_centra lack_deep_pits_ventrally bear_deep_pits_ventrally;

{19 Presacral_centra amphicoelus procoelus;

{20 Anterior_sacral_rib_capitulum broadly_visible_in_dorsal_view obscured_in_dorsal_view;

{21 Scapular_blade_shape flares_dorsally sides_sub-parallel;

{22 Deltoid_crest_of_scapula very_thin_with_sharp_margin very_wide_with_broad_margin;

{23 Scapulocoracoid_synchondrosis closes_late_in_ontogeny closes_early_in_ontogeny;

{24 Scapulocoracoid_facet_shape narrow_anterior_to_glenoid_fossa broad_anterior_to_glenoid_fossa;

{25 Proximal_edge_of_deltopectoral_crest_of_humerus not_concave concave;

{26 M._teres_major_and_M._dorsalis_scapulae_insertion seperately single_insertion_scar;

{27 Olecranon_process_of_ulna_shape narrow_and_sub-angular wide_and_rounded;

{28 Ulna_shape proximal_extremity_equal_to_distal proximal_extremity_wider_than_distal;

{29 Interclavicle_shape without_dorsoventral_flexure with_moderate_dorsoventral_flexure with_severe_dorsoventral_flexure;

{30 Anterior_end_of_interclavicle_ flat rodlike;

{31 Iliac_anterior_process_ prominent virtually_absent;

{32 Dorsal_margin_of_iliac_blade__ rounded_with_smooth_border rounded_with_modest_dorsal_indentation rounded_with_strong_dorsal_indentation narrow_with_dorsal_indentation rounded_dorsal_tip_deep;

{33 Supraacetabular_crest narrow borad;

{34 Limb_bones_form robust slender;

{35 M._caudofemoralis_ single_head souble_head;

{36 Dorsal_osteoderms_keel not_keeled keeled;

{37 Dorsal_midline_osteoderms_shape rectangular nearly_square;

{38 Number_of_contiguous_dorsal_osteoderms_per_row_ four six eight ten;

{39 Nuchal_shield grades_continously_into_dorsal_shield _with_four_nuchal_osteoderms six_nuchal_osteoderms eight_nuchal_osteoderms_in_two_parallel_rows;

{40 Ventral_armor_ absent single_ventral_osteoderms paired_ventral_osteoderms;

{41 Anterior_margin_of_dorsal_midline_osteoderms_ with_anterior_process without_anterior_process;

{42 Ventral_scales_pores have_follicle_gland_pores lack_follicle_gland_pores;

{43 Ventral_collar_scales_ not_enlarged single_enlarged_row two_parallel_enlarged_rows;

{44 Median_pelvic_keel_scales_along_tail two_parallel_rows single_row merge_with_lateral_keel_scales;

{45 Alveoli_size_of_dentary_teeth _3_and_4_same_size_and_confluent 4_larger_than_3_and_seperated 3_and_4_are_nearly_the_same_size_and_separated;

{46 Anterior_dentary_teeth strongly_procumbent project_anterodorsaly;

{47 Dentary_symphysis_extension fourth_and_fifth_alveolus sixth_through_eight_alveolus eighth_to_twelfth_alveolus twelfth_to_sixteenth beyond_the_sixteenth;

{48 Dentary_curvature_between_fourth_and_tenth_alveoli gently deeply linear;

{49 Largest_dentary_alveolus_caudal_to_fourth 13_or_14 between_11_and_14_and_a_series_behind_it 11_or_12 no_differentiation behind_14 10;

{50 Splenial_with_anterior_perforation_for_cranial_nerv_V existent lacking;

{51 Mandibular_ramus_of_cranial_nerv_V only_anterior single_perforation_posterior double_perforation_posterior;

{52 Mandibular_symphysis_size splenial_participates_
splenial_excluded,_anterior_tip_of_splenial_ventral_to_Meckelian_groove
splenial_excluded,_anterior_tip_of_splenial_dorsal_to_Meckelian_groove
deep_splenial_symphysis,_splenial_forms_wide_V
deep_splenial_symphysis,_splenial_forms_narrow_V
splenial_reaches_mandibular_symphysis_but_does_not_touch_other_splenial;

{53 Coronoid_position_for_foramen_intermandibularis_medius bounding_posterior_half_of_foramen_ completely_surrounding_foramen obliterates_foramen_;

{54 Coronoid_superior_edge sloping_strongly_anteriorly almost_horizontal;

{55 Coronoid_inferior_process laping_over_inner_surface_of_meckelian_fossa remains_on_medial_surface_of_mandible;

{56 Coronoid_perforation imperforate perforation_posterior_to_foramen_intermandibularis_medius;

{57 Splenial_process separates_angular_and_coronoid no_process_between_angular_and_coronoid;

{58 Angular-surangular_suture_with_ext.mand._fenestra contacting_fenestra_at_posterior_angle passing_along_ventral_margin_of_fenestra;

{59 Surangular_anterior_processes unequal sub-equal_to_equal;

{60 Surangular_spur_on_lingual_tooth_row spur_for_at_least_one_alveolus_length no_spur;

{61 External_mandibular_fenestra absent present_as_narrow_slit present_with_discrete_concavity_on_angular_dorsal_margin present_and_very_large;

{62 Surangular-dentary_suture_intersection_with_ext._mand._fenestra anterior_to_posterodorsal_corner at_posterodorsal_corner;

{63 Angular_anterior_tip_to_foramen_intermandibularis_caudalis towards_anterior_end_of_foramen_ not_towards_anterior_end_of_foramen;

{64 Surangular-angular_suture_lingually_meets_articular at_ventral_tip dorsal_to_tip;

{65 Surangular_at_lateral_wall_of_glenoid_fossa continuing_to_dorsal_tip truncated;

{66 Articular-surangular_suture_form simple articular_bears_anterior_lamina_dorsal_to_lingual_foramen

articular_bears_anterior_lamina_ventral_to_lingual_foramen
articular_bears_lamina_above_and_below_foramen;

{67 Lingual_foramen_for_articular_artery perforates_surangular_entirely
perforates_surangular/angular_suture;

{68 Foramen_aerum_position at_lingual_margin_of_retroarticular_process
set_in_from_margin_of_retroarticular_process;

{69 Retroarticular_process_projection posteriorly
posterodorsally,_not_higher_than_the_posterior_edge_of_the_articular_fossa
projects_posterodorsally,_higher_than_the_posterior_edge_of_the_articular_fossa;

{70 Surangular_extension posterior_end_of_retroarticular_process
pinched_off_anterior_to_tip_of_retroarticular_process;

{71 Surangular-articular_suture_orientation_within_glenoid_fossa anteroposteriorly
bowed_strongly_laterally;

{72 Articular-surangular_connection sulcus_between_articular_and_surangular
artciular_flush_against_surangular;

{73 Hyoid_cornu_dorsal_projection_form flat rodlike;

{74 Hyoid_cornu_dorsal_projection_lateromedial narrow_with_parallel_sides flared;

{75 Lingual_osmoregulatory_pores small large;

{76 Tongue with_keratinized_surface without_keratinized_surface;

{77 Teeth_and_alveoli_of_maxilla/dentary_form circular_in_cross-section
posterior_teeth_laterally_compressed_ all_teeth_compressed_;

{78 Maxillary_and_dentary_teeth_serration smooth_carinae serrated
with_neither_carinae_nor_serrations;

{79 Naris_projection anterodorsally dorsally posterodorsally;

{80 External_naris_and_nasal_interaction external_naris_birsected_by_nasals
nasal_contacts_external_naris_without_bisection nasal_excluded_externally_from_naris
nasal_and_premaxilla_not_in_contact;

{81 Naris_shape circular_or_key-hole_shaped wider_than_long
anteroposteriorly_long_and_teardrop-shaped;

{82 External_naris_of_reproductively_mature_males similar_to_that_of_females
with_bony_excrescence;

{83 External_naris_opening flush_with_dorsal_surface_of_premaxilla
circumscribed_by_thin_crest;

{84 Premaxilla_surface_lateral_to_naris smooth with_deep_notch;

{85 Number_of_teeth_in_premaxilla_early_in_ontogeny five four;

{86 Incisive_foramen_size small
large_and_more_than_half_the_greatest_width_of_premaxillae
large_and_intersects_premaxillary-maxillary_suture;

{87 Incisive_foramen_position situated_far_from_premaxillary_tooth_row
abuts_premaxillary_tooth_row projects_between_first_premaxillary_teeth;

{88 Dorsal_premaxillary_process short long_behind_3th_maxilla_tooth;

{89 Dentary_tooth_four_early_in_ontogeny in_notch_between_premaxilla_and_maxilla in_pit_between_premaxilla_and_maxilla;

{90 Dentary_teeth_position all_teeth_lingual_to_maxillary_teeth occlusion_pit_bewteen_seventh_and_eigth_maxillary_teeth dentary_teeth_in_line_with_maxillary_tooth_row;

{91 Largest_maxillary_alveolus third fifth fourth four_and_five_the_same_size six maxillary_teeth_homodont maxillary_alveloi_gradually_increase_in_diameter;

{92 Maxillary_tooth_row_form_posterior_to_first_six_maxillary_alveoli medially_curved_or_linear broadly_curved_laterally;

{93 Dorsal_surface_of_rostrum curves_smoothly bears_medial_dorsal_boss;

{94 Canthi_rostralii_at_maturity absent_or_very_modest very_prominent;

{95 Preorbital_ridges_ar_maturity absent_or_very_modest very_prominent;

{96 Antorbital_fenestra present absent;

{97 Vomer_position_anterior entirely_obscured_by_premaxilla_and_maxilla exposed_on_palate_at_premaxillary-maxillary_suture;

{98 Vomer_position_posterior entirely_obscured_by_maxillae_and_palatines exposed_on_palate_between_palatines;

{99 Surface_of_maxilla_within_narial_canal imperforate with_linear_array_of_pits;

{100 Medial_jugal_foramen_size small very_large;

{101 Maxillary_foramen_for_cranial_nerve_V_size small_or_not_present very_large;

{102 Ectopterygoid_contact_with_maillary_toothrow_forming_medial_wall_of_at_least_1_mx_alveolus absent_and_ectpt-mx_suture_anteromedially_orientated_and_separated_from_toothrow_margin absent_ans_ectopt-mx_suture_parallel_and_adjacent_to_medial_toothrow_margin present;

{103 Maxilla_termination_in_palatal_view anterior_to_lower_temporal_bar comprises_part_of_the_lower_temporal_bar;

{104 Penultimate_maxillary_alvelous_size less_than_twice_the_diamater_of_the_last_one more_than_twice_the_diamater_of_the_last_one;

{105 Prefrontal_dorsal_surface_appearance smooth_adjacent_to_orbital bearing_discrete_knoblike_processes;

{106 Dorsal_half_of_prefrontal_pillar narrow expanded_anteroposteriorly;

{107 Medial_process_of_prefrontal_pillar expanded_dorsoventrally expanded_anteroposteriroly;

{108 Prefrontal_pillar_form solid with_large_pneumatic_recess;

{109 Medial_process_of_prefrontal_pillar_at_base wide constricted;

{110 Maxilla_appearance_on_suborbital_fenestra linear_medial_margin broad_shelf,_lateral_margin_concave;

{111 Anterior_face_of_palatine_process_anteriroly rounded_or_pointed notched;

{112 Anterior_ectopetrygoid_process tapered_to_a_point forked;

{113 Palatine_process_extension beyond_anterior_end_of_suborbital_fenestra
not_beyond_anterior_end_of_suborbital_fenestra;

{114 Palatine_process_form broad_anteriroly form_of_a_thin_wedge;

{115 Lateral_edges_of_palatines_appearance smooth_anteriroly
lateral_process_projecting_into_suborbital_fenestra;

{116 Palatine-pterygoid_suture at_posterior_angle_of_suborbital_fenestra
far_from_posterior_angle_of_suborbital_fenestra;

{117 Pterygoid_ramus_of_ectopterygoid_form
straight,_posterolateral_fenestra_margin_linear
bowed,_posterolateral_fenestra_margin_concave;

{118 Lateral_edges_of_palatines_form parallel_posterior flare_posteriorly,_producing_shelf;

{119 Anterior_border_of_choana comprised_of_palatines
entirely_surrounded_by_pterygoids;

{120 Choana_projecting_at_maturity posteroventrally anteroventrally;

{121 Pterygoid_surface_around_choana flush_with_choanal_margin
pushed_inward_anterolateral_to_choana_aperture
pushed_inward_around_choana_to_form_neck_surrounding_aperture
everted_from_flat_surface_to_form_neck_surounding_aperture;

{122 Posterior_rim_of_internal_choana not_deeply_notched deeply_notched;

{123 Internal_choana_appearance not_septated
with_septum_that_remains_recessed_within_choana
with_septum_that_projects_out_of_choana;

{124 Ectopterygoid-pterygoid_flexure_appearance flexure_disappeares_during_ontogeny
flexure_remains_throughout_ontogeny;

{125 Ectopterygoid_extention_at_maturity _to_posterior_tip_of_lateral_pterygoid_flange
__not_to_posterior_tip_of_lateral_pterygoid_flange;

{126 Maxilla_connection_with_lacrimal
lacrimal_makes_broad_contact_with_nasal,_no_process
maxilla_with_posterior_process_within_lacrimal
maxilla_with_posterior_process_between_lacrimal_and_prefrontal;

{127 Prefrontal_form
separated_by_frontals_and_nasals,_anterior_process_of_frontal_extending_far_anterior_to_the_anterior_margin_of_the_orbit
prefrontals_separated_by_the_frontal_and_nasals,_anterior_process_of_frontal_around_the_same_level_or_posterior_to_the_anterior_margin_of_the_orbit
prefrontals_meet_medially,_anterior_process_of_frontal_around_the_same_level_or_posterior_to_the_anterior_margin_of_the_orbit;

{128 Lacrimal_and_prefrontal_size lacrimal_longer_than_prefrontal
prefrontal_longer_than_lacrimal lacrimal_and_prefrontal_same_size_and_elongated;

{129 Anterior_tip_of_frontal_form simple_acute_point
broad,_complex_sutural_contact_with_nasals;

{130 Ectopterygoid_extension_at_postorbital_bar
extends_along_medial_face_of_postorbital_bar stops_abruptly_ventral_to_postorbital_bar;

{131 Postorbital_bar_form massive slender;

{132 Postorbital_process prominent,_dorsoventrally_broad,_two_spines short_and_generally_not_prominent;

{133 Ventral_margin_of_postorbital_bar flush_with_lateral_jugal_surface inset_from_lateral_jugal_surface;

{134 Postorbital_bar_connection_with_skull_table continous_with_anterolateral_edge_of_skull_table inset_from_skull_table;

{135 Margin_of_orbit flush_with_skull_surface dorsal_edges_of_orbist_upturned orbital_margin_telescoped anterior_margins_of_orbit_telescoped;

{136 Ventral_margin_of_orbit_form not_upturned,_ventral_margin_gently_circular anterior_margin_upturned,_ventral_margin_gently_circular anterior_margin_upturned,_ventral_margin_with_a_prominent_notch;

{137 Palpebral_form single_ossification multiple_ossifications;

{138 Quadratojugal_spine_appearance prominent_at_maturity greatly_reduced_or_absent_at_maturity;

{139 Quadratojugal_spine_position_into_infratemporal_fenestra low,_near_posterior_angle_of_fenestra high,_between_posterior_and_superior_angles_of__fenestra;

{140 Posterior_angle_of_infratemporal_fenestra quadratojugal_forms_posterior_angle_of_fenestra jugal_forms_posterior_angle_of_fenestra quadratojugal-jugal_suture_lies_at_posterior_angle_of_fenestra;

{141 Postorbital_contacts _neither_quadrate_nor_quadratojugal_medially quadratojugal_but_not_quadrate_medially quadrate_and_quadratojugal_at_dorsal_angle_of_infrat._fenestra quadratojugal_with_significant_descending_process;

{142 Quadratojugal_process long_anterior_process_along_lower_temporal_bar _modest_process,_or_none_at_all,_along_lower_temporal_bar;

{143 Quadratojugal_extention extends_to_superior_angle_of_infratemporal_fenestra does_not_extend_to_superior_angle_of_infratemporal_fenestra;

{144 Postorbital-squamosal_suture_orientation_to_skull_table passes_ventrally passes_medially;

{145 Dorsal_and_ventral_rims_of_squamosal_groove parallel flaring_anteriorly;

{146 Quadrate_and_squamosal_on_external_auditory_meatus not_in_contact_posteriorly suture_extends_dorsally_along_caudal_margin_of_meatus extends_only_to_caudoventral_boarder_of_meatus;

{147 Caudal_margin_of_otic_aperture not_defined_and_merging_into_exoccipital smooth_and_continous_with_paroccipital_process inset;

{148 Frontoparietal_suture_position deeply_within_supratemporal_fenestra making_modest_entry_into_supratemporal_fenestra_at_maturity on_skull_table_entirely;

{149 Frontoparietal_suture_between_supratemporal_fenestrae concavoconvex linear;

{150 Supratemporal_fenestra_appearance dermal_bones_do_not_overhang_rim_of_fenestra parietal_overhangs_the_rim_at_maturity

postorbital,_squamosal_and_parietal_overhang_rim_at_maturity
fenestra_closes_during_ontogeny;

{151 Anteromedial_corner_of_supratemporal_fenestra shallow_fossa_or_no_fossa smooth;

{152 Medial_parietal_wall_of_supratemporal_fenestra imperforate bearing_foramina;

{153 Parietal_and_squamosal_on_supratemporal_fenestra
widely_separated_by_quadrate_on_posterior_fenestra_wall
approaching_each_other_on_fenestra_without_making_contact
meeting_along_posterior_wall_of_fenestra;

{154 Skull_table_surface_at_maturity sloping_ventrally_from_sagittal_axis planar
slopes_ventrally_toward_sagittal_axis_at_maturity,_lateral_elements_planar;

{155 Squamosal_on_skull_table horizontal_or_nearly_so
upturned_to_form_a_discrete_posterolateral_horn
producing_a_high_transversely_oriented_eminence_at_the_posterior_margin_late_in_ontogeny;

{156 Posterolateral_squamosal_rami rami_along_paroccipital_process_short
rami_along_paroccipital_process_significant;

{157 Squamsoal_form does_not_extend_to_lateral_extent_of_paroccipital_process
extends_to_lateral_extent_of_paroccipital_process;

{158 Supraoccipital_exposure_on_dorsal_skull_table absent small large
large_such_that_parietal_is_excluded_from_posterior_edge_of_table;

{159 Anterior_foramen_of_cranial_nerve_VII ventrolateral_to_basisphenoid_rostrum
ventral_to_basisphenoid_rostrum;

{160 Braincase_wall_lateral_to_basisphenoid_rostrum sulcus_on_anterior_braincase_wall
braincase_wall__smooth,_no_sulcus;

{161 Basisphenoid_anterior_to_trigeminal_foramen not_exposed_extensively
exposed_extensively;

{162 Prootic_on_external_braincase_wall extensively_exposured
largely_obscured_by_quadrate_and_laterosphenoid_externally;

{163 Laterosphenoid_bridge comprised_entirely_of_laterosphenoid
with_ascending_process_or_palatine;

{164 Capitate_process_of_laterosphenoid oriented_laterally_toward_midline
oriented_anteroposteriorly_toward_midline;

{165 Parietal_pneumatic_system
parietal_with_recess_communicating_with_pneumatic_system
parietal_solid,_without_recess;

{166 Lateral_braincase_wall significant_ventral_quadrate_process_on_braincase_wall q-pt_suture_linear_from_basisphenoid_exposure_to_trigeminal_fo;

{167 Lateral_carotid_foramen opens_lateral_to_basisphenoid_at_maturity
dorsal_to_to_basisphenoid_at_maturity;

{168 External_surface_of_basioccipital_ventral_to_occipital_condyle
oriented_posteroventrally_at_maturity oriented_posteriorly_at_maturity;

{169 Posterior_pterygoid_process tall_and_prominent small_and_project_posteroventrally
small_and_project_posteriorly;

{170 Basisphenoid_appearance_ventral_to_basioccipital thin_ anteroposteriorly_wide;

{171 Basisphenoid_exposure not_broadly_exposed_ventral_to_basioccipital exposed_as_broad_sheet_ventral_to_basioccipital;

{172 Exoccipital_on_paroccipital_process with_very_prominent_boss with_small_or_no_boss_on_paroccipital_process;

{173 Lateral_eustachian_canal_openings dorsal_to_medial_eustachian_canal lateral_to_medial_eustachian_canal;

{174 Exoccipital_termination dorsal_to_basioccipital_tubera sending_robust_process_ventrally,_participating_in_bo_tubera sending_slender_process_ventrally_to_basioccipital_tubera;

{175 Quadrate_foramen_aerum_position on_mediodorsal_angle_of_quadrate on_dorsal_surface_of_quadrate;

{176 Quadrate_foramen_aerum_size_at_maturity small comparatively_large absent;

{177 Quadrate_appearance_on_dorsal_surface_of_ramus lacking_prominent,_mediolaterally_thin_crest bearing_prominent,_mediolaterally_thin_crest;

{178 Attachment_scar_for_posterior_mandibular_abductor_muscle forming_modest_crest_on_ventral_surface_of_quadrate_ramus forming_prominent_knob_on_ventral_surface_of_quadrate_ramus;

{179 Quadrate_hemicondyle small,_ventrally-reflected_medial_hemicondyle small_medial_hemicondyle_dorsal_notch_for_foramen_aerum with_prominent_dorsal_projection_between_hemicondyles with_expanded_medial_hemicondyle;

{180 Iris_colour greenish/yellowish brown;

{181 Postoccipital_osteoderms two_or_more one;

{182 Paired_midline_scale_rows fewer_than_eight eight_to_14 more_than_14;

{183 Ectopterygoid_maxillary_ramus_form less_than_two-thirds_of_lateral_margin_of_suborbital_fenestra more_than_two-thirds_of_lateral_margin_of_suborbital_fenestra;

{184 Ectopterygoid_maxillary_ramus_termination at_lateral_margin_of_suborbital_fenestra lateral_to_it,_maxilla_separating_the_ectopterygoid_from_fenestra;

{185 Palatine-maxillary_suture_intersection_at_suborbital_fenestra at_its_anteromedial_margin nearly_at_its_anteriormost_limit;

{186 Frontal_with_midsagittal_crest_between_orbits lacks bears;

{187 Cervical_neural_spines_form anteroposteriorly_broad posterior_neural_spines_thin_and_rod-like;

{188 Largest_premaxilla_tooth second third fourth third_and_fourth_similar_largest all_similar_in_size fourth_and_fifth_similarly_largest first_for_similar_in_size;

{189 Dorsal_surface_of_surangular smooth large_sulcus_next_to_the_anterior_half_of_the_glenoid_fossa;

{190 U-shaped_depression_of_the_frontal_at_the_point_of_maximum absent present;

{191 Head_shape relatively_flat formed_like_a_wedge_and_trapezoid_in_cross-section;

{192 Anterior_jugal_process extends_anterior_to_the_anterior_process_of_frontal_
at_the_same_level_as_the_anterior_process_of_frontal_
well_posterior_to_the_anterior_process_of_frontal_;

{193 Notch_between_the_premaxilla_and_maxilla_in_adults present not_present;

{194 Anterior_maxilla_and_dentary_teeth
without_or_weak_dorsoventral_ridges_on_the_lateral_surface
with_dominant_dorsoventral_ridges_on_the_lateral_surface;

{195 If_largest_dentary_alveolus_is_between_11th_and_14th_and_a_series_behind_it 11th
12th 13th_or_14th;

{196 Surangular-angular_suture_lingually_originates_
near_the_ventral_border_of_the_external_mandibular_fenestra_
near_the_dorsal_border_of_the_external_mandibular_fenestra_and_straight
near_the_dorsal_border_of_theexternal_mandibular__fenestra_and_bowed;

{197 If_supraoccipital_exposure_on_skull_table_is_large_or_very_large,_is__ trapezoid
triangular block-shaped;

{198 Edge_of_the_maxillary_alveoli
lower_or_at_the_same_level_than_the_space_between_toothrow_
edge_of_maxillary_tooth_alveoli_higher_than_the_space;

{199 Ventral_border_of_exoccipital_
ventrally_projected,_hiding_the_posterior_opening_of_the_cranioquadrate_passage_from_t
he_occipital_view_
straight,_sharpen_or_smoothly_convex_and_does_not_hide_the_posterior_opening_of_the_
cranioquadrate_passage_from_the_occipital_view_;

{200 Occipital_surface_at_maturity sloped,_visible_in_dorsal_view_
vertical_or_not_visible_in_dorsal_view;

{201 Ventral_premaxilla-maxilla_suture_
short_and_ends_posteriorly_before_the_3rd_maxillary_alveoli
elongated_and_extends_or_exceeds_the_3rd_maxillary_alveoli_;

{202 Number_of_teeth_on_maxilla less_than_18_teeth 18_to_22_teeth
more_than_22_teeth;

{203 Lateral_edge_of_the_skull_table_at_the_level_of_the_postorbital-squamosal_suture_
situated_laterally_or_at_the_same_level_as_the_quadrate_condyle_in_dorsal_view_at_mat
urity situated_medially_to_the_quadrate_condyle_in_dorsal_view_at_maturity;

{204 Frontal_ending
at_the_same_level_or_posterior_to_the_anterior_extension_of_the_prefrontal
extends_well_anterior_to_the_anterior_extension_of_the_prefrontal;

{205 Maxilla_posterior_process_without_tooth_in_ventral_view short_or_absent
long_longer_than_the_distance_between_the_three_last_teeth_;

{206 Interorbital_bridge narrower_to_equivalent_than_the_width_of_the_orbit
broader_than_the_width_of_the_orbit;

{207 Supratemporal_fenestra_at_maturity
longer_than_wide_or_rounded,_posterior_bar_of_supratemporal_fenestra_thick_
wider_than_long,_posterior_bar_of_supratemporal_fenestra_thick_
wider_than_long,_posterior_bar_thin_;

{208 Medial_crest_on_the_basioccipital present absent;

{209 Posterior_dentary_process_between_splenial_and___angular_on_the_ventral_side absent present;

{210 Dorsal_margin_of_the_articular_on_the_retroarticular_process_ largely_visible_in_lateral_view slightly_or_not_visible_in_lateral_view_;

{211 Posterior_margin_of_the_orbit_measured_at_the_level_of_the_postorbital-frontal_suture_in_the_orbital_margin_ _anterior_to_the_posterior_margin_of_the_suborbital_fenestra posterior_or_at_the_same_level_than_the_posterior_margin_of_the_suborbital_fenestra;

{212 Basioccipital-exoccipital_process_ventral_to_occipital_condyle_(basioccipital_plate)_in_posterior_view with_parallel_or_ventrally_convergent_sides_ ventrally_divergent_sides_;

{213 Smooth_medial_depression_ventral_to_the_basioccipital_and_posterior_to_the_medial_Eustachian_foramen absent present;

{214 Dentary_teeth_series_behind_to_alveoli_12-13_ pointed_to_slightly_blunt globular,_different_in_size_among_them_ globular,_at_least_four_subequal_in_size_ molariform_multicusped absent;

{215 First_four_alveoli_in_the_dentary same_size_or_smaller_than_other_dentary_alveoli_ the_largest_within_the_dentary_;

{216 Obits_late_in_ontogeny longer_than_wide_ wider_than_long_to_rounded_;

{217 The_series_composed_by_the_last_three_premaxillary_teeth_ diverge_posteriorly_to_paraxial tend_to_converge_posteriorly,_straight_among_them_;

{218 Dentary,_level_of_the_first_and_fourth_alveoli lower_than_the_level_of_the_eleventh_and_twelfth_alveoli_ equal_to_higher_than_the_level_of_the_eleventh_and_twelfth_alveoli;

;

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Ancstates

-0 -1 -2 -3 -4 -5 -6 -7 -8 -9

-10 -11 -12 -13 -14 -15 -16 -17 -18 -19

-20 -21 -22 -23 -24 -25 -26 -27 -28 -29

-30 -31 -32 -33 -34 -35 -36 -37 -38 -39

-40 -41 -42 -43 -44 -45 -46 -47 -48 -49

-50 -51 -52 -53 -54 -55 -56 -57 -58 -59

-60 -61 -62 -63 -64 -65 -66 -67 -68 -69

-70 -71 -72 -73 -74 -75 -76 -77 -78 -79

-80 -81 -82 -83 -84 -85 -86 -87 -88 -89

-90 -91 -92 -93 -94 -95 -96 -97 -98 -99

-100 -101 -102 -103 -104 -105 -106 -107 -108 -109

-110 -111 -112 -113 -114 -115 -116 -117 -118 -119

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 -120   -121   -122   -123   -124   -125   -126   -127   -128   -129
 -130   -131   -132   -133   -134   -135   -136   -137   -138   -139
 -140   -141   -142   -143   -144   -145   -146   -147   -148   -149
 -150   -151   -152   -153   -154   -155   -156   -157   -158   -159
 -160   -161   -162   -163   -164   -165   -166   -167   -168   -169
 -170   -171   -172   -173   -174   -175   -176   -177   -178   -179
 -180   -181   -182   -183   -184   -185   -186   -187   -188   -189
 -190   -191   -192   -193   -194   -195   -196   -197   -198   -199
 -200   -201   -202   -203   -204   -205   -206   -207   -208   -209
 -210   -211   -212   -213   -214   -215   -216   -217   -218
;
 taxcode
+0     +1     +2     +3     +4     +5     +6     +7
+8     +9     +10    +11    +12    +13    +14    +15
+16    +17    +18    +19    +20    +21    +22    +23
+24    +25    +26    +27    +28    +29    +30    +31
+32    +33    +34    +35    +36    +37    +38    +39
+40    +41    +42    +43    +44    +45    +46    +47
+48    +49    +50    +51    +52    +53    +54    +55
+56    +57    +58    +59    +60    +61    +62    +63
+64    +65    +66    +67    +68    +69    +70    +71
+72    +73    +74    +75    +76    +77    +78    +79
+80    +81    +82    +83    +84    +85    +86    +87
+88    +89    +90    +91    +92    +93    +94    +95
+96    +97    +98    +99    +100   +101   +102   +103
+104   +105   +106   +107   +108   +109   +110   +111
+112   +113   +114   +115   +116   +117   +118   +119
+120   +121   +122   +123   +124   +125   +126   +127
;
 blocks 0;
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force
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[Gavialis_gangeticus Tomistoma_schlegelii (Bernissartia_fagesii Acynodon_adriaticus Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni Alligator_mcgrewi Alligator_mefferdi Alligator_olseni Alligator_prenasalis Alligator_thomsoni Allodaposuchus_precedens Allognathosuchus_polyodon Allognathosuchus_wartheni Arambourgia_gaudryi Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons Asiatosuchus_germanicus Australosuchus_clarkae Borealosuchus_acutidentatus Borealosuchus_formidabilis Borealosuchus_griffithi Borealosuchus_sternbergii Borealosuchus_threeensis Borealosuchus_wilsoni Bottosaurus_fustidens Bottosaurus_harlani Boverisuchus_magnifrons Boverisuchus_vorax Brachychampsa_montana Brachychampsa_sealeyi Brachyuranochampsa_eversolei Brochuchus_pigotti Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus Wannaganosuchus_brachymanus)]

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Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus Wannaganosuchus_brachymanus)]

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[Paleosuchus_palpebrosus Paleosuchus_trigonatus (Bernissartia_fagesii Acynodon_adriaticus Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni Alligator_mcgrewi Alligator_mefferdi Alligator_olseni Alligator_prenasalis Alligator_thomsoni Allodaposuchus_precedens Allognathosuchus_polyodon Allognathosuchus_wartheni Arambourgia_gaudryi Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons Asiatosuchus_germanicus Australosuchus_clarkae Borealosuchus_acutidentatus Borealosuchus_formidabilis Borealosuchus_griffithi Borealosuchus_sternbergii Borealosuchus_threeensis Borealosuchus_wilsoni Bottosaurus_fustidens Bottosaurus_harlani Boverisuchus_magnifrons Boverisuchus_vorax Brachychampsa_montana Brachychampsa_sealeyi Brachyuranochampsa_eversolei Brochuchus_pigotti Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus Wannaganosuchus_brachymanus)]

[Caiman_crocodilus Caiman_latirostris Caiman_yacare Melanosuchus_niger Paleosuchus_palpebrosus Paleosuchus_trigonatus (Bernissartia_fagesii Acynodon_adriaticus Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni Alligator_mcgrewi Alligator_mefferdi Alligator_olseni Alligator_prenasalis Alligator_thomsoni Allodaposuchus_precedens Allognathosuchus_polyodon Allognathosuchus_wartheni Arambourgia_gaudryi Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons Asiatosuchus_germanicus Australosuchus_clarkae Borealosuchus_acutidentatus Borealosuchus_formidabilis Borealosuchus_griffithi Borealosuchus_sternbergii Borealosuchus_threeensis Borealosuchus_wilsoni Bottosaurus_fustidens Bottosaurus_harlani Boverisuchus_magnifrons Boverisuchus_vorax Brachychampsa_montana

Brachychampsa_sealeyi Brachyuranochampsa_eversolei Brochuchus_pigotti Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus Wannaganosuchus_brachymanus)]

[Alligator_mississippiensis Alligator_sinensis Caiman_crocodilus Caiman_latirostris Caiman_yacare Melanosuchus_niger Paleosuchus_palpebrosus Paleosuchus_trigonatus (Bernissartia_fagesii Acynodon_adriaticus Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni Alligator_mcgrewi Alligator_mefferdi Alligator_olseni Alligator_prenasalis Alligator_thomsoni Allodaposuchus_precedens Allognathosuchus_polyodon Allognathosuchus_wartheni Arambourgia_gaudryi Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons Asiatosuchus_germanicus Australosuchus_clarkae Borealosuchus_acutidentatus Borealosuchus_formidabilis Borealosuchus_griffithi Borealosuchus_sternbergii Borealosuchus_threeensis Borealosuchus_wilsoni Bottosaurus_fustidens Bottosaurus_harlani Boverisuchus_magnifrons Boverisuchus_vorax Brachychampsa_montana Brachychampsa_sealeyi Brachyuranochampsa_eversolei Brochuchus_pigotti Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi

Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus Wannaganosuchus_brachymanus)]

[Osteolaemus_osborni Osteolaemus_tetraspis (Bernissartia_fagesii Acynodon_adriaticus Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni Alligator_mcgrewi Alligator_mefferdi Alligator_olseni Alligator_prenasalis Alligator_thomsoni Allodaposuchus_precedens Allognathosuchus_polyodon Allognathosuchus_wartheni Arambourgia_gaudryi Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons Asiatosuchus_germanicus Australosuchus_clarkae Borealosuchus_acutidentatus Borealosuchus_formidabilis Borealosuchus_griffithi Borealosuchus_sternbergii Borealosuchus_threeensis Borealosuchus_wilsoni Bottosaurus_fustidens Bottosaurus_harlani Boverisuchus_magnifrons Boverisuchus_vorax Brachychampsa_montana Brachychampsa_sealeyi Brachyuranochampsa_eversolei Brochuchus_pigotti Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus Wannaganosuchus_brachymanus)]

[Mecistops_cataphractus Osteolaemus_osborni Osteolaemus_tetraspis (Bernissartia_fagesii Acynodon_adriaticus Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni Alligator_mcgrewi Alligator_mefferdi Alligator_olseni Alligator_prenasalis Alligator_thomsoni Allodaposuchus_precedens Allognathosuchus_polyodon Allognathosuchus_wartheni Arambourgia_gaudryi Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons Asiatosuchus_germanicus Australosuchus_clarkae Borealosuchus_acutidentatus Borealosuchus_formidabilis

Borealosuchus_griffithi Borealosuchus_sternbergii Borealosuchus_threeensis Borealosuchus_wilsoni Bottosaurus_fustidens Bottosaurus_harlani Boverisuchus_magnifrons Boverisuchus_vorax Brachychampsa_montana Brachychampsa_sealeyi Brachyuranochampsa_eversolei Brochuchus_pigotti Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus Wannaganosuchus_brachymanus)]

[Crocodylus_niloticus Crocodylus_porosus Crocodylus_rhombifer Mecistops_cataphractus Osteolaemus_osborni Osteolaemus_tetraspis (Bernissartia_fagesii Acynodon_adriaticus Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni Alligator_mcgrewi Alligator_mefferdi Alligator_olseni Alligator_prenasalis Alligator_thomsoni Allodaposuchus_precedens Allognathosuchus_polyodon Allognathosuchus_wartheni Arambourgia_gaudryi Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons Asiatosuchus_germanicus Australosuchus_clarkae Borealosuchus_acutidentatus Borealosuchus_formidabilis Borealosuchus_griffithi Borealosuchus_sternbergii Borealosuchus_threeensis Borealosuchus_wilsoni Bottosaurus_fustidens Bottosaurus_harlani Boverisuchus_magnifrons Boverisuchus_vorax Brachychampsa_montana Brachychampsa_sealeyi Brachyuranochampsa_eversolei Brochuchus_pigotti Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman

Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus Wannaganosuchus_brachymanus)]

[Caiman_crocodilus Caiman_latirostris Caiman_yacare Melanosuchus_niger (Bernissartia_fagesii Acynodon_adriaticus Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni Alligator_mcgrewi Alligator_mefferdi Alligator_olseni Alligator_prenasalis Alligator_thomsoni Allodaposuchus_precedens Allognathosuchus_polyodon Allognathosuchus_wartheni Arambourgia_gaudryi Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons Asiatosuchus_germanicus Australosuchus_clarkae Borealosuchus_acutidentatus Borealosuchus_formidabilis Borealosuchus_griffithi Borealosuchus_sternbergii Borealosuchus_threeensis Borealosuchus_wilsoni Bottosaurus_fustidens Bottosaurus_harlani Boverisuchus_magnifrons Boverisuchus_vorax Brachychampsa_montana Brachychampsa_sealeyi Brachyuranochampsa_eversolei Brochuchus_pigotti Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus Wannaganosuchus_brachymanus)]

[Crocodylus_niloticus Crocodylus_rhombifer (Bernissartia_fagesii Acynodon_adriaticus Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni Alligator_mcgrewi Alligator_mefferdi Alligator_olseni Alligator_prenasalis Alligator_thomsoni Allodaposuchus_precedens Allognathosuchus_polyodon Allognathosuchus_wartheni

Arambourgia_gaudryi Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons Asiatosuchus_germanicus Australosuchus_clarkae Borealosuchus_acutidentatus Borealosuchus_formidabilis Borealosuchus_griffithi Borealosuchus_sternbergii Borealosuchus_threeensis Borealosuchus_wilsoni Bottosaurus_fustidens Bottosaurus_harlani Boverisuchus_magnifrons Boverisuchus_vorax Brachychampsa_montana Brachychampsa_sealeyi Brachyuranochampsa_eversolei Brochuchus_pigotti Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus Wannaganosuchus_brachymanus)]

[Crocodylus_niloticus Crocodylus_porosus Crocodylus_rhombifer (Bernissartia_fagesii Acynodon_adriaticus Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni Alligator_mcgrewi Alligator_mefferdi Alligator_olseni Alligator_prenasalis Alligator_thomsoni Allodaposuchus_precedens Allognathosuchus_polyodon Allognathosuchus_wartheni Arambourgia_gaudryi Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons Asiatosuchus_germanicus Australosuchus_clarkae Borealosuchus_acutidentatus Borealosuchus_formidabilis Borealosuchus_griffithi Borealosuchus_sternbergii Borealosuchus_threeensis Borealosuchus_wilsoni Bottosaurus_fustidens Bottosaurus_harlani Boverisuchus_magnifrons Boverisuchus_vorax Brachychampsa_montana Brachychampsa_sealeyi Brachyuranochampsa_eversolei Brochuchus_pigotti Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii

Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus Wannaganosuchus_brachymanus)]

[Caiman_crocodilus Caiman_yacare (Bernissartia_fagesii Acynodon_adriaticus Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni Alligator_mcgrewi Alligator_mefferdi Alligator_olseni Alligator_prenasalis Alligator_thomsoni Allodaposuchus_precedens Allognathosuchus_polyodon Allognathosuchus_wartheni Arambourgia_gaudryi Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons Asiatosuchus_germanicus Australosuchus_clarkae Borealosuchus_acutidentatus Borealosuchus_formidabilis Borealosuchus_griffithi Borealosuchus_sternbergii Borealosuchus_threeensis Borealosuchus_wilsoni Bottosaurus_fustidens Bottosaurus_harlani Boverisuchus_magnifrons Boverisuchus_vorax Brachychampsa_montana Brachychampsa_sealeyi Brachyuranochampsa_eversolei Brochuchus_pigotti Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus Wannaganosuchus_brachymanus)]

[Caiman_crocodilus Caiman_latirostris Caiman_yacare (Bernissartia_fagesii Acynodon_adriaticus Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni Alligator_mcgrewi Alligator_mefferdi Alligator_olseni

Alligator_prenasalis Alligator_thomsoni Allodaposuchus_precedens
Allognathosuchus_polyodon Allognathosuchus_wartheni Arambourgia_gaudryi
Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons Asiatosuchus_germanicus
Australosuchus_clarkae Borealosuchus_acutidentatus Borealosuchus_formidabilis
Borealosuchus_griffithi Borealosuchus_sternbergii Borealosuchus_threeensis
Borealosuchus_wilsoni Bottosaurus_fustidens Bottosaurus_harlani
Boverisuchus_magnifrons Boverisuchus_vorax Brachychampsa_montana
Brachychampsa_sealeyi Brachyuranochampsa_eversolei Brochuchus_pigotti
Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei
Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis
Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri
Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis
Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis
Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii
Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus
Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi
Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis
Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus
Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii
Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri
Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman
Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos
Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi
Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis
Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti
Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis
Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis
Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis
Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp
Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei
Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis
Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis
Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus
Wannaganosuchus_brachymanus)]

[Alligator_mississippiensis Alligator_sinensis (Bernissartia_fagesii Acynodon_adriaticus
Acynodon_iberoccitanus Agaresuchus_subjuniperus Albertochampsa_langstoni
Alligator_mcgrewi Alligator_mefferdi Alligator_olseni Alligator_prenasalis Alligator_thomsoni
Allodaposuchus_precedens Allognathosuchus_polyodon Allognathosuchus_wartheni
Arambourgia_gaudryi Arenysuchus_gascabadiolorum Asiatosuchus_depressifrons
Asiatosuchus_germanicus Australosuchus_clarkae Borealosuchus_acutidentatus
Borealosuchus_formidabilis Borealosuchus_griffithi Borealosuchus_sternbergii
Borealosuchus_threeensis Borealosuchus_wilsoni Bottosaurus_fustidens
Bottosaurus_harlani Boverisuchus_magnifrons Boverisuchus_vorax
Brachychampsa_montana Brachychampsa_sealeyi Brachyuranochampsa_eversolei
Brochuchus_pigotti Caiman_brevirostris Caiman_wannlangstoni Centenariosuchus_gilmorei
Ceratosuchus_burdoshi Chinatichampsus_wilsonorum Crocodylus_acer Crocodylus_affinis
Crocodylus_megarhinus Deinosuchus_riograndensis Deinosuchus_schwimmeri
Diplocynodon_darwini Diplocynodon_deponiae Diplocynodon_hantoniensis
Diplocynodon_muelleri Diplocynodon_ratelii Diplocynodon_remensis Diplocynodon_tormis
Dollosuchoides_densmorei Dongnanosuchus_hsui Eoalligator_chunyii
Eocaiman_cavernensis Eocaiman_itaboraiensis Eocaiman_palaeocenicus
Eogavialis_africanum Eosuchus_lerichei Eosuchus_minor Eothoracosaurus_mississippiensi
Euthecodon_arambourgii Gavialis_lewisi Gavialosuchus_eggenburgensis
Globidentosuchus_brachyrostris Gnatusuchus_pebasensis Gryposuchus_colombianus

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Hassiacosuchus_haupti Hylaeochampsa_vectiana Iharkutosuchus_makadii
Jiangxisuchus_nankangensis Kambara_implexidens Kentisuchus_spenceri
Krabisuchus_siamogallicus Kuttanacaiman_iquitosensis La_venta_Caiman
Leidyosuchus_canadensis Lohuecosuchus_mechinorum Lohuecosuchus_megadontos
Maomingosuchus_petrolica Mourasuchus_amazonensis Mourasuchus_arendsi
Mourasuchus_atopus Navajosuchus_mooki Necrosuchus_ionensis
Orientalosuchus_naduongensis Pachycheilosuchus_trinquei Paratomistoma_courti
Pietraroiasuchus_ormezzanoi Piscogavialis_jugaliperforatus Planocrania_datangensis
Planocrania_hengdongensis Procaimanoidea_kayi Procaimanoidea_utahensis
Prodiplocynodon_langi Protoalligator_huiningensis Protocaiman_peligrensis
Purussaurus_brasiliensis Purussaurus_mirandai Purussaurus_neivensis Quinkana_spp
Rimasuchus_lloydi Shamosuchus_djadochtaensis Stangerochampsa_mccabei
Thecachampsa_antiqua Thoracosaurus_macrorhynchus Thoracosaurus_neocesariensis
Tomistoma_cairense Tomistoma_lusitanica Toyotamaphimeia_machikanensis
Trilophosuchus_rackhami Tsoabichi_greenriverensis Voay_robustus
Wannaganosuchus_brachymanus )]

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proc/;
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8. Dataset: Walter et al., supplementary dataset (modified Rio & Mannion, 2021 – continuous and discrete characters; .tnt)

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nstates cont;

nstates 32 ;

xread 'Data saved from TNT'

330 146

&[cont]

Bernissartia_fagesii 0.494 1.272 ? ? ? 0.173 ? 0.870 7.000 0.375 0.717 ?
? ? ? ? 16.000 ? ? ? 60.000 ? ? ? ? ?

Isisfordia_duncani 0.646 1.482 0.657 0.180 0.093 0.232 0.362 0.823 0.000 0.525 0.663
0.346 0.421 1.016 3.650 1.918 ? ? ? ? 30.000 ? ? 0.754 1.112 ?

Acynodon_iberoccitanus ? ? ? ? ? ? ? ? ? ? ? ? ? ?
? ? 13.000 ? ? ? ? ? ? ? ? ?

Agaresuchus_fontisensis 0.534 1.366 1.375 0.420 0.287 0.308 0.576 0.595 ? 0.591
0.921 0.191 0.430 1.379 3.259 ? 15.000 ? ? ? ? ? ? ? ? ?

Allodaposuchus_precedens 0.563 1.778 1.700 0.254 0.388 0.388 ? 0.794 11.000
0.529 0.913 0.129 0.366 ? 2.900 ? 14.000 ? ? ? ? ? ? ? ? ?

Glen_Rose_form ? ? ? ? ? 0.147 ? 0.699 9.000 0.525 0.598 ? 0.533
0.308 2.858 2.421 11.000-12.000 ? ? ? ? ? ? ? ? ?

Hylaeochampsa_vectiana ? 1.517 ? ? ? 0.328 ? 1.052 0.000 0.410 0.560
? 0.250 0.846 ? 2.333 ? ? ? ? ? ? ? ? ? ?

Iharkutosuchus_makadii 0.428 1.292 1.500 0.344 ? 0.257 ? 0.667 18.000 ? ?
? 0.295 1.219 ? 1.664 13.000 ? ? ? ? ? ? ? ? ?

Lohuecosuchus_megadontos 0.482 1.579 1.667 0.296 ? 0.428 ? 0.693 5.000 0.420
0.824 0.171 0.516 0.684 3.364 ? 10.000-11.000 ? ? 1.122 ? ? ? ? ?
?

Portugalosuchus_azenhae ? 1.074 ? ? ? 0.224 ? 0.595 0.000 0.705 0.903
? 0.354 1.222 ? ? ? 2.333 36.000 ? ? ? ? ? ? ?

Shamosuchus_djadochtaensis ? 0.824 ? ? 0.425 0.241 0.503 0.597 0.000 0.535
0.800 ? ? ? 3.878 2.607 ? ? ? ? ? ? ? ? ? ?

Wannchampsus_kirpachi ? ? ? ? ? ? ? 0.733 0.000 0.651 0.537 ?
? ? 2.769 1.375 11.000 ? ? ? ? ? ? ? ? ?

Acresuchus_pachytemporalis 0.535 2.529 1.134 0.264 0.189 0.337 0.687 0.798 15.000
0.518 0.488 0.147 ? ? ? 1.389 11.000 1.373 38.000 1.088 ? ? ? ? ?
?

Aktiogavialis_caribesi ? 0.787 ? ? ? 0.283 ? 0.657 12.000 0.640 0.794 ?
0.386 1.130 ? 1.767 19.000 ? ? ? ? ? ? ? ? ?

Alligator_mcgrewi 0.444-0.478 1.495-1.518 1.291-1.429 0.242 ? 0.220-0.230 0.399-
0.489 0.679-0.788 8.000 0.425-0.496 0.738-0.829 0.203-0.217 0.530 1.667 2.147 ?
13.000 1.912-3.169 20.000 1.163 54.000 ? ? ? ? ?
```

Alligator_mefferdi 0.524 1.803 1.324 0.328 ? 0.355 0.491 0.750 4.000 0.368 1.074 ? ? 1.438 2.622 1.750 14.000 1.914 38.000 1.158 ? ? ? ? ? ?

Alligator_mississippiensis 0.579-0.586 2.000-2.021 1.421-1.475 0.466 0.288 0.322-0.341 0.479-0.578 0.711-0.835 11.000 0.408-0.453 0.793-0.862 0.154-0.157 0.380 0.947-1.000 3.330 1.607-2.048 15.000 2.200-2.618 11.000 1.174-1.391 24.000 0.832 0.592 0.687-0.783 1.070-1.159 0.492

Alligator_olseni 0.481 1.865 1.257 ? ? 0.320 ? 0.763 8.000 0.586 0.931 ? ? ? 3.330 1.342 15.000 2.925 19.000 1.193 37.000 ? ? ? ? ?

Alligator_prenasalis 0.554-0.555 1.656-1.781 1.230-1.515 ? ? 0.278-0.308 0.532-0.617 0.669-0.755 7.000 0.516-0.604 0.711-0.737 0.213 ? ? ? ? 14.000 2.017-2.533 22.000 1.229-1.252 24.000 0.914 0.507 0.739 1.220 ?

Alligator_sinensis 0.575 1.960 1.563 0.383 0.275 0.320 0.429 0.747 10.000 0.464 0.808 0.163 0.471 1.267 2.326 1.950 13.000 2.059 21.000 1.154 17.000 0.869 0.581 0.689-0.744 1.107-1.206 0.517

Hassiacosuchus_haupti 0.417-0.538 1.778 1.333 ? ? 0.311 0.706 0.756 ? 0.500 0.643-0.706 ? ? ? ? ? 14.000 1.412-1.500 46.000 1.250 65.000 ? ? 0.941 1.490 ?

Navajosuchus_mooki 0.480-0.506 ? 0.867 ? ? ? ? ? ? ? 0.625 ? ? ? ? ? 14.000 1.550 21.000 ? ? 0.730 0.671 0.764 ? ?

Allognathosuchus_polyodon ? ? 1.273 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 1.605 ? ? ? ? ? ?

Allognathosuchus_wartheni 0.472 ? 1.129 ? ? ? 0.718 ? ? 0.540 ? 0.161 ? ? ? 1.625 12.000 1.088 38.000 ? ? ? ? ? ? ?

Arambourgia_gaudryi 0.376 1.270 1.400 ? ? 0.216 0.370 0.730 0.000 0.481 0.846 ? ? 1.333 ? 1.833 ? ? 31.000 ? ? ? ? ? ? ?

Argochampsa_krebsi ? 1.143 ? 1.237 0.409 0.304 ? 0.804 6.000 0.533 0.875 ? ? 0.933 ? 1.813 26.000 ? ? ? ? ? ? ? ? ?

Asiatosuchus_germanicus 0.547 1.727 1.444 ? ? 0.410 0.436 0.791 16.000 0.327 0.806 ? ? ? ? ? 14.000 2.167 23.000 ? 23.000 0.775 0.606 0.761 1.391 ?

Asiatosuchus_nanlingensis ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 0.911 ? ? ? ? ? ?

Australosuchus_clarkae 0.526-0.552 1.906-2.033 0.988 ? 0.167 0.200-0.258 0.650 0.851-0.875 7.000 0.340-0.482 0.593-0.971 0.196 0.263 ? ? ? 14.000-15.000 ? ? ? ? ? ? ? ? ?

Baru_darrowi ? ? 1.154 ? 0.517 ? ? ? ? ? ? 0.210 0.382 ? ? ? 13.000 ? ? ? ? ? ? ? ? ?

Baru_huberi ? ? 1.010 ? 0.242 ? ? ? ? ? ? 0.202 ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Baru_wickeni ? ? 0.839 ? 0.409 ? ? ? 15.000 ? ? 0.167 0.437 ? ? ? 12.000 1.736-1.790 ? 1.553-1.690 ? ? ? ? ? ?

Borealosuchus_acutidentatus 0.603 1.237 1.200 ? ? 0.203 ? 0.619 0.000 0.545 0.949 ? ? ? ? ? 20.000 ? ? ? ? ? ? ? ? ?

Borealosuchus_griffithi ?

Borealosuchus_formidabilis 0.646 1.171 1.224 ? ? 0.200 ? 0.514 0.000 0.550 1.020 0.241 0.335 0.702 2.667 1.308 20.000 1.728 36.000 ? 55.000 1.033 0.527 ? 1.080 0.556

Borealosuchus_sternbergii 0.574-0.600 1.257-1.552 1.152-1.471 0.110 0.276-0.296 0.261-0.308 0.341-0.529 0.637-0.759 0.000-5.000 0.443-0.651 0.700-0.968 0.209-0.432 0.302-0.376 0.750-0.833 2.595 1.641-1.650 19.000 2.789-3.611 21.000-24.000 1.059 ? ? ? 0.705 ? ?

Borealosuchus_threensis ?

Borealosuchus_wilsoni 0.604 ? 0.867 0.321 ? 0.455 0.904 0.548 ? 0.592 1.302 ? ? ? ? ? 18.000 ? ? 1.846 60.000 ? ? 0.710 1.231 0.377

Bottosaurus_harlani ? ? ? ? ? 0.290 1.008 0.533 8.000 0.482 0.896 ? ? ? ? ? ? 1.284 27.000 ? ? ? ? ? ? ?

Boverisuchus_magnifrons ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 17.000 ? ? ? ? ? ? ? ? ?

Boverisuchus_vorax 0.584 1.453 0.891 0.157 ? 0.471 0.633 0.754 9.000 0.520 0.565 0.259 0.418 1.106 ? ? 17.000 ? ? ? 13.000 ? 0.679 0.870 1.408 0.458

Brachychampsa_montana 0.583 2.522 0.885-1.000 0.088 0.163 0.402 0.721 0.935 14.000 0.512 0.773 0.331 0.476 1.257 2.956 2.240 14.000 2.024 12.000 1.177 30.000 ? ? ? 1.160 ?

Brochuchus_pigotti 0.658 1.765 0.931 0.397 0.282 0.382 0.492 0.897 6.000 0.377 0.783 0.184 0.351 1.250 2.133 1.348 14.000 ? 21.000 ? ? ? ? ? ? ?

Caiman_brevirostris ? ? ? ? 0.308 ? ? ? ? ? ? ? ? ? ? 1.867 ? ? ? ? ? ? ? ? ? ?

Caiman_crocodilus 0.512-0.623 1.257-1.528 1.000-1.698 0.309-0.457 ? 0.214-0.303 0.554-0.671 0.584-0.760 5.000-15.000 0.273-0.432 0.775-0.862 0.159-0.219 0.339-0.481 1.339-1.693 2.126 1.409-1.433 14.000-17.000 1.773-1.905 21.000-33.000 1.162-1.661 18.000 ? 0.530 0.771-0.803 1.100-1.282 0.636

Caiman_gasparinae ? ? 1.220 0.763 0.470 0.447 ? 0.772 14.000 0.261 0.739 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Caiman_latirostris 0.539 2.195 1.343 0.355-0.653 0.304 0.341 0.685 0.659 8.000-9.000 0.259 0.786 0.178 0.508 2.000 2.581 1.571 13.000 1.513 30.000 1.317 ? 0.814 0.608 0.754-0.757 ? 0.538

Caiman_lutescens_MACN ? ? ? ? ? 0.462 ? 0.598 13.000 0.304 0.417 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?

UCMP_39978 ? ? 1.064 0.202 0.280 ? ? ? ? ? ? 0.187 0.450 2.077 2.294 ? 13.000 ? ? ? ? ? ? ? ? ?

Caiman_wannlangstoni 0.479 1.333 ? ? ? 0.314 ? 0.726 7.000 0.346 0.769 ? ? ? ? ? 12.000 ? ? ? ? ? ? ? ? ?

Caiman_yacare 0.567-0.579 1.575-1.595 1.115-1.208 0.269-0.318 0.333-0.366 0.325-0.329 0.686 0.646-0.663 2.000-11.000 0.349-0.353 0.667-0.692 0.177 0.385-0.406

1.941-2.063 2.316 1.348 14.000 1.618 23.000-37.000 1.342 0.000 ? ? 0.733-0.791 1.058-1.311 ?

Ceratosuchus_burdoschi 0.529 1.733 0.938 ? ? 0.343 ? 0.717 ? 0.614 1.034 0.339 ? ? ? 1.436 14.000 ? ? ? ? ? ? ? ? ?

Crocodylus_acutus 0.639 1.678 0.718 0.704 0.422 0.533 0.347 0.833 15.000 0.440 0.818 0.186 0.394 1.333 2.535 1.464 14.000 1.741 33.000 1.511 17.000 ? ? 0.712-0.741 1.041-1.121 ?

Crocodylus_affinis 0.575-0.606 1.612-1.726 0.833-1.098 0.310-0.314 0.390 0.189-0.658 0.512-0.632 0.553-0.777 2.000-8.000 0.452-0.480 0.988-1.055 0.218 0.239-0.443 0.789-1.381 3.464 1.460-1.546 13.000-14.000 1.930-2.150 41.000 1.371-1.491 33.000 ? 0.557 ? ? ?

Crocodylus_anthropophagus ? ? 0.843 ? ? ? ? ? ? ? ? 0.195 ? ? ? ? 14.000 1.166 23.000 ? 23.000 ? ? ? ? ?

Asiatosuchus_depressifrons 0.561 1.518 1.227 0.363 0.375 0.301 0.554 0.675 8.000-13.000 0.518 0.862 ? ? ? ? 1.579 14.000 1.700 31.000 ? 17.000 ? ? 0.779 1.084 ?

Crocodylus_intermedius 0.644-0.653 1.393-1.432 0.656-0.889 0.747 0.417 0.423-0.493 0.417-0.544 0.757-0.832 3.000 0.357-0.465 0.931-1.067 0.203-0.286 0.282-0.320 1.304-1.550 2.525 1.300-1.389 14.000 1.929-2.011 34.000 1.665 ? ? ? ? ? ?

Crocodylus_johnstoni 0.686 1.138 0.815 0.498 0.421 0.294 0.524 0.688 4.000 0.547 0.841 0.265 0.275 1.085 2.487 1.404 14.000 2.117 25.000 1.877 14.000 1.014 0.468 0.690-0.729 1.116-1.192 0.432

Crocodylus_megarhinus 0.662 2.193 0.700-0.807 0.419-0.429 0.416 0.307 0.505 0.887 7.000-8.000 0.360 0.850 0.161-0.348 ? ? 2.393 1.548 13.000 1.947 ? ? ? ? ? ? ? ?

Crocodylus_mindorensis 0.548 1.495 0.703 0.511 ? 0.276 0.406 0.838 12.000-16.000 0.474 1.054 0.185 0.377 0.706 2.535 1.562 13.000 2.013 33.000 1.847 ? ? ? ? ? ?

Crocodylus_moreletii 0.603 2.255 0.830 0.629 0.455 0.519 0.463 0.896 11.000 0.432 0.829 0.125 0.415 0.640 2.067 1.719 14.000 1.366 30.000 1.367 ? ? ? 0.715-0.719 1.035-1.106 ?

Crocodylus_niloticus 0.567-0.613 1.737 0.826 0.491 0.424 0.495 0.341 0.859 5.000 0.494 0.619 0.169 0.342 1.143 2.285 1.563 13.000-14.000 1.257 33.000 1.310 20.000 0.822-0.949 0.431-0.489 0.660-0.771 1.116-1.174 0.524-0.633

Crocodylus_novaeguineae 0.602 1.446 0.833 0.544 0.361 0.357 0.362 0.839 12.000 0.489 0.870 0.171 0.355 1.000 2.105 1.211 13.000-14.000 1.467 33.000 1.111 ? ? ? 0.721 1.227 ?

Crocodylus_palustris 0.533-0.601 2.087 0.850-0.873 0.579-0.863 0.365 0.470 0.410 0.904 3.000 0.471 0.592 0.229 0.457 2.769 2.000 ? 14.000-15.000 1.205 40.000 1.097 19.000 0.942 0.551 0.722-0.730 1.059-1.174 0.460

Crocodylus_porosus 0.602-0.634 1.967-2.008 0.768-1.051 0.648-0.667 0.403-0.412 0.348-0.519 0.420-0.437 0.820-0.908 9.000-14.000 0.410-0.413 0.653-0.902 0.108-0.114 0.403-0.449 1.783-2.000 2.159 1.217-1.265 14.000 1.469-1.649 36.000 1.095-1.121 17.000 0.921 0.476 0.581-0.692 1.090-1.125 0.547

Crocodylus_rhombifer 0.558-0.625 1.646 0.769 0.151-0.333 ? 0.441 0.347 ? 7.000-15.000 0.373 0.698-0.875 0.191 0.466 1.382 2.805 1.742 13.000-14.000 1.928 30.000 1.158 19.000 0.825 0.470 0.726-0.784 1.221-1.314 0.573

Crocodylus_siamensis 0.581-0.614 1.723-1.853 0.837-0.953 0.549 0.287-0.291 0.475-0.547 0.324-0.375 0.733-0.758 12.000 0.432-0.500 0.806-0.906 0.189-0.190 0.409-0.434 1.389-1.571 1.962 1.433-1.500 14.000 1.467 38.000 1.302 12.000 0.885 0.495 0.736 1.120 ?

Crocodylus_thorbjarnarsoni 0.595 1.913 1.034 0.175 0.427 0.501 0.482 0.834 12.000 0.423 0.933 0.126 0.513 1.900 2.773 ? 13.000 1.433 37.000 1.248 ? ? ? ? ? ?

Crocodylus_palaeindicus 0.531-0.568 1.714-1.785 1.130 0.675 0.367 0.439-0.473 0.333-0.385 0.771-0.793 10.000-14.000 0.346-0.415 0.759-1.037 0.189-0.221 0.422 1.600 ? 1.692 13.000-14.000 1.379 ? 1.486 ? ? 0.520 ? ? ?

Dadagavialis_gunai ? 0.938 ? ? ? ? ? ? ? ? ? ? ? ? ? ? 22.000 ? ? ? ? ? ? ? ? ?

Deinosuchus_riograndensis ?

Diplocynodon_darwini 0.479-0.618 1.386-1.424 1.000 0.446-0.623 ? 0.203-0.228 0.481-0.740 0.877-0.915 1.000-6.000 0.407-0.511 0.667-0.833 ? 0.364 1.000 2.378 ? 18.000 2.818 43.000 ? 53.000 ? 0.443 0.716-0.890 1.077-1.198 ?

Diplocynodon_deponiae 0.455-0.484 ? 0.917 ? ? ? ? ? 2.000 0.400-0.500 0.333-0.545 ? ? ? 3.231 ? 16.000 ? ? ? ? ? ? 0.750-0.789 1.200-1.531 ?

Diplocynodon_hantoniensis 0.566-0.680 1.908-1.970 0.773-1.076 0.141-0.226 0.296-0.333 0.265-0.293 0.635-0.723 0.968-1.010 9.000-10.000 0.550-0.564 0.551-0.591 0.216-0.249 0.392-0.464 0.918-0.962 3.258 1.713-1.905 17.000 1.857-2.138 44.000-45.000 1.466 37.000-47.000 ? ? ? ? ?

Diplocynodon_muelleri 0.507 1.721 ? ? ? 0.233 ? 0.965 0.000 0.518 0.558 ? ? ? ? ? 20.000 ? ? ? 48.000 ? ? ? ? ?

Diplocynodon_ratelii 0.586 1.485 1.037 0.130 ? 0.265 0.625 0.824 8.000-9.000 0.429 0.792 ? 0.349 1.067 3.543 1.533 16.000 ? ? ? 47.000 ? 0.430 ? ? ?

Diplocynodon_remensis ? ? ? ? ? 0.244 ? ? ? ? 0.667 ? ? ? ? ? 17.000 2.211 30.000 1.316 ? ? ? ? ? ?

Diplocynodon_tormis 0.594 1.614 0.868 0.289 0.422 0.302 0.472 0.881 7.000 0.539 0.646 ? 0.390 ? ? ? 17.000 ? ? ? ? ? ? ? ? ?

Dollosuchoides_densmorei 0.668 1.225 0.813 0.385 ? 0.285 0.650 0.795 0.000 0.646 1.071 0.378 0.350 1.063 3.174 ? 15.000 ? ? ? ? ? ? ? ? ?

Eocaiman_cavernensis ? ? ? ? ? ? ? ? ? ? ? ? 0.633 ? ? ? 14.000 1.833 28.000 ? ? ? ? ? ? ?

Eocaiman_palaeocenicus ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 1.556 24.000 1.202 ? ? ? ? ? ?

Eogavialis_africanum 0.693-0.725 0.857-1.118 0.909-1.128 0.620-0.823 0.518 0.247-0.308 0.359-0.604 0.604-0.882 7.000-16.000 0.440-0.661 0.974-1.129 0.091 0.357-0.358 1.026-1.417 ? 1.433-1.886 20.000 ? 21.000 ? ? ? 0.374 ? ? 0.485

Eosuchus_lerichei 0.653 ? 0.815 ? ? ? 0.576 ? 0.000 0.576 0.868 0.250 0.410 1.733 3.646 1.524 16.000-17.000 ? ? ? ? ? ? ? ? ?

Eosuchus_minor 0.657 ? ? ? ? ? ? ? 1.000-5.000 ? ? ? ? ? ? ? 17.000 ? 23.000 ? ? ? ? ? ? ?

Eothoracosaurus_mississippiensi 0.689 0.955 1.030 ? ? 0.318 0.433 0.577-0.656 5.000 0.547-0.571 0.938-1.079 ? ? ? ? 1.936 22.000 ? ? ? ? ? 0.288 ? ? ?

Euthecodon_arambourgi 0.748 1.608 0.966 0.590 ? 0.304 0.486 0.886 1.000 0.443 0.806 0.091 ? ? ? ? 15.000 ? ? ? ? ? ? ? ? ?

Gavialis_browni ? 0.853 ? ? ? 0.441 0.550 0.588 10.000 0.568 1.216 ? 0.481 ? 2.222 ? 18.000 ? ? ? ? ? ? ? ? ?

Gavialis_gangeticus 0.716-0.727 0.799-0.892 0.719-1.045 0.429 0.581-0.605 0.387-0.496 0.503-0.550 0.555-0.677 6.000 0.543-0.622 1.113-1.195 0.105-0.118 0.465-0.589 1.500-2.357 3.256 1.490-1.932 23.000-24.000 1.905-2.318 23.000 1.887-2.148 40.000 1.020 0.436-0.485 0.553-0.614 1.132-1.189 0.723-0.838

Gavialis_lewisi ? 0.974 ? ? ? 0.346 0.200 0.789 8.000 0.497 0.940 ? 0.427 5.496 2.523 2.510 ? ? 33.000 ? ? ? ? ? ? ?

Gavialosuchus_eggenburgensis 0.676 1.382 0.904 ? 0.577 0.274 0.579 0.682 11.000 0.579 1.032 ? ? ? ? 1.385 15.000 ? ? ? ? ? ? ? ? ?

Globidentosuchus_brachyrostris ? ? ? ? ? ? ? 0.759 14.000 0.245 0.815 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Gnatusuchus_pebasensis 0.450 2.115 ? ? ? 0.165 ? 0.921 5.000 0.319 0.700 ? ? ? 3.520 ? 9.000 ? ? ? ? ? ? ? ? ?

Gryposuchus_colombianus ? 0.850 ? ? ? 0.313-0.375 ? 0.563-0.631 8.000 ? ? ? 0.466 ? ? ? 21.000 1.389-2.125 ? 1.469 ? ? ? ? ? ?

Gryposuchus_croizati ? ? 1.258 0.548 ? ? ? ? 27.000 ? ? ? ? ? ? 2.133 19.000 ? ? ? ? ? ? ? ? ?

Gryposuchus_neogaeus 0.787 ? 1.143 0.665 0.527 0.289 ? 0.483 8.000 0.675 1.266 0.080 ? ? ? 1.667 ? 2.581 18.000 ? ? ? ? ? ? ?

Gryposuchus_pachakamue ? 0.840 0.959 0.413 0.636 0.291-0.344 ? 0.664-0.782 19.000-29.000 0.564-0.693 1.065-1.144 ? 0.434-0.502 1.448 ? ? 22.000 1.859 29.000 ? ? ? ? ? ? ?

Ikanogavialis_gameroi ? 1.140 ? ? ? 0.240 0.923 0.520 15.000 0.654 1.294 ? 0.400 ? ? 1.471 30.000 ? ? ? ? ? ? ? ? ?

Jiangxisuchus_nankangensis 0.551 1.434 ? ? ? 0.217 0.531 0.603 7.000 0.617 0.852 0.324 ? ? 2.733 ? 14.000 ? ? ? ? ? ? ? ? ?

Kambara_implexidens ? 1.256-1.466 0.820 0.427 ? 0.195-0.239 0.332-0.399 0.839-0.894 2.000 0.399-0.415 0.773-0.791 0.274 ? 0.966 ? 1.484 15.000 2.592 15.000 ? ? ? ? ? ? ?

Kambara_murgonensis ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 16.000 ? ? ? ? ? ? ? ? ?

Kambara_taraina ? ? ? ? ? ? ? 0.878 7.000-11.000 0.419 0.722 ? ? ? 2.793 ? 14.000 ? ? ? ? ? ? ? ? ?

Kentisuchus_spenceri ? 1.022-1.395 0.875 ? ? 0.271-0.322 ? 0.722-0.752 3.000-16.000 0.509-0.583 0.889-1.080 ? 0.341 0.969 ? 1.421-1.706 13.000 1.462 ? ? ? ? ? ? ? ?

Kuttanacaiman_iquitosensis ? 1.840 0.662 0.344 ? 0.203 ? 0.640 9.000 0.409 ? ? ? 1.667 1.634 ? 13.000 ? ? ? ? ? ? ? ? ?

Leidyosuchus_canadensis 0.596-0.615 1.710 1.079 0.121 ? 0.215 0.556 0.581 ? 0.648 0.629 0.323 0.487-0.494 0.941-1.176 3.333 1.696 18.000 ? 30.000 ? ? ? ? ? ? ?

Mecistops_cataphractus 0.670 1.458 0.938 0.500 0.515 0.361 0.553 0.916 8.000 0.447 0.794 0.282 0.314 1.625 1.785 1.333 13.000 1.964 32.000 1.705 23.000 1.057 0.410 0.717-0.740 1.144-1.203 0.510

Mekosuchus_inexpectatus ? ? 1.000 0.119 ? ? ? ? ? ? ? ? ? ? ? 1.486 ? 2.250 55.000 1.040 ? ? ? ? ? ?

Mekosuchus_sanderi ? ? ? ? ? 0.409 ? 0.536 ? 0.487 0.548 ? ? ? ? 1.900 ? ? ? ? ? ? ? ? ? ?

Mekosuchus_whitehunterensis ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 2.000 35.000 ? ? ? ? ? ? ?

Melanosuchus_niger 0.495 2.090 0.953 0.641 0.281 0.320 0.550 0.820 17.000 0.180 0.722 0.156 0.534 2.762 2.366 1.326 13.000-14.000 1.485 47.000 1.253 7.000 0.767 0.481 0.711-0.761 1.241-1.297 0.603

Moroccosuchus_zennaroi ? ? 1.140 0.531 0.427 0.312 ? 0.594 0.000-11.000 0.614 1.194 ? ? ? ? ? 14.000 2.043 22.000 1.295 ? ? ? ? ? ?

Mourasuchus_amazonensis 0.745 3.178 2.057 0.340 ? 0.434 1.046 0.704 0.000 0.211 0.579 0.332 ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Mourasuchus_arendsi ? 3.140 ? ? ? 0.420-0.482 ? 0.570-0.691 ? 0.215-0.276 0.810-0.857 ? ? ? 1.922 1.528-2.000 ? ? ? ? ? ? ? ? ? ?

Mourasuchus_atopus ? ? ? ? ? ? ? ? ? ? ? ? ? 5.750 3.152 ? ? 2.500 ? 1.250 10.000 ? ? ? ? ?

Necrosuchus_ionensis ? 0.502 0.763 1.141 0.363

Osteolaemus_tetraspis 0.523-0.558 1.531-1.673 1.277-1.364 0.397 0.325 0.250-0.282 0.256-0.317 0.634-0.745 0.000 0.222-0.259 0.717-1.000 0.047-0.149 0.350-0.381 1.617-2.000 1.675 1.714-1.733 12.000 1.487-1.615 39.000 1.350-1.667 2.000 0.761-0.770 0.504-0.569 0.739-0.786 1.133-1.228 0.406-0.444

Paleosuchus_palpebrosus 0.544 1.210 0.674 0.306 ? 0.275 0.397 0.824 0.000 0.000 ? 0.156 0.419 2.400 2.121 1.261 14.000-15.000 2.272 31.000-39.000 1.250 20.000 0.758-0.791 0.507-0.651 0.750-0.821 1.260-1.300 0.590-0.599

Paleosuchus_trigonatus 0.549-0.592 1.238-1.328 1.030-1.143 0.274-0.366 0.400 0.236-0.279 0.390-0.500 0.754-0.837 0.000-3.000 0.000 ? 0.203-0.205 0.433-0.460 1.308-2.105 2.121 1.267-1.400 15.000-16.000 2.478 29.000-31.000 1.438 32.000 0.715 0.636 0.770-0.776 1.246-1.273 0.553

Paratomistoma_courti ? ? ? ? ? 0.263 ? 0.688 6.000 0.511 0.982 ? ? ? ? 1.264 ? ? ? ? ? ? ? ? ? ?

Penghusuchus_pani 0.683 1.392 ? ? 0.313 0.289 ? 0.597 15.000 0.543 1.083 ? 0.350 1.175 2.925 1.727 16.000 ? ? ? ? 0.788 0.488 0.610 1.206 0.602

Piscogavialis_jugaliperforatus 0.766 1.086 1.371 0.775 ? 0.223 0.486 0.800 12.000 0.479 1.030 0.038 0.300 1.119 3.476 1.538 28.000 ? 13.000-24.000 ? ? ? 0.356 ? ? ?

Planocrania_datangensis 0.596 1.016 1.050 ? ? 0.444 ? 0.683 ? 0.628 0.741 ? ? ? ? ? 18.000 ? ? ? ? ? ? ? ? ?

Planocrania_hengdongensis 0.519 ? ? ? ? 0.233 0.400 0.713 ? 0.457 0.653 ? ? ? ? 2.125 ? ? ? 1.083 ? ? ? ? ? ?

Procaimanoidea_utahensis 0.485 ? 0.900 0.184 ? 0.218 ? 0.909 ? 0.663 0.482 0.174 ? 0.890 ? ? 13.000 ? 18.000 ? ? ? ? ? ? ?

Protocaiman_peligrensis ? ? ? ? ? 0.259 ? 0.634 12.000 0.538 0.749 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Purussaurus_brasiliensis 0.630 2.381 0.696 0.262 0.367 0.540 1.121 0.524 1.000 0.576 0.663 0.268 0.631 4.800 ? 1.684 14.000 2.167 ? 1.000 13.000 ? ? ? ? ?

Purussaurus_mirandai ? ? ? ? ? ? ? ? ? ? ? ? 0.400 ? ? ? 14.000 ? ? ? ? ? ? ? ? ?

Purussaurus_neivensis 0.549 2.136 0.654 0.368 0.279 0.403 0.929 0.757 0.000 0.410 0.563 0.153 0.427-0.500 3.600-5.000 2.239 1.702 14.000 ? 20.000 1.154 13.000 ? ? ? ? ?

Quinkana ? ? 1.167 0.500 0.486-0.500 ? ? ? ? ? ? ? ? ? ? ? 12.000-14.000 ? ? ? ? ? ? ? ? ?

Siquisiquesuchus_venezuelensis 0.730 1.045 ? ? ? ? ? 0.606 ? 0.650 1.038 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Stangerochampsa_mccabei 0.463 1.750 0.883 0.100 ? 0.243 0.687 0.718 5.000 0.682 0.708 0.298 0.477 1.953 3.367 ? 14.000 1.450 30.000 ? 37.000 ? ? 0.750 ? ?

Thecachampsa_antiquus ? 1.315 ? 0.617-0.676 ? 0.256 ? 0.717 11.000-12.000 0.402 1.242 ? ? ? ? ? 14.000 ? ? ? ? ? ? ? ? ?

Thecachampsa_sericodon 0.694 1.209 0.940 ? ? 0.233 0.506 0.761 15.000 0.518 1.000 0.238 0.433 0.960 3.538 ? 14.000 ? ? ? ? ? ? ? ? ?

Thoracosaurus_isorhynchus 0.734 0.970 0.735 0.282 ? 0.364 0.500 0.707 0.000-2.000 0.543 1.053 ? 0.293 1.455 ? 2.182 20.000 ? ? ? ? ? ? ? ? ?

Thoracosaurus_neocesariensis ? ? 1.091 0.844 ? 0.301-0.399 ? 0.609-0.634 8.000-15.000 0.593-0.623 1.123-1.300 ? ? ? ? 1.313-1.604 ? ? ? ? ? ? ? ? ? ?

Tomistoma_cairense ? 1.205 ? ? ? 0.260 0.468 0.849 0.000 0.419 1.038 ? 0.363 0.909 3.692 1.350 ? ? ? ? ? ? ? ? ? ?

Tomistoma_dowsoni ? 1.347 0.758 ? 0.583 0.429 ? 0.857 0.000 0.536 0.844 ? ? ? ? 1.483 15.000 ? ? ? ? ? ? ? ? ?

Tomistoma_lusitanica 0.682 1.572 0.717 0.967 ? 0.250 0.511 0.761 0.000 0.511 0.900 ? ? ? ? ? 14.000 ? ? ? ? ? ? ? ? ?

Maomingosuchus_petrolica 0.697-0.723 0.872-1.111 0.750-0.805 0.196 ? 0.308-0.333 0.667-0.714 0.667-0.808 3.000-9.000 0.476-0.567 0.833-0.882 ? ? 0.820 ? ? 15.000 ? 21.000 ? 31.000 ? ? ? ? ?

Tomistoma_schlegelii 0.666-0.670 1.217-1.655 0.704-0.907 0.800-0.835 0.636-0.720 0.293-0.345 0.436-0.489 0.848-0.942 12.000-20.000 0.458-0.500 0.846-0.983 0.157-0.212 0.312-0.456 0.632-1.207 2.472 1.464-1.756 17.000 2.308-2.500 20.000 1.568-1.878 44.000 0.931 0.394 0.640-0.710 1.071-1.224 0.659

Toyotamaphimeia_machikanensis 0.711 1.511 1.115 0.354 0.459 0.223 0.548 0.638 2.000 0.260 0.758 ? 0.302 1.181 3.815 1.452 16.000 2.077 24.000 1.500 40.000 0.852 0.569 0.531 ? ?

Trilophosuchus_rackhami ? ? ? ? ? ? 0.282 ? 0.000 0.518 0.349 ? 0.329 ? 1.929 1.643 ? ? ? ? ? ? ? ? ? ?

Tsoabichi_greenriverensis 0.466-0.546 1.360-1.447 0.940-1.359 ? ? 0.252-0.257 0.350 0.929-1.040 ? 0.370 0.391 ? ? ? ? ? ? ? ? ? ? ? ? 0.745-0.851 1.312-1.542 0.593

Ultrastenos_willisi ? ? ? ? ? 0.215 ? 0.783 13.000-16.000 0.473 0.664 ? ? ? 2.615 1.642 ? ? ? ? ? ? ? ? ? ?

Voay_robustus 0.535 1.473 1.083 0.412 0.372 0.402 0.539 0.679 23.000 0.303 1.000 0.250 0.463 1.000 3.273 1.560 13.000 1.933 25.000 1.128 32.000 ? 0.617 ? ? 0.582

Wannaganosuchus_brachymanus 0.236 1.521 0.995 ? ? 0.271 ? 0.750 11.000 0.556 0.800 ? ? ? ? ? 13.000 ? ? ? 46.000 ? ? 0.812 1.293 0.538

Theriosuchus_pusillus ? 1.008 ? ? ? 0.220 ? 0.686 ? 0.600 0.875 ? ? 0.557 3.091 ? 13.000 ? ? ? ? ? ? 0.800 ? ?

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Bernissartia_fagesii
00000??00010??0?0000?000?100??120000?00????0011101???0000?0???00?101000?01000???0??1??0??0013000100??????????0000??0000300000000100?0??00000001?01000000000?0?0001000000000?000??????????????0002100????0?00?000????01???011000000?0???????????????0??01?1?01001?00???1?100?????0?00000000?0???????????0?1100100

Isisfordia_duncani
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Acynodon_iberoccitanus
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Agaresuchus_fontisensis
000010000000??1000001000?001?0100010100???001110100100000??00?0111000?0?
?100?10001010??010?01001000000100110000?0100?320001000000001011010000?0110
10000????0011200001?00000000???1?????????11021020??10?10?000????0101?0??11
0110????000001??????????????????1?????????????????????????????????????????
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Allodaposuchus_precedens
000010000010??000001000?001?011000?001???001110100000000??20100110000001
0000?10001010??0103010110000001001100000010000200011010?000001000000?0110
200000???1011200110?0000001???1???????1???021?2?????0????0?0?????????????
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Glen_Rose_form
000010000000??0000000000?0111?1200000001?0?1010000000000100?0?110100000???
?????100??0?0?????????0?0100000000100?000001?000000100000000100000000?0100
00000010?0010000001?00000?1??0?1??0??????0102120?20?0000?000???????1??????
????????00??????????????????????????1????????????????????????????????????1???
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Hylaeochampsa_vectiana
00000??00000??????????????1100?120101000???0011?01001001000?0?00??10?00?0?
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2?0100?0??0?12?0001?0000010????10?0???????????????????????????????????????
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Iharkutosuchus_makadii
00000??00010??1000001011?1100?12010010?????0?010?10100200?????0??????00000
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2001000?0?01120001??00000101???1????????0?104110?1??0?00?000????0011?00?00
000000????????0?????????????????????????????????????????????????????????
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Lohuecosuchus_megadontos
000010100010??0000001000?000?111??0?100???0011111??000[01]00??011001000000
010100?10011010??010301010000?00?00?100000010011200000000000000020000000?01
11200000??10011200?01?00000000???1?????????11021020??10?10?000???0000000?
1??11010?00???00???????????????????????????????????????????????00????????
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Portugalosuchus_azenhae
????0???0010??????????????1????1?0??01001???0001?0100000001??00001101000100
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0000?00???0?12?0001?00000?1?001?0?0????11????????????0?0?0010??00?000?????
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Shamosuchus_djadochtaensis
00000??00000??0??????000?0101?100000000???00110011?0000110?00100100000001
001??100?101?000????10000000000000010??????????000010?0?00?101?0?1????01??
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?000???????????????0??????01?0??1?11??1???????1????????????111????????????????
??1?01??
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Wannchampsus_kirpachi
00000??00000?????????000?0100?1?0000?00????10000010100001???0111011000000?
?[01]1??10021?0???01?2?10000000000000010???????0??000000100000????00000???01
000?000??0??010000001?0000001??????????????01?2?20?20?00???000????0????00?
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Acresuchus_pachytemporalis
00001010002110 1?00001010?01???0110010001???001?12002001001???1110002000001
101?110011100?101211100100?0011000100100010010200001000000 0????????1??????
0???010000???????????????0?0???1110??1?0?11021021??0001??00120200111?00001
110000?11???0???
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Aktiogavialis_caribesi
00000??00010??1?000???0??0100???????1?0????001101100010001??0?0011?1?00???
????????02???????00010?0??10111?1101??????00??701020000000?1000001?00?010?
0??01???????12?0001?000?0011???0????????????3???????0?????????????????????
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Alligator_mcgrewi
00000??00010??0001000010?0101?1000000001?0000101201?[01]000010?211101010100
01001?110021000110110100000000011000100000020003200[01]01000000000101001111
001100000120000112011100110000000?001110??1?001111220?1??1001000111000 01000
1001010000?011000100011100??11000000101?1???????????200?1101?????????????0
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Alligator_mefferdi
000010000010??1?01000010?0101?1200000001?1?00101201?1000010?21110101010001
001?11001100011012011000000000010001 00?0001000320000101000000001010001???011
0000012000011200 11??11000000?001110??1?1011001021??10001000120100011?11001
011010?00000010??????????????????????????????00???????????????????????????
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Alligator_mississippiensis
000010000010??100100001000101?120000000111000101201?1000010121110101000001
001?110011000[01]101101100100000110001001000100032000010100000000101000 10?10
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01111010?00100010001110011 00[01]010001011110101 10[01]000001011011110001110 11
00010102111100

Alligator_olseni
000010000010??1001000010?0110?120100000??0?00101201?0000010?2111010100000?
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000001200?0112001 1??10000000?????????????1111200?0??0001000120100011?01001
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Alligator_prenasalis
00000??00010??0001000010?0101?1200000101?0?[01]010120001000[01]10?2111010100
000??01?110011000110110110000000001 00010[01]000020003200001000100000 0110001
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11?01001011010?000??1??10??????????0000?1???1??????0??00??101101110010????
???00??012111100

Alligator_sinensis
000010000010??1001000010?0101?120000000110000101201?1000010121110101000001

001?1100110001101101100000000001000100100010003200001000000000000000110?1000
00000120000112001101100000001001110?11?0011001121??0001000120100011?01001
011010?000000101011100110100000011121???011011??00101101111210??1?11000111
12111100

Hassiacosuchus_haupti
10000??00010??000??01010?001?01201010001?0?000?010??0000010?21110101000000
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0100?????????????10????????????????1???1??????0??????00???111?0??????????????
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Navajosuchus_mooki
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100??1???0??010001??10111????????????
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Allognathosuchus_polyodon
00000??00????0000001000?000?012010000?????0?0?0????????????????????1000???
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???11?1210????10010??1????001??01001
11?0?0??
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Allognathosuchus_wartheni
00000??00000??0?0000?01??0101?020100000????000??201?0000010??1?????10?????
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00000?2??????1????100?0??0?????????????????1111210?0??000100011110001000100?
?1?010??0???
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Arambourgia_gaudryi
10000??00010??0?00001010?0110?1201000001000100?0200000000110?211101010000??
?01???0111000??0111110000000000000010???0???0??200?01??1000?00?01?10???????
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11?0??
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Argochampsa_krebsi
00000??00000??100001?101??00?01000000001???0011011000100010?210111?1111?0?
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0??01020?1?11210001?0000?011???0???????????1??0?0????0??????1????00????101?
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Asiatosuchus_germanicus
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10000???????120??00?000???????????????????????1102110?1??0000?0011010000??10010
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??111???

Asiatosuchus_nanlingensis
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??000????????????????????
??10?1120??000?0?00110??0000?1010?

0110?????????????0???
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Australosuchus_clarkae
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??101???

Baru_darrowi
00000??00?????000001?0000000?0120000100???00101???????????????1??100000???
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10[01]00?????011200????0??10??0????????????1??2112???10????001????00???????
???11???
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Baru_huberi
00010??00?????0?000010000?00?01?0000??0???????????????????????????????????
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2?1??????????????????????????????????????11021020??10?1???????????????????
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Baru_wickeni
00010??00010??0000001000?001?0110000100????0010?1101000001??0?1??100010???
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10100020?001120011??00110000?????????????11021120??1001??0?110100000100010
01101100??
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Borealosuchus_acutidentatus
00000??00010??0?0001?00??000?0110000000????000?01000?00001???????1000000??
?000??????10???0??????1??0???0????????001?001?300120000000?00110?0000????0
0??00???0????????????????00???
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Borealosuchus_griffithi
00000??00010??000001?000?00000110100000???0000000010??0001??1?1?01?000?010
0011?1?0?1?????00??0?000??000010101?00001[01]0013300010010??0?0010??0000???
101??0?1??11?1120?1???0?0?000??????????????100210100?00?00?001?010010??000
01?11000?????0?????0???1???????0?010021?0?1?10??????1?????????????????????
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Borealosuchus_formidabilis
00000??00010??0?0001?000?000?01100000001001000?00100000001??0?1?010000000?
?000??001100001011301000000001000100000110003300120010000010100000000?0110
000000??00011200100000000000??????0?????01002120?1??0000?00110100111?00101
011000?00000?0?10000001001100001011011??11110?00100100001000001???????????
?10002??

Borealosuchus_sternbergii
00000??00010??00000120000000?011000000010010000000000000010?01100100000000
?0001100110000101100100000000010001000001[01]001[03]3000100100000001[01]00000
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01?00100011000?0???0?00??10101??0??0?0101?0?1??????????00??00001000???????
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Borealosuchus_threensis
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???0?0???????????0?0???
??10021020??00????0?10120010??00?00
011010?0????????0??????????????1???1??????0????????????0?????????????????
??0002??

Borealosuchus_wilsoni
00000??00010??000001?001??????11000???????000?01000?0000???0?00?1??????0?
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Bottosaurus_harlani
????10000010???????????????????0000?0?1???001??210100100?????1?0002100???
?0??????1?0?1101???10?1???0???????????????0??????????100?????????0?0?01?0
?000?????1??12?????????0???0???1?????????10210?????0????0011010011??01?0?
?1?00111???????????????????????1???1?????????????0??101111110????????????
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Boverisuchus_magnifrons
10?10??00010???000001000?00???00?0???0????0?1?0100??0000????????1?0????0?
?00??????10???00000?1??????????????000000001030100001201000?1???0000??111
1000?0??00??12?0?0??0?1????0????????????1102100????0????0?1????0?0?????0?
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Boverisuchus_vorax
10010??00010??0000001000000?0100100000??0?1010020000000010?01110100000000
?0???10011000100010010010?0000100???00003100003010000120100001000000?0111
100000200001120010??000??000???1????????1102110?0??0000?001??1?11???0?000
010010?0????????0???1??110010??11?11????110??????001101110100????????????
??101???

Brachychampsa_montana
00000??00010??1000101011?0101?110100001?0?0000120011000011?11110101000000
?01111001100010011111000000000010000020?0130003100001000100001101000 10?1001
000001?000011200010010000000?0?1110?01?10110?1121??1?010?0?12010001??01001
110000?0???????001110?101000??0011???????????000000010111???????????????0
241111??

Brochuchus_pigotti
00010??00010??0?00001000?000?1100000100???00101211?0000010?01110101000110
?0???001100101000201000000000100?00001001001210002001000001010000000?1010
210000201111120010??30100000???1110????0?110?102????0????0?1102000000????0
?1??110????????????????1???????1???1???11?0??????001???11????????????????
??111???

Caiman_brevirostris
010011100??0??1000001010??01?0?20001?0????001????????1????????????10?????
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????0?1000??12??1??????0?0??????????????11001121??0001??001??????11???001
???????????????????????????????1???1??????0??????????????????????????????
??111???

Caiman_crocodilus
000011[01]00010??10000[01]10000001?0000000000110000100200[12]0010011121110102

0000111011110011000110121110000000001000100 1[01]0010013200[01]11010000000101
00[01]10?0[01]10[012]000011000111201110111000000100111 0??1?001102102 1??000110
00120[12]00111?00[01]01111001111101001111110011110010001011110101101101000 11
10111100011101110010023111211

Caiman_gasparinae
000????0?010??1?0001?000??01?0??????????????0???2102001 1?1??211?0?????????
????1100110 0??????????0?00?0????????????01?001?200?010????0???????????????
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???0???????????
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Caiman_latirostris
010011100010??1000001010000 1?002[01]000000110000101200 2[01]01101112111010200
0011101?110011000110121110000000000100010011 00[12]0013200001010000001101000 1
0?0[01]1000000110001112011101110000001001111 0?1?0011021121??00011000121200 1
11?000011100011111 0[01]0011110100111100100010 1?1???01101101 00?1110111??????
1011[01]0010023111211

Caiman_lutescens_MACN
????110?0020???????????????????1001???????001??2102001101????????????????
??????0011??
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UCMP_39978
0100???0??????1?00011000??111?0???0???0????????0??????????????????102000???
???????????????01211?0?0????????????0010001001320000100000000010 10?010?0010
00000?1000?1120001??11000??
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Caiman_wannlangstoni
010111100010??0?00001010?001??1110010001???00100200200100 1????1?010?0??01?
??????001100?110121?100000?00?1???????????1???3200001000100?????????1110010
00000???0011120?0?????00?00??
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Caiman_yacare
000010100010??10000[01]10000001?002100100010000010020020010011121 11010[12]00
00111011110011000110121110000000000100010011001001320 00[01]1010000000101000 1
0?00100000011000111201110111000000100111 0?01?0011021021??00011[01]00120[12]0
0111?000011110011111000 01??1110011110000001011 1???11011010001110111110 0??
1011[01]001?0?3111211

Ceratosuchus_burdoschi
00000??00011100?00001010?001?00011010 00???00000????000001???1???101?00???
??????00?1?00??????110000?000?1000?????03200032000 01010?0000?0?10101??0?01
00000??0????12??????????00????????????????11012 10?0??0????0?1??????????0???1
?????????????????????????????????1???????????????????????????????????????
??1?????

Crocodylus_acutus
00100??00010??10000010001001?01000000001101101102000000001000111010000001 0
?[12]000000110000100020100000000010010100100100131000200000000 0001001000 0?11
112[01]00002011011200000000100000010111100 1?0111021020??00010?001102000000 1

001001101100001011010000010011001001110?1???11000101000110111020 0??011000
001111111000

Crocodylus_affinis
00000??00010??1000001000?000?01200000??0?0001[01]200000000 10?011101000000
?0?10?0100110000000 2?1000000000 10010001001[01]000[01]1000100000001002000000
0?011011000020000112001000000000 00???11110?1?0111021110??00010?00110100000
010[01]10011000?00000110??0???1???????????0???????????????001101??0100????
??????????111???

Crocodylus_anthropophagus
00000??00?11110000010001?0????00000?0?11010?1??200????0??????1??10?0???0?
?2????00?1000010002??000000?0?1101010?00?10?13100020010000000100??????11?
2?0????011??1????????0??00??????????????11021020??10?10?0?11010000??10110
?110110???00?1???0???1??????10??1????????????????0??101??????????????????
??11????

Asiatosuchus_depressifrons
00000??00010??10000010010000?0120000001???00000100100000 10?01110100010100
?00111001100001000001000000001000000000110013100010010000100200000 00?0110
10000020010112001?????1000?0?00111001?11110 21110??10010?00110100000?00110
011000?00???????????1??1110000111?21??11110?0????000101110100????????????
??101???

Crocodylus_intermedius
00100??00010??10000010001000?0120000[01]001101001102000000001000111010 00000
10?200000011000000002010000000001001010000010013100020010000000100 10000?11
112[01]0000201101120000000000000000111111001?1111021120??00010?0011010000001
0010011011000010110??000010011001001110?1???1110?01010?????????????011100
001112111?00

Crocodylus_johnstoni
00000??00010??10000110001000?01000[01]0[01]00110100110200100000100011101 0000
0110?[12]000000110001100000100000000010010101101100121010200000000 10[01]0000
[01]00?11111[01][01]000201101120000000000000000111112101?1111021120??00010?001
1020000000100100110110000000110100000100001010 01110?1???1110?010000011011112
000?011100001112111100

Crocodylus_megarhinus
00000??00010??10000001000000 0?01000 10100??0?00101200100000 10?0111010001 0010
?200000011000010002010000000000100001011001001110002001000000002000000 0?1111
1000002011011200000000100000?1?111??1??1111021120??00010?00110100001?0?110
011011000??????????????????????1???1?????????????????????????????????????
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Crocodylus_mindorensis
00010??00010??10000010001001?0100000000110100110200000000100011101000000 10
?2000000110000100020100001000010010100100200121000200100000000100000100?1111
2100002011011200000000000000000111111001?0111021020??00010?00110100000110010
011011000000110????????????????1?0?1????????0???????????????????011000011
12111000

Crocodylus_moreletii
00100??00010??10000010001001?0100000000110100101200000000100011101000000 10
?10000001100001000201000000000100101001003001110002000000000010000000?1111
2100002011011200000000100000010111100 1?0111021020??00010?00110100000110010
011011000000110??????1?????????1?0?1????????0???????????????????011000011
12111000

Crocodylus_niloticus
00000??00010??1000001000100 1?0100000000 1101[01]0111200000000100011101000000
10?20000001100001000201000000000100101001 00[12]001310002001000000 0100[01]000
0?01112[01]000020110112000000000[01]0000001011121 01?0111021020??00010?0011020
0000110010011011000000110100000100111010011101110111 10?0101000110111120010
011100001113111000

Crocodylus_novaeguineae
00010??00010??10000010001000?01000000001101001002000000001000111010000001 0
?1000000110000100020100000000010010100100200131000200100000101 0000100?1111
2100002011011200000000000000001111110?1?0111021020??00010?00110100000110010
01101100000110?????????????????1?0?1????????0??????????????????0111000011
13111000

Crocodylus_palustris
00000??00010??1000001010100 1?0100000100 11010[01]101200000000100011101000000
10?[12]000000110000100020100000000010010100000000101 0002001000000010000000?
[01]1102[01]00002011011200000000100000010111210 1?0111021020??00010?001101000
00110010011011000000110110000100001 01001110?1???1110?0101000110111 1200??01
1100001112111000

Crocodylus_porosus
00010??00010??10000010[01]0100[01]?010000000011010[01]10[01]2000000000100011101
00010010?[12]00000011000010002010000000001 0010100100[12]001310002001 00000001
0000000?11112[01]00002011011200000000[01]0000011011121 01?0111021020??00010?0
011020000000100100110110 00[01]0011010000010 0[01]0001001110211 0?11100010100001
01111200??0110000011 12111000

Crocodylus_rhombifer
00100??00010??1000001000100 0?0100000100110100101200000000100011101 00000010
?[12]0000001100001000201000000000100101001001001010002001000000010010000?11
1121000020110112000000000000000101111001?0111021020??00010?001101000000100
1001101100000011011000010011101001110111011110001010001101111110??01110000
1112111000

Crocodylus_siamensis
00010??0001111100000100010 00?01000001001101111012000000001000111010001 0000
?200000011000010002010000000001001010010010013100020010000000011000000?1110
2100002011011200000000100000010111210 1?0111021020??00010?0011020000010010
011011000000010??0000100010010001 10?1???1110?0101000110111 1210??0110000011
12111000

Crocodylus_thorbjarnarsoni
00000??00010??0000001000?000?01100000001???1010120??110001????1?01?00??000
?1????00110000100?20?00?0000??10?10?00000200131000200100000000100000000?1111
200000????011200001?001?0000???1?????????11021020???0?10?0?11020000??10?10
?111110?0100110???
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Crocodylus_palaeindicus
00000??00010??1000001010?00?????0????00????0[01]101??0000000010???1101000000
1??2000?0111000??000?0100000000010010100 0?0100?11000200100000000 10000000?01
1021000?2?1?01120000??001?00???????????????110?1020??00010?0?110100000?10?
1001100110????????????????????????1???1???1?10????????1101????????????????
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Dadagavialis_gunai
00000??000?0?????00??0?1?100?01000101?0???0021021???????1???????111?01???

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0?001????0???????????????0??????0????????????3???????????????????????00?????
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Deinosuchus_riograndensis
????0??01??0??100000?000?0000110010000?1??001010001?001010?210?01?100?100
?0??111011100????????00?00?00?1?????00001[0123]000030000010?00?001???0000?
????0???????1??1?????????????00????????????????1002102???000???00100210?11?1
0001?111???0??010???????????????????0?1???1??????0???????????1???????????????
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Diplocynodon_darwini
00000??00010??10[01]0012000?000?0020000000????000?1000100000010??11101010000
00?011?1001100000011001000000??1??0100??010001?3000110100000?0011000????11
??????0??0??0112011?0?2?000?00???????????????10021020??10010?001101001 1??010
01011010?00000?01000100 1??01000000111?1?????100100000 0?101110000??????????
?112100201

Diplocynodon_deponiae
00000??00010??001001?00??000?0120?00000????000?10100001001??[01]11??1010000
0??01??00021?0????????00?0???0????????0???0???????300?11010000?00110???????1
??????0????011120??01?2??00?????????????????????100210 2????0010?0?1???000???0??
?1?1?0?????????????????????????????1???1???????0???????0??101111000??????????
?0?2101211

Diplocynodon_hantoniensis
00011000001 0??0001012000?000?0100000000????00111010[01]0000010??1110101000 0
00?0110101110000101100100000000010001000001000003000110101000001100001 0?01
100000011001111201100120000000???1110??1?0?10021020??1001[01]00011010010010
1001110010?10??????00????1??010000 0011?21???0??0??????00110111100 0?????????
??????1002??

Diplocynodon_muelleri
00?01000001 0????1101?01??000?0100?00100????001?10100000010?2?1????100??0?
?011?????1?0?01011??10?0000???10?0?0?0?0??00??300??10?0000?00110??00???110
0?000????1011200100????00?00???????????????10?2?021???0????0?1??????????????0?
?100??????????????????????????????????1????????????????0??101??00???????????????
??1112??

Diplocynodon_ratelii
00011000001 0??1001001000 0000?0100000100100100110000100000 10?1111010100 0000
?0110?0021000000110010000000001000000100100010300011010000000110000 00?1110
100001100101120110012000000010011 10?11?11100210 20??00010?001101000000 01001
0110?0??0??????????????1??0100000?11??1???????0???????00110111120 0?????????????
??100???

Diplocynodon_remensis
000110000010??100001?000?000?0100010100 1???000?11101000001 0?2111010000000?
?0??0100110000?0110110000000001000100000100010300 01?0100000001 10?000??01??
0??00?000[01]011201100020000000????1??0????011002100?0??0010?001101001 01?000
01110010??0??????????????????????????????????0????????????????????????????????
????1002??

Diplocynodon_tormis
000010000010??1?1101?000?000?0100000100????000000100000001??111101?10??000
??1101001100?01??????????0??000?00?0????0?000?03?0?????000??001?0?0000??1??
0????????????120?1??????????????0?1110??1?011????02?????????????1??1?0??????????

??01??????????
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Dollosuchoides_densmorei
00000??00010??1?0001?001?001?0100000000????001002000100?0????????1????????
?0???????1?0???00???1??0???0??1?????000?1111?2100120000000011100?0000?0110
2?000?????01120000??00000????????????????1103?20?10?0??0?00110200000100?10
0110????0???????????????0???
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Eocaiman_cavernensis
0000111000?0?????????????00??????????00????????02000000?0?????1??102?00???
?????????1????????????0?0??0?????????????1????20000?0000000?10???001110010
00000?00??0?12??????1?????????????????????1121021???00???00110100?11??????
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Eocaiman_palaeocenicus
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??0?0?????????????????
???11101021???0????001101?00???0?001
110000??
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Eogavialis_africanum
00000??00000??100001?001?000?0100000?0010000011020001100010?01001111010100
?0??1111110000000020100001101110000100001[23]011271112000000101000000000?01
112000000000001121000000000011???00?0????0?1103030?30?0000?001101000001110
000110?0?0?????????????????????1??????????????????????0?????1?????????????
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Eosuchus_lerichei
00000??00000??1?00012001?000?01001000101?0?00010000?0000010?0100?100100010
?000?00011000011002010000000?1000000000002000370112000000000110000100?0100
000000100001120000000000000???0??????????11030?0?21?00?0?00???????????????
????????????????????1????11101?1????????????????????????11????????????????
??011???

Eosuchus_minor
00000??00010??100001?001?000?0100000010??0?00010101?1000010?0?00?100100?0?
????0?10110000?1002010000010001000000000010003701120000001001100?0000?0110
0000000000?112?000??000?001??0?1??0??01111103120?21?00?0?0011010000??00000
110010?00????????????1??0001?11?1???1??????0??????0?0100110???????????????
?1010???

Eothoracosaurus_mississippiensi
00000??00000??1?0001?001?000?01?00?01?0????00010010?100001????0??1?1??????
??????1?0100?00000??10000??0?010000000001200027?1020000001010000?000??0?00
0000??0????112?0?01?000?000????0?????????1003030?2??0????0?1001?001??10?0?
?1?010??????????????????????????1???1?????1???????00??????????????????????
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Euthecodon_arambourgi
00010??00010??0?00012101?000?01000000001101001?021010000010??1110100000010
?1??000001100101002010000?0?????????00001?0012700020000??000?11??0?0????0?
2000?02011???????????????0?0???1?????????11???????????????????????????????
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Gavialis_browni
00000??00000??100??1?2?1?100?1100010?0?????002?021????0001????0010?11??1??
??????111100?00000?01??0??????????010?????????701120000001010000?1100?0101
0?001?0???011210?0??0???10??
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Gavialis_gangeticus
00000??00000??11000122010101?110001010000000021011001100010002001013110100
?00001111100000000001000011111101001000014111270112000000101100001100?0101
0000100000011210001?000010110000110?01?201103040?31?0100?01110210000201000
011000?0000010010000010000111111110110100010000110000010110010010100000010
210?0000

Gavialis_lewisi
???00??00000?????????????10???100010?00??0?0021???001000010???0010?3110100
?00001111100?000000?1000011011111001??????????7??12???000101?00000?00?0111
00001?00?0011212001?30101011?????????????1?????0??1?01?0?01110?10000201000
01?0???0??
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Gavialosuchus_eggenburgensis
00000??00010??1?0001?001??00?10000100?0????001?02100000001????1?01110001??
??1???101100?????0??100000000001000?0??03101?2411120000?00?10100?000?????0
?????0200???????????????0???
????????????????????????????????????1?????????????????????????????????????
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Globidentosuchus_brachyrostris
0000???00010??10000??01??001?0??10010?0????000112102001001???????1?200?00?
?????????1?0?????????0???????????????000??00002?00010?0100???????001110???
0???????????12???????????????????????????11021001??11????0?120100111??0?0?
?10001?111??
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Gnatusuchus_pebasensis
0?000??100?0??1?0??01010?0????1?0001000????0000120020010011??????1??0?????
?0???????1?0?010120??00?001000100010???0??000?000001000100?????1???????0??
0??00???0001120100001100?10??????????????0100?20?1??0????00120?00111??0001
?1100??0??
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Gryposuchus_colombianus
00000??00000??1100012001?000?0100010000???0021011001100?10?02001003111110?
?0??011?0200000000001000011101111001000?2211?2701120000??101000000100?0111
00000?0?0?0?12?????????0?0???0?00?0??01001103030?20?001??0011?1?000000?000
0111?0??0000100???
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Gryposuchus_croizati
00000??000?0??100001??01???????????????0?????02100?1?1?00?1???00?113??0???
?????1???1???????0??1??0??11??111???010?1?01??7?1120000??1????????????????
????1???00?11????????????1?1?????????????1103030?21?0????00???????????????
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Gryposuchus_neogaeus
00000??00000??1?00012101????????0??0???????002?0??0?1?0001???2???????????0

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??????1102?00????00?1?0001111111001000?2211?27?1?20000001???????????????
????????????????????????01????????????????0??????????????110100?0??0?0?0
01?0???0????????????????????????????????????????????????????0???????????
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Gryposuchus_pachakamue
00000??00000??1?00012001?000?0100010100???001101000110001???0011?1??110?
?000??1?01000?0000?010?0?01101111???011?2111?2711120000001010000?0100?0???
0???100?000112???0??000?101????0?????????1103030?20?0?00?00111100000201010
0111???0????????????????????????????????????????????????????????????????
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Ikanogavialis_gameroi
00000??00000??1?0001?101?000?01000?0100???00110110?1?0001??0?0010?31?????
?0????11?1?0?????0??1??0?1?1?0??1???0????501?2701120000???010000??100?0?00
00001?0?000112???01?000?0?11???????????????1?3040?30????????1??????0???????
?1??????????????????????????????????????????????????????????????????????
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Jiangxisuchus_nankangensis
0000100000?0???00001000?000?0100000000???000?10101000001??0111?1?00??010
?000?00011?000?00?2?1000000?00?000??0?00110000100?10010000?002?000000?11?0
00000???1?01120010010000000??????????????11021020??10?10?001?01???00??????
???????????????????????????????????1????????????????????????????????????
????11???

Kambara_implexidens
00000??00110??1?00001001000???100000000???001?020010000010?011101000000000
?000000011000000010?100000000010000?0000010013100020010000?????0?0?00?0110
10100000010?120000002?11000????1??0??1?01?1021020??000???00110100?00?0?000
?1?0110000???1??????????????????????????????????????????????????????????
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Kambara_murgonensis
00000??001?0??1?0000100???00?01000000?0????001??2001000?0?0???1??1?00??0??
?100??0011?0?????10??0??????????????0?0?????????0?????????????????????????
?????????????12????????1????????????????????11???12???0???????1??1?0????0?1??
????11??????????????????????????????????????????????????????????????????
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Kambara_taraina
00?00??00110??1000001001?000?01000?0000???000?12101000001???????1?000?0??
?1????0021?00??0010010000??000100?0?00000?00121000200?0000?00100?0000?0111
0??00?????01120??0??2?1100?0??????????????1102102????00???001?01?00?01001??
?110????????????????????????????????????????????????????????????????????
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Kentisuchus_spenceri
00000??00000??1?00001001?001?01[12]0000100????00110200010010 10???1001?0000?
00??????111100??????????0??000001000??0000?1011210012000000001?100?0000?01
1020000?2???0?12???0????100?0??????????????????????????????????????00???001
1001?100?0??????????????????????????????????????????????????????????????
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Kuttanacaiman_iquitosensis
00?0110000?0??1?00001010?0??????0001000???0000121????1?011?2????1????????
?0???????1????10121??000000000?000?????00?000?200001000100?00??10?????00??
0???01??000112011??1100??0??????????????1??2?121???00?????1??1???????????
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?1?0???
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Leidyosuchus_canadensis
000010000010??000001100000000?010000000010000010101001000010?011101000?0000
?00101001100001011000001000000100010[01]00010000330000000000000000[01]0[01]001
0?011000000000000011200100020000000???11010?001?1002100?0??0000?00110100110
101?01?10000?00?000????0????????????????????????????????????001??????0?????
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Mecistops_cataphractus
00000??00010??10000110010000?0100000000110100000200100000100011101000000010
?100100011000010002010000000000100101001011011310002000000001010000100?1[01]
111110102011011200000000000000011011110 01?0111021120??10010?001102000000100
0001101100100011010010010001101000110111011110001010001 10?111200??01110000
01121110?0

Mekosuchus_inexpectatus
????0??00010??0?0001?00???0???120101?021???101???10????00?????1??000000???
?1????0021?????0010??0?0??0?00?000?????00?000?????1???0??0??????????????1??
??????0100??????????????0???????????????01021120???0010?1010100110??000?1
0000110001?0110?????????110010??11??1??????0??????????????????????????????
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Mekosuchus_sanderi
?0??0????010????????????????????01??1?2????101??20010000110?0?1??100000???
?1????012?00?0?0010010?0??????????????????????100?1?010?001???????00??????
??1???0100???????????????0???
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Mekosuchus_whitehunterensis
?0??0???0??????????????????????010??02????001???0??????????????????????????
???0????100?1?010??01???????0???????
???01021120???001??10101011101?0?0??
????10?000??110??
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Melanosuchus_niger
010011100010??10000010100001?00[12]00010001100001012002001001 1?211101010000
11201?110011000110121110000000011000100100010010200001000000000000100010?00
00000001100011120111011010000010011 1[01]?0??0011021021??00011000120100111?0
000111000111110110110111001111001?001?111???0110210100011101111000??101100
0100231112?1

Moroccosuchus_zennaroi
00000??00010??1000001001?001?01000000001???001?0211?0001010?011001000??010
?00010101100011000??1000000000100??100?00?011?1000200?0000?01100?0000?01??
?????02?1?011200001?001000?????0?????????1102120?1??000??00110200000?100??
?10000?0????????????????????????????1?????10??????????????????????????????
??111???

Mourasuchus_amazonensis
000010101011001?0?01?011?0100?121101000????002?12002001111????1?010300?00?
?01????011001110100110010??01110????0010??00????0001??0?00?0?0110??10?00?0
0??0?0000?0112?????????0?00?0?1??1110?????11?3?02???10????0?1202?0???????0?
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Mourasuchus_arendsi
000011101011001?0101?011?01?1?121101000????002?12102001[01]11??211?01?30??0
01101?110011000110100110010000111010??0000?30003??0001??0??0?000?1??010?1?
100?000???0?01120??????????00??001113211?01??030??????0????0?1????0???????
?????0????010?1????11???110???100?1???1?????????????01???????????1????????
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Mourasuchus_atopus
00?011101?????1?010???1??0????1?1101000????002????????????????1?0103000???
?????????????????????????????1?010?0?0?03?000??1?001??0??000??11???10??01?
00?0??0000011202110?11100?0??????????????1103002???100?10001??100110201001
1110011???????????????????????????????????????????001101??1110????????????
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Necrosuchus_ionensis
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??111???

Osteolaemus_tetraspis
00010??00010??10010000000000?01000001001101001002000001001?001110101000010
?200000021001010002000000000001000100011010002100020010000000211[01]0011011
10200001201101120000003010000001011 10?11?0111021020??10010?001101011000000
1001101100000011010000001000010000011011101111000102000?101111110100111[01]1
000102111100

Paleosuchus_palpebrosus
10000??00010??10000010000000?0100[01]000001100001002101002001?1??1101020000
11101?1100200001101211100000000010001001111[01]00?320000101100000111100010?
011000000110001112001100110000001001110?01?0011021021??10012100120101111?0
0001110000?111010010011110110000100110121???0110010121011101111110??101111
110022111211

Paleosuchus_trigonatus
00000??00010??10010010000000?10001000001000001002101002001?1??110102000011
101?110020000[01]1012111000000000100010011110 00?320000101100000111100010?01
10000001100011120111001100000010011 10?01?0011021021??10012100120101111?000
01111000?111010010011110110000100110121???0110?10121011101111100??10111111
1022111211

Paratomistoma_courti
00000??00000??????????????00?010001010?1?0?001??2000100001??011??????????0
????1?1?1??0??????????0?0000001000????????????????2???0???????????????????
???????????????????????????????01010???11??????0???????????1?01000???00010
?1?000?0??????????????????????????????????????????????????????????????????
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Penghusuchus_pani
00000??000?0????00????1?001?01200000001???000102?????0?01???0101?00001??
??????1111000?1??0201000000?001?0001??????????501120000000010100?0000?0100
000000????001213001?00100000???011???????1100130?20?00?0?0012?000?00????0?
????10?0???????1000??11?0?1111011??211??0110??????0??011110010????????????
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Piscogavialis_jugaliperforatus
00000??00000??1?00012101?00?????0?101001???0001020001100010?01001111101010
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?00000110200000000301000011111111?010?0?1501?271112000000101000000100?0111
10001000000011210?11?2?0000?1??000?0????0?1103040?21?00?0?0011010001010????
???1???0?????0????????????????????????????0?0??????1????????????????????
??001???

Planocrania_datangensis
10000??00010??0?00001001?0??????0000000????001?00000000001??011101?00000??
??????0???0???0???????0?00?0??1??0?????02?00??3000100?2000?0?100?0000?????
?????????????12?0?????????0????????????????????110???0????00????????????????????
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Planocrania_hengdongensis
???00??00010????????????????0??????0000000????000???000000001??011??1??000???
??????0???0???00010?1?00???0?????0???????1????300?000?2000???10000?0??????
????????????112????????????00??????????????????110?1120??10????????????????????00
0110?0?????????????????????????????1?????????????????????????????????????
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Procaimanoidea_utahensis
10000??00010??0?00001010?0100?120100000???000012000000010??111010100 00??
?0??1?001100010012111000000000?000100000001000020000101100000????0?1?10?0100
00000?0?0?011200010?10000000??????????????1110200?0??000??0?11110000???1001
010000???10000??
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Protocaiman_peligrensis
?????????010??????????????????????????????????0?1??000000010011??11?0?????????
????1100110001?011111000000?0???
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Purussaurus_brasiliensis
01000??10020??1000001110?0110?1210010001???0010121020010010?21110102000 0?1
1011110011100?00121110000000001100010000012000220000 10?0?00?0?1???0010?00??
0???0??000??1???????????????0?????????????????11001021??000010001201001 1??010?1
110000?1???????????????????????????1???1????????????????1?1101??????????????????
??111???

Purussaurus_mirandai
01000??10020??1000001110??101?1110010?0????001012001??1001????1??1??0000??
?0???1???1?0???????????????????????0??00000200?2??0001??0000?????1?0010?00??
0???0???0?111202?10?????0??????????????????11?2?02????0?0??001202?0????11?01
?100??
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Purussaurus_neivensis
0000100000020??1000001010?0110?1210010001???001012001001001??21110102000 01?
?01111001110010012111000000000001000100?00?10000200001000?000001010001 0?0010
00000100001112020101111000001001110??1?0??????????????????100?120100111?1?001
?10000?11?01?01??1010011000 0000?101?1???????????????0?11????????????????????????
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Quinkana
[01]0010??00????0000001001000[01]?01?0?00??0??????????????????????????0?1??10001
0?????????00???0??????????????????????????0??00[01]0012[13]001[012][01]0[01][012]0
[01]000?2???0000???0?00000?2011???????????????????????????????????????11??102???10?

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Siquisiquesuchus_venezuelensis
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Stangerochampsa_mccabei
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xgroup
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agroup
;
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+8     +9     +10    +11    +12    +13    +14    +15
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+144 +145

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tshrink

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9. Dataset : Walter et al., supplementary dataset (modified Rio & Mannion, 2021 – discrete and redescretised characters; .tnt)

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??1?1??????00???0?????????00000??00??????000001?0000000?0120000100????00101
??????????????1??100000???????????????????????????????????????000000001010
0000000000?1020000010?011110[01]00?????011200????0??10??0?????????????1??21
12???10????001????00??????????11??????????????????????????????????????????
????????????????????????????????????

Baru_huberi
??1?0??????0??????????????00010??00?????0?000010000?00?01?0000??0?????????
??????????????????????????????????????????????????????????????0?0000001010
00100100001???0??001????1?2?1??????????????????????????????????????1102102
0??10?1???????????????????????????????????????????????????????????????????
??????????????????????????????????

Baru_wickeni
??0?0???1??00???00?1??????00010??00010??0000001000?001?0110000100????0010?
1101000001??0?1??100010????0????001100???????0??0?000000100100001?0000?010
0010010000100100?0010?011110100020?001120011??00110000?????????????1102112
0??1001??0?11010000010001001101100????????????????????????????????????????
??????????????????????????????????
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Borealosuchus_acutidentatus
101??0?0010?????1?????????00000??00010??0?0001?00??000?0110000000???000?0
1000?00001??????1000000??000?????10???0?????1??0???0??????????001?001?30
0120000000?00110?0000???00??00???0????????????????00?????????????????????
?????????????????????????????????????????????????????????????????????????
?????????????????????????????????

Borealosuchus_formidabilis
101??0?0011000101010?011?0100000??00010??0?0001?000?000?0110000000100100?0
0100000001??0?1?010000000??000??001100001011301000000000100010000011000330
0120010000010100000000?0110000000??000112001000000000000?????0?????01002120
?1??0000?0011010011100?0010101100000?00000?0?10000010011000010110111??11110?001
0010000100000001??????????????10002??

Borealosuchus_sternbergii
101000[01]02[01]0000101100???1??00000??00010??00000120000000?011000000010010
00000000000010?0110010000000?000110011000010110010000000001000100001[01]
001[03]30001001000000001[01]000000?[01]110000001201101120010101?00000000?001??0?
?00111002110?1??0000?00120100101?0010001100000?0???0?00??10101??0??0?0101?0?
1?????????00??000001000???????????????????0002?0

Borealosuchus_wilsoni
1?00?010211?????1??10??11000000??00010??000001?001??????110000????????000?0
1000?0000???0?00?1??????0??0???????10??00??????00?0?????????????0??01?001?30
0020010000?????0?0?00??????????0????????1????000000????0?????????????????0?????
???????????101100101?00??0?110????????0?0???????????????????1???1??????000??
??00?0??010001????????????????000200

Borealosuchus_threensis
?????????????????????????????????????????????????????????????????????????
?????????????????????????????????????????????????????????????????????????
??????0?0??????????0?0????????????????????????????????????????????1002102
0??00????0?10120010??00?00011010?0?????????0??????????????1???1??????0????
????????0??????????????????0002??

Borealosuchus_griffithi
1000?0?00110??10110???????00000??00010??000001?000?000001101000000???00000
010???0001??1?1?01?000?0100011?1?0?1?????00??0?000??0000101010?00001[01]0013
300010010??0?0010??0000???101??0?1??11?1120?1???0?0?000???????????????10021
0100?00?00?001?010010??00001?11000?????0?????0???1????????0?010021?0?1?10??
????1???????????????????????????000???

Bottosaurus_harlani
?????010000??????01????????????10000010????????????????????????0000?0?1???001??
210100100?????1?0002100????0???????1?0?1101???10?1???0???????????????????0????
??????100??????????0?0?01?0?000?????1??12??????????0???0???1?????????????10210?
????0????0011010011??01?0??1?00111?????????????????????????1???1????????????
??0??101111110?????????????????1?????

Boverisuchus_magnifrons
????????????????0?????????10?10??00010???00000?1000?00???00?0???0????0?1?0
100??0000????????1?0????0??00??????10???00000?1?????????????????000000001030
100001201000?1???0000??1111000?0??00??12?0?0??0?1????0??????????????1102100
????0????0?1????0?0?????0????????????????????????????????????????????????
?????????????????????????????????

Boverisuchus_vorax
1000?000010000??0???1??11010010??00010??000000010000000?0100100000??0?10100
```

2000000010?01110100000000?0???100110001000100 10010?0000100???000031000030
10000120100001000000?0111100000200001120010??000??000???1?????????1102110
?0??0000?001??1?11???0?000010010?0?????????0???1??110010??11?11???110????
??001101110100??????????????101???

Brachychampsa_montana
100000001100001100000???0?00000??0010??1000101011?0101?110100000 1?0?00001
20011000011?111101010000000?0111100110001001111100000000010000020?013000310
0001000100001101000010?100100000 1?000011200010010000000?0?1110?01?10110?112
1??1?010?0?12010001??0100111 0000?0???????001110?101000??0011???????????00
0000010111???????????????0241111??

Brochuchus_pigotti
1000000000000100?0????????00010??00010??0?00001000?000?1100000100???00101
211?0000010?01110101000110?0????0011001010002010000000000100?00001001001210
0020010000010100000000?1010210000201111120010??30100000???1110????0?110?102
????0????0?1102000000????0?1??110????????????????1???????1???1???11?0????
??001???11??????????????????111???

Caiman_brevirostris
????0?????????0??????????010011100??0??1000001010??01?0?20001?0?????001??
??????1???????????10???????????0011????????1?????????00?000??????0?00??20
0?010?0100?000???????????????0?1000??12??1??????0?0???????????????1100112
1??0001??001??????11???001???????????????????????????????1???1??????0????
????????????????????????????111???

Caiman_crocodilus
10[01]0?0[01]00000001000[01][01]1?11[01]1000011[01]00010??10000[01]10000001?00000
00000110000100200[12]00100111211101020000111011110011000110121110000000010
001001[01]0010013200[01]11010000000010100[01]10?0[01]10[012]00001100011120111011
10000001001110??1?0011021021??00011000120[12]00111?00[01]01111001111110100111
111001111001000101111010110110100011101111000111011100100231112 11

Caiman_gasparinae
??1100?0100??????????????000????0?010??1?0001?000??01?0??????????????0???
21020011?1??211?0????????????11001100??????????0?00?0???????????01?001?20
0?010????0??1??10????????????
???
??????????????0???????????????????

Caiman_latirostris
101[01]0000000011100010?011?1010011100010??1000001010000 1?002[01]00000011000
01012002[01]01101112111010200001110 1?1100110001101211100000000010001001100[
12]0013200001010000000110100010?0[01]1000001100011120111011100000010011110?
1?0011021121??00011000121200111?00001110001111 10[01]0011110100111100100 0101
?1???011011010 0?1110111??????1011[01]0010023111211

Caiman_lutescens_MACN
?????0?0100??????????????????110?0020????????????????????1001???????001??
2102001101?????????????????????0011??????????????????????????????????????
???
???
??????????????????????????????????

Caiman_wannlangstoni
00???0?0000?????0?????????010111100010??0?00001010?001??1110010001??00100
2002001001????1?010?0??01??????001100?110121?100000?00?1??????????1???320
0001000100????????111001000000???0011120?0????00?00??????????????????????

???
??????????????????????????????????

Caiman_yacare
10100000[01]0000[01]1000[01]01??1[01]?000010100010??10000[01]10000001?002100100
0100000100200200100111211101 0[12]00001110111100110001101211100000000100010
01100100132000[01]1010000000101000 10?0010000001100011120111011100000100111
0?01?0011021021??00011[01]00120[12]00111?0000111100111110000 1??1110011110000
0010111???11101101000111011111 00??1011[01]001?0?3111211

Ceratosuchus_burdoschi
100??0?0?110???00?????????00000??00011100?00001010?001?0001101000???00000
????000001???1???101?00?????????00?1?00??????110000?000?1000?????032000320
0001010?0000?0?10101??0?0100000??0????12???????????00???????????????1101210
?0??0????0?1?????????0???1???????????????????????????????????1???????????????
????????????????????????????1?????

Crocodylus_acutus
10010100100000100011 1??10?00100??00010??1000001000 1001?0100000000110110110
200000000100011101000000 10?[12]000000110000100020100000000010010100100 10013
10002000000000010010000?11112[01]0000201101120000000010000001011110 01?01110
21020??00010?001102000000100100110110000101101000001001100100 1110?1???1110
00101000110111020 0??011000001111111000

Crocodylus_affinis
10[01]00[01][01]000[01]0000000100?1???00000??00010??1000001000?000?0120000000?
?0?0001[01]2000000010?011101000000?0?10?010011000000002?1000000000 10010001
001[01]000[01]10001000000010020000000?011011000020000112001000000000 00???111
10?1?0111021110??00010?001101000000 10[01]10011000?00000110??0???1??????????
??0?????????????????001101??0100?????????????????111???

Crocodylus_anthropophagus
??0????????0????000?1?????00000??00?1111000000010001?0????00000?0?11010?1??
200????0??????1??10?0???0??2????00?1000010002??000000?0?1101010?00?10?1310
002001000000100????????11?2?0????011??1??????????0??00???????????????1102102
0??10?10?0?11010000??10110?110110???00?1???0???1??????10??1????????????????
??0??101????????????????????11????

Crocodylus_intermedius
100100[01]000[01]000100011??????00100??00010??1000001000 1000?0120000[01]00110
1001102000000000100011101000000 10?20000001100000000201000000000 100101000001
00131000200100000000 10010000?11112[01]000020110112000000000000000111111001?1
111021120??00010?001101000000100100110110000 10110??00001001100100111 0?1???
1110?01010???????????????011100001112111?00

Crocodylus_johnstoni
1000000001000010001111 0[01]0000000??00010??100001100010 00?01000[01]0[01]00110
100110200100000100011101000001 10?[12]00000011000110000010000000001001010110
11001210102000000010[01]0000[01]00?11111[01][01]000201101120000000000000000111
112101?1111021120??00010?00110200000010010011011000000110100000100001 01001
110?1???1110?01000001101111200 0?011100001112111100

Crocodylus_megarhinus
100000000000??1000????????00000??00010??1000001000 0000?0100010100??0?00101
2001000001 0?01110100010010?2000000110000100020100000000010000101100100 1110
0020010000000020000000?11111000002011011200000000100000?1?111??1??111102112
0??00010?0011010000 1?0?11001101100 0?????????????????????????1???1???????????
??????????????????????????????????

Crocodylus_mindorensis
1001?000101000100011??????00010??00010??10000010001001?0100000000110100110
20000000010001110100000010?20000001100001000201000010000100101001002001210
0020010000000010000100?111121000020110112000000000000000001111 11001?011102102
0??00010?00110100000110010011011000000110??????????????????1?0?1????????0??
????????????????01100000111 2111000

Crocodylus_moreletii
100101001000000100010???10?00100??00010??10000010001001?0100000000110100101
20000000010001110100000010?10000001100001000201000000000100101001003001110
00200000000000100000000?11112100002011011200000000100000001011 11001?011102102
0??00010?00110100000110010011011000000110??????1????????????1?0?1????????0??
????????????????01100000111 2111000

Crocodylus_niloticus
10000000000000100010100[01]0100000??00010??1000001000 1001?0100000000 01101[01]
01112000000000100011101000000 10?2000000110000100020100000000010010100100[12]
00131000200100000000100[01]0000?01112[01]0000201101120 0000000[01]0000001011121
01?0111021020??00010?00110200000110010011011000000110100000100111010011101
11011110?0101000110111120010011100001113111000

Crocodylus_novaeguineae
10010000100000100010???11?00010??00010??10000010001000?0100000000110100100
20000000010001110100000010?10000001100001000201000000000100101001002001310
0020010000010100001 00?11112100002011011200000000000000000111111 0?1?011102102
0??00010?00110100000110010011011000000110??????????????????1?0?1????????0??
????????????????01110000111 3111000

Crocodylus_palaeindicus
1011000010[01]000?000?0??1???00000??00010??1000001010?00?????0????00????0[0
1]101??000000010???11010000001??2000?0111000??000?01000000000100101000?010
0?11000200100000000100000000?011021000?2?1?01120000??001?00???????????????11
0?1020??00010?0?110100000?10?100110 0110??????????????????????????1???1???1?1
0????????1101?????????????????????111???

Crocodylus_palustris
100100000000011?00101011000000 0??00010??10000010101001?010000010011010[01]1
0120000000001000111010000000 10?[12]0000001100001000201000000000100101000000000
101000200100000000100000000?[01]1102[01]000020110112000000000100000010111 2101?0
111021020??00010?00110100000110010011011000000110110000100001010 01110?1???
1110?0101000110111 1200??01110000111 2111000

Crocodylus_porosus
10[01]10[01][01]0[01]0000[01]1000101000010001 0??00010??10000010[01]0100[01]?01000
0000011010[01]10[01]2000000001000111010001001 0?[12]0000001100001000201000000 0
0010010100100[12]00131000200100000000100000000?11112[01]0000201101120000000[0
1]000001101112101?0111021020??00010?0011020000001001001101 1000[01]001101000
00100[01]0001001110211 0?11100010100001011 11200??01100000111 2111000

Crocodylus_rhombifer
1000?00?[01]0000010001010011100100??00010??1000001000 1000?0100000100110100 1
0120000000001000111010000000 10?[12]0000001100001000201000000000100101001001 00
101000200100000000100 10000?1111210000201101120000000000000001011 11001?01110
21020??00010?001101000000100100110110000001101100001001110100111011 1011110
00101000110111 1110??01110000111 2111000

Crocodylus_siamensis
10010[01]001[01]00001000101001 0?00010??00011111000001000 1000?0100000100110 11

1101200000000010001110100010000?200000110000100020100000000010010100100100
131000200100000000110000000?11102100020110112000000001000000101112101?01110
21020??00010?0011020000001001001101100000000010??00001000100100011 0?1???1110
?01010001101111210??01100000111211000

Crocodylus_thorbjarnarsoni
10100100100010 1?0010??????00000??00010??0000001000?000?01100000001???10101
20??110001????1?01?00??000?1????00110000100?20?00?0000??10?10?000002001310
002001000000010000000?1111200000????011200001?001?0000???1?????????1102102
0???0?10?0?11020000??10?10?111110?010011 0?????????????????????????????????
??????????????????????????????????

Dadagavialis_gunai
?0??????????????1?????????00000??000?0?????00??0?1?100?01000101?0????00210
21???????1??????111?01????????????0???????????????????????????0????????271
1120000001010000?0?00???0?0?001????0??????????????0??????0????????????3???
???????????????????00???
??????????????????????????????????

Deinosuchus_riograndensis
1001?1?02010???02010??1???????0??01??0??100000?000?000011001000000?1??00101
0001?001010?210?01?100?100?0??1110111 00???????00?00?00?1?????000013000030
0000010?00?001???0000?????0???????1??1?????????????00??????????????1002102
???000???00100210?11?10001?111???0??010?????????????????0?1???1??????0????
??????1?????????????????????10????

Diplocynodon_darwini
0000?0[01]00[01]0?001?111?0?010?00000??00010??10[01]0012000?000?0020000000???
?000?10001000001 0??11101010000000?011?10011000000110010000000??1??0100??010
001?30001101 0000?00110000???11??????0??0??0112011?0?2?000?00?????????????1
0021020??10010?0011010011??0100101101 0?00000?010001001??0100000011 1?1?????
1001000000?101110000???????????112100201

Diplocynodon_deponiae
0?0?????0[01]0???0?0??????11?00000??00010??001001?00??000?0120?00000????000
?10100001001??[01]11??10100000??01??00021?0????????00?0???0???????0???0?0??
??300?11010000?00110???????1??????0????011120??01?2??00?????????????????100
2102????0010?0?1???000???0???1?1?0??????????????????????????????1???1??????0
??????0??101111000???????????0?2101211

Diplocynodon_hantoniensis
10[01]000[01]0[01]10000000010??????00011000 0010??0001012000?000?0100000000???
?00111010[01]0000010??1110101000000?01101011100001011001000000000001000100000
10000030001101010000011000010?0110000001100111201100120000000???1110??1?0
?10021020??1001[01]000110100100101001110010?10??????00????1??010000001 1?21?
??0??0??????001101111000???????????????1002??

Diplocynodon_muelleri
10???0?0010?????1???0?????00?01000001 0????1101?01??000?0100?00100????001?1
0100000001 0?2?1????100??0??011?????1?0?01011??10?0000???10?0?0?0?0??00??30
0??10?0000?00110??00???1100?000????1011200100????00?00??????????????10?2?02
1???0????0?1?????????????0??100?????????????????????????????????1???????????
??0??101??00??????????????????1112??

Diplocynodon_ratelii
1010?000000?00000???0?0???000110000010??100100100000 00?0100000100100100110
00000000010?11110101000000?0110?002100000011001000000000100000010010001030
0011010000000011000000?111010000110010112011001200000001001110?11?111002102

0??00010?001101000000010010110?0??0????????????1??0100000?11??1??????0??????001101111200??????????????100???

Diplocynodon_remensis
?????0????0?????0010??????000110000010??100001?000?000?01000101001???000?111010000010?2111010000000??0??0100110000?011011000000000100010000010001030001?0100000000110?000??01??0??00?000[01]01120110002000000????1??0???011002100?0??0010?00110100101?00001110010??0??????????????????????????????????0????????????????????????????????1002??

Diplocynodon_tormis
1000000010?0???0??????????000010000010??1?1101?000?000?0100000100???000000100000001??111101?10??000??1101001100?01?????????0??000?00?0????0?000?03?0?????000??001?0?0000??1??0????????????120?1???????????0?1110??1?011????02???????????1??1?0??01??????????????????

Dollosuchoides_densmorei
1000?0000110000?0??????????00000??00010??1?0001?001?001?0100000000???001002000100?0????????1?????????0???????1?0???00???1??0???0??1?????000?1111?210012000000011100?0000?01102?000????01120000??00000??????????????????1103?20?10?0??0?00110200000100?100110????0???????????????0???

Eocaiman_cavernensis
????????????1???001???????0000111000?0?????????????00??????????00????????02000000?0?????1??102?00????????????1????????????0?0??0??????????????1???20000?00000000?10??00111001000000?00??0?12??????1?????????????????????1121021???00???00110100?11??

Eocaiman_palaeocenicus
?????????????????000??0?0??11101021???0????001101?00???0?001110000??

Eogavialis_africanum
10[01]110[01]0[01][01][01]000?01?0???0??000000??00000??100001?001?000?0100000?0010000011020001100010?01001111010100?0??1111110000000020100001101110000100001[23]011271112000000101000000000?011120000000000001121000000000011??00?0????0?1103030?30?0000?001101000001110000110?0?0?????????????????????1??????????????????????0?????1?????????????????000???

Eosuchus_lerichei
1?0???0?01000000??????????00000??00000??1?00012001?000?01001000101?0?00010000?0000010?0100?100100010?000?000110000110020100000000?100000000002000370112000000000110000100?01000000001000011200000000000000???0?????????11030?0?21?00?0?00????????????????????????????????????1????11101?1???????????????????????11??????????????????011???

Eosuchus_minor
1???????0???????0?0???????00000??00010??100001?001?000?0100000010??0?00010101?1000010?0?00?100100?0?????0?10110000?100201000001000100000000001000370112000001001100?0000?011000000000000?112?000??000?001??0?1??0??01111103120?21?00?0?0011010000??00000110010?00????????????1??0001?11?1???1??????0??????0?0100110????????????????1010???

Eothoracosaurus_mississippiensi
101??00001[01]????01?????0???00000??00000??1?0001?001?000?01?00?01?0????000
10010?100001????0??1?1????????????1?0100?00000??10000??0?01000000000120002
7?10200000001010000?000??0?000000??0????112?0?01?000?000????0?????????10030
30?2??0????0?1001?001??10?0??1?010??????????????????????????1???1?????1???
????00????????????????????????000???

Euthecodon_arambourgi
1001?0000000????0?????????00010??00010??0?00012101?000?01000000001101001?0
21010000010??1110100000010?1??0000110010100020100000?0????????00001?001270
0020000??000?11??0?0????0?2000?02011????????????????0?0???1?????????11?????
??
??????????????????????????????????

Gavialis_browni
?0???000111?0?1?1?????????00000??00000??100??1?2?1?100?1100010?0????002?0
21????0001????0010?11??1????????111100?00000?01??0??????????010?????????70
1120000001010000?1100?01010?001?0???011210?0??0???10??????????????????????
??
??????????????????????????????????

Gavialis_gangeticus
10[01]010[01]00110[01][01]00200101000100000??00000??11000122010101?11000101000
0000021011001100010002001013110100?000011111000000000010000111111010010000
14111270112000000101100001100?01010000100000011210001?000010110000110?01?2
01103040?31?0100?01110210000201000011000?000001001000001000011111111011010
0010000110000010110010010100000010210?0000

Gavialis_lewisi
?0???000000?0111??1?????????00??00000?????????????10???100010?00??0?0021?
??001000010???0010?3110100?00001111100?000000?100001101111001??????????7?
?12???000101?00000?00?011100001?00?0011212001?30101011??????????????1?????0
??1?01?0?01110?1000020100001?0???0??
??????????????????????????????????

Gavialosuchus_eggenburgensis
100?1000111????00?????????00000??00010??1?0001?001??00?10000100?0????001?0
2100000001????1?01110001????1???101100?????0??10000000001000??0??03101?241
1120000?00?10100?000?????0?????0200?????????????????0??????????????????????
???1?????????????
??????????????????????????????????

Glen_Rose_form
?????0?0010?10110?????????0000100000000??0000000000?0111?1200000001?0?10100
00000000100?0?110100000????????100??0?0?????????0?01000000000100?0000001?00
00001000000000100000000?010000000010?0010000001?00000?1??0?1??0??????0102120
?20?0000?000???????1???????????????00???????????????????????????1???????????
??????????????????????1???????????

Globidentosuchus_brachyrostris
???????0100????????????????0000???00010??10000??01??001?0??10010?0????00011
2102001001???????1?200?00???????????1?0?????????0????????????????000??00002?
00010?0100???????001110???0?????????????12??????????????????????????????1102100
1??11????0?120100111??0?0??10001?111??????????????????????????????????????
??????????????????????????????????

Gnatusuchus_pebasensis
00???0?0000???0?0??????????0?000??100?0??1?0??01010?0????1?0001000????00001

20020010011??????1??0??????0???????1?0?010120??00?001000100010???0??000?00
0001000100?????1???????0??0??00???0001120100001100?10??????????????0100?20
?1??0???00120?00111??0001?1100??0???
??????????????????????????????????

Gryposuchus_colombianus
?0???0?00???0???10?0??????00000??00000??1100012001?000?0100010000???00210
11001100?10?0200100311110??0??011?0200000000001000011101111001000?2211?270
1120000??101000000100?011100000?0?0?12?????????0?0???0?00?0??01001103030
?20?001??0011?1?000000?0000111?0??0000100?????????????????????????????????
??????????????????????????????????

Gryposuchus_croizati
??11????1?????11?????????00000??000?0??100001??01???????????????0?????0210
0?1?1?00?1????00?113??0????????1???1???????0??1??0??11??111???010?1?01??7?
1120000??1????????????????????1???00?11????????????1?1?????????????1103030
?21?0???00??
??????????????????????????????????

Gryposuchus_neogaeus
1?1110?00110???0?10???????00000??00000??1?00012101????????0??0???????002?0
??0?1?0001???2????????????0??????1102?00???00?1?0001111111001000?2211?27?
1?20000001??01?????????????????0????
???????????110100?0??0?0?001?0???0??
??????????????0???????????????????

Gryposuchus_pachakamue
?00010?0111?[01]0??101???????00000??00000??1?00012001?000?0100010100???001
101000110001???0011?1??110??000??1?01000?0000?010?0?01101111??011?2111?2
711120000001010000?0100?0???0???100?000112???0??000?101????0?????????11030
30?20?0?00?001111000002010100111???0??????????????????????????????????????
????????????????????????????????????

Hassiacosuchus_haupti
[01]01??000?10????00100??11?10000??00010??000??01010?001?01201010001?0?000
?010??0000010?21110101000000?01?1100110?0???1???0?000??0???????????????0??
2000010?0100?00??10?????0??11??2
?0?????000?0?1?010101??010??0100???????????10???????????????1???1??????0??
????00???111?0???????????????3111111

Hylaeochampsa_vectiana
?0???0?1000?00?1??????????00000??00000?????????????1100?120101000????0011?
01001001000?0?00??10?00?0??????10110010????0??0110110000100010??????????60
??0???0?0?000100011?0?01?12?0100?0??0?12?0001?0000010????10?0?????????????
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??????????????????????????????????

Iharkutosuchus_makadii
0010?0?01??00?00?????????00000??00010??1000001011?1100?12010010????0?010
?10100200????0??????00000?01???00?0010??0103001101?100?000?00???033000160
01010?020000011001000?01112001000?0?01120001??00000101???1????????0?104110
?1??0?00?000???0011?00?00000000???????0???????????????????????????????????
??????????????????????????????????

Ikanogavialis_gameroi
?0???010111?0??02?????????00000??00000??1?0001?101?000?01000?0100???00110
110?1?0001??0?0010?31??????0????11?1?0?????0??1??0?1?1?0??1???0????501?270
1120000???010000??100?0?0000001?0?000112???01?000?0?11???????????????1?3040

?30????????1??????0????????1???
?????????????????????????????????

Isisfordia_duncani
1000000001000000????0??10?00000??00010??1?00001010?001?0100100000????00000
100000001100?0100010110000?000??0011?00??0000000000000000001002?0032000070
0101002000000010000000??10000000?????01000000000000?00????????????????3???
????0????0?1101000???01????00????????????1?0??????1100??1011??1???0?00????
??000??10010?0????????????102111100

Jiangxisuchus_nankangensis
10???0000100??1?0?????????00001000000?0????00001000?000?0100000000????000?1
0101000001??0111?1?00??010?000?00011?000?00?2?1000000?00?000??0?0011000010
0?10010000?002?000000?11?000000???1?01120010010000000??????????????1102102
0??10?10?001?01???00???????????????????????????????????????1???????????
??????????????????????????????11???

Kambara_implexidens
?000?0000000?0?0010???????00000??00110??1?00001001000???100000000????001?0
20010000010?0111010000000000?000000011000000010?100000000010000?000001001310
0020010000?????0?0?00?011010100000010?120000002?11000????1??0??1?01?102102
0??000???00110100?00?0?000?1?0110000???1?????????????????????????????????
?????????????????????????????????

Kambara_murgonensis
????????????????0??????????00000??001?0??1?0000100???00?0100000?0????001??
2001000?0?0???1??1?00??0???100??0011?0?????10??0???????????????0?0?????????
0????????????????????????????????????12????????1??????????????????11???12
???0???????1??1?0????0?1??????11??
?????????????????????????????????

Kambara_taraina
???????0[01]00???1?0??????????00?00??00110??1000001001?000?01000?0000????000
?12101000001???????1?000?0???1????0021?00??0010010000??000100?0?00000?0012
1000200?0000?00100?0000?01110??00?????01120??0??2?1100?0??????????????11021
02????00???001?01?00?01001???110???
????????????????????????????????????

Kentisuchus_spenceri
?00??0?0[01]1[01]?00?000????????00000??00000??1?00001001?001?01[12]0000100???
?0011020001001010???1001?0000?00??????111100??????????0??000001000??0000?1
011210012000000001?100?0000?011020000?2???0?12???0????100?0???????????????
?????????????????????00???0011001?100?0????????????????????????????????????
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Kuttanacaiman_iquitosensis
?000?0?000???01?0??????????00?0110000?0??1?00001010?0??????0001000????00001
21????1?011?2????1??????????0???????1????10121??000000000?000?????00?000?20
0001000100?00??10?????00??0???01??0001120111??1100??0???????????????1??2?12
1???00?????1??1??????????????1?0???
?????????????????????????????????

Leidyosuchus_canadensis
1010?000?10000001?1???????000010000010??00000110000000?0100000000100000101
01001000010?011101000?0000?00101001100001011000001000000100010[01]000100003
3000000000000000[01]0[01]0010?0110000000000001120010002000000???11010?001?1
002100?0??0000?00110100110101?01?10000?00?000????0?????????????????????????
???????????001??????0??????????????1111??

Lohuecosuchus_megadontos
0010?0?00000100?0??0??????00001010010??0000001000?000?111??0?100????00111
11??000[01]00??0110010000000010100?10011010??010301010000?00?00?100000010011
200000000000000020000000?0111200000??10011200?01?00000000???1?????????11021
020??10?10?000????0000000?1??11010?00???00????????????????????????????????
???????????????????00??????????????????

Maomingosuchus_petrolica
1000?0[01]00[01]0??0??0?0?0?????00000??00010??1000011001?000?01000000001???0
01102?000000010?01110100000100?000??0011000??00??010000000001000010010?001
?310112000000000110000[01]00?0110000000201001120000??30000000???1??0????0?1
10?020?2??00?0?0?1202000001?1?10011 0????000000????????00111000001???1?????
????????0??001??1??????????????????1011??

Mecistops_cataphractus
1001100000000001000111101[01]100000??00010??10000110010000?01000000001101000
0020010000010001110100000010?100100011000010002010000000001001010010110113
100020000000001010000100?1[01]1111101020110112000000000000001101111001?01110
21120??10010?00110200000001000001101100100011010010010001101000110111011110
00101000110?111200??0111000001121110?0

Mekosuchus_inexpectatus
??00???????????0?010??????????0??00010??0?0001?00???0???120101?021???101??
?10????00?????1??000000????1????0021?????0010??0?0??0?00?000?????00?000???
??1???0??0?????????????1????????0100??????????????0??????????????0102112
0???0010?1010100110??000?10000110001?0110?????????110010??11??1??????0????
??????????????????????????????????

Mekosuchus_sanderi
?????0?0?00????0???????????0??0????010????????????????????01??1?2????101??
20010000110?0?1??100000????1????012?00?0?0010010?0?????????????????????10
0?1?010?001???????00????????1???0100??????????????0?????????????????????
???
??????????????????????????????????

Mekosuchus_whitehunterensis
????????????????01????????0??0???0???????????????????????010??02????001??
?0???0???10
0?1?010??01???????0??0102112
0???001??10101011101?0?0??????10?000??110????????????????????????????????
??????????????????????????????????

Melanosuchus_niger
00010000100011100010100111010011100010??10000010100001?00[12]00010001100001
0120020010011?21110101000011201?110011000110121110000000011000100100010010
200001000000000000100010?00000000011000111201110110100000100111[01]?0??00110
21021??00011000120100111?0000111000111110110110111001111001?001?111???0110
210100011101111000??1011000100231112?1

Moroccosuchus_zennaroi
??1100?0[01]11????0000??????00000??00010??1000001001?001?01000000001???001
?0211?0001010?011001000??010?00010101100011000??1000000000100??100?00?011?
1000200?0000?01100?0000?01???????02?1?011200001?001000?????0?????????11021
20?1??000??00110200000?100???10000?0???????????????????????????1?????10??
?????????????????????????????????111???

Mourasuchus_amazonensis
1110?0100??0????????????????00001010101100 1?0?01?011?0100?121101000????002?1

2002001111????1?010300?00??01????011001110100110010??01110????0010??00????
0001??0?00?0?0110??10?00?00??0?0000?0112????????0?00?0?1??1110?????11?3?02
???10????0?1202?0???????0?????011???
??????????????????????????????????

Mourasuchus_arendsi
?1???0?0?00???1[01]2?????????000011101011001?0101?011?01?1?121101000????002
?12102001[01]11??211?01?30??001101?110011000110100110010000111010??0000?300
03??0001??0??0?000?1??010?1?100?000???0?01120??????????00??001113211?01??0
30??????0????0?1????0????????????0????010?1????11???110???100?1???1???????
??????01???????????1??????????????????

Mourasuchus_atopus
?????????????10??1?01????00?011101??????1?010???1??0????1?1101000????002??
?????????????1?0103000???????????????????????????????????1?010?0?03?000??1
?001??0??000??11???10??01?00?0??0000011202110?11100?0??????????????1103002
???100?10001??10011020100111100111??
??001101??1110????????????????????

Navajosuchus_mooki
0?0???????0?????000??011??000010000010??0?00001000?000?0120110000????000?[
01][12]0000000010?2?110101000????0??110011?????012111000?0000?1000?01??0020
00320000100010000010?00010???110000012000??12?0?10?10???0?????1?????????11
11210?1??101100011100011000100??1???0??010001?????????????????????????????
??????????10111?????????????????1?????

Necrosuchus_ionensis
??????????????????????1?00??
??11???????????????0??????????????
??????0?0??1102102
1??000???00???1???1???0???????
??01?101111100?????????????111???

Osteolaemus_tetraspis
1010000000000[01]10001[01]1011[01]000010??00010??10010000000000?0100000100110
1001002000001001?001110101000010?20000002100101000200000000000100010001101
0002100020010000000211[01]00110111020000120110112000000301000000101110?11?0
111021020??10010?001101011000000100110110000001101000001000010000011011101
111000102000?101111110100111[01]1000102111100

Paleosuchus_palpebrosus
1000?00000?00110001010111110000??00010??10000010000000?0100[01]000001100001
002101002001?1??110102000011101?1100200001101211100000000010001001111[01]00
?320000101100000111100010?011000000110001112001100110000001001110?01?00110
21021??10012100120101111?00001110000?111010010011110110000100110121???0110
01012101110111110??10111111002211211

Paleosuchus_trigonatus
10[01]000[01]000?00[01]10001000111100000??00010??10010010000000?1000100000100
0001002101002001?1??110102000011101?110020000[01]10121110000000001000100111
1000?320000101100000111100010?011000000110001112011100110000001001110?01?0
011021021??10012100120101111?00001111000?111010010011110110000100110121???
0110?10121011101111100??101111111022111211

Paratomistoma_courti
?????0?0010????0??????????00000??00000??????????????00?010001010?1?0?001??
2000100001??011??????????0????1?1?1??0??????????0?000001000???????????????
??2???0??01010??11???????0

???????????1?01000???00010?1?000?0??
??????????????????????????????????

Penghusuchus_pani
10??00?0111?00100???0001100000??000?0????00????1?001?01200000001???00010
2?????0?01????0101?00001????????1111000?1??0201000000?001?0001??????????50
11200000000010100?0000?010000000????001213001?00100000???011????????1100130
?20?00?0?0012?000?00????0?????10?0???????1000??11?0?1111011??211??0110????
??0??01110010??????????????000???

Piscogavialis_jugaliperforatus
1011?000101000002?0???0???00000??00000??1?00012101?00?????0?101001???00010
20001100010?01001111101010?0000011020000000030100001111111?010?0?1501?271
112000000101000000100?01111000100000011210?11?2?0000?1??000?0????0?1103040
?21?00?0?001101000101 0???????1???0?????0??????????????????????????????0?0??
????1????????????????????????001???

Planocrania_datangensis
101??0?0?10?????1?????????10000??00010??0?00001001?0??????000000????001?0
0000000001??011101?00000????????0???0???0???????0?00?0??1??0?????02?00??30
00100?2000?0?100?0000?????????????????12?0?????????0???????????????110???0
????00??
??????????????????????????????????

Planocrania_hengdongensis
1????000?00????1???0?????????00??00010??????????????0??????0000000????000??
?000000001??011??1??000?????????0???0???00010?1?00???0?????0???????1????30
0?000?2000???10000?0?????????????????112??????????00???????????????110?112
0??10???????????????????000110?0??????????????????????????????1???????????
??????????????????????????????????

Portugalosuchus_azenhae
?0???0?0010?00???01????????????0???0010??????????????1????1?0??01001???0001?
0100000001??00001101000100???010???????????????0??0?0??1????0???????????0
??????000?0???1000000?01000000?00???0?12?0001?00000?1?001?0?0????11???????
?????0?0?0010??00?000????????????????1???00??????????????????????????????????
??????????????????????????????????

Procaimanoidea_utahensis
0?00?0?0?100?0??0?0???????10000??00010??0?00001010?0100?120100000???00001
20000000010??11101010000???0??1?0011000100121110000000000?00010000001000020
00010110000????0?1?10?010000000?0?0?011200010?10000000????????????1110200
?0??000??0?11110000???1001010000???10000????????????????????????????????????
??????????????????????????????????

Protocaiman_peligrensis
?????0?0110???????????????????????010??????????????????????????????????0?1??
00000010011??11?0??????????????1100110001?01111100000?0??????????????????????
??0??????????????????????????
??
??????????????????????????????????

Purussaurus_brasiliensis
10000110010011?000?01?????01000??10020??1000001110?0110?121001000 1???00101
21020010010?21110102000 0?11011110011100?0012111000000001100010000012000220
00010?0?00?0?1???0010?00??0???0??000??1?????????????0????????????????1100102
1??00001000120100 11??010?1110000?1????????????????????????1???1???????????
??1?1101??????????????????????111???

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Purussaurus_mirandai
????????????0???0?????????01000??10020??1000001110??101?1110010?0????00101
2001??1001????1??1??0000???0???1???1?0????????????????????0??00000200?2??
0001??0000?????1?0010?00??0???0???0?11202?10?????0????????????????11?2?02
????0?0??001202?0????11?01?100???????????????????????????????????????????
?????????????????????????????????
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Purussaurus_neivensis
10000010000001100?001????000010000020??1000001010?0110?1210010001??00101
2001001001??2111010200001??0111100111001001211100000000001000100?00?1000020
0001000?0000010100010?0010000000100001112020101111000001001110??1?0????????
???????100?120100111?1?001?10000?11?01?01??10100110000000?101?1???????????
??0?11????????????????????????????
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Quinkana
??11[01]????????????0?????????[01]0010??00?????0000001001000[01]?01?0?00??0???
???????????????????0?1??100010??????????00???0?????????????????????????0??00[
01]0012[13]001[012][01]0[01][012]0[01]000?2???0000???0?00000?2011???????????????
?????????????????11??102???10???????????????0????????????????????????????????
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Shamosuchus_djadochtaensis
?0??0000010??01??????????00000??00000??0??????000?0101?100000000????00110
011?0000110?001001000000001001??100?101?000????1000000000000010??????????00
00010?0?00?101?0?1????01??????????????010000001?00000?1?????0?????????????1?0
?????01??0?0????1?1??00????000????????????????0??????01?0??1?11??1???????1????
???????111??????????????????????1?01??
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Siquisiquesuchus_venezuelensis
10?????0?11?????????????????00000??00000??1?0001??01??????????????????????110
?????100?1????????1?1?????????????????2?00?0??03?1??0??11?11????????????????7?
11200?0??1?10000?1?????1?10?????????????12????????????00?????????????????1103040
?30?0?????0?????00?????????0111???????????0????????????????????????????????????
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Stangerochampsa_mccabei
0000?0000100000?001?0??1??00000??00010??1?00101011??101?120100000????0000?
1001000001??2111?10101?0010011?10011?0??1??111100000??00?000?0200002000320
0001000100000001?1110?000100000012?00011200110011000000????????????0?1101110
?0??1001000110100011??100??10?00?010100?????????????010000001???1???0???????
001??101111100???????????????0111??
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Thecachampsa_antiquus
?0?1?0?0101?????0??????????00000??00010??100001?001?001?0000010100????00110
201?1000010?010?0111001??0???????10?1?00????????????????0?????????000012000210
11200000000010000?0?00?0?0?2000002001??12??????????????????????????????1102020
?20?00????0?????????????????????????????????????????????????????????????????
??????????10?0???????????????001???
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Thecachampsa_sericodon
100??0001100000?0??????????00000??00010??100001?001?001?1000010100????00010
101?1000010?01010111001110?010101011000102?0201001000000100001000012010210
1120010??011000000100?010120000020010112130000000000010?00110????1?110??20
?20?0???????1?01?00????0????????????????????????????????????????????????????
???????????1??????????????????00????
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Theriosuchus_pusillus
?0???0?0?10??00?0???????1??00010??00000??0000000000000???000001000????10100
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010?0000100?111111000000??01?1?0011??0??00030101000000?000010???030000030
000000100000000100100?01??1??????0??0100100000000000????1?????????1102210
?20?000??000????1101?010???000????????????????????????????1???0???0???????
??0??00?11?????????????11????010011?

Thoracosaurus_isorhynchus
1000?000011?00?11?????????00000??00000??1?0001??01?000?0100000010????00110
01000000010?00000111110100?000??10110000?000301000000001100000000013010270
1120100000010000?0100??1?0???????????0?1210001?00000?0?????????????????????
???1?1???????1???????????
?????0?0????????????????????0?????

Thoracosaurus_neocesariensis
??11?0?0[01]11????0???????????00?00??0?000??1?000???01??00?0?00???????????00?
?001001000010??0?????????????????0?1011???0?000????0?0?01001000???????????
??11???????????????????????????????????1????01???0??0?????0???????????????
???1?1???????1?????????
???????0?0???????????????????????????

Tomistoma_cairense
?0???000001?0000???????????00000??00010??100001??0??00?????0?0??00??0?00110
200?0001010??10?0100100????0????00120000?00100100000000100001???????????71
1120000?000100000100?11?0???????0???0112100???00000000???0????????????030?0
?20?00?0?001????00???0001?011010?0???
??????????????????????????????????

Tomistoma_dowsoni
?00?10?0010????00??????????00000??00000??100001200 1?000?0100010100 1???001?0
200000000 10?01???????00?0????????1111000????????00?0000011100??0????101?371
1120000??101?00??0100???1????00????1?????????????????1???000?0??1??????????
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??????????????????????????????????

Tomistoma_lusitanica
1001?000010?????0??????????00000??00010??100001?001?000?11?00?0100????00110
211???0001??010?01?100111??01???101200?01??02010?000?000100?01000012011211
1?200?0000?1??00?01???01????????0????0112030000000?0???????????????????1102020
?20?00???0012?10000??00?0??110??
?????????????????????????????1?????

Tomistoma_schlegelii
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Snout_length_in_dorsal_view,_ratio_of_anteroposterior_snout_length_(measured_from_leve
l_of_anterior_orbital_margin,_to_anteriormost_point_of_rostrum),_to_total_skull_length_(me
asured_from_posteriormost_level_of_quadrate_condyle_to_anteriormost_point_of_rostrum)
?_0.5_ >_0.5;
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{1 Skull_proportions,_ratio_of_mediolateral_rostrum_width_at_the_level_of_the_anterior_orbital_margin,_to_mediolateral_width_across_anterior_margin_of_the_cranial_table <_3 ?_3;

{2 External_naris,_mediolateral_width_to_anteroposterior_length_ratio ?_1 _>_1_;

{3 External_nares,_anterior_margin_thickness,_ratio_of_distance_between_anterior_margin_of_nares_and_anterior_margin_of_rostrum_to_maximum_anteroposterior_length_of_external_nares_in_dorsal_view <_0.5 ?_0.5_;

{4 Rostral_depth,_ratio_of_maximum_dorsoventral_height_of_the_maxilla_to_mediolateral_width_of_the_maxilla_at_the_5th_maxillary_alveolus <_0.5 ?_0.5_;

{5 Interorbital_distance,_ratio_of_minimum_mediolateral_width_between_orbits_to_maximum_mediolateral_width_across_anterior_cranial_table <_0.5 ?_0.5_;

{6 Infratemporal_fenestra_size,_ratio_of_maximum_anteroposterior_infratemporal_fenestra_length,_to_maximum_anteroposterior_length_of_the_cranial_table <_0.8 ?_0.8_;

{7 Cranial_table_shape,_ratio_of_maximum_anteroposterior_cranial_table_length_(measured_from_the_level_of_the_frontal-postorbital_suture),_to_maximum_mediolateral_width_(measured_at_the_level_of_the_anterior_table_corner) <_1 ?_1_;

{8 Cranial_table_shape,_minimum_angle_subtended_by_the_posterolateral_cranial_table_margin_and_sagittal_axis_of_skull <_10 >=_10 =_0_(parallel);

{9 Supratemporal_fenestra_size,_ratio_of_maximum_anteroposterior_supratemporal_fenestra_length_to_anteroposterior_cranial_table_length_(measured_from_the_level_of_the_frontal-postorbital_suture) <_0.5 ?_0.5;

{10 Supratemporal_fenestra_shape,_ratio_of_maximum_mediolateral_width_to_maximum_anteroposterior_length ?_1 >_1;

{11 Incisive_foramen_size,_ratio_of_maximum_mediolateral_width_to_the_mediolateral_width_of_the_rostrum_at_the_premaxilla-maxilla_suture <_0.3 ?_0.3;

{12 Suborbital_fenestra_shape,_ratio_of_maximum_mediolateral_width_to_maximum_anteroposterior_length: ?_0.5_ >_0.5;

{13 Choana_shape,_ratio_of_maximum_mediolateral_choanal_width_to_maximum_anteroposterior_length <_2 ?_2_;

{14 Pterygoid,_proportions_of_pterygoid_wing:_maximum_mediolateral_width_to_maximum_anteroposterior_length_ratio ?_3_ <_3;

{15 Basioccipital_tubera,_ratio_of_maximum_mediolateral_width_of_basioccipital_tubera_to_maximum_mediolateral_width_of_the_occipital_condyle <_2 ?_2;

{16 Number_of_maxillary_alveoli <_18 18-22 >_22;

{17 External_mandibular_fenestra_shape,_ratio_of_anteroposterior_length_(between_anterior_and_posterior_limits)_to_dorsoventral_height_(between_dorsal_and_ventral_limits) <_2.5 ?_2.5;

{18 External_mandibular_fenestra_shape,_minimum_angle_subtended_by_dorsal_margin_of_fenestra_and_the_horizontal <_25 ?_25;

{19 Articular,_retroarticular_process,_ratio_of_anteroposterior_length_(measured_from_the_transverse_ridge_to_the_posteriormost_tip_of_articular)_to_the_mediolateral_width_across_the_glenoid_fossa <_1.5 ?_1.5;

{20 Scapular_blade,_anteroposterior_?are_of_dorsal_end_(at_maturity):_angle_subtended_by_anterior_and_posterior_margins ?_35 <_35;

{21 Scapula-coracoid,_ratio_of_maximum_proximodistal_coracoid_length_to_maximum_proximodistal_scapula_length <_1.0 ?_1;

{22 Coracoid_shape,_ratio_of_maximum_expansion_of_distal_coracoid,_to_maximum_proximo-distal_coracoid_length <_0.5 ?_0.5;

{23 Ulna_length,_ratio_of_maximum_proximodistal_ulna_length_to_maximum_proximodistal_humeral_length <_0.7 ?_0.7;

{24 Femur_length,_ratio_of_maximum_proximodistal_femur_length_to_maximum_proximodistal_humeral_length_(at_maturity) <_1.2 ?_1.2;

{25 Ischial_blade_shape,_ratio_of_maximum_expansion_of_distal_ischial_blade_to_maximum_proximodistal_length_of_ischium <_0.5 ?_0.5;

{26 Rostral_ornamentation,_canthi_rostralii absent present;

{27 Rostral_ornamentation,_development_of_anterolaterally_directed_ridges_on_the_lateral_surface_of_the_rostrum_(at_maturity) absent present;

{28 Rostral_ornamentation,_dorsal_boss_on_sagittal_axis absent present;

{29 Rostral_ornamentation,_anteroposteriorly_orientated_preorbital_ridges_extending_from_the_anterior_corner_of_the_orbit_(at_maturity) absent present;

{30 Rostral_ornamentation,_transverse_ridge_between_the_orbits_(i.e._spectacle) absent present;

{31 Rostral_ornamentation,_morphology_of_the_transverse_orbital_ridge_(i.e._spectacle) low,_lacking_a_posterior_fossa tall,_with_deep_posterior_fossa;

{32 Rostral_ornamentation:_anterior_extent_of_transverse_bridge_between_orbits_(i.e._spectacle) posterior_to_anterior_orbital_margin level_with_or_anterior_to_anterior_orbital_margin_;

{33 Rostral_ornamentation,_extensive_fossa_extending_anteriorly_from_the_frontal_to_the_posterior_margin_of_the_external_naris absent present;

{34 Prefrontal,_prominence_at_anteromedial_orbital_margin not_thickened hypertrophied,_forming_rounded_protuberances;

{35 Cranial_table_ornamentation,_fossa_on_the_sutural_intersection_of_the_postorbital,_frontal_and_parietal absent present;

{36 Skull_table_morphology posterolateral_edges_directed_ventrolaterally_from_the_sagittal_axis_ planar_across_entire_length,_or_lateral_edges_directed_dorsolaterally_<20 _across_entire_length lateral_edges_directed_dorsolaterally_?_20 _along_entire_length;

{37 Cranial_table_ornamentation posterolateral_and/or_posterior_margin_of_squamosal_?at upturned_to_form_a_discrete_eminence_(i.e._a_squamosal_horn);

{38 Cranial_table_ornamentation,_squamosal_horn_position restricted_to_posterior_end_of_skull_table_ extends_anteriorly_along_the_whole_lateral_margin_of_the_skull_table_;

{39 Cranial_table_ornamentation,_direction_of_squamosal_horn_expansion_from_cranial_table dorsally_only dorsally_and_laterally;

{40 External_nares,_orientation projects_anterodorsally dorsally;

{41 External_nares,_development_of_bony_excrescence_(ghara)_in_reproductively_mature_males absent present;

{42 External_nares,_thin_crest_circumscribing_narial_margin absent present;

{43 Premaxilla,_notch_posterolateral_to_naris absent present;

{44 Premaxilla,_fossa_on_the_lateral_margin_of_the_naris absent present;

{45 Nasals,_external_contact_with_naris present absent;

{46 Nasals bisect_nares_completely protrude_partially_into_posterior_narial_margin_ excluded_internally_from_posterior_narial_margin;

{47 Nasals,_contact_with_premaxillae present_with_overlap_ present,_point_contact absent;

{48 Premaxilla-maxilla_suture,_anterior_limit_relative_to_posterior_margin_of_external_naris posterior_to level_with_or_anterior_to_;

{49 Premaxilla,_posterior_extent_of_dorsal_process terminating_level_with_or_anterior_to_the_third_maxillary_alveolus extending_posterior_to_third_maxillary_alveolus;

{50 Maxilla,_linear_array_of_pits_(cecal_recesses)_on_lateral_margin_of_narial_canal absent present;

{51 Maxilla,_posterior_extent_relative_to_anterior_margin_of_postorbital_bar
terminates_anterior_to_the_level_of_the_postorbital_bar
level_with_or_posterior_to_the_postorbital_bar_;

{52 Lacrimal,_sutural_contact_with_nasal present absent;

{53 Maxilla,_posterior_process_in_the_lacrimal absent present;

{54 Maxilla,_posterior_process_extends_between_lacrimal_and_prefrontal absent present;

{55 Maxilla,_posterior_process_extends_between_nasal_and_lacrimal absent present;

{56 Lacrimal,_mediolateral_width_in_relation_to_prefrontal
equal_to_or_greater_than_twice_the_maximum_prefrontal_width
less_than_twice_the_maximum_prefrontal_width_;

{57 Lacrimal,_anteroposterior_length_relative_to_that_of_prefrontal longer equal_in_length_ shorter;

{58 Prefrontals,_sutural_contacts_(at_maturity)
separated_by_frontal_and_nasals_at_maturity prefrontals_meet_medially;

{59 Frontal,_anterior_process_morphology
forms_an_acute,_?v?_shape_that_extends_anteriorly_into_posterior_margins_of_nasals
forms_broad_sutural_contact_with_the_nasals_or_prefrontals;

{60 Frontal,_position_of_tip_of_anterior_process_relative_to_anterior_tip_of_prefrontal
posterior_or_at_the_same_level anterior;

{61 Frontal,_position_of_tip_of_anterior_process_relative_to_anterior_orbital_margin anterior
level_with_or_posterior;

{62 Jugal,_anterior_extent_relative_to_anterior_tip_of_frontal
anterior_to_or_level_with_frontal posterior_to_frontal;

{63 Prefrontal,_linear_sulcus_adjacent_to_medial_orbital_margin absent present;

{64 Jugal,_suture_with_lacrimal long,_widely_separating_maxilla_from_orbital_margin
point_contact,_narrowly_separating_maxilla_from_orbital_margin jugal-lacrimal_contact_absent,_maxilla_contributes_to_orbital_margin;

{65 Prefrontal_pillar_morphology
dorsal_half_of_pillar_narrow,_less_than_twice_minimum_anteroposterior_length
equal_to_or_greater_than_twice_minimum_anteroposterior_length;

{66 Prefrontal_pillar,_morphology_of_medial_processes,_long_axis_orientation
dorsoventrally anteroposteriorly;

{67 Prefrontal_pillar_internal_morphology solid with_pneumatic_recess;

{68 Prefrontal_pillar,_morphology_of_medial_process_at_base_of_pillar wide constricted;

{69 Frontal,_ornamentation,_midsagittal_crest_on_fused_frontals absent present;

{70 Orbit,_ornamentation,_protuberance_on_the_frontal-prefrontal_suture_intersection_with_the_orbit absent present;

{71 Orbit,_dorsomedial_margin ?ush_with_skull_surface upturned projecting_into_orbit;

{72 Orbit,_position_of_posterior_margin_(measured_at_the_level_of_the_postorbital-frontal_suture)_relative_to_posterior_margin_of_suborbital_fenestra
posterior_to_or_at_the_same_level anterior;

{73 Orbit,_lateral-most_margin_relative_to_the_lateral_margin_of_the_maxilla_at_the_level_of_alveoli_3?6 lateral level_with_or_medial;

{74 Frontoparietal_suture,_intersection_with_supratemporal_fenestra_(at_maturity) deep_intersection,_postorbital-parietal_suture_not_exposed_on_skull_table frontoparietal_suture_incipiently_contacts_supratemporal_fenestra,_postorbital-parietal_suture_slightly_visible frontoparietal_suture_does_not_intersect_supratemporal_fenestra,_postorbital-parietal_contact_fully_exposed_on_skull_table;

{75 Frontoparietal_suture,_shape_between_supratemporal_fenestrae concavo-convex straight;

{76 Supraoccipital,_exposure_on_dorsal_skull_table present absent;

{77 Supraoccipital,_extent_of_exposure_on_skull_table small,_mediolateral_width_across_dorsal_supraoccipital_exposure_less_than_half_that_along_the_posterior_margin_of_the_parietal moderate,_medio-lateral_width_across_dorsal_supraoccipital_exposure_more_than_half_to_equal_that_along_the_posterior_margin_of_the_parietal large,_such_that_the_parietal_is_excluded_from_the_posterior_edge_of_skull_table;

{78 Supraoccipital,_posterolateral_tuberosities_in_dorsal_view not_visible visible;

{79 Supraoccipital,_acute_process_projecting_posteriorly_from_the_midline_of_the_cranial_table absent present;

{80 Supratemporal_fenestra,_morphology_of_fenestral_rim_(at_maturity) with_fossa,_dermal_bones_of_skull_roof_do_not_overhang_rim dermal_bones_overhang_rim_ supratemporal_fenestra_completely_closed;

{81 Skull_table_morphology,_acute_dorsal_indentation_on_the_supraoccipital_(and_sometimes_the_parietal) absent present;

{82 Parietal,_sagittal_crest_between_supratemporal_fenestrae absent present;

{83 Supratemporal_fenestra,_shallow_fossa_at_anteromedial_corner present absent;

{84 Parietal,_medial_wall_of_the_supratemporal_fenestra_with_one_or_more_foramina absent present;

{85 Parietal,_recess_communicating_with_pneumatic_system present absent;

{86 Supratemporal_fenestra,_posterior_wall quadrate_forms_entire_ventral_margin_of_orbitotemporal_canal_(no_parietal-squamosal_contact) quadrate_partially_forms_ventral_margin_of_orbitotemporal_canal_(parietal_and_squamosal_narrowly_separated) quadrate_excluded_from_ventral_margin_of_orbitotemporal_canal_(parietal_and_squamosal_in_contact);

{87 Supratemporal_fenestra,_posterior_wall squamosal-parietal_suture_passes_medially_to_the_orbitotemporal_foramen,_little_to_no_development_of_fossa_medial_to_orbitotemporal_foramen squamosal-parietal_suture_intersects_dorsal_margin_of_orbitotemporal_foramen,_large_medial_fossa squamosal-parietal_suture_intersects_dorsal_margin_of_orbitotemporal_canal,_medial_fossa_extends_over_entire_width_of_posterior_supratemporal_fenestra_wall;

{88 Postorbital,_morphology_of_postorbital_bar
anteroposteriorly_expanded,_elliptical_in_cross_section
columnar_and_slender,_circular_in_cross_section;

{89
Postorbital,_protuberance_on_the_dorsolateral_margin_of_the_postorbital_bar_(at_maturity)
present absent;

{90 Postorbital_bar,_orientation laterally_inclined,_greater_than_or_equal_to_20
_(bar_visible_in_dorsal_view) slightly_inclined_to_vertical,_lateral_inclination_<_20
_(not_visible_in_dorsal_view);

{91 Postorbital_bar ?ush_with_dorsolateral_margin_of_jugal
dorsolateral_margin_of_jugal_raised_to_form_ridge,_with_sulcus_separating_it_from_postorbital_bar;

{92 Jugal,_posterodorsal_jugal_foramen,_at_base_of_postorbital_bar
absent_or_small,_diameter_less_than_half_the_minimum_mediolateral_width_of_the_jugal_arch large,_equal_to_or_greater_than_half_the_minimum_jugal_arch_width;

{93 Orbit,_dorsal_pro?le_of_jugal_forming_posteroventral_margin
convex_or_straight,_continuous_with_the_dorsal_margin_of_the_lower_temporal_bar
posteroventrally_sloping,_gradually_descending_into_the_lower_temporal_bar
strongly_convex_with_a_step_anterior_to_the_lower_temporal_bar_
abruptly_angled_ventrally,_creating_a_near_vertical_margin_descending_toward_the_postorbital_bar_(i.e._a_notch);

{94 Jugal,_ventral_margin_of_jugal_arch concave straight;

{95 Jugal,_ventrolateral_sulcus_on_jugal_and_maxilla,_at_level_of_the_jugal-maxilla_suture
absent present;

{96 Jugal,_ventrolateral_foramina_adjacent_to_the_jugal-maxilla_suture
small,_less_than_half_the_diameter_of_the_last_maxillary_alveolus_(and_usually_numerous)
large,_equal_to_or_greater_than_half_the_diameter_of_the_last_maxillary_alveolus_(usually_2?3_foramina);

{97 Infratemporal_fenestra,_dorsal_margin_shape triangular broadly_curved,_oval-shaped_;

{98 Infratemporal_fenestra,_dorsal_extent_of_quadratojugal
reaches_dorsal_angle_of_fenestra does_not_reach_dorsal_angle_of_fenestra;

{99
Postorbital,_posteroventral_process_in_quadratojugal_at_dorsal_corner_of_the_infratemporal_fenestra absent present;

{100 Postorbital,_morphology_of_posteroventral_process_in_quadratojugal
narrow_with_acute_?V?_shaped_tip broad,_blunt_tip;

{101 Infratemporal_fenestra,_posterior_angle quadratojugal_forms_posterior_angle
quadratojugal-jugal_suture_lies_at_posterior_angle;

{102 Quadratojugal,_development_of_spina_quadratojugalis_(at_maturity) prominent
greatly_reduced_or_absent;

{103 Quadratojugal,_position_of_spina_quadratojugalis
low,_near_posterior_angle_of_infratemporal_fenestra
high,_between_posterior_and_dorsal_angles_of_infratemporal_fenestra;

{104
Postorbital,_medial_contact_with_quadrate_at_dorsal_corner_of_the_infratemporal_fenestra
absent present;

{105
Postorbital,_medial_contact_with_quadratojugal_at_dorsal_angle_of_infratemporal_fenestra
absent present;

{106 Squamosal,_anterior_divergence_of_dorsal_and_ventral_rims_of_lateral_groove
absent present;

{107 Squamosal,_shape_of_the_lateral_cranial_table_edge,_dorsal_to_the_otic_aperture
vertical,_dorsal_and_ventral_edges_equally_expanded_laterally
bevelled,_ventral_edge_projects_further_laterally_than_dorsal_edge;

{108
Squamosal,_angle_between_dorsal_pro?le_of_the_paroccipital_process_and_dorsal_margin_of_the_cranial_table <_10 _(approximately_horizontal) 10-50 >_50;

{109 Squamosal,_posterolateral_prongs
absent,_or_very_short,_barely_exceeding_the_level_of_the_posterior_wall_of_the_cranial_table_behind_supratemporal_fenestrae
long,_exceeding_the_level_of_the_posterior_margin_of_the_cranial_table,_less_than_half_anteroposterior_cranial_table_length
long,_greater_than_or_equal_to_half_anteroposterior_cranial_table_length;

{110 External_auditory_meatus,_position_of_ventral_margin
ventral_to_the_level_of_the_dorsal_margin_of_infratemporal_fenestra
level_with_or_dorsal_to_the_dorsal_margin_of_the_infratemporal_fenestra;

{111 Quadrate,_sutural_contact_with_squamosal_posterior_to_external_auditory_meatus
present
absent,_exoccipital_separates_squamosal_and_quadrate_posterior_to_external_auditory_meatus;

{112
Squamosal,_descending_lamina_extending_anteriorly_over_quadrate_ramus_from_paroccipital_process absent present;

{113 Quadrate-squamosal_suture,_intersection_with_external_auditory_meatus_(EAM)
extends_dorsally_along_posterior_margin_of_EAM_(suture_separated_from_posterior_margin)
extends_only_to_posteroventral_corner_of_EAM_(suture_incipiently_contacts_posterior_margin);

{114 External_auditory_meatus,_posterior_margin_shape straight invaginated;

{115 Quadrate,_foramen_aereum_size
small,_diameter_less_than_half_dorsoventral_height_of_medial_hemicondyle
large,_equal_to_or_greater_than_half_dorsoventral_height_of_medial_hemicondyle_;

{116 Quadrate,_foramen_aereum_position_on_posterior_quadrate_ramus
dorsomedial_corner dorsal_surface_;

{117 Quadrate_condyle,_notch_on_the_dorsal_articular_border
absent_or_small,_restricted_to_dorsomedial_edge_of_quadrate_articular_border

large,_as_an_extensive_indentation_of_the_dorsal_articular_1408
inset_from_dorsomedial_edge_of_the_condyle;

{118 Quadrate_condyle_shape,_dorsal_and_ventral_margins subparallel_across_length_(sub-rectangular_condyle) medially_tapering constricted_at_mid-length ventrally_re?ected_medial_hemicondyle;

{119 Quadratojugal,_extent_over_lateral_surface_of_posterior_quadrate_ramus covers_entire_lateral_surface notch_in_quadratojugal,_exposing_quadrate_ventrolaterally;

{120 Quadrate,_posterior_ramus_length
distance_between_posterior_margin_of_quadrate_condyle_and_the_level_of_the_anterior_margin_of_the_occipital_condyle,_less_than_quadrate_condyle_mediolateral_width
equal_to_or_greater_than_quadrate_condyle_mediolateral_width;

{121 Exoccipital,_extent_on_dorsal_surface_of_quadrate_ramus
small,_not_reaching_articular_border_of_quadrate_condyle
large,_extending_to_border_of_quadrate_condyle;

{122 Exoccipital,_posterior_projection_of_the_paroccipital_process absent present;

{123
Quadrate,_paroccipital_process,_distance_between_distal_tip_of_paroccipital_process_and_distal_end_of_the_quadrate_condyle
less_than_the_maximum_mediolateral_width_of_the_quadrate_condyle
equal_to_or_greater_than_the_maximum_mediolateral_width_of_the_quadrate_condyle;

{124 Exoccipital,_paroccipital_process_dorsal_margin squamosal-exoccipital_suture_sub-horizontal dorsolaterally_directed;

{125 Lateral_carotid_foramen,_proximity_to_metotic_foramen
separated_(positioned_ventral_to_metotic_foramen) adjacent_to_the_metotic_foramen_;

{126 Exoccipitals,_contact_with_basioccipital_tubera absent present;

{127 Exoccipitals,_posteroventral_inclination
absent,_occiput_vertical_and_not_visible_in_dorsal_view
present,_occiput_inclined_posteriorly,_visible_in_dorsal_view;

{128 Basioccipital,_orientation_of_lateral_margins_of_ventral_basioccipital_plate
parallel_or_ventrally_convergent ventrally_divergent_;

{129
Basioccipital,_dorsoventral_height_of_ventral_plate_exposed_below_occipital_condyle_relative_to_occipital_condyle_height greater_or_equal_in_height shorter;

{130 Basioccipital_and_ventral_portion_of_exoccipital_(otoccipital),_orientation_(at_maturity) inclined_anteriorly vertical;

{131 Basioccipital,_sagittal_crest_on_ventral_plate present absent;

{132
Basioccipital,_concavity_on_ventral_margin,_posterior_to_median_eustachian_foramen
absent present;

{133 Lateral_eustachian_foramina,_position_relative_to_medial_eustachian_foramen dorsal lateral_(at_same_level);

{134
Basisphenoid,_dorsoventral_exposure_ventral_to_basioccipital,_in_posterior_view_(at_maturity) little_to_no_exposure large_exposure;

{135 Pterygoid,_shape_of_posterior_process_ventrolateral_to_basioccipital tall,_long_axis_orientated_dorsoventrally dorsoventrally_short,_no_discernible_long_axis;

{136 Incisive_foramen,_intersection_of_premaxilla-maxilla_suture separated_by_inter-premaxillary_suture intersecting_at_posterior_margin_ intersecting_at_lateral_margin_;

{137 intersecting_at_lateral_margin_
absent_(anterior_margin_around_2nd_or_3rd_alveolus)
present_(projects_between_or_abuts_?rst_premaxillary_teeth);

{138 Incisive_foramen,_posterior_margin rounded
invaginated_by_anterior_process_of_premaxilla_(spade-shaped_foramen);

{139 Premaxilla,_number_of_teeth_early_in_post-hatching_ontogeny five four;

{140 _Premaxilla,_size_of_the_three_most_posterior_alveoli
penultimate_alveolus_is_the_largest
penultimate_and_antepenultimate_alveoli_are_largest_and_similar_in_size
antepenultimate_alveolus_is_largest alveoli_are_same_size;

{141
Premaxilla,_posterior_extent_on_palate,_relative_to_number_of_maxillary_alveoli,_in_ventral_view '0' '1' '2' '3' '4' 5_or_more;

{142
Premaxilla,_position_of_the_penultimate_premaxillary_alveolus_relative_to_the_antepenultimate_alveolus posterolateral_or_in_the_same_line posteromedial;

{143
Premaxilla,_position_of_the_last_premaxillary_alveolus_relative_to_the_penultimate_alveolus posterior_or_posterolateral posteromedial;

{144 Premaxilla,_alveolar_spacing_(at_maturity) all_alveoli_equally_separated
second_alveolus_separated_from_the_?rst_and_close_to_the_third;

{145 Premaxilla-maxilla_suture,_shape_on_palate_in_ventral_view horizontal
posteriorly_bowed,_with_one_rounded_apex posteriorly_bowed,_with_one_acute_apex_
posteriorly_bowed_with_two_or_more_apices;

{146 Maxilla,_number_of_the_largest_alveolus '3' '5' '4' 4_and_5 '6' '7'
maxillary_alveoli_gradually_increase_in_diameter_posteriorly_toward_penultimate_alveolus
homodont;

{147 Maxilla,_interalveolar_distances_between_alveoli_1?10
less_than_or_equal_to_diameter_of_?rst_maxillary_alveolus
greater_than_the_diameter_of_the_?rst_maxillary_alveolus;

{148 Maxilla,_shape_of_the_lateral_pro?le_between_alveoli_1_to_5 flaring_posteriorly
straight;

{149 Maxilla,_shape_of_the_toothrow_posterior_to_the_first_six_alveoli
laterally_convex_or_linear laterally_concave_;

{150 Occlusion_pattern all_dentary_teeth_occlude_lingual_to_maxillary_teeth_
partial_interlocking_occlusion,_with_at_least_one_pit_between_maxillary_teeth_5and8,_all_other_dentary_teeth_occlude_lingually
all_dentary_teeth_occlude_in_line_with_maxillary_teeth_;

{151 Occlusion_pattern
4th_dentary_tooth_occludes_in_notch_between_premaxilla_and_maxilla_early_in_ontogeny
occludes_in_a_pit_between_premaxilla_and_maxilla no_notch_early_in_ontogeny;

{152 Maxilla,_diastema_between_alveoli_5_and_6 absent present;

{153 Maxilla,_diastema_between_alveoli_6?8 absent present;

{154 Maxillary_and_dentary_alveoli,_shape all_circular_in_cross-section posterior_alveoli_mediolaterally_compressed all_alveoli_mediolaterally_compressed;

{155 Dentary_and_maxillary_teeth,_shape_behind_alveoli_12?13 pointed_to_slightly_blunt globular molariform,_multicusped;

{156 Maxillary_and_dentary_tooth_carinae smooth serrated;

{157 Maxilla,_position_of_alveoli_relative_to_maxillary_palate_separating_toothrows ventral_or_at_the_same_level dorsal;

{158 Maxilla,_size_of_foramen_for_palatine_ramus_of_cranial_nerve_V small_or_absent,_less_than_half_diameter_of_6th_maxillary_alveolus large,_equal_to_or_greater_than_half_diameter_of_6th_maxillary_alveolus;

{159 Palatine,_anterior_process_shape rounded_or_quadrangular wedge_shaped_(i.e._forms_a_?V?_shape_anteriorly);

{160 Palatine,_invagination_of_anterior_process absent present;

{161 Palatine,_anterior_process_position_relative_to_anterior_margin_of_suborbital_fenestra anterior_to,_and_at_the_level_of_more_than_two_full_alveoli anterior_to_and_at_the_level_of_two_or_fewer_full_alveoli at_the_same_level_or_posterior_to_anterior_margin_of_suborbital_fenestra;

{162 Palatine,_palatal_bar,_lamina_projecting_into_suborbital_fenestrae_from_anterolateral_margin absent present;

{163 Palatine,_palatal_bar,_orientation_of_posterolateral_margin_realtive_to_sagittal_axis sub-parallel_(<40) flared_(?_40);

{164 Palatine,_ventrolateral_?ear-shaped?_process_projecting_from_base_of_prefrontal_pillar absent present;

{165 Suborbital_fenestra,_position_of_anterior_margin_relative_to_anterior_orbital_margin anterior_to level_with,_or_posterior_to;

{166 Suborbital_fenestra,_anteromedial_margin,_intersection_of_maxilla-palatine_suture at_anteromedial_margin at_anterior_corner;

{167 Suborbital_fenestra,_anterolateral_margin_width,_distance_from_medial_edge_of_the_tooth row_to_fenestral_margin narrow,_less_than_or_equal_to_one_alveolus_width broader_than_one_alveolar_width_(usually_at_least_twice_alveolar_width);

{168 Suborbital_fenestra,_lateral_margin_shape straight projecting_medially_into_fenestra_;

{169 Suborbital_fenestra,_contribution_of_maxilla_to_medial_projection absent,_projection_entirely_formed_by_ectopterygoid present;

{170 Suborbital_fenestra,_posterolateral_margin_shape_at_ectopterygoid-pterygoid_suture_intersection straight bowed_anteromedially;

{171 Suborbital_fenestra,_posterior_margin,_intersection_of_palatine-pterygoid_suture at_posterior_corner on_the_posteromedial_margin_;

{172 Ectopterygoid,_anterior_extent_relative_to_maxillary_alveoli reaches_the_level_of_two_or_fewer_alveoli more_than_two_alveoli;

{173 Ectopterygoid,_anterior_extent_relative_to_anteroposterior_length_of_suborbital_fenestra less_than_two_thirds_of_fenestra_length equal_to_or_greater_than_two_thirds_of_fenestra_length;

{174 Ectopterygoid,_contact_with_maxillary_toothrow,_forming_the_medial_wall_of_at_least_one_maxillary_alveolus absent,_ectopterygoid-maxilla_suture_anteromedially_orientated_and_separated_from_toothrow_margin absent,_ectopterygoid-maxilla_suture_parallel_and_adjacent_to_medial_toothrow_margin present;

{175 Ectopterygoid,_morphology_of_anterior_maxillary_ramus_on_lateral_suborbital_fenestra_wall acute,_tapering_to_a_single_point forked;

{176 Ectopterygoid,_anterior_maxillary_ramus contacts_suborbital_fenestra separated_from_the_suborbital_fenestra_by_the_maxilla;

{177 Ectopterygoid,_position_relative_to_maxillary_alveoli restricted_to_medial_side_ forming_posterior_and_lateral_margins;

{178 Maxilla,_non-dentigerous_posterior_process_between_jugal_and_ectopterygoid short,_less_than_anteroposterior_length_across_last_three_maxillary_alveoli long,_equal_to_or_greater_than_anteroposterior_length_across_last_three_maxillary_alveoli ;

{179 Ectopterygoid,_dorsal_extent_along_medial_surface_of_postorbital_bar large,_extends_dorsal_to_level_of_ventral_orbital_margin small,_level_with_or_ventral_to_level_of_ventral_orbital_margin;

{180 Ectopterygoid,_morphology_of_posterior_process_on_the_medial_jugal_surface acute,_extends_beyond_level_of_posterior_margin_of_postorbital_bar acute,_terminating_before_posterior_margin_of_postorbital_bar rounded;

{181 Jugal,_extent_of_ectopterygoid_and_maxilla_on_medial_surface,_anterior_to_the_postorbital_bar minimal,_visible_jugal extensive,_covering_medial_surface_of_jugal;

{182 Quadratojugal,_anterior_process_on_medial_surface_of_lower_temporal_bar present absent_(or_very_modest);

{183 Jugal,_morphology_of_medial_foramen_anterior_to_postorbital_bar small_foramen large_recess;

{184 Ectopterygoid-pterygoid_suture,_shape_(at_maturity) straight kinked_(i.e._with_'flexure');

{185 Ectopterygoid,_posterior_extent_on_pterygoid_?ange reaches_posterior_tip_ _does_not_reach_posterior_tip;

{186 Choanae,_palatine_participation present,_forms_anterior_margin_of_choanae absent,_choanae_entirely_surrounded_by_the_pterygoids;

{187 Choanae,_position_of_anterior_margin anterior_to_posterior_margin_of_suborbital_fenestra

level_with_posterior_margin_of_suborbital_fenestra
posterior_to_posterior_margin_of_suborbital_fenestra;

{188
Choanae,_position_of_posterior_margin_relative_to_posterior_edge_of_pterygoid_?ange
anterior_to_or_at_the_same_level_as_the_posterior_edge_of_pterygoid_?ange
posterior_to_posterior_edge_of_pterygoid_flange;

{189 Choanae,_shape circular_or_elliptical sub-triangular,_tapering_posteriorly sub-rectangular_(long-axis_orientated_mediolaterally) sub-triangular,_tapering_anteriorly;

{190 Choanae,_anterior_margin_shape linear_o_curved invaginated;

{191 Choanae,_direction_of_choanal_projection_(at_maturity) posteroventrally
ventrally_to_anteroventrally;

{192 Choanae,_septum present absent;

{193 Choanae,_external_projection_of_septum
absent,_septum_remains_recessed_within_choanae
present,_septum_approaches_external_margin_of_choanae;

{194 Choanae,_ornamentation_of_margins
unornamented,_margins_(usually)_?ush_with_pterygoid_surface
elevated,_forming_a_wall_restricted_to_the_posterior_and_posterolateral_margins
elevated_forming_a_wall_which_extends_to_the_anterolateral_(but_not_anterior)_margins_of_the_choanae elevated,_forming_a_wall_which_completely_circumscribes_the_choanae;

{195 Choanae,_morphology_of_posterior_wall
not_notched,_or_with_broadly_rounded_notch_ acutely_notched;

{196 _Pterygoid,_surface_lateral_and_anterior_to_choanae flush
depressed_to_form_?neck?;

{197
Pterygoid,_ornamentation_lateral_to_choanae,_anteriorly_directed_ridges_on_the_pterygoid_extending_from_the_lateral_margins_of_the_choanae absent present;

{198 Pterygoid,_bulbous_differentiated_bullae_(at_maturity) absent present;

{199
Quadrate,_ventral_surface,_attachment_scar_for_posterior_mandibular_adductor_muscle,_morphology linear_crest ventrally_directed_knob;

{200 Basisphenoid,_exposure_between_basioccipital_and_pterygoids_in_ventral_view
not_or_poorly_exposed,_basisphenoid_anteroposteriorly_short
largely_exposed,_basisphenoid_anteroposteriorly_long;

{201 Jugal,_posterior_extent_relative_to_basioccipital_tubera
extends_beyond_level_of_posterior_margin_of_basioccipital_tubera_
level_with_or_anterior_to_posterior_margin_of_basioccipital_tubera;

{202 Basisphenoid_rostrum,_posteroventrally_directed_ridge_on_lateral_margins absent present;

{203
Basisphenoid,_exposure_on_the_lateral_braincase_wall,_anteroventral_to_the_trigeminal_foramen absent present;

{204 Basisphenoid,_sulcus_on_anterior_braincase_wall,_lateral_to_basisphenoid_rostrum present absent;

{205 Laterosphenoid,_orientation_of_capitate_process_anterior_margin perpendicular_to_the_sagittal_plane directed_anterolaterally_from_the_sagittal_plane;

{206 Laterosphenoid,_lateral_laterosphenoid_bridge_over_cavum_epiptericum absent present;

{207 Laterosphenoid,_lateral_laterosphenoid_bridge_morphology
short_process,_which_does_not_suture_to_the_pterygoid_ventrally
robust_process,_which_sutures_to_the_pterygoid_ventrally;

{208 Laterosphenoid,_caudal_laterosphenoid_bridge_over_cavum_epiptericum absent present;

{209 Laterosphenoid,_caudal_laterosphenoid_bridge_morphology
short_ventrally_directed_strut
long_ventral_process_joining_with_extra_process_of_the_quadrate
hypertrophied_wall,_which_bisects_the_foramen_ovale;

{210
Laterosphenoid,_ascending_process_of_the_pterygoid_forming_ventral_portion_of_lateral_laterosphenoid_bridge absent present;

{211 Epipterygoid present absent;

{212 Epipterygoid,_retraction_from_the_cavum_epitericum
epipterygoid_overhangs_cavum_epitericum epipterygoid_isolated_from_cavum_epitericum;

{213 Prootic,_exposure_on_external_braincase_wall
small,_little_to_no_exposure_dorsal_and_ventral_to_the_trigeminal_foramen
large_exposure_ventral_to_trigeminal_foramen_only
extensive_exposure_dorsal_and_ventral_to_trigeminal_foramen;

{214 Quadrate-pterygoid_suture,_path_on_lateral_braincase_wall_between_basisphenoid_exposure_and_foramen_ovale ventrally_de?ected straight;

{215 Dentary,_anteriormost_teeth strongly_procumbent,_appraoching_sub-horizontal
project_dorsally_or_steeply_anterodorsally;

{216 Dentary,_alveoli_3_and_4 confluent separate;

{217 Dentary,_dorsoventral_height_at_the_level_of_alveoli_1?4_relative_to_alveoli_11?12
at_same_level_or_higher lower;

{218 Dentary,_numerical_position_of_largest_alveolus_posterior_to_4_th_dentary_alveolus
13_and/or_14 13_and/or_14_and_a_posterior_series 10,_11_and/or_12
no_differentiation_posterior_to_4th_alveolus posterior_to_14;

{219 Dentary,_shape_of_dorsal_pro?le_between_4_th_and_10_th_alveoli_in_lateral_view
linear curved deeply_curved;

{220 Mandibular_symphysis,_posterior_extent,_adjacent_to_number_of_full_dentary_alveoli
<_6 6-8 9-12 13-20 >_20;

{221 Splenial,_participation_in_symphysis
full_participation,_dorsal_and_ventral_to_Meckelian_fossa
partial_participation_by_splenial_rostral_tip_ no_participation;

{222 Splenial,_position_of_anteriormost_tip_relative_to_Meckelian_fossa ventral dorsal;

{223 Splenial,_anterior_extent_in_dentary_symphysis adjacent_to_1_full_alveolus 2_to_3_alveoli 4_to_7_alveoli >_7_alveoli;

{224 Splenial,_shape_of_splenial-dentary_suture_adjacent_to_dentary_toothrow_(in_dorsal_view) constricted,_laterally_concave_(narrow_?V?-shape)_ straight_(wide_?V?-shape);

{225 Dentary_symphysis,_shape_of_posterior_margin_of_symphyseal_surface_in_medial_view dorsal_lobe_extends_further_posterior_than_ventral_lobe dorsal_and_ventral_lobes_subequal_in_extent,_or_ventral_lobe_projects_further_posterior_than_dorsal_lobe;

{226 Dentary,_orientation_of_posteriormost_alveoli in_a_straight_line in_a_laterally_curved_line;

{227 Dentary,_posterior_process_between_angular_and_splenial_on_ventral_side_of_the_mandible absent present;

{228 Splenial,_anterior_perforation_for_mandibular_ramus_of_cranial_nerve_V_(i.e._foramen_intermandibularis_oralis) present absent;

{229 Splenial,_posterior_perforation(s)_for_mandibular_ramus_of_cranial_nerve_V absent present;

{230 Splenial,_number_of_posterior_perforations_for_mandibular_ramus_of_cranial_nerve_V one two;

{231 Splenial,_shape_of_dorsal_pro?le straight_(anterodorsally_inclined) concave_(abruptly_dorsally_inclined_at_posterior_end);

{232 Splenial,_anterior_process_within_the_dentary,_medial_to_the_posterior_toothrow absent present;

{233 External_mandibular_fenestra absent present;

{234 External_mandibular_fenestra,_size narrow_slit,_no_discrete_fenestral_concavity_on_angular_dorsal_margin,_foramen_intermandibularis_caudalis_not_visible moderate_discrete_concavity_on_angular_dorsal_margin,_foramen_intermandibularis_caudalis_not_visible large,_most_of_foramen_intermandibularis_caudalis_visible;

{235 Surangular-dentary_suture,_intersection_with_external_mandibular_fenestra anterior_to_posterodorsal_corner at_posterodorsal_corner;

{236 Surangular-angular_suture,_intersection_with_external_mandibular_fenestra_(at_maturity) at_posterodorsal_angle at_posterior_margin passes_broadly_along_ventral_margin;

{237 Dentary,_acute_posterior_process_in_the_angular_ventral_to_the_external_mandibular_fenestra present absent;

{238 Angular_and_surangular margins_?ush_with_lateral_surface_of_mandible margins_everted_forming_flange;

{239 Angular,_fossa_for_M._pterygoideus_ventralis visible_on_posterolateral_surface_of_the_mandible not_visible_on_posterolateral_surface;

{240 Surangular,_relative_length_of_the_anterior_processes unequal,_ventral_process_<75%_anteroposterior_length_of_dorsal_process_(measured_from_surangular_foramen) sub-equal,_ventral_process_?75%_length_of_dorsal_process;

{241 Surangular,_anterodorsal_process_(spur)_lingual_to_posterior_most_dentary_alveoli,_between_splenial_and_dentary present absent;

{242 Surangular,_anterodorsal_process_(spur),_anterior_extent not_reaching_1_full_alveolus reaching_1?2_alveoli reaching_3_or_more_alveoli;

{243 Surangular,_ascending_process_on_lateral_wall_of_glenoid_fossa present absent;

{244 Surangular,_posterior_extent_on_lateral_margin_of_retroarticular_process reaches_posterior_tip pinches_out_anterior_to_posterior_tip;

{245 Surangular,_sulcus_on_dorsal_margin_lateral_to_glenoid_fossa absent present;

{246 Surangular-articular_suture,_shape_in_glenoid_fossa straight,_oriented_anteroposteriorly bowed_laterally;

{247 Articular,_position_of_foramen_aerum at_medial_margin_of_retroarticular_process inset_from_medial_margin_of_retroarticular_process;

{248 Articular,_lamina_extending_from_posterior_edge_of_foramen_aerum absent present;

{249 Articular,_orientation_of_retroarticular_process projects_posteriorly projects_posterodorsally;

{250 Articular,_dorsal_extent_of_retroarticular_process at_the_same_level_or_ventral_to_posterior_edge_of_articular_ dorsal_to_posterior_edge_of_articular_fossa;

{251 Articular,_sharp_longitudinal_crest_on_dorsal_surface_of_retroarticular_process absent present;

{252 Articular,_lingual_foramen_for_articular_and_alveolar_nerve perforates_surangular_only perforates_surangular-articular_suture;

{253 Articular,_anterior_process_on_posterior_wall_of_adductor_chamber absent present;

{254 Articular,_position_of_anterior_process_on_posterior_wall_of_adductor_chamber dorsal_to_lingual_foramen ventral_to_lingual_foramen;

{255 Surangular-angular_suture,_lingual_intersection_with_articular_in_the_?oor_of_the_adductor_chamber at_ventral_tip dorsal_to_ventral_tip;

{256 Angular,_anterior_extent_relative_to_foramen_intermandibularis_caudalis_(FIC)_(in_medial_view) extends_anteriorly_beyond_half_the_anteroposterior_length_of_the_FIC terminates_at,_or_posterior_to_the_anteroposterior_mid-length_of_the_FIC;

{257 Splenial,_acute_posterior_process_separating_angular_and_coronoid present absent;

{258 Foramen_intermandibularis_medius_(FIM),_anteroposterior_length_relative_to_foramen_intermandibularis_caudalis_(FIC) short,_less_than_25%_FIC_length long,_equal_to_or_greater_than_25%_FIC_length;

{259 Coronoid,_position_of_foramen_intermandibularis_medius_(FIM)_(at_maturity) on_coronoid-splenial_suture entirely_within_coronoid;

{260
Coronoid,_anterior_extent_relative_to_level_of_anterior_margin_of_foramen_intermandibula
ris_caudalis_(FIC) anterior at_the_same_level_or_posterior;

{261 Coronoid,_orientation_of_dorsal_pro?le inclined_anteriorly_across_entire_length
horizontal_towards_posterior_end;

{262
Coronoid,_prominent_medioventral_lamina_extending_over_inner_(medial)_surface_of_Mec
kelian_fossa present absent;

{263 Proatlas,_acute_anterior_process
present,_anterolateral_margin_of_proatlas_prominently_concave
absent,_anterior_margin_of_proatlas_straight_or_convex;

{264 Proatlas,_dorsal_keel present absent;

{265 Atlas_intercentrum,_shape_in_lateral_view wedge-shaped plate-shaped;

{266 Atlantal_rib,_dorsal_margin_shape straight,_or_with_modest_process
with_prominent_process;

{267 Atlantal_rib,_thin_medial_lamina_at_proximal_end absent present;

{268 Atlantal_rib,_proximal_articular_facet_for_opposing_atlantal_rib absent present;

{269
Odontoid_process:_mediolateral_width_across_axial_rib_facets,_relative_to_mediolateral_w
idth_across_axial_tubercula_facets narrower subequal;

{270 Axial_rib,_tuberculum_shape short_and_broad,_equal_in_size_to_capitulum_
long_and_acute,_narrower_than_capitulum;

{271 Axial_rib,_tuberculum,_contact_with_axial_diapophysis
absent,_or_occurs_late_in_ontogeny present_early_in_ontogeny;

{272 Axis,_neural_spine,_anterior_half_of_dorsal_margin_in_lateral_view_(at_maturity)
horizontal slopes_such_that_it_faces_anterodorsally;

{273 Axis,_neural_spine,_posterior_half dorsally_in?ected_to_form_crest
continuous_with_anterior_half,_not_crested;

{274 Axis,_neural_spine,_shape_of_distal_end dorsoventrally_thick dorsoventrally_thin,_rod-like;

{275 Axis,_lateral_process_(diapophysis)_on_neural_arch_lateral_margin absent present;

{276 Axis,_hypapophysis_position located_towards_centre_of_centrum_
toward_anterior_end_of_centrum;

{277 Axis,_hypapophysis_shape un-forked forked;

{278 Prominent_cervical_hypapophyses present absent;

{279
First_postaxial_vertebra_(Cv3),_anteroposterior_length_at_the_distal_end_of_the_neural_s
pine long,_greater_than_or_equal_to_half_the_length_of_the_non-condylar_centrum
short,_dorsal_tip_acute_and_less_than_half_the_length_of_the_non-condylar_centrum;

{280 Cervical_centra amphicoelous_(both_articular_surfaces_concave)
procoelous_(anterior_articular_surface_concave,_posterior_articular_surface_convex);

{281 Posterior_cervical_vertebrae_(C7?C9),_anterior_extent_of_hypapophyses_(C7?C9) level_with,_or_anterior_to_the_level_of_anterior_margin_of_the_prezygapophyses posterior_to_the_level_of_anterior_margin_of_prezygapophyses;

{282 Cervical_rib_8,_length_in_proportion_to_cervical_rib_9 long,_greater_than_half_the_length_of_cervical_rib_9 short,_equal_to_or_less_than_half_the_length_of_cervical_rib_9;

{283 Hypapophyseal_keels,_posterior_retention until_10th_postatlantal_vertebra_(Dv2) 11th_postatlantal_vertebra_(Dv3) 12th_postatlantal_vertebra_(Dv4);

{284 Dorsal_centra amphicoelous procoelous;

{285 Dorsal_vertebrae,_maximum_mediolateral_width_across_both_transverse_processes_at_vertebrae_7-10 equal_to_or_greater_than_twice_the_equivalent_width_on_DV1 less_than_twice_the_equivalent_width_on_DV1;

{286 Dorsal_vertebrae,_fusion_of_the_diapophysis_and_parapophysis,_occurrence anterior_to_or_on_the_12th_dorsal_vertebra_ on_the_13th_dorsal_vertebra;

{287 Presacral_vertebrae,_maximum_mediolateral_width_across_prezygapophyses sub-equal_throughout increases_posteriorly_throughout_presacral_vertebrae;

{288 Sacral_vertebra_1,_anterior_extent_of_sacral_rib_capitulum anterior_to_tuberculum_(visible_in_dorsal_view) at_the_same_level_as_tuberculum_(obscured_in_dorsal_view);

{289 Sacral_vertebra_2,_posterior_extent_of_ribs extend_beyond_level_of_posterior_extent_of_postzygapophyses terminate_level_with_or_anterior_to_level_of_postzygapophyses;

{290 Caudal_vertebra_1,_centrum opisthocoelous_or_procoelous biconvex;

{291 Caudal_centra,_posterior_to_?rst_caudal_vertebra procoelous amphicoelous_or_opisthocoelous;

{292 Caudal_vertebrae,_number_with_transverse_processes ?rst_15_or_fewer 16_to_20_ 21_or_more;

{293 Caudal_vertebrae,_articular_surfaces_of_chevrons_posterior_to_the_?rst open,_or_partially_fused completely_fused;

{294 Hyoid,_shape_of_dorsal_projection_(cornu) plate-shaped rod-shaped;

{295 Hyoid,_?are_of_dorsal_projection_(cornu) absent present;

{296 Interclavicle_flexure minimal_dorsoventral_flexure,_minimum_angle_between_anterior_and_posterior_ends_<15 moderate_dorsoventral_flexure,_minimum_angle_15?25 severe_dorsoventral_flexure,_minimum_angle_>_25;

{297 Interclavicle,_shape_of_anterior_end_(at_maturity) plate-shaped rod-shaped;

{298 Scapula,_deltoid_crest_shape thin,_with_sharp_margin wide,_with_broad_margin;

{299 Scapulocoracoid_synchondrosis closes_very_late_in_ontogeny closes_early_in_ontogeny;

{300 Scapulocoracoid_facet,_shape_anterior_to_glenoid_fossa_(at_maturity) uniformly_narrow broad_immediately_anterior_to_glenoid_fossa,_tapering_anteriorly;

{301 Humerus,_proximal_margin_of_deltopectoral_crest straight,_emerging_smoothly_from_proximal_end_of_the_humerus concave,_emerging_abruptly_from_proximal_end_of_humerus;

{302 Humerus,_axial_rotation_of_the_proximal_epiphysis_relative_to_the_distal_epiphysis small,_ventral_surface_of_the_proximal_epiphysis_not_visible_in_medial_view_ large,_ventral_surface_exposed_in_medial_view;

{303 Humerus,_scarring_on_proximodorsal_surface_for_M._teres_major_and_M._dorsalis_scapulae_(at_maturity) two_muscle_scars single_muscle_scar_(M._teres_major_and_M._dorsalis_scapulae_insert_on_common_tendon);

{304 Ulna,_shape_of_olecranon_process narrow_and_sub-angular_ wide_and_rounded;

{305 Ulna,_proximal_diaphysis curved straight;

{306 Ilium,_preacetabular_process_shape acute,_pointed_anteriorly broad,_rounded_anteriorly;

{307 Ilium,_dorsal_outline_of_postacetabular_process convex,_no_dorsal_indentation broadly_concave_with_a_small_indentation strongly_concave,_with_an_acute_indentation_(?wasp-waisted?);

{308 Ilium,_posterior_margin_of_the_postacetabular_process deep,_anteroposterior_length_to_dorsoventral_height_ratio_<_1 shallow,_length_to_height_?1;

{309 Ilium,_postacetabular_process projects_posteriorly posterodorsally;

{310 Cerebrum,_posterodorsal_outline_anterior_to_optic_lobe flat with_sharp_step;

{311 Medial_pharyngeal_sinus,_ratio_of_ventral_length_(measured_from_ventral_tip_to_junction_with_basisphenoid_diverticulum)_to_dorsal_length_(measured_from_basisphenoid_diverticulum_to_dorsal_tip) ?2 <_2;

{312 Keratinised_buccal_cavity present absent;

{313 Integumentary_sensory_organs,_distribution_on_body cranial_only cranial_and_postcranial;

{314 Ventral_scales,_follicle_gland_pore present absent;

{315 Ventral_collar_scales not_enlarged_relative_to_other_ventral_scales in_1?2_enlarged_rows;

{316 Tail_dorsal_scalation,_number_of_transverse_scale_rows_from_the_level_of_the_cloacal_vent_to_the_point_of_convergence_of_paired_mid-dorsal_crests_into_a_single_longitudinal_crest >_13 ?13;

{317 Palpebral,_number_of_ossi?cations one two_or_more;

{318 Palpebral,_size_in_relation_to_orbit small,_covering_no_more_than_half_the_area_of_the_orbit large,_covering_more_than_half_the_orbit_(usually_completely_concealing_it);

{319 Tongue,_lingual_osmoregulatory_pores large,_1?2_mm_ small,_<_1_mm_;

{320 Postoccipital_osteoderms,_number_of_rows two_or_more one;

{321 Nuchal_osteoderms grade_continuously_into_dorsal_shield differentiated_from_dorsal_shield;

{322 Number_of_nuchal_osteoderms four six eight_or_more;

{323 Dorsal_osteoderms,_maximum_number_in_the_middle_transverse_row_(at_maturity) two four six eight ten;

{324 Dorsal_osteoderms,_longitudinal_midline_keel absent present;

{325 Dorsal_midline_osteoderm_shape rectangular,_width_to_length_ratio_>_1 approximately_square,_width_to_length_ratio_?_1;

{326 Dorsal_midline_osteoderms,_anterolateral_process present absent;

{327 Ventral_osteoderms absent_(or_poorly_developed) present,_single_ossi?cation present,_paired_ossi?cation;

{328 Tail_armour partial_covering_(usually_?_10_transverse_rows_of_contiguous_osteoderms_posteriorly_from_the_level_of_caudal_vertebra_one) tail_completely_encased_in_osteoderms;

{329 Limb_armour forelimbs_and_hindlimbs_lack_osteoderms,_or_weakly_armoured_with_patches_of_poorly_developed_osteoderms densely_covered_in_well-formed_osteoderms;

;

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Ancstates

-0 -1 -2 -3 -4 -5 -6 -7 -8 -9

-10 -11 -12 -13 -14 -15 -16 -17 -18 -19

-20 -21 -22 -23 -24 -25 -26 -27 -28 -29

-30 -31 -32 -33 -34 -35 -36 -37 -38 -39

-40 -41 -42 -43 -44 -45 -46 -47 -48 -49

-50 -51 -52 -53 -54 -55 -56 -57 -58 -59

-60 -61 -62 -63 -64 -65 -66 -67 -68 -69

-70 -71 -72 -73 -74 -75 -76 -77 -78 -79

-80 -81 -82 -83 -84 -85 -86 -87 -88 -89

-90 -91 -92 -93 -94 -95 -96 -97 -98 -99

-100 -101 -102 -103 -104 -105 -106 -107 -108 -109

-110 -111 -112 -113 -114 -115 -116 -117 -118 -119

-120 -121 -122 -123 -124 -125 -126 -127 -128 -129

-130 -131 -132 -133 -134 -135 -136 -137 -138 -139

-140 -141 -142 -143 -144 -145 -146 -147 -148 -149

-150 -151 -152 -153 -154 -155 -156 -157 -158 -159

-160 -161 -162 -163 -164 -165 -166 -167 -168 -169

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 -170   -171   -172   -173   -174   -175   -176   -177   -178   -179
 -180   -181   -182   -183   -184   -185   -186   -187   -188   -189
 -190   -191   -192   -193   -194   -195   -196   -197   -198   -199
 -200   -201   -202   -203   -204   -205   -206   -207   -208   -209
 -210   -211   -212   -213   -214   -215   -216   -217   -218   -219
 -220   -221   -222   -223   -224   -225   -226   -227   -228   -229
 -230   -231   -232   -233   -234   -235   -236   -237   -238   -239
 -240   -241   -242   -243   -244   -245   -246   -247   -248   -249
 -250   -251   -252   -253   -254   -255   -256   -257   -258   -259
 -260   -261   -262   -263   -264   -265   -266   -267   -268   -269
 -270   -271   -272   -273   -274   -275   -276   -277   -278   -279
 -280   -281   -282   -283   -284   -285   -286   -287   -288   -289
 -290   -291   -292   -293   -294   -295   -296   -297   -298   -299
 -300   -301   -302   -303   -304   -305   -306   -307   -308   -309
 -310   -311   -312   -313   -314   -315   -316   -317   -318   -319
 -320   -321   -322   -323   -324   -325   -326   -327   -328   -329
;
xgroup
;
agroup
;
taxcode
+0    +1    +2    +3    +4    +5    +6    +7
+8    +9    +10   +11   +12   +13   +14   +15
+16   +17   +18   +19   +20   +21   +22   +23
+24   +25   +26   +27   +28   +29   +30   +31
+32   +33   +34   +35   +36   +37   +38   +39
+40   +41   +42   +43   +44   +45   +46   +47
+48   +49   +50   +51   +52   +53   +54   +55
+56   +57   +58   +59   +60   +61   +62   +63
+64   +65   +66   +67   +68   +69   +70   +71
+72   +73   +74   +75   +76   +77   +78   +79
+80   +81   +82   +83   +84   +85   +86   +87
+88   +89   +90   +91   +92   +93   +94   +95
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+96    +97    +98    +99    +100   +101   +102   +103
+104   +105   +106   +107   +108   +109   +110   +111
+112   +113   +114   +115   +116   +117   +118   +119
+120   +121   +122   +123   +124   +125   +126   +127
+128   +129   +130   +131   +132   +133   +134   +135
+136   +137   +138   +139   +140   +141   +142   +143
+144   +145
;
blocks 0;
tshrink
;
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APPENDIX 2: Supplementary information and data for Chapter 2

1. Supplementary Table of worldwide Diplocynodon *occurences*

	to count	new identification (this	Accepted name	Country	Locality	Miocene	REF	with no	with	figured	described	articulate	known	genus	genus	genus	species	species	species	species	species	disarticula	teeth	osteoder	cranial	mandible	postcrani	only jaw	only	only teeth	only	only
	1	Crocodylia indet.	Diplocynodon sp.	Germany	Walbeck (Weferlingen), Germany		Kuhn 1940	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0
	1	Diplocynodon remensis	Diplocynodon remensis	France	Cernay, Lemoine Quarry, France		Martin et al. 2014	0	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon remensis	Diplocynodon remensis	France	Mont Berru; Mouras Quarry; Cernay, France		Martin et al. 2014	0	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Portugal	Silveirinha clay pit, Silveirinha Pequena, Portugal		Antunes 2003	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	France	Prémontré, Anizy-Le-Chateau, France		Augé et al. 1997	0	1	0	1	0	0	1	0	1	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	France	Meudon, France		Russell et al. 1988	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	France	Le Quesnoy (QNY2), France		Hua 2004	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0
	1	cf. Allognathosuchus	aff. Diplocynodon sp.	France	Le Quesnoy (QNY2), France		Hua 2004	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Belgium	Dormaal, Orsmael, Belgium		Buffetaut 1985	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	France	Rouzilhac, France		Godinot et al. 2018	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0
	1	impossible	Diplocynodon sp.	Spain	Casaseca de Campean (Z-5), Las Zorras, La Laguna, Spain		Ortega et al. 2022	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Spain	Cubillos, Cubillos-Monfarracinos, Valdegallina, Tardemayas,		Ortega et al. 2022	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Spain	Corrales del Vino, Spain		Fuentes 2003	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Spain	Fuente el Carnero, Spain		Ortega et al. 2022	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Spain	Jambrina, Spain		Ortega et al. 2022	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Spain	Cerro del Viso (Z-11), El Viso, Madridanos, Spain		Fuentes et al. 1993	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
	1	impossible	Diplocynodon sp.	France	Hill of La Défense (Puteaux), France		Ginsburg et al. 1977	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon darwini	Diplocynodon darwini	Germany	Geiseltal, Mittelkohle, Zone III, Germany		Kuhn 1938; Hastings & Helmund 2015; Ludwig 1877	0	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	cf. Diplocynodon sp.	Ukraine	Ikovo, Novopskov		Kuzmiv & Znovok 2021	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon sp.	Spain	Cazurra, Spain		Alonso Santiago et al. 2008	0	1	1	0	0	0	1	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon tormis	Spain	Teso de la Flecha, Spain		Jiménez Fuentes 1983	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon deponiae	Diplocynodon deponiae	Germany	Messel, Germany		Delfino & Smith 2012	0	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Germany	Eckfeld Maar, Germany		Windolf, 1994	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0
	1	Diplocynodon darwini	Diplocynodon darwini	Germany	Messel, Germany		Ludwig 1877	0	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1	Crocodylia indet.	cf. Diplocynodon sp.	Czech Republic	Kučlín, Trupelník Hill		Chroust et al. 2019	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0
	1	Crocodylia indet.	Diplocynodon tormis	Spain	Duero basin, Spain		Buscalioni et al. 1992	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon tormis	Spain	Aldearrubia-Babilafuente, Spain		Ortega et al. 2022	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Spain	Mazateròn, La Solana, Spain		Ruiz-colmenares & Fuentes 1993	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0
	1	impossible	Diplocynodon tormis	Spain	San Morales, Spain		Ortega et al. 2022	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon sp.	France	Sainte Néboule, Saint-Dezery, France		Buffetaut 1978	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Zambrana		Astibia et al. 2000	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon elavericus	France	Domérat, Montluçon, Domérat basin		Martin 2010	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon hantonier	Diplocynodon hantoniensis	UK	Hordle Cliff Crocodile Bed, Hampshire, Hordwell, UK		Rio et al. 2020	0	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon hantonier	Diplocynodon hantoniensis	UK	Headon Hill Lignite Bed, Isle of Wight, UK		Rio et al. 2020	0	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon kochi	Diplocynodon kochi	Romania	Rădaia		Venczel 2023	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0
	1	Diplocynodon kochi	Diplocynodon kochi	Romania	Treznea		Venczel 2023	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	1	0	1	1	0	0	0	0	0	0
	1	Diplocynodon kochi	Diplocynodon kochi	Romania	Leghia		Venczel 2023	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	1	0	0	1	1	0	0	0	0	0
	1	Diplocynodon kochi	Diplocynodon kochi	Romania	Cluj-Manastur		Venczel & Codrea 2022	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Czech Republic	Roudníky (drilling Ru 60,		Böhme 2007	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Crocodylia indet.	cf. Diplocynodon sp.	France	Grandes Platières		Delamette & Remy 2013	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0
	1	Diplocynodon monsvial	Diplocynodon muelleri	Spain	El Talladell, TÃ rrega, Spain		Piras & Buscalioni 2006	0	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Belgium	Hoogbutsel, Belgium		Smith 2003	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon monsvial	Diplocynodon muelleri	Italy	Ligniti di Monteviale, Italy		Macaluso et al. 2019	0	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Romania	Suceag 1		Codrea & Venczel 2020	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0
	1	impossible	Diplocynodon sp.	Czech Republic	Bechlejovice near		Böhme 2007	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Crocodylia indet.	cf. Diplocynodon sp.	Czech Republic	Dětaň ~20 km SW Žatec,		Chroust et al. 2019	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0
	1	Crocodylia indet.	cf. Diplocynodon sp.	Czech Republic	Kundratice 4 km NNW		Chroust et al. 2019	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0
	1	impossible	Diplocynodon sp.	Czech Republic	Lukavice, , Czech		Böhme 2007	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Crocodylia indet.	cf. Diplocynodon sp.	Czech Republic	Větruše hill in the Ústí		Chroust et al. 2019	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0
	1	Diplocynodon sp.	Diplocynodon gervaisi	France	Ronzon near Le Puy,		Gervais 1859; pers. data	0	1	1	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0
	1	Diplocynodon sp.	Diplocynodon sp.	Germany	Borken open pit mine		Rio et al. 2020	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon sp.	Germany	Espenhain near Leipzig,		Karl 2007	0	1	0	1	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0
	1	impossible	?Diplocynodon sp.	Germany	Neumühle near		Karl & Tichy 1999	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
	1	impossible	Diplocynodon sp.	Germany	Espenhain/Sachsen, Germany		Karl 2007	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
	1	Diplocynodon ratelii	Diplocynodon ratelii	France	Between Céreste and Apt, France		Brinkmann & Rauhe 1998	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	?Diplocynodon sp.	Germany	Neumuhle bei Weinheim, Germany		Karl & Tichy 1999	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	France	Aubenas-les-Alpes		Menouret 2014	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	cf. Diplocynodon sp.	Germany	Enspel, Germany		Tütken & Absolon 2015	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
	1	impossible	Diplocynodon ratelii	Germany	Rott, Germany		Mörs 2002	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Germany	Oberleichtersbach, Germany		Böhme 2008	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0
	1	Diplocynodon levantinic	Diplocynodon levantinicum	Bulgaria	Nadeshda underground mine, Kipra coal-seam; 4.5 km NNE		Massonne & Bohme 2022	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	0	1	1	1	0	0	0	0	0	0
	1	Diplocynodon levantinic	Diplocynodon levantinicum	Bulgaria	Radievo 1 underground mine, Kipra coal-seam; Dimitrovgrad		Massone & Bohme 2022	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	France	Pech-du-Fraysse, Saint-		De Bonis et al. 1973	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon sp.	France	Toulouse Puits		Antoine et al. 2006	0	1	0	1	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0
	1	Diplocynodon sp.	Diplocynodon cf. ratelii	France	Venelles 35 km N		Buffetaut & Cornée 1982	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Germany	Gusternhain, Germany		Ludwig 1877	0	1	1	0	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon sp.	Germany	Sieblos		Böhme et al. 2005	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	As Pontes coal seam package H, Spain		Cabrera et al. 1994	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon sp.	Switzerland	Wallenried WallA	1	Mennecart et al. 2016	0	1	1	0	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales Barranc	1	Murelaga et al. 2002	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales Barranc	1	Murelaga et al. 2002	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales La Nasa	1	Murelaga et al. 2002	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales La Nasa	1	Murelaga et al. 2002	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales La Nasa	1	Murelaga et al. 2002	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales La Nasa	1	Murelaga et al. 2002	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales La Nasa	1	Murelaga et al. 2002	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales La Nasa	1	Murelaga et al. 2002	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales Barranc	1	Murelaga et al. 2002	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales Barranc	1	Murelaga et al. 2002	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales Barranc	1	Murelaga et al. 2002	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales Barranc	1	Murelaga et al. 2002	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales Barranc	1	Murelaga et al. 2002	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales Cabezo	1	Murelaga et al. 2002	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales Cabezo	1	Murelaga et al. 2002	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales Barranc	1	Murelaga et al. 2002	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales Barranc	1	Murelaga et al. 2002	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	Spain	Bardenas Reales RincÃ³n	1	Murelaga et al. 2002	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon cf. ratelii	Diplocynodon cf. ratelii	France	Venelles	1	Buffetaut & Cornèe 1982	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon ungeri	Austria	Obritzberg	1	Thenius 1960	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	1	cf. Diplocynodon sp.	cf. Diplocynodon sp.	Hungary	Mariahalom	1	Kocsis et al. 2023	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon ungeri	France	Channay-sur-Lathan	1	Spijkerman 2010	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0
	1	impossible	cf. Diplocynodon sp.	Spain	Les Cases de Valenciana	1	Jovells-Vaqué et al. 2018	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon	Germany	Langenau 1	1	Sach & Heizmann 2000	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon	Germany	Langenau 2	1	Sach & Heizmann 2000	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon	Germany	Illerkirchberg 1	1	Sach & Heizmann 2000	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon	Germany	Baggersee Freudenegg 3	1	Sach & Heizmann 2000	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon ratelii	Diplocynodon ratelii	Czech Republic	Tusimice	1	Lujan et al. 2019	0	1	1	1	1	0	0	0	0	1	0	1	0	0	1	0	0	1	1	1	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon	Turkey	4 km N of Tuzluca	1	Sen et al. 2011	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0
	1	impossible	Diplocynodon	Germany	Grimmelfingen	1	Sach & Heizmann 2000	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Bezian	1	Ginsburg & Bulot 1997	0	1	1	1	1	0	0	0	0	1	0	1	0	1	1	1	1	1	1	1	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Aerotrain a Chevilly pres d'.	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	0	1	1	1	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Artenay	1	Ginsburg & Bulot 1997	0	1	0	1	1	0	0	0	0	1	0	1	0	1	1	1	1	1	1	1	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Baigneaux-en-Beauce	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Chevilly	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Pellecahus a La Romieu	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	0	1	1	0	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Suèvres aux Imberts	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon sp.	Czech Republic	Blov	1	Štúr 1873; Chroust 2016	0	1	1	0	0	0	1	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon sp.	Czech Republic	Břešťany (Preschen)	1	Liebus 1936	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	(vertebrae)	0	0	0	0	1
	1	Crocodylia indet.	Diplocynodon cf. darwini	Czech Republic	Skyrice opencast Marianna	1	Laube 1910	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0
	1	impossible	Diplocynodon sp.	Germany	Adelschlag	1	Schlosser 1916	1	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon cf. ratelii	Germany	Hessler, Wiesbaden-Biebri	1	Schleich 1988	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon ungeri	Germany	Burtenbach	1	Abdul-Aziz et al. 2010	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon ungeri	Germany	Ichenhausen	1	Abdul-Aziz et al. 2010	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon ungeri	Germany	Offingen	1	Abdul-Aziz et al. 2010	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon cf. ratelii	Germany	Wiesbaden-Kastel	1	Berg, 1966; Schleich 1988	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	1	0	0	0	0
	1	impossible	Diplocynodon cf. ratelii	Germany	Mombach bei Mainz	1	Berg, 1966; Schleich 1988	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon ungeri	France	Béon 1 (Montréal du Gers)	1	Duranthon et al. 1999	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon cf. ungeri	France	La Brosse (Maine-et-Loire)	1	Ginsburg et al. 2000	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	France	Lectoure Navere 1 niveau 3	1	Buffetaut et al. 1984	1	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0
	1	impossible	Diplocynodon sp.	France	Mauvieres, Macilly sur Mau	1	Gagnaison et al. 2023	1	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon ungeri	France	Mauvieres, Macilly sur Mau	1	Ginsburg et al. 2000	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	1	impossible	Diplocynodon ratelii	France	Pyrimont-Challonges	1	Depéret 1902	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0
	1	Diplocynodon ratelii	Diplocynodon ratelii	France	Saint-Gérand-le-Puy	1	Vaillant 1872	0	1	1	1	0	1	0	0	0	1	0	1	0	1	1	1	1	1	1	1	0	0	0	0	0
	1	impossible	Diplocynodon cf. ratelii	Germany	Wiesbaden-Amöneburg (q	1	Schleich 1988	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0
	1	Crocodilya indet.	Diplocynodon sp.	Portugal	Lisboa	1	Antunes & Mein 1992; Antunes 1994	0	1	0	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0
	1	impossible	Diplocynodon sp.	Germany	Heggbach, "Knauerschicht	1	Bechly & Sach 2002	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Germany	Gerlenhofen	1	Sach & Heizmann 2000	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Germany	Hambach mine horizon 6C	1	Mörs et al. 2000	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Germany	Sand pit at Maurerkopf hill	1	Sach 2010	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon sp.	Germany	Untereichen-Altenstadt 565	1	Prieto et al. 2009	0	1	1	0	0	0	1	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon cf. ungeri	Germany	Oggenhausen 2	1	Bottcher et al. 2009	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0
	1	Crocodylia indet.	Diplocynodon cf. ungeri	Austria	Teiritzberg 1	1	Bohme 2002	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon cf. ungeri	Austria	Teiritzberg 2	1	Bohme 2002	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0
	1	Diplocynodon cf. ratelii	Diplocynodon cf. ratelii	Czech Republic	Ahnikov I	1	Chroust et al. 2021	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
	1	Diplocynodon cf. ratelii	Diplocynodon cf. ratelii	Czech Republic	Ahni-kov II	1	Chroust et al. 2021	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Bossee et Mantelan	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Clere-les-Pins	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Dénezé-sous-le-Lude	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Lassé	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Les Gandes a Thenay	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Noyant-sous-le-Lude	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	1	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Pontigné-les-Buisseneaux	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Pontlevoy-Thenay	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Saint Michelle sur Loire	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	France	Savigné-sur-Lathan	1	Ginsburg & Bulot 1997	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	1	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	Austria	Pölfing-Brunn	1	Gross & Martin 2008	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	1	0	0	0	0
	1	impossible	Diplocynodon ungeri	France	Lectoure le Chene de Nave	1	Buffetaut et al. 1984	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	1	0	0
	1	Diplocynodon sp.	Diplocynodon sp.	France	Pont Boutard	1	Antunes & Ginsburg 1989	0	1	0	1	0	0	1	0	1	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon cf. ungeri	France	Sos	1	Ginsburg 1967	0	1	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1
	1	impossible	Diplocynodon ungeri	France	Contres, Loir-et-Cher	1	Augé et al. 2002	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	1	1	0	0	0	0	0
	1	Diplocynodon ratelii	Diplocynodon ratelii	Spain	Els Casots	1	Araez et al. 2017	0	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Germany	Ziemetshausen 1b	1	Heissig 1989	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Germany	Ziemetshausen 1a	1	Heissig 1989	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon ungeri	Germany	Griesbeckerzell 1a	1	Ivanov & Bohme 2011	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon ungeri	Germany	Griesbeckerzell 1b	1	Ivanov & Bohme 2011	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Germany	Unterneul 1a	1	Heissig 1989	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Germany	Unterneul 1c	1	Heissig 1989	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon ungeri	Germany	Sandelzhausen gravel pit	1	Bohme 2010	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	Austria	Schonegg, Wies coal sean	1	Martin & Gross 2011; Berg 1966	0	1	1	1	1	0	0	0	0	1	0	1	0	0	1	0	0	0	1	0	1	0	0	0	0
	1	Diplocynodon ungeri	Diplocynodon ungeri	Austria	Vordersdorf	1	Martin & Gross 2011; Berg 1966	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Crocodylia indet.	Diplocynodon sp.	Romania	Subpiatra 2/1R	1	Venczel et al. 2005	0	1	1	1	0	0	1	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	?Diplocynodon sp.	Bosnia-Herzegovin	Gracanica	1	Vasilyan 2020	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	France	Sansan (Gers)	1	Ginsburg & Bulot 1997	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	impossible	Diplocynodon sp.	Turkey	Calikli [erronously named E	1	Reichenbacher & Kowalke 2009	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Crocodilya indet.	Diplocynodon sp.	Hungary	Pécsvárad SW of, SE mar	1	Sebe et al. 2024	0	1	1	0	0	0	1	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
	1	Crocodilya indet.	Diplocynodon sp.	Portugal	Ribatejo	1	Antunes 1994	0	1	0	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0
	1	Crocodylia indet.	Diplocynodon buetikonensis	Switzerland	Lindenberg-Buttikon	1	Meyer 1855	0	1	1	1	1	0	0	0	0	1	0	1	0	1	1	1	1	0	1	0	0	0	0	0	0
	1	impossible	Diplocynodon ungeri	France	Grand Morier, assemblage	1	Gagnaison 2017	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	Diplocynodon sp.	Diplocynodon kintyktshensis	Kazakhstan	Kintykche	1	Efimov 1988	0	1	1	1	0	0	0	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0
Total	169					101		66	103	75	96	24	11	93	49	46	76	17	15	10	41	91	64	46	30	38	27	11	3	19	6	3
					Percentage out of total entries	0,597633136		0,390533	0,609467					0,550296			0,449704					0,538462										
															0,526882																	
																0,938776																
									Percentage out of total entries with evidence	0,728155	0,93203883	0,23301	0,106796				Percentage out of total entries where the species level is reached	0,223684	0,197368	0,131579	0,539474											
														Percentage out of total entries where the genus level is reached	0,526882	0,494624						Percentage out of total entries based on disarticualted material	0,703297	0,505495	0,32967	0,417582	0,296703	0,120879	0,032967	0,208791	0,065934	0,032967

2. Summary table of values presented in Figure 1

	Number of occurrences	Percentage out of total entries	Percentage out of total entries with evidence
Paleocene	3	0,017751479	/
Eocene	37	0,218934911	/
Oligocene	28	0,165680473	/
Miocene	101	0,597633136	/
Without evidence (only	66	0,390532544	/
With evidence (figured or	102	0,603550296	/
Material is figured	75		0,735294118
Material is described	96		0,941176471
Based on articulated	24		0,235294118
Based on several	11		0,107843137

ATTRIBUTIONS	Number of occurrences	Percentage out of total entries	Percentage out of total entries where the genus level is reached
Only referred at genus level	93	0,550295858	/
Genus level + only	49		0,52688172
Genus level + disarticulated	46		0,494623656
			Percentage out of total entries where the species level is reached
Species level reached	76	0,449704142	/
species level + only	17		0,223684211
species level reached +	15		0,197368421
species level reached +	10		0,131578947
species level +	41		0,539473684

TYPE	Number of occurrences	Percentage out of total entries with evidence	Percentage out of total entries based on disarticualted material
Based on articulated	24	0,235294118	/
Comprising several	11	0,107843137	/
Based on disarticulated	91	0,538461538	/
Including teeth	64		0,703296703
Including osteoderms	46		0,505494505
Including cranial	30		0,32967033
Including mandible	38		0,417582418
Including postcranium	27		0,296703297
Only jaw	11		0,120879121
Only osteoderms	3		0,032967033
Only teeth	19		0,208791209
Only parts of the skull	6		0,065934066
Only postcranium (except	3		0,032967033

3. Supplementary references cited in Supplementary table

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APPENDIX 3: Supplementary information and data for Chapter 3

1. *Dataset modifications*

We used a modified version of Chabrol et al. (2024) dataset for the phylogenetic analysis, the latter expanded from the parent Rio & Mannion (2021) dataset. Modifications of the latter dataset by Walter et al. (2025; Chapter 1) were implemented here, which include the addition of *Deinosuchus riograndensis* Colbert, 1954 and *Borealosuchus griffithi* Wu, 2001. *Diplocynodon tormis* was removed following Walter et al. (Chapter 2). *Diplocynodon darwini* was rescored based on the complete sample of specimens seen in collections (see Appendix 4 for a complete list) and scores differing from the previous version of the datasets are indicated here. Other *Diplocynodon* species were rescored for some characters, and a justification is provided.

List of modifications and updates of scores in the dataset of Chabrol et al. (2024)

32. Rostral ornamentation, morphology of the transverse orbital ridge (i.e. spectacle): low, lacking a posterior fossa (0); tall, with deep posterior fossa (1).

Diplocynodon remensis: 1 > 0

The spectacle is only known from the best-preserved specimen CE 0001. The bridge is however low and does not bear any posteriorly excavating fossae, as in all other *Diplocynodon* species where present, and in contrast to other crocodylian species scored as state (1) (e.g. *Caiman latirostris*)

41. External nares, orientation: projects anterodorsally (0); dorsally (1).

Diplocynodon darwini: 1 > 0

Diplocynodon deponiae: 0 > 1

Diplocynodon ratelii: 1 > 0

Diplocynodon remensis: 1 > 0

The external nares of *Diplocynodon* species actually project anterodorsally in all adult specimens that preserve the relevant region in 3 dimensions. Only *D. deponiae* differs from this condition.

43. External nares, thin crest circumscribing narial margin: absent (0); present (1).

Diplocynodon darwini: 0/1 > 0

44. Premaxilla, notch posterolateral to naris: absent (0); present (1).

Diplocynodon muelleri: 1 > 0

Diplocynodon ratelii: 1 > 0

47. Nasals, bisect nares completely (0); protrude partially into posterior narial margin (1); excluded internally from posterior narial margin (2) (ORDERED).

Diplocynodon deponiae: ? > 2

Diplocynodon muelleri: ? > 2

Diplocynodon remensis: ? > 2

The only species not bearing state (2) among *Diplocynodon* is *D. ratelii*. State (2) was observed in all other species preserving the relevant region.

57. Lacrimal, mediolateral width in relation to prefrontal: equal to or greater than twice the maximum prefrontal width (0); less than twice the maximum prefrontal width (1).

Diplocynodon darwini: 0 > 1

58. Lacrimal, anteroposterior length relative to that of prefrontal: longer (0); equal in length (1); shorter (2) (ORDERED).

Diplocynodon darwini: 2 > 0/1

Diplocynodon deponiae: 2 > 1

The lacrimal and the prefrontal are always sub-equal in length in specimens of *Diplocynodon deponiae* that preserve both bones. Deformation sometimes flattens the bones and uproots the sutures, but the respective size of the elements remains comparable (e.g. SMF-Me 2609; HLMD-Be 147). We therefore rescore the taxon to (1). *Diplocynodon darwini* is instead scored polymorphic here, after observation of state (0) in some specimens (HLMD-Me 236; HLMD-Me 7500; SMF-Me 2748; SMNK-PAL 6517) and (1) in others (HLMD-Me 233; HLMD-Me 10496).

73. Orbit, position of posterior margin (measured at the level of the postorbital-frontal suture) relative to posterior margin of suborbital fenestra: posterior to or at the same level (0); anterior (1).

Diplocynodon darwini: ? > 0

75. Frontoparietal suture, intersection with supratemporal fenestra (at maturity): deep intersection, postorbital-parietal suture not exposed on skull table (0); frontoparietal suture incipiently contacts supratemporal fenestra, postorbital-parietal suture slightly visible (1);

frontoparietal suture does not intersect supratemporal fenestra, postorbital-parietal contact fully exposed on skull table (2) (ORDERED).

Diplocynodon remensis: 1 > 0

As in all other *Diplocynodon* species, the frontoparietal suture enters the supratemporal fenestra, and the parietal-postorbital suture is not exposed on the skull table (Martin et al., 2014). This morphology is mediolaterally deformed in the best-preserved specimen CE 0001, but recognised in MNHN F BR 13105, MNHN F BR 13106 and MNHN BR 2622.

76. Frontoparietal suture, shape between supratemporal fenestrae: concavo-convex (0); straight (1).

Diplocynodon darwini: 0 > 1

77. Supraoccipital, exposure on dorsal skull table: absent (0); present (1).

Deinosuchus riograndensis: 0 > 1

Borealosuchus griffithi: 0 > 1

Both taxa scores were changed to state (1) to accommodate the inversion of the character definition by Chabrol et al. (2024).

78. Supraoccipital, extent of exposure on skull table: small, mediolateral width across dorsal supraoccipital exposure less than half that along the posterior margin of the parietal (0); moderate, mediolateral width across dorsal supraoccipital exposure more than half to equal that along the posterior margin of the parietal (1); large, such that the parietal is excluded from the posterior edge of skull table (2) (ORDERED).

Diplocynodon darwini: 1 > 0

90. Postorbital, protuberance on the dorsolateral margin of the postorbital bar (at maturity): present (0); absent (1)

Diplocynodon deponiae: ? > 1

SMF-Me 2609 shows the absence of this feature in the species.

91. Postorbital bar, orientation: laterally inclined, greater than or equal to 20° (bar visible in dorsal view) (0); slightly inclined to vertical, lateral inclination < 20° (not visible in dorsal view) (1).

Diplocynodon deponiae: ? > 0

SMF-Me 2609 preserves the postorbital bar that is not severely deformed. It is rather slender dorsoventrally oriented. Character state (0) seems appropriate here.

105. Postorbital, medial contact with quadrate at dorsal corner of the infratemporal fenestra: absent (0); present (1).

Diplocynodon darwini: ? > 0

108. Squamosal, shape of the lateral cranial table edge, dorsal to the otic aperture: vertical, dorsal and ventral edges equally expanded laterally; (0) bevelled, ventral edge projects further laterally than dorsal edge (1).

Diplocynodon hantoniensis: 1 > 0

This character shows some degree of variation, where an intermediate morphology can be observed: the ventral margin is slightly more exposed laterally than the dorsal margin.

Diplocynodon hantoniensis bears the latter condition, otherwise observed in other *Diplocynodon* species scored for the primitive condition (such as *D. darwini*, *D. deponiae*, or *D. remensis*). Since this condition is clearly different from state (1) observed in longirostrine taxa, and similar to congeneric species scored (0), we hereby rescore the taxon as (0).

115. External auditory meatus, posterior margin shape: straight (0); invaginated (1).

Diplocynodon darwini: 0 > 1

116. Quadrate, foramen aereum size: small, diameter less than half dorsoventral height of medial hemicondyle (0); large, equal to or greater than half dorsoventral height of medial hemicondyle (1).

Diplocynodon deponiae: ? > 0

The foramen aërum is small in *D. deponiae*, as can be observed on the left side of HLMD-Be 147.

123. Exoccipital, posterior projection of the paroccipital process: absent (0); present (1)

Diplocynodon deponiae: ? > 0

Three specimens of *D. deponiae* lack the posterior projection described in this character (HLMD-Be 147; SMF-Me 2609; HLMD-Me 7496). State (0) is appropriate here.

129. Basioccipital, orientation of lateral margins of ventral basioccipital plate: parallel or ventrally convergent (0); ventrally divergent (1).

Diplocynodon darwini: ? > 0

130. Basioccipital, dorsoventral height of ventral plate exposed below occipital condyle relative to occipital condyle height: greater or equal in height (0); shorter (1).

Diplocynodon darwini: ? > 0

132. Basioccipital, sagittal crest on ventral plate: present (0); absent (1).

Diplocynodon darwini: ? > 0

133. Basioccipital, concavity on ventral margin, posterior to median eustachian foramen: absent (0); present (1).

Diplocynodon darwini: ? > 0

138. Incisive foramen, anterior margin intersection with premaxillary tooth row: absent (anterior margin around 2nd or 3rd alveolus) (0); present (projects between or abuts first premaxillary teeth) (1).

Diplocynodon darwini: ? > 0

Diplocynodon ratelii: 1 > 0

First hand study of specimens studied by Rio & Mannion (2021) did not show the state (1) as scored in the authors dataset. Instead, we recognise the state (0) in MNHN SG 13728, MNHN SG 539, NHMB 4005 and NHMB 6507. We therefore rescore the character as (0) for the taxon. *Diplocynodon darwini* is newly scored for this character.

139. Incisive foramen, posterior margin: rounded (0); invaginated by anterior process of premaxilla (spade-shaped foramen).

Diplocynodon darwini: ? > 0

146. Premaxilla-maxilla suture, shape on palate in ventral view: horizontal (0); posteriorly bowed, with one rounded apex (1); posteriorly bowed, with one acute apex (2); posteriorly bowed with two or more apicies (3).

Diplocynodon darwini: ? > 0

156. Dentary and maxillary teeth, shape behind alveoli 12–13: pointed to slightly blunt (0); globular (1); molariform, multicusped (2) (after Salas-Gismondi et al. 2015 [198]).
Change state 0 to "pointed to blunt" (state 1 should be only for globidonts)

Diplocynodon hantoniensis: 1 > 0

159. Maxilla, size of foramen for palatine ramus of cranial nerve V: small or absent, less than half diameter of 6th maxillary alveolus (0); large, equal to or greater than half diameter of 6th maxillary alveolus (1).

Diplocynodon darwini: ? > 0

168. Suborbital fenestra, anterolateral margin width, distance from medial edge of the toothrow to fenestral margin: narrow, less than or equal to one alveolus width (0); broader than one alveolar width (usually at least twice alveolar width) (1).

Diplocynodon darwini: ? > 1

169. Suborbital fenestra, lateralmargin shape: straight (0); projectingmedially into fenestra (1).

Diplocynodon darwini: ? > 0

172. Suborbital fenestra, posterior margin, intersection of palatine-pterygoid suture: at the posterior corner (0); on the posteromedial margin (1).

Orientalosuchus naduongensis: 1 > 2

Dongnanosuchus hsui: 1 > 2

Mekosuchus inexpectatus: 1 > 2

Trilophosuchus rackhami: 1 > 2

These taxa scores were modified following changes reported in Chabrol et al. (2024), but that as a likely mistake were not implement in the discrete version of the dataset.

184. Jugal, morphology of medial foramen anterior to postorbital bar: small foramen (0); large recess (1).

Diplocynodon darwini: ? > 1

Diplocynodon deponiae: 0 > 1

A large anterior medial foramen is here newly recognised in *D. darwini*. *D. deponiae* is rescored as having and enlarged foramen (1), following the respective descriptions of Delfino & Smith (2012) and first-hand study of several specimens.

185. Ectopterygoid-pterygoid suture, shape (at maturity): straight (0); kinked (i.e. with ‘flexure’) (1).

Diplocynodon darwini: 0 > 1

190. Choanae, shape: circular or elliptical (0); sub-triangular, tapering posteriorly (1); sub-rectangular (long-axis orientated mediolaterally) (2); sub-triangular, tapering anteriorly (3).

Diplocynodon deponiae: ? > 1

Diplocynodon muelleri: 0 > 1

The choanae are split in two in the holotype specimen of D. muelleri (Spa 4), but the lateral margins are well preserved and taper posteromedially (1). This condition is similar to all other *Diplocynodon* species, including *D. deponiae* that is here newly scored for this morphology.

192. Choanae, direction of choanal projection (at maturity): posteroventrally (0); ventrally to anteroventrally (1).

Diplocynodon darwini: ? > 0

193. Choanae, septum: absent (0); present (1)

Diplocynodon deponiae: 1 > 0

194. Choanae, external projection of septum: absent, septum remains recessed within choanae (0); present, septum approaches external margin of choanae (1).

Diplocynodon darwini: ? > 0

Diplocynodon hantoniensis: 1 > 0

Diplocynodon ratelii: 1 > 0

Diplocynodon muelleri: ? > 0

196. Choanae, morphology of posterior wall: not notched, or with broadly rounded notch (0); acutely notched (1).

Diplocynodon darwini: ? > 0

230. Splenial, posterior perforation(s) for mandibular ramus of cranial nerve V: absent (0); present (1).

Diplocynodon hantoniensis: 0/1 > 0

This binary character was previously scored polymorphic in D. hantoniensis, because of the absence of the foramen in some specimens and definite presence in NHMUK OR 30394. Given the latter evidence, we choose here to score the taxon as having a posterior foramen for the mandibular ramus of cranial nerve V (1). The scoring of the dependent character 231 was not altered (0).

233. Splenial, anterior process within the dentary, medial to the posterior toothrow: absent (0); present (1)

Diplocynodon deponiae: ? > 0

242. Surangular, anterodorsal process (spur) lingual to posterior most dentary alveoli, between splenial and dentary: absent (0); present (1).

Deinosuchus riograndensis: 1 > 0

Diplocynodon darwini: ? > 0

Deinosuchus riograndensis score was changed to state (0) to accommodate the inversion of the character definition by Chabrol et al. (2024).

243. Surangular, anterodorsal process (spur), anterior extent: not reaching 1 full alveolus (0); reaching 1–2 alveoli (1); reaching 3 or more alveoli (2) (ORDERED).

Diplocynodon hantoniensis: 1 > 2

The spur described in this character reaches at least 3 alveoli in the specimens NHMUK OR 25178 and CAMSM TN 904, despite the latter being incomplete (Rio et al., 2020). We therefore rescore the taxon to state (2).

249. Articular, lamina extending from posterior edge of foramen aerum: absent (0); present (1).

Diplocynodon darwini: 0 > 1

256. Surangular-angular suture, lingual intersection with articular in the floor of the adductor chamber: at ventral tip (0); dorsal to ventral tip (1).

Diplocynodon darwini: 0 > 1

266. Atlas intercentrum, shape in lateral view: wedge-shaped (0); plate-shaped (1).

Diplocynodon ratelii: ? > 0

First-hand observation of the specimen NMB Ph 4110 indicates that the intercentrum is wedge-shaped in *D. ratelii*.

271. Axial rib, tuberculum shape: short and broad, equal in size to capitulum (0); long and acute, narrower than capitulum (1).

Diplocynodon darwini: ? > 0

281. Cervical centra: amphicoelous (both articular surfaces concave) (0); procoelous (anterior articular surface concave, posterior articular surface convex) (1).

Diplocynodon remensis: ? > 1

289. Sacral vertebra 1, anterior extent of sacral rib capitulum: anterior to tuberculum (visible in dorsal view) (0); at the same level as tuberculum (obscured in dorsal view).

Diplocynodon darwini: ? > 1

301. Scapulocoracoid facet, shape anterior to glenoid fossa (at maturity): uniformly narrow (0); broad immediately anterior to glenoid fossa, tapering anteriorly (1).

Diplocynodon darwini: ? > 1

308. Ilium, dorsal outline of postacetabular process: convex, no dorsal indentation (0); broadly concave with a small indentation (1); strongly concave, with an acute indentation (“wasp-waisted”) (2) (ORDERED).

Diplocynodon ratelii: 2 > 1

The dorsal indentation of the postacetabular process is not “wasp-waisted” in D. ratelii, as a more acute constriction defines the latter morphology. This region of the ilium however exhibits a variable indentation corresponding to the intermediate state, as observed first-hand in MNHN SG 13728 or NHMB SG 10514. We therefore rescore the taxon to state (1).

318. Palpebral, number of ossifications: one (0); two or more (1).

Diplocynodon darwini: ? > 0

319. Palpebral, size in relation to orbit: small, covering no more than half the area of the orbit (0); large, covering more than half the orbit (usually completely concealing it) (1).

Diplocynodon darwini: ? > 0

326. Dorsal midline osteoderm shape: rectangular, width to length ratio > 1 (0); approximately square, width to length ratio < = 1 (1).

Diplocynodon muelleri: 1 > 0

Although described as "more squared than *D. ratelii*", the dorsal midline osteoderms of *D. muelleri* are primarily rectangular in shape (Piras & Buscalioni, 2006).

328. Ventral osteoderms: absent (or poorly developed) (0); present, single ossification (1); present, paired ossification (2)

Diplocynodon ratelii: ? > 2

D. ratelii was previously scored as unknown for this character. It is however diagnostic of the genus, and paired ossifications are reported for the latter species (e.g. NMB Ph. 4052)

List of modifications and updates of scores in the dataset of Walter et al. (2025; Chapter 1)

Where possible, corresponding characters from the above dataset were rescored for consistency in the dataset of Walter et al. (2025; Chapter 1).

Ch. 6.

Diplocynodon deponiae: 0 > ?

Diplocynodon hantoniensis: 1 > ?

Diplocynodon ratelii: 0 > ?

Diplocynodon remensis: 0 > ?

Ch. 7.

Diplocynodon remensis: 0 > ?

Ch. 21.

Diplocynodon darwini: 0 > 1

Diplocynodon remensis: 0 > ?

Ch. 25.

Diplocynodon darwini: ? > 1

Diplocynodon ratelii: ? > 1

Diplocynodon remensis: 0 > ?

Ch. 30.

Diplocynodon darwini: ? > 0

Diplocynodon ratelii: 0 > ?

Ch. 31.

Diplocynodon darwini: ? > 0

Diplocynodon ratelii: 0 > ?

Ch. 51.

Diplocynodon darwini: 0 > 1

Diplocynodon deponiae: ? > 1

Diplocynodon remensis: 0 > 1

Ch. 52.

Diplocynodon hantoniensis: 0 > 1

Ch. 54.

Diplocynodon darwini: 0 > 1

Ch. 55.

Diplocynodon darwini: ? > 0

Ch. 58.

Diplocynodon darwini: ? > 0

Ch. 61.

Diplocynodon darwini: ? > 1

Diplocynodon hantoniensis: 1 > 0

Ch. 65.

Diplocynodon darwini: 0 > 1

Diplocynodon hantoniensis: 0 > 1

Ch. 80.

Diplocynodon hantoniensis: 1 > 0

Diplocynodon ratelii: 1 > 0

Ch. 84.

Diplocynodon deponiae: 0 > 1

Ch. 85.

Diplocynodon hantoniensis: ? > 1

Ch. 101.

Diplocynodon darwini: 0 > 1

Ch. 102.

Diplocynodon muelleri: 0 > ?

Diplocynodon deponiae: 0 > ?

Ch. 121.

Diplocynodon darwini: ? > 1

Diplocynodon remensis: 1 > 0

Ch. 123.

Diplocynodon muelleri: 0 > ?

Ch. 125.

Diplocynodon darwini: 0 > 1

Diplocynodon hantoniensis: 0 > 1

Diplocynodon deponiae: 0 > 1

Ch. 142.

Diplocynodon deponiae: 1 > ?

Ch. 150.

Diplocynodon ratelii: 0 > 1

Ch. 215.

Diplocynodon darwini: ? > 0

Diplocynodon deponiae: ? > 0

Diplocynodon hantoniensis: ? > 0

Diplocynodon muelleri: ? > 0

2. Supplementary figures

Figure S1

Articulated adult specimen of *Diplocynodon darwini*. A, HLMD-Me 20336 exposed ventrally (scale bar = 10 cm); B, close-up view of ventral armor made of bipartite osteoderms; C, close-up view of the bipartite osteoderms organisation; D, close-up view of the medial side of the splenial and dentary (arrow points at the anterior tip of the splenial passing ventral to the Meckelian groove). E, close-up view of the anterior part of the tail bearing dorsal osteoderms (scale bar = 10 cm).

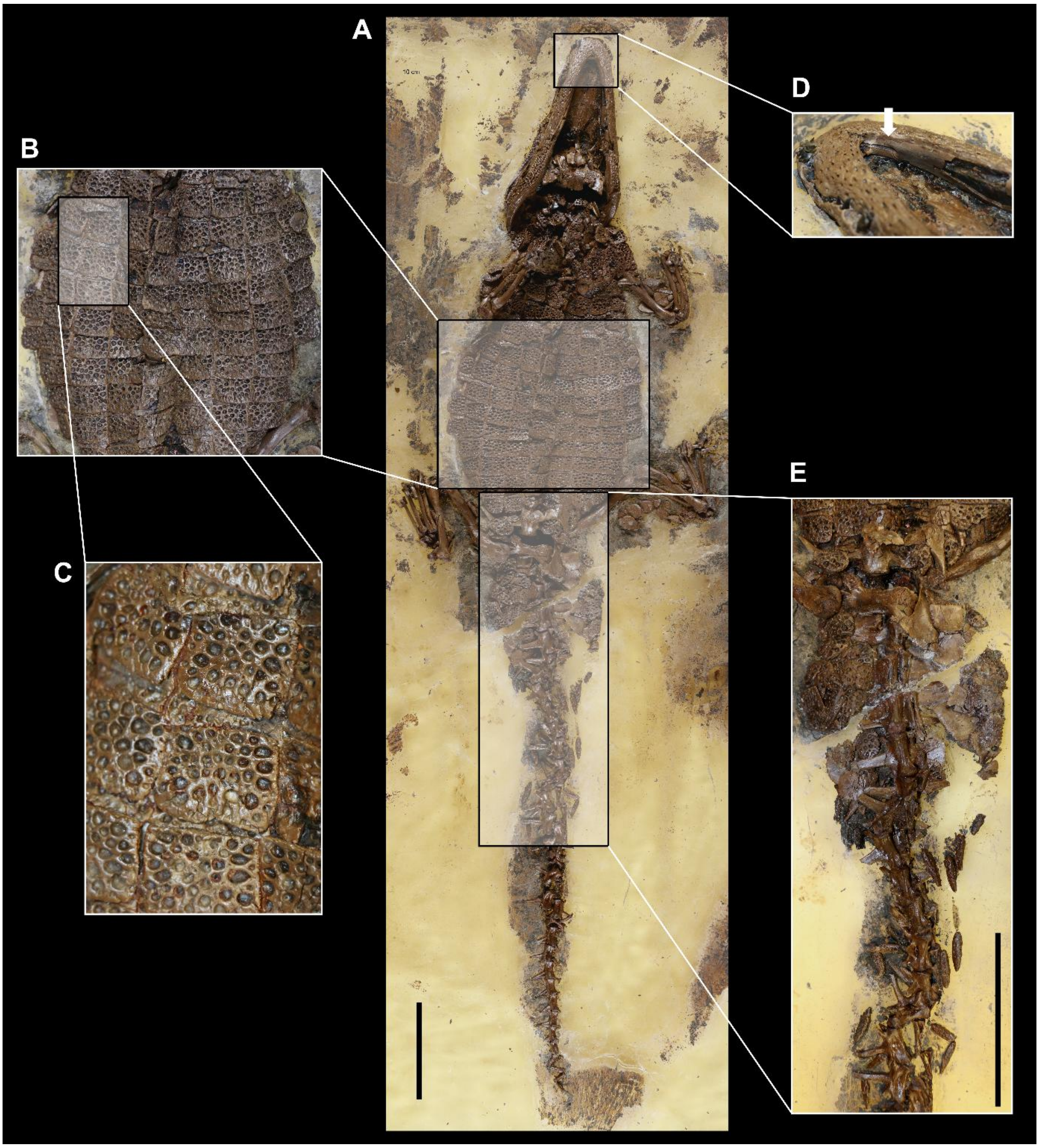
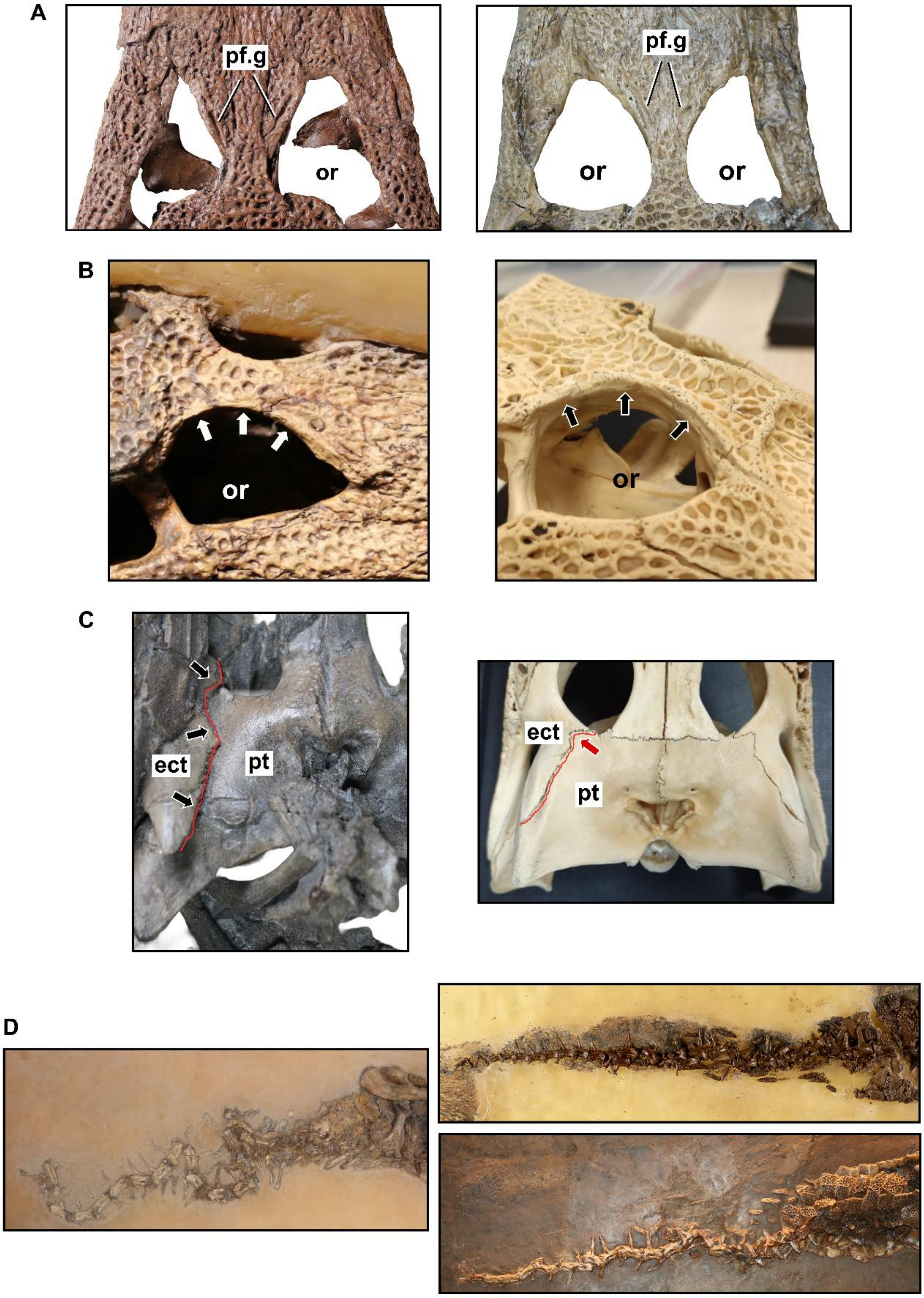


Figure S2

Articulated sub-adult specimen of *Diplocynodon darwini*. A, HLMD-Me 10262 exposed dorsally (scale bar = 3 cm). B, close-up view of the ultimate caudal vertebrae bearing osteoderms (scale bar = 3 cm); C, close-up view of the skull in dorsal view (scale bar = 3 cm); D, close-up view of the pelvic girdle and first caudal vertebrae (scale bar = 1.5 cm).

Figure S3

Diagnostic characters of *Diplocynodon darwini*. A, presence of prefrontal grooves/sulci (left, GMH XXXVI-524-1966; right, SMF-Me 900); B, orbital margin is flush with the skull surface (left, HLMD-Me 7500; right *Caiman yacare* with the "upturned" orbital margin condition); C, retention of the ectopterygoid-pterygoid flexure (left, HLMD-Me 7571; right, *Caiman yacare* showing the same condition in situ; D, lack of osteoderm coverage on the posterior part of the tail (left, HLMD-Me 7500; top right, HLMD-Me 20336; bottom right, HLMD-Me 236).



3. Dataset: Walter et al., supplementary dataset (modified Walter et al. (2025; Chapter 1); .tnt)

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Crocodylus_acer
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0?0000?1?210000100??010001???000100?10100000100010111100?002?01?01?2001001010101??
0??11100010000003????000?2?0010?-?-01100100000??1?0??0??

Crocodylus_affinis
01001001?10001000011100001111001100?10???1???11102101010000012000000201100
??00110?000010?110000100?011000??0?000100110100000100000111100?0?010??012200100101
0101??0???1100010000003???000012?00000-?-011001000000?100??00?

Crocodylus_megarhinus
?????0???????????001????????????????????????11102101?????00120000??0?011????00
110?000010?23000010001?1000??0?00000011010000012000011111 0?002?11?0122?01001010?01
100???1110010000003???0000?2?00?00-??01100100000?1?00000?1

Crocodylus_niloticus
01000001?101010001011100111112012000111201101110021010100010120001110201 11
00100110000000100210000100110200[0 1]110100[0
1]0001101000001100001111100001011101220010010101011101011110011000003011000012000
000-0-0110010000001100000?1

Crocodylus_porosus
11000001?00101010101110001111201200011120110111002101010001012000111020111
00100110000001002100011001102000110100[0
1]0001101000001000001111100001011101220010010101011101011110011000003011000012000
000-0-0110010000001100000?1

Crocodylus_rhombifer
01000001?101010001011100111112011000111201101110021010100010120001110201 11
00100110000001002101001001102000110100[0
1]0001101000101100001111100001011101220010011101011101011110011000003012000012?00
100-0-0110010000001100000?1

Deinosuchus_riograndensis
?????0????????????01????????????????00???1???01102??501?0?11?10??0??12?0?????00
2?1?0???0??0300001???0?[0
1]00011?00?0?????????????00?0111131?012210?1220001002?1010??000?0?1???1??100?1???00
00???00?00-?-0?1121??010?1?00?11?1

Deinosuchus_schwimmeri
???????????????????10??????????110??10???1???0?002??5?0???11010??0??1200?????00
????????????30??01000??10011?0?0?0000???????????0010011131?012210012200010020101????
?1?0?1????????00????0000?1000???-0-0?11210001??0???0?1??

Diplocynodon_darwini
00001001?010000?000101001111000400?101120???0110210110?000112001001111 0100
??00020?0000101130000100?1??000??0?0000001111001110001?111100?110100?022010101101
010??????0100110010001???000012?00?00-?-011001?000?011?00?0?1

Diplocynodon_deponiae
00?0?????????0????01?0???1?????04?0?101?21???01?021?0?????0??20??0??1?10?????00
12??100??011300001?0????000?????0?0001?11000?110001?111100?1-
0?00?0??012?0?101?10????????1???1??10001????0001?00??00-?-0???0???00??????0???1

Diplocynodon_hantoniensis
00?????1?010000100010000111111??0400?10??20???011021110????0002001001121 01???
?00020?01001??1300?0100?1000001?0?000000101100011100010111100?110100?0120101011010
10??0?1??010011?010001???000012100?0?-?-011001?000001100000?1

Diplocynodon_muelleri
???????????????????1?01??1??????4?0?10??21???01002??2?????0??20??100??100????00
120?1000?0113000010001?0000????000001111100?0010001?1?1100?110??0?02?01010110101??
??????0100110010001????000??000210-?-01??0100000?????0?0??

Diplocynodon_ratelii
????????????000???010?0011111??1400?10??21???01002101?????00120000011?101????
00010?00001011300001000101000?00?0000000111100010100010111100?1-
0100101101010110101000001?10100110010001???000012000?00-?-011001000000110000001

Diplocynodon_remensis
???01???????????00010?00?1111???400?10??20???01002100?????00020?00011?001????
00020?000000?1300001000[0
1]00000????00000011?10?0?010000?111100???0?000001010100101010??0?10?0100000010001??
?0?00?3100000-2-0??00?00000?110?0000?

Diplocynodon_tormis
???????????????????1????????????????10???????01?021?1?????0??2?00?????1??????0?1
20??000?0?130000100?1000001???00000011?100?0?100010111100???0100001?01010110101?0?
??1?001?0110010001???0000???0010?-?-?11??1??000???00?????

Dollosuchoides_densmorei
01???0???111010?0001?0?001111??1?00??????????1120???0????000200?0??0201?????0
0120?00?001?210000100??02000????01?01010010000011000?011110????????1??20010?1010101
???????10?01000?003???00001300?100-?-01100100020?1100000?1

Dongnanosuchus_hsui
???1101???0????????????????1???????101
10?000011?110001100??01000????00011011011101010000?111110?112?1?102220000010112??0
??????100110000001???0000?20001000?0011001000000??00000?1

Eoalligator_chunyii 010?????????000?????????????????????1??????????0?11?[1
2]????????????10?01?01????10????????????????0????????????????1?????1????????0??1?1????
??0?????12??0?0010112?????????1???1?00?003????????11?????0?0??1??????0??1????0???

Eocaiman_cavernensis
???10000??2?????01120??????????????00?
??????????0?0?0?1?????000???0?10?000?1?????????????1?11?0??????????????????????????????
??????????????????0????0??0-??0???0?00????????00?00

Eocaiman_itaboraiensis
???1?1????2????????????????????????????
??
??0

Eocaiman_palaeocenicus
???11120??2?????0??20?????11??????????
??
???1???????0

Eogavialis_africanum
???????1?????11???010??????????0?????????0???1122??03?????10?200000??2101????00
120?000?01?25?000100?002000000000000101001000001000000000121?000100?111100100001000
0?000??0101010100000???00?013??0?0?-?-10010000??0?00?0?????

Eosuchus_lerichei
?????0??????01????01???????1????????0????????1122???3??????????????????0?????001
20?0000?1?250000100?0000000???0000101001000001000000?0110?000?0??11?2001000010?1??
??????10?01?101003???000012?00000-??10100000000??010000?1

Eosuchus_minor
?????0???0??111???01?00?0?01???0000?000??0???1122??0300?0000?20?000002100????
00120?0000?1?25?000100?000000?0000001010010000?10000000110???0100?11?10010001?1
100??1???101010101003???000012000000-?-10100000000?1010000?1

Eothoracosaurus_mississippiensis
?????0?????????????01??000????????00?00???0????122???3??????0?0???00?021?0????00
120?000??1?25000010??000000????0000101001000????000?000100???01???11100010?001?10??
??????100010000000???000016000200-?-1001101?010?1010001?1

Euthecodon_arambourgii
??0??????????????????1?????0002
0?0000?1?25000110 0?102000110100000 0??0????0???0000111110??11011?0122101001011 10????
1??11?0?1000?003???0000??????0?-?-0111010000???????????

Gavialis_gangeticus
20000000?00111101101000000011100000 0?000000001132300300000000200000000210001
0000130100000102 5?0001000000000000000001010010000011000000012200001000111101000 0
1010000000001210101000000010010130002 00-0-100120111211001100 1?1

Gavialis_lewisi
??????????????????010??????????????????????????22???3??????0?200000??2?0?????00?
30?0??????2??0??1?0?0?0000??0?0000?0?00100?0?1???00000122?000100?111??0?000010100???
??0012101010000 0???00101???????-?-?0???011101??011??1??

Gavialosuchus_eggenburgensis
???????????????????1???0012
0?0000?1?240000100??0?000????00?0101001000?012000?0?1110?0??????1?221010?10101?????
???11???10000003???0000???00?0?-?-0110010?010???00?????

Globidentosuchus_brachyrostris ??????????????????01?????????????????????????11[0
1]01??0?11?10?1301103111011????0012??000??0??200001???1?00?0??????0???0?11?????1?2???
1?1100??????0?0??2?21??101?3?????????1???1?????0???????0??00?010??00?1?0?00000???0?20
00?

Gnatusuchus_pebasensis
???2020?12000?01111201000011001????02
110?010010?0000001???0000?0????1?????11?1001101?1?1???1100???0?0?1?1220211?10103????
?1??0100110210001??????????????????01100100000110040101

Gryposuchus_colombianus
???0?0???001??????01??000????????????????0???11323?030100?000200000002100????0
012010000?1?25?000100?0?0000??0?0000101001000001100000001 22?000100?111110100002010
00100?001210101000000???001010??0?00-?-100?10?0??1?00?100??1

Hassiacosuchus_haupti 0111?0?1?[0
1]?0?10???01?000?1111?????0??11?11???11111 0?0?????01?20??1??11101????00010?00???0?0?0
0001??????0001?0??????0????????11101?111100?1?0200?02220010210100????????01???10010
001???0000120011101?-011?00000000 1???100?1

Hylaeochampsa_vectiana
???0????????????????0?0?10001?00??2110?0?0000000001001000?0?22110000120????1?0?00001010000010????1?001001000?0110????10?????0??-?-001??000000??000??0??

Iharkutosuchus_makadii
??10124?????????110???00??10?1????0001??000001?0610001?0???2110????00000010011000012111001?100?1?0?00?0???13???100?2?????1???1000000??110???1010?4?00?10-??00110000?-0??0?0300?1

Jiangxisuchus_nankangensis ??????????????????010????????????????????????1100?[0 1]01?????0[0 1]021??????????????10110?000111?110000100???0000????00010001011201110000?11110001?0011101111000010111?????????100110000001???0000?1?0?000?1-011001000000??01000?1

Kambara_implexidens
?????0?????????????01????11????1100?10???1???11102101????00120000110?011????00110?000011?21000010001010001?010000001001000000100000111110?002011?01220010010101011101?11110010000001???000012000100-0-01100100000?11000?0??

Kentisuchus_spenceri
?????0???????????????????????????????????????1?????0?????0??2000?110??11????00110?0000?1?210000100???2000??0?010010100100?0011000?111110??????0?0??20010?10101???????111?0?100?0?03???0000???00200-?-0?100100000?1100??0??

Krabisuchus_siamogallicus
???????????????????1??0????????1?0??11???1???11011??1?????01?2101?0?0?001????10010???00?1???0[0 1]0??00???1????????00?001101100?01?00??111100[0 1]1[0 1]00?0?0??2001??1?112????????????????0???1???0??0??00???1?100?1?0?00000???00000?1

Kuttanacaiman_iquitosensis
??1110211200?0101120?102011001????10110?000010?0200001?0?000000????1000010111101?1102001??1100???020?10?221211210103?????1??0100?10210001?????????????????0110010000011002000?

La_venta_Caiman
???00110?000010?020010100?001000????1000000111111111?0????1??0?????0???????????????????????????????10001??????????????????0??00?00???????????0?

Leidyosuchus_canadensis
???0?0???????1????010000001?1???0?0?11??11???0110?00000?0?01?20000011101????00010?000000?0300001000000000100010000111010001010001011110 0?0101001012000100101010 00001?0010011001000 1???000013100000-0-01101100000?010000001

Lohuecosuchus_mechinorum
???00011?000000??20001?00?00200?????000100100100???1100?00?1110???0??0??000?100?10?01???1?????1??00?010000???0010?2?0020?-?-00?00010100??00???1??

Lohuecosuchus_megadontos
??11005101???0??010??011??101?????00011?010000?020011100?002000????0001001001000001100001011 10?002110?0000110001010?????????110010?010000???0000?[1 3]000200-??00000000100?100?001?1

Maomingosuchus_petrolica
???000010101000?0001?000?11???01?00?10??11???1112010300000000200100012010???
?00122?00000102100?0100?0?0000????000010100103000000000111100?002110111220000 01010
1????010??110010000003???0000?2000111-1-001001000000[0 1]000000?1

Mecistops_cataphractus
0?001001?0000100000111001111120120001111011011110410101000100200011102 01?10
0100120000001002100001000101000110100001011010001010000011111000010111012200 10010
1010111010111100100000030 0?11101?000100-0-0110010000001100000?1

Melanosuchus_niger
01111001?1?0010000010101111110011000111221210110021121010111120110201 1001??
110011000000201020010110000000011001000000111101111110111111100110201102221211210
103000101100100110210001002000012000110-?20110010000001100 00001

Mourasuchus_amazonensis
???0???????????????????????????????12
0?10???1???0?01???0?????1????????????????????221??111?12?1102?0?0??2121??1?1?3????????
?????1??????????????????????????0???210?00????????00?

Mourasuchus_arendsi
??????????????1?00??110011?????01????????????11?2????2????????????????1?0??????1
2??1?0?01??60?01?00??00?1?????0000????????1?1?21????1?12?1????1??????????1?103???????
???????0?????????????????????????0???210?00????????001

Mourasuchus_atopus
0??100?1?00?010?00?1?10?011????1300?11???1???1102?112?????01120?100011000????
00120?100001?060001100?0000011???0100000111011?10210?111112?110?0010??2121??12103
0????1???100110?10001???00?0????0?1?-??0110210?000????0?1001

Navajosuchus_mooki
?????0?1??????0???0?00???1111??1??0?101111???1101010?????01?21??00??110?????0
0010?000111?0200001???0?0000??0???00?00?11100101110111111 00???020??0222?0102101010?
???1??010??10010001???0000120001102?-01100?000000?1001000?

Necrosuchus_ionensis
?????0????????????0???01?111???1300?11???1???11000??2????????2???0?????0?????00
??0???????
???0????1?0?1?????????????????????????????0???00?0??1

Orientalosuchus_naduongensis ???1????????000???01?0?0???????1[1 4]0??[0
1]1???1???110111?1[0
2]??0101?111110?010??????101?0?010011?110001100??010001???0001001101?20?01000011?11
00?1??????0??2[0
1]010?10113?????????10?110000001???0000?200?1010100110010000001100000?1

Osteolaemus_osborni
?1?00001?001010100011100111112011100111111101110021010100000120000110101110
01101100001010021000110001020001101100100100102000100000111110100101010122131 0010
11101110101111011000000310000001??00?0?-?-011001?0000?1100??0?1

Osteolaemus_tetraspis
?1?00001?001010100011100111112011100111111101110021010100010120000110101110
011010000010100210001100010200011011001011101020001000101111101001010101221310010
111011101011110110000003110000 01?000?00-0-0110010000001100000?1

Pachycheilosuchus_trinquei

?????????????????0?01?00010?10??000??10???0???11?03?????????1?0??????????????00????????????50???????00[0 1]00????????0?????????????????1?1????????????????0?0??0??2???????0?0???????2000??????0????????-??0??????????????1?0??1

Paleosuchus_palpebrosus

00111111?010010101010001111112113000111321120110021222111?111201102011 00?011110110000101010200001000000000110001000111111011110001111111011102011022 21?1?210102000101100100110210001111000 01?000210-0101100100000?110000001

Paleosuchus_trigonatus

00111111?010010100010001111112113000111321120110021222111111120110201100101111011000010101020000100000000011000100011111101111000111111101110201102221?1?210102000101100100110210001101000 01?000?10-01011001000000110000001

Paratomistoma_courti

???0??20?00001010???00???????????2??0?0???????0001?0?????????????????0000?1??11?????1???1??200100001010?1000?101?0?100??00???????0??1?01??-0-??1???1?000?1?00?????

Pietraroiasuchus_ormezzanoi

????????????????????1?000??0???????0?10021????111?3??????????10???????00??????00?21?00?0?0?050???1?0??????0???????0????000000??2000?1?00?0??????0????010?0??00?1???????????01??????1???????0?4000210-?-0??0000000?0?????01??

Piscogavialis_jugaliperforatus

??????????????????????????????1??????????????1142???3?????0002???????20??????00120?001001?250000100?001000???00001010010000000?0000000111?1?0001011120010000201?0?1?0?0?12??1?10?000???010??00200-0-1001201102??01?001?1

Planocrania_datangensis

??11?????0?????????????????????????20010?000??1?030000100??0?000???????000??01???????0?0?1?1110????????0?100010010??1?????????????10??0?0????0000?2?00?00-?-0?1?0?0??00???????0?1

Planocrania_hengdongensis

????????????????????1?????????????????????????1110???1?????????[1 2]????0?01?0?????20010?0??????1300??1????0?000????0????01001???????0?0?1?1100????????0?1?00100?0101?????1???1???10?10001???0000?2?00?0?-?-0??000??000?1??00?0?1

Procaimanoidea_kayi

???110?1??????0???010?00?1111??10?0?112121????001?1??100?01?2100000111 0?????10?????0???0?0?00001???0?2000??0?000000011100?0110111111 1000??0200?022200102101010???????0100110010001??????01?00011?2?-0?1???00?00011?0?0?0?

Procaimanoidea_utahensis

??110010??0??01011210??0011101???10110?0100?0?020?00100??00000???0000000?11100101111 1?111100?1?0200?0222001 0?101010???????0100110010001???0000?200?2102?-0???000000??11?000001

Prodiplocynodon_langi

???00110?0000???030000100??1[1 2]0001??00001001 1?1000001???0?111100???0?0??0?21?010?1010101??01?01100110000003???0000?2?00?00-?-01100100010??100??0??

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Protoalligator_huiningensis
        ????????????????????????????????????????????1100??????????112???????????????001
?0?000??1?0100001?????????????????????????????00??1?1??0??????????????????????????????
????????????????????????0?00-??0???0???????????00??1

Protocaiman_peligrensis
        ????????????????????????????????????????????????????????????????????????????????
????????????????????????????????????????????????????10????02?0102200111210111?????1???
????1??10001??????0???0??????0?00??0??00???????????

Purussaurus_brasiliensis
        ????????????????????????????????????????????11002??2?????1113??????110??????001
12?000211?0000111?0???0000????0?00000111?????10210?111110?11????102?2101??101?3?????
????1?0?1??10001??????????????????0110010?000??10001001

Purussaurus_mirandai
        ???????????????????1?11001?????11?0?1????????1100?0?2??1?11?1301100?11?01????0?
112?00021??000011100???0000????00000001111?1?110210?111110?11020010222000??10103??
????????0011?2?00?1??????????????????0??00100000??100?1001

Purussaurus_neivensis
        01?100?1?000010?0??1????011???????0?11???1???1100??1?1010?111301100011001????
00110?000020?000001110?0000001?0?000000011110111112101111110?110201?0222001?210103
000101??010??10210001???00?0????0?10-?20?100100000?010001001

Quinkana_spp
        ????????????????????????????????????????????11?0???1??????????????????1?????2101
0?0000?1?[0 2][1 5]00[0
1]0?000100000????0?0?????????????100?0111?10?002011101221010010102?11101?11??01?000?
??1???????????0?00-??0??0?????????????????

Rimasuchus_lloydi
        ???????????????????????????????????????????????????1??????????????????1?????0011
0?0000?0?210001100?100000110100000????10?????1000?111110?001011?012200100101110111
?1??1110?1000?003?????00?2????0?-?-?1?001?0???????0?????

Shamosuchus_djadochtaensis
        ???0???????0????1?01?????0?1??????0?11??????????????0??????1?0????0?10???????00?
????????0?0000001?0?????00???????0000??00000?12011?1?0100?110??0?011000?0?00????????
????0?10?00??00??????011?000010-??0???00000000?0010?0??

Stangerochampsa_mccabei        ???110???010010?0001000001111001?00?[0
1]1??11???111010100????0112110000?110??????0110?000211?020000100?000000????00000001
1110010121011111100?110200?0?2100102101010??1?1??0100110010001???000012?0?01022-
01100100000?1100?0001

Thecachampsa_antiqua
        2000000??001010?00011010111?1??11?0?00???1???1122???4?100????2000031??01?0???
00120?000011?210000100?102000??0?0000101?01000?0110000011110???011??11220010010100
0??00???11100100?2003???000013??0?0?-?-01?00110000??000??0??

Thoracosaurus_macrorhynchus
        ?????0???0?1111?1?01?????00????0????00???0???1?22???3??????0?10000000?100????0
0120?00?0?1?250000100??000000?0?000010100100001100000000110?000100?11101010?001010
0???0??0100010000000???0000?2?0??0?-?-1001100??10??010?????
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Thoracosaurus_neocesariensis
          ?????0??????111?1?010????0011??0??0?00???0???1122???3?????????10?000?02?0?????0
0120?0000?1?250000100??0?0000?0?00001010010000?000000000110?00010??1?1000100001010
00000?00100?10000000???000012?0??0?-?-100???0?010?10?00?1?1

Tomistoma_cairense
          ??????????????????????????????????????????????1??2???4????????2000001??010????00?
20?0??????25?0??1?0????000??0?000010100100000?00?0?011110???01???11?2001001010101??
0???11?001?000003???0000??????0?-?-0?1??10?000?1100000?1

Tomistoma_lusitanica
          ?????0??????????????01???????????????10???1???1??2???4?????00?20000??0201?????00
120?0000?1?21?000101?10?000110?0000101001000?0100000111110?0001?1?1122101001010101
1001??1110010000003???000012??0?0?-?-011001[0 1]?00?01??0000?1

Tomistoma_schlegelii
          21000001?0010100010110001111110110001013011011122?1040000010020000000201000
010012000000110210000101010000011010001001001000001100001111100000110101221010010
1010110010111100100000031110000130000000-0-0110010000000100000?1

Toyotamaphimeia_machikanensis
          0100100??11111100101100011111101100?00???1????22??04????10020?0000??01000?
?00120?000011?04000010???00000????0000?010010000?100000011110??00?1??1??21010?1010?
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Trilophosuchus_rackhami
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Tsoabichi_greenriverensis
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Voay_robustus
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00?1101?11110010000003???000012100000-2-0110010000001100000?1

Wannaganosuchus_brachymanus
          ???1?0???1?00?0???010000?1111001000?11???1???111110?0?????0??200?00?1??0?????0
0110?00001??0200??100???0000??0?100000???1??0??11111?111100????????0?22001??101010??
??????10011?010001???000012?0?1102?-01100100000??1?010001

;


cnames

{0 Fused_proatlas_shape boomerang-shaped strap-shaped block-shaped;

{1 Proatlas_process with_anterior_process without_anterior_process;

{2 Proatlas_dorsal_keel with_dorsal_keel without_dorsal_keel;

{3 Atlas_intercentrum_shape wedge-shaped plate-shaped;
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{4 Dorsal_margin_of_atlantal_rib_process smooth dorsal_process;

{5 Atlantal_ribs_lamina without_lamina with_lamina;

{6 Atlantal_ribs_articular_facets without_facets with_facets;

{7 Axial_rib_tuberculum_tip broad_dorsal_tip acute_dorsal_tip;

{8 Axial_rib_tuberculum_diapophysis contact_late_in_ontogeny contact_early_in_ontogeny;

{9 Axis_neural_spine_shape horizontal_anteriorly slopes_anteriorly;

{10 Axis_neural_spine_ crested not_crested;

{11 Posterior_half_of_axis_neural_spine_ wide narrow;

{12 Axis_neural_arch_ lacks_diapophysis bears_diapophysis;

{13 Axial_hypapophysis_location _center_of_centrum anterior_end_of_centrum;

{14 Axial_hypapophysis_shape without_deep_fork with_deep_fork;

{15 Hypapophyseal_keels_presence 11th_vertebra_behind_atlas 12th_vertebra_behind_atlas 10th_vertebra_behind_atlas;

{16 Third_cervical_vertebra_hypapophysis prominent not_prominent;

{17 Neural_spine_on_third_cervical long short;

{18 Cervical_and_anterior_dorsal_centra lack_deep_pits_ventrally bear_deep_pits_ventrally;

{19 Presacral_centra amphicoelus procoelus;

{20 Anterior_sacral_rib_capitulum broadly_visible_in_dorsal_view obscured_in_dorsal_view;

{21 Scapular_blade_shape flares_dorsally sides_sub-parallel;

{22 Deltoid_crest_of_scapula very_thin_with_sharp_margin very_wide_with_broad_margin;

{23 Scapulocoracoid_synchondrosis closes_late_in_ontogeny closes_early_in_ontogeny;

{24 Scapulocoracoid_facet_shape narrow_anterior_to_glenoid_fossa broad_anterior_to_glenoid_fossa;

{25 Proximal_edge_of_deltopectoral_crest_of_humerus not_concave concave;

{26 M._teres_major_and_M._dorsalis_scapulae_insertion seperately single_insertion_scar;

{27 Olecranon_process_of_ulna_shape narrow_and_sub-angular wide_and_rounded;

{28 Ulna_shape proximal_extremity_equal_to_distal proximal_extremity_wider_than_distal;

{29 Interclavicle_shape without_dorsoventral_flexure with_moderate_dorsoventral_flexure with_severe_dorsoventral_flexure;

{30 Anterior_end_of_interclavicle_ flat rodlike;

{31 Iliac_anterior_process_ prominent virtually_absent;

{32 Dorsal_margin_of_iliac_blade__ rounded_with_smooth_border rounded_with_modest_dorsal_indentation rounded_with_strong_dorsal_indentation narrow_with_dorsal_indentation rounded_dorsal_tip_deep;

{33 Supraacetabular_crest narrow borad;

{34 Limb_bones_form robust slender;

{35 M._caudofemoralis_ single_head souble_head;

{36 Dorsal_osteoderms_keel not_keeled keeled;

{37 Dorsal_midline_osteoderms_shape rectangular nearly_square;

{38 Number_of_contiguous_dorsal_osteoderms_per_row_ four six eight ten;

{39 Nuchal_shield grades_continously_into_dorsal_shield _with_four_nuchal_osteoderms six_nuchal_osteoderms eight_nuchal_osteoderms_in_two_parallel_rows;

{40 Ventral_armor_ absent single_ventral_osteoderms paired_ventral_osteoderms;

{41 Anterior_margin_of_dorsal_midline_osteoderms_ with_anterior_process without_anterior_process;

{42 Ventral_scales_pores have_follicle_gland_pores lack_follicle_gland_pores;

{43 Ventral_collar_scales_ not_enlarged single_enlarged_row two_parallel_enlarged_rows;

{44 Median_pelvic_keel_scales_along_tail two_parallel_rows single_row merge_with_lateral_keel_scales;

{45 Alveoli_size_of_dentary_teeth _3_and_4_same_size_and_confluent 4_larger_than_3_and_seperated 3_and_4_are_nearly_the_same_size_and_separated;

{46 Anterior_dentary_teeth strongly_procumbent project_anterodorsaly;

{47 Dentary_symphysis_extension fourth_and_fifth_alveolus sixth_through_eight_alveolus eighth_to_twelfth_alveolus twelfth_to_sixteenth beyond_the_sixteenth;

{48 Dentary_curvature_between_fourth_and_tenth_alveoli gently deeply linear;

{49 Largest_dentary_alveolus_caudal_to_fourth 13_or_14 between_11_and_14_and_a_series_behind_it 11_or_12 no_differentiation behind_14 10;

{50 Splenial_with_anterior_perforation_for_cranial_nerv_V existent lacking;

{51 Mandibular_ramus_of_cranial_nerv_V only_anterior single_perforation_posterior double_perforation_posterior;

{52 Mandibular_symphysis_size splenial_participates_
splenial_excluded,_anterior_tip_of_splenial_ventral_to_Meckelian_groove
splenial_excluded,_anterior_tip_of_splenial_dorsal_to_Meckelian_groove
deep_splenial_symphysis,_splenial_forms_wide_V
deep_splenial_symphysis,_splenial_forms_narrow_V
splenial_reaches_mandibular_symphysis_but_does_not_touch_other_splenial;

{53 Coronoid_position_for_foramen_intermandibularis_medius bounding_posterior_half_of_foramen_ completely_surrounding_foramen obliterates_foramen_;

{54 Coronoid_superior_edge sloping_strongly_anteriorly almost_horizontal;

{55 Coronoid_inferior_process laping_over_inner_surface_of_meckelian_fossa remains_on_medial_surface_of_mandible;

{56 Coronoid_perforation imperforate perforation_posterior_to_foramen_intermandibularis_medius;

{57 Splenial_process separates_angular_and_coronoid no_process_between_angular_and_coronoid;

{58 Angular-surangular_suture_with_ext.mand._fenestra contacting_fenestra_at_posterior_angle passing_along_ventral_margin_of_fenestra;

{59 Surangular_anterior_processes unequal sub-equal_to_equal;

{60 Surangular_spur_on_lingual_tooth_row spur_for_at_least_one_alveolus_length no_spur;

{61 External_mandibular_fenestra absent present_as_narrow_slit present_with_discrete_concavity_on_angular_dorsal_margin present_and_very_large;

{62 Surangular-dentary_suture_intersection_with_ext._mand._fenestra anterior_to_posterodorsal_corner at_posterodorsal_corner;

{63 Angular_anterior_tip_to_foramen_intermandibularis_caudalis towards_anterior_end_of_foramen_ not_towards_anterior_end_of_foramen;

{64 Surangular-angular_suture_lingually_meets_articular at_ventral_tip dorsal_to_tip;

{65 Surangular_at_lateral_wall_of_glenoid_fossa continuing_to_dorsal_tip truncated;

{66 Articular-surangular_suture_form simple articular_bears_anterior_lamina_dorsal_to_lingual_foramen articular_bears_anterior_lamina_ventral_to_lingual_foramen articular_bears_lamina_above_and_below_foramen;

{67 Lingual_foramen_for_articular_artery perforates_surangular_entirely perforates_surangular/angular_suture;

{68 Foramen_aerum_position at_lingual_margin_of_retroarticular_process set_in_from_margin_of_retroarticular_process;

{69 Retroarticular_process_projection posteriorly posterodorsally,_not_higher_than_the_posterior_edge_of_the_articular_fossa projects_posterodorsally,_higher_than_the_posterior_edge_of_the_articular_fossa;

{70 Surangular_extension posterior_end_of_retroarticular_process pinched_off_anterior_to_tip_of_retroarticular_process;

{71 Surangular-articular_suture_orientation_within_glenoid_fossa anteroposteriorly bowed_strongly_laterally;

{72 Articular-surangular_connection sulcus_between_articular_and_surangular artciular_flush_against_surangular;

{73 Hyoid_cornu_dorsal_projection_form flat rodlike;

{74 Hyoid_cornu_dorsal_projection_lateromedial narrow_with_parallel_sides flared;

{75 Lingual_osmoregulatory_pores small large;

{76 Tongue with_keratinized_surface without_keratinized_surface;

{77 Teeth_and_alveoli_of_maxilla/dentary_form circular_in_cross-section posterior_teeth_laterally_compressed_ all_teeth_compressed_;

{78 Maxillary_and_dentary_teeth_serration smooth_carinae serrated with_neither_carinae_nor_serrations;

{79 Naris_projection anterodorsally dorsally posterodorsally;

{80 External_naris_and_nasal_interaction external_naris_birsected_by_nasals nasal_contacts_external_naris_without_bisection nasal_excluded_externally_from_naris nasal_and_premaxilla_not_in_contact;

{81 Naris_shape circular_or_key-hole_shaped wider_than_long anteroposteriorly_long_and_teardrop-shaped;

{82 External_naris_of_reproductively_mature_males similar_to_that_of_females with_bony_excrescence;

{83 External_naris_opening flush_with_dorsal_surface_of_premaxilla circumscribed_by_thin_crest;

{84 Premaxilla_surface_lateral_to_naris smooth with_deep_notch;

{85 Number_of_teeth_in_premaxilla_early_in_ontogeny five four;

{86 Incisive_foramen_size small large_and_more_than_half_the_greatest_width_of_premaxillae large_and_intersects_premaxillary-maxillary_suture;

{87 Incisive_foramen_position situated_far_from_premaxillary_tooth_row abuts_premaxillary_tooth_row projects_between_first_premaxillary_teeth;

{88 Dorsal_premaxillary_process short long_behind_3th_maxilla_tooth;

{89 Dentary_tooth_four_early_in_ontogeny in_notch_between_premaxilla_and_maxilla in_pit_between_premaxilla_and_maxilla;

{90 Dentary_teeth_position all_teeth_lingual_to_maxillary_teeth occlusion_pit_bewteen_seventh_and_eigth_maxillary_teeth dentary_teeth_in_line_with_maxillary_tooth_row;

{91 Largest_maxillary_alveolus third fifth fourth four_and_five_the_same_size six maxillary_teeth_homodont maxillary_alveloi_gradually_increase_in_diameter;

{92 Maxillary_tooth_row_form_posterior_to_first_six_maxillary_alveoli medially_curved_or_linear broadly_curved_laterally;

{93 Dorsal_surface_of_rostrum curves_smoothly bears_medial_dorsal_boss;

{94 Canthi_rostralii_at_maturity absent_or_very_modest very_prominent;

{95 Preorbital_ridges_ar_maturity absent_or_very_modest very_prominent;

{96 Antorbital_fenestra present absent;

{97 Vomer_position_anterior entirely_obscured_by_premaxilla_and_maxilla exposed_on_palate_at_premaxillary-maxillary_suture;

{98 Vomer_position_posterior entirely_obscured_by_maxillae_and_palatines exposed_on_palate_between_palatines;

{99 Surface_of_maxilla_within_narial_canal imperforate with_linear_array_of_pits;

{100 Medial_jugal_foramen_size small very_large;

{101 Maxillary_foramen_for_cranial_nerve_V_size small_or_not_present very_large;

{102 Ectopterygoid_contact_with_maillary_toothrow_forming_medial_wall_of_at_least_1_mx_alveolus absent_and_ectpt-mx_suture_anteromedially_orientated_and_separated_from_toothrow_margin absent_ans_ectopt-mx_suture_parallel_and_adjacent_to_medial_toothrow_margin present;

{103 Maxilla_termination_in_palatal_view anterior_to_lower_temporal_bar comprises_part_of_the_lower_temporal_bar;

{104 Penultimate_maxillary_alvelous_size less_than_twice_the_diamater_of_the_last_one more_than_twice_the_diamater_of_the_last_one;

{105 Prefrontal_dorsal_surface_appearance smooth_adjacent_to_orbital bearing_discrete_knoblike_processes;

{106 Dorsal_half_of_prefrontal_pillar narrow expanded_anteroposteriorly;

{107 Medial_process_of_prefrontal_pillar expanded_dorsoventrally expanded_anteroposteriroly;

{108 Prefrontal_pillar_form solid with_large_pneumatic_recess;

{109 Medial_process_of_prefrontal_pillar_at_base wide constricted;

{110 Maxilla_appearance_on_suborbital_fenestra linear_medial_margin broad_shelf,_lateral_margin_concave;

{111 Anterior_face_of_palatine_process_anteriroly rounded_or_pointed notched;

{112 Anterior_ectopetrygoid_process tapered_to_a_point forked;

{113 Palatine_process_extension beyond_anterior_end_of_suborbital_fenestra not_beyond_anterior_end_of_suborbital_fenestra;

{114 Palatine_process_form broad_anteriroly form_of_a_thin_wedge;

{115 Lateral_edges_of_palatines_appearance smooth_anteriroly lateral_process_projecting_into_suborbital_fenestra;

{116 Palatine-pterygoid_suture at_posterior_angle_of_suborbital_fenestra far_from_posterior_angle_of_suborbital_fenestra;

{117 Pterygoid_ramus_of_ectopterygoid_form straight,_posterolateral_fenestra_margin_linear bowed,_posterolateral_fenestra_margin_concave;

{118 Lateral_edges_of_palatines_form parallel_posterior flare_posteriorly,_producing_shelf;

{119 Anterior_border_of_choana comprised_of_palatines entirely_surrounded_by_pterygoids;

{120 Choana_projecting_at_maturity posteroventrally anteroventrally;

{121 Pterygoid_surface_around_choana flush_with_choanal_margin pushed_inward_anterolateral_to_choana_aperture pushed_inward_around_choana_to_form_neck_surrounding_aperture everted_from_flat_surface_to_form_neck_surounding_aperture;

{122 Posterior_rim_of_internal_choana not_deeply_notched deeply_notched;

{123 Internal_choana_appearance not_septated with_septum_that_remains_recessed_within_choana with_septum_that_projects_out_of_choana;

{124 Ectopterygoid-pterygoid_flexure_appearance flexure_disappeares_during_ontogeny flexure_remains_throughout_ontogeny;

{125 Ectopterygoid_extention_at_maturity _to_posterior_tip_of_lateral_pterygoid_flange __not_to_posterior_tip_of_lateral_pterygoid_flange;

{126 Maxilla_connection_with_lacrimal lacrimal_makes_broad_contact_with_nasal,_no_process maxilla_with_posterior_process_within_lacrimal maxilla_with_posterior_process_between_lacrimal_and_prefrontal;

{127 Prefrontal_form separated_by_frontals_and_nasals,_anterior_process_of_frontal_extending_far_anterior_to_the_anterior_margin_of_the_orbit prefrontals_separated_by_the_frontal_and_nasals,_anterior_process_of_frontal_around_the_same_level_or_posterior_to_the_anterior_margin_of_the_orbit prefrontals_meet_medially,_anterior_process_of_frontal_around_the_same_level_or_posterior_to_the_anterior_margin_of_the_orbit;

{128 Lacrimal_and_prefrontal_size lacrimal_longer_than_prefrontal prefrontal_longer_than_lacrimal lacrimal_and_prefrontal_same_size_and_elongated;

{129 Anterior_tip_of_frontal_form simple_acute_point broad,_complex_sutural_contact_with_nasals;

{130 Ectopterygoid_extension_at_postorbital_bar extends_along_medial_face_of_postorbital_bar stops_abruptly_ventral_to_postorbital_bar;

{131 Postorbital_bar_form massive slender;

{132 Postorbital_process prominent,_dorsoventrally_broad,_two_spines short_and_generally_not_prominent;

{133 Ventral_margin_of_postorbital_bar flush_with_lateral_jugal_surface inset_from_lateral_jugal_surface;

{134 Postorbital_bar_connection_with_skull_table continous_with_anterolateral_edge_of_skull_table inset_from_skull_table;

{135 Margin_of_orbit flush_with_skull_surface dorsal_edges_of_orbist_upturned orbital_margin_telescoped anterior_margins_of_orbit_telescoped;

{136 Ventral_margin_of_orbit_form not_upturned,_ventral_margin_gently_circular anterior_margin_upturned,_ventral_margin_gently_circular anterior_margin_upturned,_ventral_margin_with_a_prominent_notch;

{137 Palpebral_form single_ossification multiple_ossifications;

{138 Quadratojugal_spine_appearance prominent_at_maturity greatly_reduced_or_absent_at_maturity;

{139 Quadratojugal_spine_position_into_infratemporal_fenestra low,_near_posterior_angle_of_fenestra high,_between_posterior_and_superior_angles_of__fenestra;

{140 Posterior_angle_of_infratemporal_fenestra quadratojugal_forms_posterior_angle_of_fenestra jugal_forms_posterior_angle_of_fenestra quadratojugal-jugal_suture_lies_at_posterior_angle_of_fenestra;

{141 Postorbital_contacts _neither_quadrate_nor_quadratojugal_medially quadratojugal_but_not_quadrate_medially

quadrate_and_quadratojugal_at_dorsal_angle_of_infrat._fenestra
quadratojugal_with_significant_descending_process;

{142 Quadratojugal_process long_anterior_process_along_lower_temporal_bar
_modest_process,_or_none_at_all,_along_lower_temporal_bar;

{143 Quadratojugal_extention extends_to_superior_angle_of_infratemporal_fenestra
does_not_extend_to_superior_angle_of_infratemporal_fenestra;

{144 Postorbital-squamosal_suture_orientation_to_skull_table passes_ventrally passes_medially;

{145 Dorsal_and_ventral_rims_of_squamosal_groove parallel flaring_anteriorly;

{146 Quadrate_and_squamosal_on_external_auditory_meatus not_in_contact_posteriorly
suture_extends_dorsally_along_caudal_margin_of_meatus
extends_only_to_caudoventral_boarder_of_meatus;

{147 Caudal_margin_of_otic_aperture not_defined_and_merging_into_exoccipital
smooth_and_continous_with_paroccipital_process inset;

{148 Frontoparietal_suture_position deeply_within_supratemporal_fenestra
making_modest_entry_into_supratemporal_fenestra_at_maturity on_skull_table_entirely;

{149 Frontoparietal_suture_between_supratemporal_fenestrae concavoconvex linear;

{150 Supratemporal_fenestra_appearance dermal_bones_do_not_overhang_rim_of_fenestra
parietal_overhangs_the_rim_at_maturity
postorbital,_squamosal_and_parietal_overhang_rim_at_maturity fenestra_closes_during_ontogeny;

{151 Anteromedial_corner_of_supratemporal_fenestra shallow_fossa_or_no_fossa smooth;

{152 Medial_parietal_wall_of_supratemporal_fenestra imperforate bearing_foramina;

{153 Parietal_and_squamosal_on_supratemporal_fenestra
widely_separated_by_quadrate_on_posterior_fenestra_wall
approaching_each_other_on_fenestra_without_making_contact
meeting_along_posterior_wall_of_fenestra;

{154 Skull_table_surface_at_maturity sloping_ventrally_from_sagittal_axis planar
slopes_ventrally_toward_sagittal_axis_at_maturity,_lateral_elements_planar;

{155 Squamosal_on_skull_table horizontal_or_nearly_so
upturned_to_form_a_discrete_posterolateral_horn
producing_a_high_transversely_oriented_eminence_at_the_posterior_margin_late_in_ontogeny;

{156 Posterolateral_squamosal_rami rami_along_paroccipital_process_short
rami_along_paroccipital_process_significant;

{157 Squamsoal_form does_not_extend_to_lateral_extent_of_paroccipital_process
extends_to_lateral_extent_of_paroccipital_process;

{158 Supraoccipital_exposure_on_dorsal_skull_table absent small large
large_such_that_parietal_is_excluded_from_posterior_edge_of_table;

{159 Anterior_foramen_of_cranial_nerve_VII ventrolateral_to_basisphenoid_rostrum
ventral_to_basisphenoid_rostrum;

{160 Braincase_wall_lateral_to_basisphenoid_rostrum sulcus_on_anterior_braincase_wall
braincase_wall__smooth,_no_sulcus;

{161 Basisphenoid_anterior_to_trigeminal_foramen not_exposed_extensively exposed_extensively;

{162 Prootic_on_external_braincase_wall extensively_exposured largely_obscured_by_quadrate_and_laterosphenoid_externally;

{163 Laterosphenoid_bridge comprised_entirely_of_laterosphenoid with_ascending_process_or_palatine;

{164 Capitate_process_of_laterosphenoid oriented_laterally_toward_midline oriented_anteroposteriorly_toward_midline;

{165 Parietal_pneumatic_system parietal_with_recess_communicating_with_pneumatic_system parietal_solid,_without_recess;

{166 Lateral_braincase_wall significant_ventral_quadrate_process_on_braincase_wall q-pt_suture_linear_from_basisphenoid_exposure_to_trigeminal_fo;

{167 Lateral_carotid_foramen opens_lateral_to_basisphenoid_at_maturity dorsal_to_to_basisphenoid_at_maturity;

{168 External_surface_of_basioccipital_ventral_to_occipital_condyle oriented_posteroventrally_at_maturity oriented_posteriorly_at_maturity;

{169 Posterior_pterygoid_process tall_and_prominent small_and_project_posteroventrally small_and_project_posteriorly;

{170 Basisphenoid_appearance_ventral_to_basioccipital thin_ anteroposteriorly_wide;

{171 Basisphenoid_exposure not_broadly_exposed_ventral_to_basioccipital exposed_as_broad_sheet_ventral_to_basioccipital;

{172 Exoccipital_on_paroccipital_process with_very_prominent_boss with_small_or_no_boss_on_paroccipital_process;

{173 Lateral_eustachian_canal_openings dorsal_to_medial_eustachian_canal lateral_to_medial_eustachian_canal;

{174 Exoccipital_termination dorsal_to_basioccipital_tubera sending_robust_process_ventrally,_participating_in_bo_tubera sending_slender_process_ventrally_to_basioccipital_tubera;

{175 Quadrate_foramen_aerum_position on_mediodorsal_angle_of_quadrate on_dorsal_surface_of_quadrate;

{176 Quadrate_foramen_aerum_size_at_maturity small comparatively_large absent;

{177 Quadrate_appearance_on_dorsal_surface_of_ramus lacking_prominent,_mediolaterally_thin_crest bearing_prominent,_mediolaterally_thin_crest;

{178 Attachment_scar_for_posterior_mandibular_abductor_muscle forming_modest_crest_on_ventral_surface_of_quadrate_ramus forming_prominent_knob_on_ventral_surface_of_quadrate_ramus;

{179 Quadrate_hemicondyle small,_ventrally-reflected_medial_hemicondyle small_medial_hemicondyle_dorsal_notch_for_foramen_aerum with_prominent_dorsal_projection_between_hemicondyles with_expanded_medial_hemicondyle;

{180 Iris_colour greenish/yellowish brown;

{181 Postoccipital_osteoderms two_or_more one;

{182 Paired_midline_scale_rows fewer_than_eight eight_to_14 more_than_14;

{183 Ectopterygoid_maxillary_ramus_form less_than_two-thirds_of_lateral_margin_of_suborbital_fenestra more_than_two-thirds_of_lateral_margin_of_suborbital_fenestra;

{184 Ectopterygoid_maxillary_ramus_termination at_lateral_margin_of_suborbital_fenestra lateral_to_it,_maxilla_separating_the_ectopterygoid_from_fenestra;

{185 Palatine-maxillary_suture_intersection_at_suborbital_fenestra at_its_anteromedial_margin nearly_at_its_anteriormost_limit;

{186 Frontal_with_midsagittal_crest_between_orbits lacks bears;

{187 Cervical_neural_spines_form anteroposteriorly_broad posterior_neural_spines_thin_and_rod-like;

{188 Largest_premaxilla_tooth second third fourth third_and_fourth_similar_largest all_similar_in_size fourth_and_fifth_similarly_largest first_for_similar_in_size;

{189 Dorsal_surface_of_surangular smooth large_sulcus_next_to_the_anterior_half_of_the_glenoid_fossa;

{190 U-shaped_depression_of_the_frontal_at_the_point_of_maximum absent present;

{191 Head_shape relatively_flat formed_like_a_wedge_and_trapezoid_in_cross-section;

{192 Anterior_jugal_process extends_anterior_to_the_anterior_process_of_frontal_ at_the_same_level_as_the_anterior_process_of_frontal_ well_posterior_to_the_anterior_process_of_frontal_;

{193 Notch_between_the_premaxilla_and_maxilla_in_adults present not_present;

{194 Anterior_maxilla_and_dentary_teeth without_or_weak_dorsoventral_ridges_on_the_lateral_surface with_dominant_dorsoventral_ridges_on_the_lateral_surface;

{195 If_largest_dentary_alveolus_is_between_11th_and_14th_and_a_series_behind_it 11th 12th 13th_or_14th;

{196 Surangular-angular_suture_lingually_originates_ near_the_ventral_border_of_the_external_mandibular_fenestra_ near_the_dorsal_border_of_the_external_mandibular_fenestra_and_straight near_the_dorsal_border_of_theexternal_mandibular__fenestra_and_bowed;

{197 If_supraoccipital_exposure_on_skull_table_is_large_or_very_large,_is__ trapezoid triangular block-shaped;

{198 Edge_of_the_maxillary_alveoli lower_or_at_the_same_level_than_the_space_between_toothrow_ edge_of_maxillary_tooth_alveoli_higher_than_the_space;

{199 Ventral_border_of_exoccipital_ ventrally_projected,_hiding_the_posterior_opening_of_the_cranioquadrate_passage_from_the_occipital_view_ straight,_sharpen_or_smoothly_convex_and_does_not_hide_the_posterior_opening_of_the_cranioquadrate_passage_from_the_occipital_view_;

{200 Occipital_surface_at_maturity sloped,_visible_in_dorsal_view_ vertical_or_not_visible_in_dorsal_view;

{201 Ventral_premaxilla-maxilla_suture_ short_and_ends_posteriorly_before_the_3rd_maxillary_alveoli elongated_and_extends_or_exceeds_the_3rd_maxillary_alveoli_;

{202 Number_of_teeth_on_maxilla less_than_18_teeth 18_to_22_teeth more_than_22_teeth;

{203 Lateral_edge_of_the_skull_table_at_the_level_of_the_postorbital-squamosal_suture_ situated_laterally_or_at_the_same_level_as_the_quadrate_condyle_in_dorsal_view_at_maturity situated_medially_to_the_quadrate_condyle_in_dorsal_view_at_maturity;

{204 Frontal_ending at_the_same_level_or_posterior_to_the_anterior_extension_of_the_prefrontal extends_well_anterior_to_the_anterior_extension_of_the_prefrontal;

{205 Maxilla_posterior_process_without_tooth_in_ventral_view short_or_absent long_longer_than_the_distance_between_the_three_last_teeth_;

{206 Interorbital_bridge narrower_to_equivalent_than_the_width_of_the_orbit broader_than_the_width_of_the_orbit;

{207 Supratemporal_fenestra_at_maturity longer_than_wide_or_rounded,_posterior_bar_of_supratemporal_fenestra_thick_ wider_than_long,_posterior_bar_of_supratemporal_fenestra_thick_ wider_than_long,_posterior_bar_thin_;

{208 Medial_crest_on_the_basioccipital present absent;

{209 Posterior_dentary_process_between_splenial_and___angular_on_the_ventral_side absent present;

{210 Dorsal_margin_of_the_articular_on_the_retroarticular_process_ largely_visible_in_lateral_view slightly_or_not_visible_in_lateral_view_;

{211 Posterior_margin_of_the_orbit_measured_at_the_level_of_the_postorbital-frontal_suture_in_the_orbital_margin_ _anterior_to_the_posterior_margin_of_the_suborbital_fenestra posterior_or_at_the_same_level_than_the_posterior_margin_of_the_suborbital_fenestra;

{212 Basioccipital-exoccipital_process_ventral_to_occipital_condyle_(basioccipital_plate)_in_posterior_view with_parallel_or_ventrally_convergent_sides_ ventrally_divergent_sides_;

{213 Smooth_medial_depression_ventral_to_the_basioccipital_and_posterior_to_the_medial_Eustachian_foramen absent present;

{214 Dentary_teeth_series_behind_to_alveoli_12-13_ pointed_to_slightly_blunt globular,_different_in_size_among_them_ globular,_at_least_four_subequal_in_size_ molariform_multicusped absent;

{215 First_four_alveoli_in_the_dentary same_size_or_smaller_than_other_dentary_alveoli_ the_largest_within_the_dentary_;

{216 Obits_late_in_ontogeny longer_than_wide_ wider_than_long_to_rounded_;

{217 The_series_composed_by_the_last_three_premaxillary_teeth_ diverge_posteriorly_to_paraxial tend_to_converge_posteriorly,_straight_among_them_;

```
{218 Dentary,_level_of_the_first_and_fourth_alveoli
lower_than_the_level_of_the_eleventh_and_twelfth_alveoli_
equal_to_higher_than_the_level_of_the_eleventh_and_twelfth_alveoli;

;


ccode     +  38 47 61 80 123 148 150 153 158 192 202 *;



proc /;

comments 0

;
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4. Dataset: Walter et al., supplementary dataset (modified Chabrol et al. (2024); continuous and discrete characters; .tnt)

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nstates cont;

nstates 32 ;

xread 'Data saved from TNT'

330 156

&[cont]

Bernissartia_fagesii  0.494  1.272  ?   ?   ?   0.173  ?   0.870  7.000  0.375  0.717  ?   ?   ?   ?
?  16.000  ?   ?   ?  60.000  ?   ?   ?   ?   ?

Isisfordia_duncani  0.646  1.482  0.657  0.180  0.093  0.232  0.362  0.823  0.000  0.525  0.663  0.346
0.421  1.016  3.650  1.918  ?   ?   ?   ?  30.000  ?   ?   0.754  1.112  ?

Acynodon_iberoccitanus  ?   ?   ?   ?   ?   ?   ?   ?   ?   ?   ?   ?   ?   ?   ?   ?
13.000  ?   ?   ?   ?   ?   ?   ?   ?   ?

Agaresuchus_fontisensis  0.534  1.366  1.375  0.420  0.287  0.308  0.576  0.595  ?   0.591  0.921
0.191  0.430  1.379  3.259  ?  15.000  ?   ?   ?   ?   ?   ?   ?   ?   ?

Allodaposuchus_precedens  0.563  1.778  1.700  0.254  0.388  0.388  ?   0.794  11.000  0.529  0.913
0.129  0.366  ?   2.900  ?  14.000  ?   ?   ?   ?   ?   ?   ?   ?   ?

Glen_Rose_form   ?   ?   ?   ?   ?   0.147  ?   0.699  9.000  0.525  0.598  ?   0.533  0.308
2.858  2.421  11.000-12.000  ?   ?   ?   ?   ?   ?   ?   ?   ?

Hylaeochampsa_vectiana  ?   1.517  ?   ?   ?   0.328  ?   1.052  0.000  0.410  0.560  ?   0.250
0.846  ?   2.333  ?   ?   ?   ?   ?   ?   ?   ?   ?   ?

Iharkutosuchus_makadii  0.428  1.292  1.500  0.344  ?   0.257  ?   0.667  18.000  ?   ?   ?
0.295  1.219  ?   1.664  13.000  ?   ?   ?   ?   ?   ?   ?   ?   ?

Lohuecosuchus_megadontos  0.482  1.579  1.667  0.296  ?   0.428  ?   0.693  5.000  0.420  0.824
0.171  0.516  0.684  3.364  ?  10.000-11.000  ?   ?  1.122  ?   ?   ?   ?   ?   ?

Portugalosuchus_azenhae  ?   1.074  ?   ?   ?   0.224  ?   0.595  0.000  0.705  0.903  ?   0.354
1.222  ?   ?   ?   2.333  36.000  ?   ?   ?   ?   ?   ?   ?

Shamosuchus_djadochtaensis  ?   0.824  ?   ?   0.425  0.241  0.503  0.597  0.000  0.535  0.800  ?
?   ?   3.878  2.607  ?   ?   ?   ?   ?   ?   ?   ?   ?   ?

Wannchampsus_kirpachi  ?   ?   ?   ?   ?   ?   ?   0.733  0.000  0.651  0.537  ?   ?   ?
2.769  1.375  11.000  ?   ?   ?   ?   ?   ?   ?   ?   ?

Acresuchus_pachytemporalis  0.535  2.529  1.134  0.264  0.189  0.337  0.687  0.798  15.000  0.518
0.488  0.147  ?   ?   ?   1.389  11.000  1.373  38.000  1.088  ?   ?   ?   ?   ?   ?

Aktiogavialis_caribesi  ?   0.787  ?   ?   ?   0.283  ?   0.657  12.000  0.640  0.794  ?   0.386
1.130  ?   1.767  19.000  ?   ?   ?   ?   ?   ?   ?   ?   ?
```

Alligator_mcgrewi 0.444-0.478 1.495-1.518 1.291-1.429 0.242 ? 0.220-0.230 0.399-0.489 0.679-0.788 8.000 0.425-0.496 0.738-0.829 0.203-0.217 0.530 1.667 2.147 ? 13.000 1.912-3.169 20.000 1.163 54.000 ? ? ? ? ?

Alligator_mefferdi 0.524 1.803 1.324 0.328 ? 0.355 0.491 0.750 4.000 0.368 1.074 ? ? 1.438 2.622 1.750 14.000 1.914 38.000 1.158 ? ? ? ? ? ?

Alligator_mississippiensis 0.579-0.586 2.000-2.021 1.421-1.475 0.466 0.288 0.322-0.341 0.479-0.578 0.711-0.835 11.000 0.408-0.453 0.793-0.862 0.154-0.157 0.380 0.947-1.000 3.330 1.607-2.048 15.000 2.200-2.618 11.000 1.174-1.391 24.000 0.832 0.592 0.687-0.783 1.070-1.159 0.492

Alligator_olseni 0.481 1.865 1.257 ? ? 0.320 ? 0.763 8.000 0.586 0.931 ? ? ? 3.330 1.342 15.000 2.925 19.000 1.193 37.000 ? ? ? ? ?

Alligator_prenasalis 0.554-0.555 1.656-1.781 1.230-1.515 ? ? 0.278-0.308 0.532-0.617 0.669-0.755 7.000 0.516-0.604 0.711-0.737 0.213 ? ? ? ? 14.000 2.017-2.533 22.000 1.229-1.252 24.000 0.914 0.507 0.739 1.220 ?

Alligator_sinensis 0.575 1.960 1.563 0.383 0.275 0.320 0.429 0.747 10.000 0.464 0.808 0.163 0.471 1.267 2.326 1.950 13.000 2.059 21.000 1.154 17.000 0.869 0.581 0.689-0.744 1.107-1.206 0.517

Hassiacosuchus_haupti 0.417-0.538 1.778 1.333 ? ? 0.311 0.706 0.756 ? 0.500 0.643-0.706 ? ? ? ? ? 14.000 1.412-1.500 46.000 1.250 65.000 ? ? 0.941 1.490 ?

Navajosuchus_mooki 0.480-0.506 ? 0.867 ? ? ? ? ? ? ? 0.625 ? ? ? ? ? 14.000 1.550 21.000 ? ? 0.730 0.671 0.764 ? ?

Allognathosuchus_polyodon ? ? 1.273 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 1.605 ? ? ? ? ? ?

Allognathosuchus_wartheni 0.472 ? 1.129 ? ? ? 0.718 ? ? 0.540 ? 0.161 ? ? ? 1.625 12.000 1.088 38.000 ? ? ? ? ? ? ?

Arambourgia_gaudryi 0.376 1.270 1.400 ? ? 0.216 0.370 0.730 0.000 0.481 0.846 ? ? 1.333 ? 1.833 ? ? 31.000 ? ? ? ? ? ? ?

Argochampsa_krebsi ? 1.143 ? 1.237 0.409 0.304 ? 0.804 6.000 0.533 0.875 ? ? 0.933 ? 1.813 26.000 ? ? ? ? ? ? ? ? ?

Asiatosuchus_germanicus 0.547 1.727 1.444 ? ? 0.410 0.436 0.791 16.000 0.327 0.806 ? ? ? ? ? 14.000 2.167 23.000 ? 23.000 0.775 0.606 0.761 1.391 ?

Asiatosuchus_nanlingensis ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 0.911 ? ? ? ? ? ?

Australosuchus_clarkae 0.526-0.552 1.906-2.033 0.988 ? 0.167 0.200-0.258 0.650 0.851-0.875 7.000 0.340-0.482 0.593-0.971 0.196 0.263 ? ? ? 14.000-15.000 ? ? ? ? ? ? ? ? ?

Baru_darrowi ? ? 1.154 ? 0.517 ? ? ? ? ? ? 0.210 0.382 ? ? ? 13.000 ? ? ? ? ? ? ? ? ?

Baru_huberi ? ? 1.010 ? 0.242 ? ? ? ? ? ? 0.202 ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Baru_wickeni ? ? 0.839 ? 0.409 ? ? ? 15.000 ? ? 0.167 0.437 ? ? ? 12.000 1.736-1.790 ? 1.553-1.690 ? ? ? ? ? ?

Borealosuchus_acutidentatus 0.603 1.237 1.200 ? ? 0.203 ? 0.619 0.000 0.545 0.949 ? ? ? ? ? 20.000 ? ? ? ? ? ? ? ? ?

Borealosuchus_formidabilis 0.646 1.171 1.224 ? ? 0.200 ? 0.514 0.000 0.550 1.020 0.241 0.335 0.702 2.667 1.308 20.000 1.728 36.000 ? 55.000 1.033 0.527 ? 1.080 0.556

Borealosuchus_sternbergii 0.574-0.600 1.257-1.552 1.152-1.471 0.110 0.276-0.296 0.261-0.308 0.341-0.529 0.637-0.759 0.000-5.000 0.443-0.651 0.700-0.968 0.209-0.432 0.302-0.376 0.750-0.833 2.595 1.641-1.650 19.000 2.789-3.611 21.000-24.000 1.059 ? ? ? 0.705 ? ?

Borealosuchus_threensis ?

Borealosuchus_wilsoni 0.604 ? 0.867 0.321 ? 0.455 0.904 0.548 ? 0.592 1.302 ? ? ? ? ? 18.000 ? ? 1.846 60.000 ? ? 0.710 1.231 0.377

Bottosaurus_harlani ? ? ? ? ? 0.290 1.008 0.533 8.000 0.482 0.896 ? ? ? ? ? ? 1.284 27.000 ? ? ? ? ? ? ?

Boverisuchus_magnifrons ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 17.000 ? ? ? ? ? ? ? ? ?

Boverisuchus_vorax 0.584 1.453 0.891 0.157 ? 0.471 0.633 0.754 9.000 0.520 0.565 0.259 0.418 1.106 ? ? 17.000 ? ? ? 13.000 ? 0.679 0.870 1.408 0.458

Brachychampsa_montana 0.583 2.522 0.885-1.000 0.088 0.163 0.402 0.721 0.935 14.000 0.512 0.773 0.331 0.476 1.257 2.956 2.240 14.000 2.024 12.000 1.177 30.000 ? ? ? 1.160 ?

Brochuchus_pigotti 0.658 1.765 0.931 0.397 0.282 0.382 0.492 0.897 6.000 0.377 0.783 0.184 0.351 1.250 2.133 1.348 14.000 ? 21.000 ? ? ? ? ? ? ?

Caiman_brevirostris ? ? ? ? 0.308 ? ? ? ? ? ? ? ? ? ? 1.867 ? ? ? ? ? ? ? ? ? ?

Caiman_crocodilus 0.512-0.623 1.257-1.528 1.000-1.698 0.309-0.457 ? 0.214-0.303 0.554-0.671 0.584-0.760 5.000-15.000 0.273-0.432 0.775-0.862 0.159-0.219 0.339-0.481 1.339-1.693 2.126 1.409-1.433 14.000-17.000 1.773-1.905 21.000-33.000 1.162-1.661 18.000 ? 0.530 0.771-0.803 1.100-1.282 0.636

Caiman_gasparinae ? ? 1.220 0.763 0.470 0.447 ? 0.772 14.000 0.261 0.739 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Caiman_latirostris 0.539 2.195 1.343 0.355-0.653 0.304 0.341 0.685 0.659 8.000-9.000 0.259 0.786 0.178 0.508 2.000 2.581 1.571 13.000 1.513 30.000 1.317 ? 0.814 0.608 0.754-0.757 ? 0.538

Caiman_lutescens_MACN ? ? ? ? ? 0.462 ? 0.598 13.000 0.304 0.417 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?

UCMP_39978 ? ? 1.064 0.202 0.280 ? ? ? ? ? ? 0.187 0.450 2.077 2.294 ? 13.000 ? ? ? ? ? ? ? ? ?

Caiman_wannlangstoni 0.479 1.333 ? ? ? 0.314 ? 0.726 7.000 0.346 0.769 ? ? ? ? ? 12.000 ? ? ? ? ? ? ? ? ?

Caiman_yacare 0.567-0.579 1.575-1.595 1.115-1.208 0.269-0.318 0.333-0.366 0.325-0.329 0.686 0.646-0.663 2.000-11.000 0.349-0.353 0.667-0.692 0.177 0.385-0.406 1.941-2.063 2.316 1.348 14.000 1.618 23.000-37.000 1.342 0.000 ? ? 0.733-0.791 1.058-1.311 ?

Ceratosuchus_burdoshi 0.529 1.733 0.938 ? ? 0.343 ? 0.717 ? 0.614 1.034 0.339 ? ? ? 1.436 14.000 ? ? ? ? ? ? ? ? ?

Crocodylus_acutus 0.639 1.678 0.718 0.704 0.422 0.533 0.347 0.833 15.000 0.440 0.818 0.186 0.394 1.333 2.535 1.464 14.000 1.741 33.000 1.511 17.000 ? ? 0.712-0.741 1.041-1.121 ?

Crocodylus_affinis 0.575-0.606 1.612-1.726 0.833-1.098 0.310-0.314 0.390 0.189-0.658 0.512-0.632 0.553-0.777 2.000-8.000 0.452-0.480 0.988-1.055 0.218 0.239-0.443 0.789-1.381 3.464 1.460-1.546 13.000-14.000 1.930-2.150 41.000 1.371-1.491 33.000 ? 0.557 ? ? ?

Crocodylus_anthropophagus ? ? 0.843 ? ? ? ? ? ? ? ? 0.195 ? ? ? ? 14.000 1.166 23.000 ? 23.000 ? ? ? ? ?

Asiatosuchus_depressifrons 0.561 1.518 1.227 0.363 0.375 0.301 0.554 0.675 8.000-13.000 0.518 0.862 ? ? ? ? 1.579 14.000 1.700 31.000 ? 17.000 ? ? 0.779 1.084 ?

Crocodylus_intermedius 0.644-0.653 1.393-1.432 0.656-0.889 0.747 0.417 0.423-0.493 0.417-0.544 0.757-0.832 3.000 0.357-0.465 0.931-1.067 0.203-0.286 0.282-0.320 1.304-1.550 2.525 1.300-1.389 14.000 1.929-2.011 34.000 1.665 ? ? ? ? ? ?

Crocodylus_johnstoni 0.686 1.138 0.815 0.498 0.421 0.294 0.524 0.688 4.000 0.547 0.841 0.265 0.275 1.085 2.487 1.404 14.000 2.117 25.000 1.877 14.000 1.014 0.468 0.690-0.729 1.116-1.192 0.432

Crocodylus_megarhinus 0.662 2.193 0.700-0.807 0.419-0.429 0.416 0.307 0.505 0.887 7.000-8.000 0.360 0.850 0.161-0.348 ? ? 2.393 1.548 13.000 1.947 ? ? ? ? ? ? ? ?

Crocodylus_mindorensis 0.548 1.495 0.703 0.511 ? 0.276 0.406 0.838 12.000-16.000 0.474 1.054 0.185 0.377 0.706 2.535 1.562 13.000 2.013 33.000 1.847 ? ? ? ? ? ?

Crocodylus_moreletii 0.603 2.255 0.830 0.629 0.455 0.519 0.463 0.896 11.000 0.432 0.829 0.125 0.415 0.640 2.067 1.719 14.000 1.366 30.000 1.367 ? ? ? 0.715-0.719 1.035-1.106 ?

Crocodylus_niloticus 0.567-0.613 1.737 0.826 0.491 0.424 0.495 0.341 0.859 5.000 0.494 0.619 0.169 0.342 1.143 2.285 1.563 13.000-14.000 1.257 33.000 1.310 20.000 0.822-0.949 0.431-0.489 0.660-0.771 1.116-1.174 0.524-0.633

Crocodylus_novaeguineae 0.602 1.446 0.833 0.544 0.361 0.357 0.362 0.839 12.000 0.489 0.870 0.171 0.355 1.000 2.105 1.211 13.000-14.000 1.467 33.000 1.111 ? ? ? 0.721 1.227 ?

Crocodylus_palustris 0.533-0.601 2.087 0.850-0.873 0.579-0.863 0.365 0.470 0.410 0.904 3.000 0.471 0.592 0.229 0.457 2.769 2.000 ? 14.000-15.000 1.205 40.000 1.097 19.000 0.942 0.551 0.722-0.730 1.059-1.174 0.460

Crocodylus_porosus 0.602-0.634 1.967-2.008 0.768-1.051 0.648-0.667 0.403-0.412 0.348-0.519 0.420-0.437 0.820-0.908 9.000-14.000 0.410-0.413 0.653-0.902 0.108-0.114 0.403-0.449 1.783-2.000 2.159 1.217-1.265 14.000 1.469-1.649 36.000 1.095-1.121 17.000 0.921 0.476 0.581-0.692 1.090-1.125 0.547

Crocodylus_rhombifer 0.558-0.625 1.646 0.769 0.151-0.333 ? 0.441 0.347 ? 7.000-15.000 0.373 0.698-0.875 0.191 0.466 1.382 2.805 1.742 13.000-14.000 1.928 30.000 1.158 19.000 0.825 0.470 0.726-0.784 1.221-1.314 0.573

Crocodylus_siamensis 0.581-0.614 1.723-1.853 0.837-0.953 0.549 0.287-0.291 0.475-0.547 0.324-0.375 0.733-0.758 12.000 0.432-0.500 0.806-0.906 0.189-0.190 0.409-0.434 1.389-1.571 1.962 1.433-1.500 14.000 1.467 38.000 1.302 12.000 0.885 0.495 0.736 1.120 ?

Crocodylus_thorbjarnarsoni 0.595 1.913 1.034 0.175 0.427 0.501 0.482 0.834 12.000 0.423 0.933 0.126 0.513 1.900 2.773 ? 13.000 1.433 37.000 1.248 ? ? ? ? ? ?

Crocodylus_palaeindicus 0.554-0.573 1.690-1.750 0.900-1.260 0.780-1.157 0.265-0.411 0.439-0.473 0.333-0.397 0.771-0.793 10.000-14.000 0.299-0.415 0.759-1.043 0.151-0.221 0.422-0.457 1.600 1.604 1.692-1.909 11.000 1.379 ? 1.486 ? ? 0.520 ? ? ?

Crocodylus_checchiai 0.610 1.810 0.880 0.530 0.260 0.540 0.460 0.770 11.000-13.000 0.370 0.840 0.180 0.400 1.600 ? 1.570 12.000-14.000 1.100 27.000 ? ? ? ? ? ? ?

Crocodylus_falconensis ?

Prodiplocynodon_langi 0.556 1.804 0.881 0.304 ? 0.296 0.507 0.542 ? 0.478 0.896 0.289 0.451-0.460 0.821 2.327 1.354 ? ? ? ? ? ? ? ? ? ?

Albertosuchus_knudsenii ?

Orientalosuchus_naduongensis 0.549 ? 1.066 ? ? 0.207-0.241 0.261 1.335 ? 0.393 1.260-1.563 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Dongnanosuchus_hsui 0.455-0.507 1.575 1.027-1.333 0.319 ? 0.236 0.375 0.701 ? 0.360-0.397 1.111-1.478 0.255 0.291-0.416 ? 2.586 1.620 ? ? ? ? ? ? ? ? ? ?

Kinyang_mabokoensis ?

Dadagavialis_gunai ? 0.938 ? ? ? ? ? ? ? ? ? ? ? ? ? ? 22.000 ? ? ? ? ? ? ? ? ?

Krabisuchus_siamogallicus ?

Protoalligator_huiningensis ?

Eurycephalosuphus_gannanensis 0.589 ? 1.653 ? ? ? ? ? ? 0.563 1.045 ? 0.404 ? ? ? ? 0.690 ? ? ? ? ? ? ? ?

Diplocynodon_darwini 0.479-0.618 1.386-1.424 1.000 0.446-0.623 ? 0.203-0.228 0.481-0.740 0.877-0.915 1.000-6.000 0.407-0.511 0.667-0.833 ? 0.364 1.000 2.378 ? 18.000 2.818 43.000 ? 53.000 ? 0.443 0.716-0.890 1.077-1.198 ?

Diplocynodon_deponiae 0.455-0.484 ? 0.917 ? ? ? ? ? 2.000 0.400-0.500 0.333-0.545 ? ? ? 3.231 ? 16.000 ? ? ? ? ? ? 0.750-0.789 1.200-1.531 ?

Diplocynodon_hantoniensis 0.566-0.680 1.908-1.970 0.773-1.076 0.141-0.226 0.296-0.333 0.265-0.293 0.635-0.723 0.968-1.010 9.000-10.000 0.550-0.564 0.551-0.591 0.216-0.249 0.392-0.464 0.918-0.962 3.258 1.713-1.905 17.000 1.857-2.138 44.000-45.000 1.466 37.000-47.000 ? ? ? ? ?

Diplocynodon_muelleri 0.507 1.721 ? ? ? 0.233 ? 0.965 0.000 0.518 0.558 ? ? ? ? ? 20.000 ? ? ? 48.000 ? ? ? ? ?

Diplocynodon_ratelii 0.586 1.485 1.037 0.130 ? 0.265 0.625 0.824 8.000-9.000 0.429 0.792 ? 0.349 1.067 3.543 1.533 16.000 ? ? ? 47.000 ? 0.430 ? ? ?

Diplocynodon_remensis ? ? ? ? ? 0.244 ? ? ? ? 0.667 ? ? ? ? ? 17.000 2.211 30.000 1.316 ? ? ? ? ? ?

Dollosuchoides_densmorei 0.668 1.225 0.813 0.385 ? 0.285 0.650 0.795 0.000 0.646 1.071 0.378 0.350 1.063 3.174 ? 15.000 ? ? ? ? ? ? ? ? ?

Eocaiman_cavernensis ? ? ? ? ? ? ? ? ? ? ? ? 0.633 ? ? ? 14.000 1.833 28.000 ? ? ? ? ? ? ?

Eocaiman_palaeocenicus ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 1.556 24.000 1.202 ? ? ? ? ? ?

Eogavialis_africanum 0.693-0.725 0.857-1.118 0.909-1.128 0.620-0.823 0.518 0.247-0.308 0.359-0.604 0.604-0.882 7.000-16.000 0.440-0.661 0.974-1.129 0.091 0.357-0.358 1.026-1.417 ? 1.433-1.886 20.000 ? 21.000 ? ? ? 0.374 ? ? 0.485

Eosuchus_lerichei 0.653 ? 0.815 ? ? ? 0.576 ? 0.000 0.576 0.868 0.250 0.410 1.733 3.646 1.524 16.000-17.000 ? ? ? ? ? ? ? ? ?

Eosuchus_minor 0.657 ? ? ? ? ? ? ? 1.000-5.000 ? ? ? ? ? ? ? 17.000 ? 23.000 ? ? ? ? ? ? ?

Eothoracosaurus_mississippiensi 0.689 0.955 1.030 ? ? 0.318 0.433 0.577-0.656 5.000 0.547-0.571 0.938-1.079 ? ? ? ? 1.936 22.000 ? ? ? ? ? 0.288 ? ? ?

Euthecodon_arambourgi 0.748 1.608 0.966 0.590 ? 0.304 0.486 0.886 1.000 0.443 0.806 0.091 ? ? ? ? 15.000 ? ? ? ? ? ? ? ? ?

Gavialis_browni ? 0.853 ? ? ? 0.441 0.550 0.588 10.000 0.568 1.216 ? 0.481 ? 2.222 ? 18.000 ? ? ? ? ? ? ? ? ?

Gavialis_gangeticus 0.716-0.727 0.799-0.892 0.719-1.045 0.429 0.581-0.605 0.387-0.496 0.503-0.550 0.555-0.677 6.000 0.543-0.622 1.113-1.195 0.105-0.118 0.465-0.589 1.500-2.357 3.256 1.490-1.932 23.000-24.000 1.905-2.318 23.000 1.887-2.148 40.000 1.020 0.436-0.485 0.553-0.614 1.132-1.189 0.723-0.838

Gavialis_lewisi ? 0.974 ? ? ? 0.346 0.200 0.789 8.000 0.497 0.940 ? 0.427 5.496 2.523 2.510 ? ? 33.000 ? ? ? ? ? ? ?

Gavialosuchus_eggenburgensis 0.676 1.382 0.904 ? 0.577 0.274 0.579 0.682 11.000 0.579 1.032 ? ? ? ? 1.385 15.000 ? ? ? ? ? ? ? ? ?

Globidentosuchus_brachyrostris ? ? ? ? ? ? ? 0.759 14.000 0.245 0.815 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Gnatusuchus_pebasensis 0.450 2.115 ? ? ? 0.165 ? 0.921 5.000 0.319 0.700 ? ? ? 3.520 ? 9.000 ? ? ? ? ? ? ? ? ?

Gryposuchus_colombianus ? 0.850 ? ? ? 0.313-0.375 ? 0.563-0.631 8.000 ? ? ? 0.466 ? ? ? 21.000 1.389-2.125 ? 1.469 ? ? ? ? ? ?

Gryposuchus_croizati ? ? 1.258 0.548 ? ? ? ? 27.000 ? ? ? ? ? ? 2.133 19.000 ? ? ? ? ? ? ? ? ?

Gryposuchus_neogaeus 0.787 ? 1.143 0.665 0.527 0.289 ? 0.483 8.000 0.675 1.266 0.080 ? ? ? 1.667 ? 2.581 18.000 ? ? ? ? ? ? ?

Gryposuchus_pachakamue ? 0.840 0.959 0.413 0.636 0.291-0.344 ? 0.664-0.782 19.000-29.000 0.564-0.693 1.065-1.144 ? 0.434-0.502 1.448 ? ? 22.000 1.859 29.000 ? ? ? ? ? ? ?

Ikanogavialis_gameroi ? 1.140 ? ? ? 0.240 0.923 0.520 15.000 0.654 1.294 ? 0.400 ? ? 1.471 30.000 ? ? ? ? ? ? ? ? ?

Jiangxisuchus_nankangensis 0.551 1.434 ? ? ? 0.217 0.531 0.603 7.000 0.617 0.852 0.324 ? ? 2.733 ? 14.000 ? ? ? ? ? ? ? ? ?

Kambara_implexidens ? 1.256-1.466 0.820 0.427 ? 0.195-0.239 0.332-0.399 0.839-0.894 2.000 0.399-0.415 0.773-0.791 0.274 ? 0.966 ? 1.484 15.000 2.592 15.000 ? ? ? ? ? ? ?

Kambara_murgonensis ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 16.000 ? ? ? ? ? ? ? ? ?

Kambara_taraina ? ? ? ? ? ? ? 0.878 7.000-11.000 0.419 0.722 ? ? ? 2.793 ? 14.000 ? ? ? ? ? ? ? ? ?

Kentisuchus_spenceri ? 1.022-1.395 0.875 ? ? 0.271-0.322 ? 0.722-0.752 3.000-16.000 0.509-0.583 0.889-1.080 ? 0.341 0.969 ? 1.421-1.706 13.000 1.462 ? ? ? ? ? ? ? ?

Kuttanacaiman_iquitosensis ? 1.840 0.662 0.344 ? 0.203 ? 0.640 9.000 0.409 ? ? ? 1.667 1.634 ? 13.000 ? ? ? ? ? ? ? ? ?

Leidyosuchus_canadensis 0.596-0.615 1.710 1.079 0.121 ? 0.215 0.556 0.581 ? 0.648 0.629 0.323 0.487-0.494 0.941-1.176 3.333 1.696 18.000 ? 30.000 ? ? ? ? ? ? ?

Mecistops_cataphractus 0.670 1.458 0.938 0.500 0.515 0.361 0.553 0.916 8.000 0.447 0.794 0.282 0.314 1.625 1.785 1.333 13.000 1.964 32.000 1.705 23.000 1.057 0.410 0.717-0.740 1.144-1.203 0.510

Mekosuchus_inexpectatus ? ? 1.000 0.119 ? ? ? ? ? ? ? ? ? ? ? 1.486 ? 2.250 55.000 1.040 ? ? ? ? ? ?

Mekosuchus_sanderi ? ? ? ? ? 0.409 ? 0.536 ? 0.487 0.548 ? ? ? ? 1.900 ? ? ? ? ? ? ? ? ? ?

Mekosuchus_whitehunterensis ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? 2.000 35.000 ? ? ? ? ? ? ?

Melanosuchus_niger 0.495 2.090 0.953 0.641 0.281 0.320 0.550 0.820 17.000 0.180 0.722 0.156 0.534 2.762 2.366 1.326 13.000-14.000 1.485 47.000 1.253 7.000 0.767 0.481 0.711-0.761 1.241-1.297 0.603

Maroccosuchus_zennaroi ? ? 1.140 0.531 0.427 0.312 ? 0.594 0.000-11.000 0.614 1.194 ? ? ? ? ? 14.000 2.043 22.000 1.295 ? ? ? ? ? ?

Mourasuchus_amazonensis 0.745 3.178 2.057 0.340 ? 0.434 1.046 0.704 0.000 0.211 0.579 0.332 ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Mourasuchus_arendsi ? 3.140 ? ? ? 0.420-0.482 ? 0.570-0.691 ? 0.215-0.276 0.810-0.857 ? ? ? 1.922 1.528-2.000 ? ? ? ? ? ? ? ? ? ?

Mourasuchus_atopus ? ? ? ? ? ? ? ? ? ? ? ? ? 5.750 3.152 ? ? 2.500 ? 1.250 10.000 ? ? ? ? ?

Necrosuchus_ionensis ? 0.502 0.763 1.141 0.363

Osteolaemus_tetraspis 0.523-0.558 1.531-1.673 1.277-1.364 0.397 0.325 0.250-0.282 0.256-0.317 0.634-0.745 0.000 0.222-0.259 0.717-1.000 0.047-0.149 0.350-0.381 1.617-2.000 1.675 1.714-1.733 12.000 1.487-1.615 39.000 1.350-1.667 2.000 0.761-0.770 0.504-0.569 0.739-0.786 1.133-1.228 0.406-0.444

Paleosuchus_palpebrosus 0.544 1.210 0.674 0.306 ? 0.275 0.397 0.824 0.000 0.000 ? 0.156 0.419 2.400 2.121 1.261 14.000-15.000 2.272 31.000-39.000 1.250 20.000 0.758-0.791 0.507-0.651 0.750-0.821 1.260-1.300 0.590-0.599

Paleosuchus_trigonatus 0.549-0.592 1.238-1.328 1.030-1.143 0.274-0.366 0.400 0.236-0.279 0.390-0.500 0.754-0.837 0.000-3.000 0.000 ? 0.203-0.205 0.433-0.460 1.308-2.105 2.121 1.267-1.400 15.000-16.000 2.478 29.000-31.000 1.438 32.000 0.715 0.636 0.770-0.776 1.246-1.273 0.553

Paratomistoma_courti ? ? ? ? ? 0.263 ? 0.688 6.000 0.511 0.982 ? ? ? ? 1.264 ? ? ? ? ? ? ? ? ? ?

Penghusuchus_pani 0.683 1.392 ? ? 0.313 0.289 ? 0.597 15.000 0.543 1.083 ? 0.350 1.175 2.925 1.727 16.000 ? ? ? ? 0.788 0.488 0.610 1.206 0.602

Piscogavialis_jugaliperforatus 0.766 1.086 1.371 0.775 ? 0.223 0.486 0.800 12.000 0.479 1.030 0.038 0.300 1.119 3.476 1.538 28.000 ? 13.000-24.000 ? ? ? 0.356 ? ? ?

Planocrania_datangensis 0.596 1.016 1.050 ? ? 0.444 ? 0.683 ? 0.628 0.741 ? ? ? ? ? 18.000 ? ? ? ? ? ? ? ? ?

Planocrania_hengdongensis 0.519 ? ? ? ? 0.233 0.400 0.713 ? 0.457 0.653 ? ? ? ? 2.125 ? ? ? 1.083 ? ? ? ? ? ?

Procaimanoidea_utahensis 0.485 ? 0.900 0.184 ? 0.218 ? 0.909 ? 0.663 0.482 0.174 ? 0.890 ? ? 13.000 ? 18.000 ? ? ? ? ? ? ?

Protocaiman_peligrensis ? ? ? ? ? 0.259 ? 0.634 12.000 0.538 0.749 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Purussaurus_brasiliensis 0.630 2.381 0.696 0.262 0.367 0.540 1.121 0.524 1.000 0.576 0.663 0.268 0.631 4.800 ? 1.684 14.000 2.167 ? 1.000 13.000 ? ? ? ? ?

Purussaurus_mirandai ? ? ? ? ? ? ? ? ? ? ? ? 0.400 ? ? ? 14.000 ? ? ? ? ? ? ? ? ?

Purussaurus_neivensis 0.549 2.136 0.654 0.368 0.279 0.403 0.929 0.757 0.000 0.410 0.563 0.153 0.427-0.500 3.600-5.000 2.239 1.702 14.000 ? 20.000 1.154 13.000 ? ? ? ? ?

Quinkana ? ? 1.167 0.500 0.486-0.500 ? ? ? ? ? ? ? ? ? ? ? 12.000-14.000 ? ? ? ? ? ? ? ? ?

Siquisiquesuchus_venezuelensis 0.730 1.045 ? ? ? ? ? 0.606 ? 0.650 1.038 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?

Stangerochampsa_mccabei 0.463 1.750 0.883 0.100 ? 0.243 0.687 0.718 5.000 0.682 0.708 0.298 0.477 1.953 3.367 ? 14.000 1.450 30.000 ? 37.000 ? ? 0.750 ? ?

Thecachampsa_antiquus ? 1.315 ? 0.617-0.676 ? 0.256 ? 0.717 11.000-12.000 0.402 1.242 ? ? ? ? ? 14.000 ? ? ? ? ? ? ? ? ?

Thecachampsa_sericodon 0.694 1.209 0.940 ? ? 0.233 0.506 0.761 15.000 0.518 1.000 0.238 0.433 0.960 3.538 ? 14.000 ? ? ? ? ? ? ? ? ?

Thoracosaurus_isorhynchus 0.734 0.970 0.735 0.282 ? 0.364 0.500 0.707 0.000-2.000 0.543 1.053 ? 0.293 1.455 ? 2.182 20.000 ? ? ? ? ? ? ? ? ?

Thoracosaurus_neocesariensis ? ? 1.091 0.844 ? 0.301-0.399 ? 0.609-0.634 8.000-15.000 0.593-0.623 1.123-1.300 ? ? ? ? 1.313-1.604 ? ? ? ? ? ? ? ? ? ?

Tomistoma_cairense ? 1.205 ? ? ? 0.260 0.468 0.849 0.000 0.419 1.038 ? 0.363 0.909 3.692 1.350 ? ? ? ? ? ? ? ? ? ?

Tomistoma_dowsoni ? 1.347 0.758 ? 0.583 0.429 ? 0.857 0.000 0.536 0.844 ? ? ? ? 1.483 15.000 ? ? ? ? ? ? ? ? ?

Tomistoma_lusitanica 0.682 1.572 0.717 0.967 ? 0.250 0.511 0.761 0.000 0.511 0.900 ? ? ? ? ? 14.000 ? ? ? ? ? ? ? ? ?

Maomingosuchus_petrolica 0.697-0.723 0.872-1.111 0.750-0.805 0.196 ? 0.308-0.333 0.667-0.714 0.667-0.808 3.000-9.000 0.476-0.567 0.833-0.882 ? ? 0.820 ? ? 15.000 ? 21.000 ? 31.000 ? ? ? ? ?

Tomistoma_schlegelii 0.666-0.670 1.217-1.655 0.704-0.907 0.800-0.835 0.636-0.720 0.293-0.345 0.436-0.489 0.848-0.942 12.000-20.000 0.458-0.500 0.846-0.983 0.157-0.212 0.312-0.456 0.632-1.207 2.472 1.464-1.756 17.000 2.308-2.500 20.000 1.568-1.878 44.000 0.931 0.394 0.640-0.710 1.071-1.224 0.659

Toyotamaphimeia_machikanensis 0.711 1.511 1.115 0.354 0.459 0.223 0.548 0.638 2.000 0.260 0.758 ? 0.302 1.181 3.815 1.452 16.000 2.077 24.000 1.500 40.000 0.852 0.569 0.531 ? ?

Trilophosuchus_rackhami ? ? ? ? ? ? 0.282 ? 0.000 0.518 0.349 ? 0.329 ? 1.929 1.643 ? ? ? ? ? ? ? ? ? ?

Tsoabichi_greenriverensis 0.466-0.546 1.360-1.447 0.940-1.359 ? ? 0.252-0.257 0.350 0.929-1.040 ? 0.370 0.391 ? ? ? ? ? ? ? ? ? ? ? ? 0.745-0.851 1.312-1.542 0.593

Ultrastenos_willisi ? ? ? ? ? 0.215 ? 0.783 13.000-16.000 0.473 0.664 ? ? ? 2.615 1.642 ? ? ? ? ? ? ? ? ? ?

Voay_robustus 0.535 1.473 1.083 0.412 0.372 0.402 0.539 0.679 23.000 0.303 1.000 0.250 0.463 1.000 3.273 1.560 13.000 1.933 25.000 1.128 32.000 ? 0.617 ? ? 0.582

Wannaganosuchus_brachymanus 0.236 1.521 0.995 ? ? 0.271 ? 0.750 11.000 0.556 0.800 ? ? ? ? ? 13.000 ? ? ? 46.000 ? ? 0.812 1.293 0.538

Theriosuchus_pusillus ? 1.008 ? ? ? 0.220 ? 0.686 ? 0.600 0.875 ? ? 0.557 3.091 ? 13.000 ? ? ? ? ? ? 0.800 ? ?

Qianshanosuchus_youngi 0.463 1.096 0.500 0.250 0.571 0.290 0.464 0.735 2.000 0.480 0.583 0.277 0.423 ? ? ? ? ? 6.000 ? ? ? ? ? ? ?

Borealosuchus_griffithi ?

Deinosuchus_riograndensis ?

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Alligator_mefferdi
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Alligator_sinensis
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Asiatosuchus_germanicus

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Asiatosuchus_nanlingensis

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Australosuchus_clarkae

00000??00010??00000010010000?0100000001?0?000?101110000010?011?011100001??
1???0011100?110000?1000000000?00???0??0010013100011010?000001???0000???10000000200
1???????????????0?????1?????????11021020??100???001??100?01?0?0???????????????????????
1????????????????????????????????101?????????????????????101???

Baru_darrowi

00000??00?????000001?0000000?0120000100????00101??????????????1??100000??????
??????????????????????????????????00000000101000000000000?1020000010?011110[0
1]00?????011200????0??10??0?????????????1??2112???10????001????00?????????11??????????
???

Baru_huberi

00010??00?????0?000010000?00?01?0000??0??
???????????????????????????????0?000000101000100100001???0??001????1?2?1??????????????
????????????????????????11021020??10?1??
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Baru_wickeni

00010??00010??0000001000?001?0110000100????0010?1111000001??0?1??100010????0
????001100???????0??0?000000100100001?0000?0100010010000100100?0010?011110100020?0
01120011??00110000?????????????11021120??1001??0?11010000110001001101100???????????
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Borealosuchus_acutidentatus

00000??00010??0?0001?00??000?0110000000????000?01010?00001??????1000000???00
0?????10???0?????1??0???0??????????001?001?300120000000?00110?0000????00??00???0?????
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Borealosuchus_formidabilis

00000??00010??0?0001?000?000?01100000001001000?00110000001??0?1?010000000??0
00??001100001011301000000000100010000011000330012001000001010000000?0110000000??0
001120010100000000??????0?????01002120?1??0000?00110100110?00101011000?00000?0?10
00001001100001011011??11110?00100100001000001?????????????10002??

Borealosuchus_griffithi

00000??00010??000001?000?00000110100000????00000011???0001??1?1?01?000?01000
11?1?0?1????00??0?000??000010101?00001[0
1]0013300010010??0?0010??0000???101??0?1??11?1120?1???0?0?000??????????????100210100
?00?00?001?010010??00001?11000?????0?????0???1???????0?010021?0?1?10??????1??????????
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Borealosuchus_sternbergii
00000??00010??00000120000000?0110000000100100000000100000010?0110010000000?
0001100110000101100100000000010001000001[0 1]001[0 3]3000100100000001[0 1]000000?[0
1]1100000012011011200100?00000000?001??0??00111002110?1??0000?00120100100?00100011
000?0???0?00??10101??0??0?0101?0?1?????????00??000001000????????????????0002?0

Borealosuchus_threensis
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???0?0???????????0?0?????????????????????????
????????????????????10021020??00????0?10120010??00?00011010?0?????????0??????????????
1???1??????0?????????????0???????????????????0002??

Borealosuchus_wilsoni
00000??00010??000001?001??????110000???????000?01010?0000???0?00?1??????0??0?
??????10??00??????00?0????????????0??01?001?30002001000?????0?0?00?????????0???????1??
??010000????0???????????????0????????????????101100100?00??0?110???????0?0?????????????
?????1???1??????000????00?0??010001??????????????000200

Bottosaurus_harlani
????10000010??????????????????????0000?0?1???001??211100100?????1?0002100????0??
?????1?0?1101???10?1???0????????????????0???????????100?????????0?0?01?0?000?????1??12??
???????0???0???1??????????10210?????0????0011010011??01?0??1?00111???????????????????
????1???1??????????????0??101111110???????????????1?????

Boverisuchus_magnifrons
10?10??00010???000001000?00????00?0???0????0?1?0101??0000????????1?0????0??00?
?????10???00000?1??????????????0000000010301000012010000?1???0000??1111000?0??00??12
?0?0??0?1????0??????????????1102100????0????0?1????0?0?????0????????????????????????????
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Boverisuchus_vorax
10010??00010??00000010000000?0100100000??0?10100201000000010?01110100000000?
0???1001100010001001001 0?0000100???000031000030100001201000010000000?0111100000200
001120010??000??000???1?????????1102110?0??0000?001??1?11???0?000010010?0?????????0?
??1??110010??11?11????110??????001101110100??????????????101???

Brachychampsa_montana
00000??00010??100010101 1?0101?1101000001?0?00001201110000 11?111101010 00000?
011110011000100111110000000000100000 20?0130003100001000100001101000 10?1001000001?0
00011200011010000000?0?1110?01?10110?1121??1?010?0?12010001??01001110000?0???????00
1110?101000??0011?????????????000000010111???????????????0241111??

Brochuchus_pigotti
00010??00010??0?00001000?000?1100000100????00101210?0000010?01110101000110?0
????0011001010002010000000000100?0000100100121000200100000101000000 0?1010210000201
111120010??30100000???1110????0?110?102????0????0?1102000010????0?1??110????????????
?????1???????1???1???11?0??????001???11???????????????????111???

Caiman_brevirostris
010011100??0??1000001010??01?0?20001?0?????001????????1????????????10?????????
??0011????????1?????????00?000??????0?00??200?010?0100?000???????????????0?1000??12?
?1??????0?0???????????????11001121??0001??001??????10???001???????????????????????????
?????1???1??????0??????????????????????????????????111???

Caiman_crocodilus 000011[0 1]00010??10000[0 1]10000001?0000000000110000100201[1
2]001001112111010200001110111100110001101211100000000010001001[0 1]0010013200[0
1]1101000000010100[0 1]10?0[0 1]10[0 1
2]0000110001112011111110000001001110??1?0011021021??00011000120[1 2]00110?00[0
1]01111001111101001111110011110010001011110101101101000111011110001110111001002 31
11211

Caiman_gasparinae
000????0?010??1?0001?000??01?0??????????????0???2112011?1??211?0?????????????
11001100??????????0?00?0???????????01?001?200?010????0????????????????????????????????
????????????????1??10???
????????????????????????????????0???????????????????

Caiman_latirostris 010011100010??10000010100001?002[0 1]0000001100001012012[0
1]0110111211101020000011101?11001100011012111000000000100010011 00[1
2]00132000010100000001101000 10?0[0
1]10000001100011120111111000000100111 10?1?0011021121??000110001212001 10?000011100
0111110[0 1]0011110100111100100010 1?1???0110110100?1110111??????1011[0
1]0010023111211

Caiman_lutescens_MACN
????110?0020????????????????????1001???????001??2112001101????????????????????
?0011??
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Caiman_wannlangstoni
010111100010??0?00001010?001??1110010001???00100201200100 1????1?010?0??01???
????001100?110121?100000?00?1???????????1???320000100010 0?????????111001000000???0011
120?0?????00?00??
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Caiman_yacare 000010100010??10000[0
1]10000001?00210010001000001002012001001112111010[1
2]000011101111001100011012111000000000100010011001001 32000[0
1]1010000000101000 10?001000000110001112011111110000001001110?01?0011021021??00011[
0 1]00120[1
2]00110?000011110011111000 01??1110011110000001 0111???11101101000111011111 00??1011[
0 1]001?0?3111211

Ceratosuchus_burdoshi
00000??00011100?00001010?001?0001101000????00000????000001???1???101?00??????
???00?1?00??????110000?000?1000?????03200032000010 10?0000?0?10101??0?0100000??0????
12???????????00???????????????1101210?0??0????0?1?????????0???1??????????????????????????
???????1???1?????

Crocodylus_acutus
00100??00010??10000010001001?010000000011011011020100000010001110100000010?
[1 2]00000011000010002010000000001001010010010013100020000000000100 10000?11112[0
1]000020110112000010001000000101111001?0111021020??00010?0011020000101001001101100
00101101000001001100100111 0?1???11100010100011011102 00??01100000111111000

Crocodylus_affinis 000010000010??1000001000?000?0120000000??0?0001[0
1]2010000001 0?011101000000?0?10?010011000000002?1000000000100100010 01[0 1]000[0
1]100010000000100200000 00?011011000020000112001010000000000???11110?1?0111021110??0

0010?00110100001010[0
1]10011000?00000110??0???1????????????0??????????????001101??0100??????????????111???

Crocodylus_anthropophagus
00000??00?11110000001000 1?0????00000?0?11010?1??201????0??????1??10?0???0??2?
???00?100001000 2??000000?0?1101010?00?10?1310002001000000100???????11?2?0????011??
1?????????0??00??????????????11021020??10?10?0?11010000??10110?110110???00?1???0???1?
?????10??1?????????????????0??101????????????????????11????

Crocodylus_checchiai
00100??00010??1000001000?000?01000000001101001012010000001000?11010000?00??
0???000110000000002010000?000010???1000001001110002001000000001000000?00102[0
1]00000?100?120000??000000010?11?????????1?0?1?????????????11??????????????11?????????
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Crocodylus_falconensis
00100??00010??100001?000?000?0100010000?????00012?10??00010???1101000???????
???0?11?0????????100?0??0???????????00???????00?0??0?0??????0?0?00??1?????????????????
?????????????????????????1?0?1?????????????11??
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Crocodylus_intermedius 00100??00010??10000010001000?0120000[0
1]00110100110201000000100011101000000010?2000000110000000020100000000010010100000 1
0013100020010000000100100 00?11112[0
1]0000201101120000100000000000111111001?1111021120??00010?00110100001010010011011 00
0010110??000010011001001110?1???1110?01010??????????????01110000111 2111?00

Crocodylus_johnstoni 00000??00010??1000011000 1000?01000[0 1]0[0
1]0011010011020110000010001110100000110?[1
2]0000001100011000001000000000100101011011001210102000000000 10[0 1]0000[0
1]00?11111[0 1][0
1]00020110112000010000000000111111101?1111021120??00010?0011020000101001001101 1000
000110100000100001010011 10?1???1110?0100000110111120 00?01110000111 2111100

Crocodylus_megarhinus
00000??00010??100000100000 00?0100010100??0?00101201100000 10?01110100010010?
200000011000010002010000000001000010110010011100020010000000200000 00?111110000020
1101120000100010 0000?1?111??1??1111021120??00010?00110100000?0?110011011000???????
?????????????????1???1???

Crocodylus_mindorensis
00010??00010??10000010001001?01000000001101001102010000001000111010000 0010?
2000000110000100020100001000010010100100200121000200100000001000 0100?111121000020
1101120000100000000001111110 01?0111021020??00010?00110100001110010011011000000110
?????????????????1?0?1????????0?????????????????01100000111 2111000

Crocodylus_moreletii
00100??00010??10000010001001?01000000001101001012010000001000111010000 0010?
1000000110000100020100000000010010100100300111000200000000001000000 0?111121000020
1101120000100010000001011110 01?0111021020??00010?00110100001110010011011000000110
??????1??????????1?0?1????????0?????????????????01100000111 2111000

Crocodylus_niloticus 00000??00010??100[0 1]0010001001?01000000001101[0
1]011120100000010001110100000010?2000000110000100020100000000010010100100[1
2]001310002001000000100[0 1]0000?01112[0 1]00002011011200001000[0

1]000000101111101?0111021020??00010?00110200001110010011011000000110100000100111011
001110111011110?0101000110111120010011100001113111000

Crocodylus_novaeguineae
00010??00010??1000001000100 0?010000000011010010020100000010001110100000010?
1000000110000100020100000000010010100100200131000200100000101000010 0?111121000020
1101120000100000000001111110?1?0111021020??00010?0011010000111001001101100000110
??????????????????1?0?1????????0??????????????????01110000111311 1000

Crocodylus_palaeindicus 00000??00010??1000001010?00?????0????00????0[0
1]101??100000010???11010000001??2000?0111000??000?010000000001001010 00?01001110002
0010000000100000000?011021000?2?1?01120000??001?00???????????????11021020??00010?0?1
10100001?10?1001100110????????????????????????1???1???1?10????????1101????????????????
????111???

Crocodylus_palustris 00000??00010??1000001010100 1?010000010011010[0
1]101201000000100011101000000010?[1
2]0000001100001000201000000000100101000000000101000200100000000100000000?[0 1]1102[0
1]00002011011200001000100000010111110 1?0111021020??00010?0011010000111001001101100
00001101100001000010100111 0?1???1110?010100011011112 00??011100001112111000

Crocodylus_porosus 00010??00010??10000010[0 1]0100[0 1]?010000000011010[0 1]10[0
1]20100000001000111010001001 0?[1 2]0000001100001000201000000000100101001 00[1
2]00131000200100000000100000000?11112[0 1]0000201101120000100 0[0
1]000001101111101?0111021020??00010?0011020000101001001101100 0[0 1]00110100000100[0
1]0001001110211 0?111000101000010111120 0??0110000011121110 00

Crocodylus_rhombifer
00100??00010??1000001000100 0?0100000100110100101201000000100011101000000010?
[1
2]000000110000100020100000000010010100100100101000200100000000100100 00?11112100002
01101120000100000000000101111001?0111021020??00010?0011010000101001001101100000011
011000010011101001110111011110001010001101111110??01110000111211 1000

Crocodylus_siamensis
00010??0001111100000100010 00?01000001001101111012010000001000111010001000 0?
20000001100001000201000000000100101001001001310002001000000011000000?11102100002 0
1101120000100010000001011111 01?0111021020??00010?0011020000101001001101100000001 0
??0000100010010001 10?1???1110?01010001101111210??0110000011121110 00

Crocodylus_thorbjarnarsoni
00000??00010??0000001000?000?011000000 01???1010120??110001????1?01?00??000?1
????00110000100?20?00?0000??10?10?000002001310002001000000001000000 0?1111200000????
011200000?001?0000???1?????????11021020???0?10?0?11020000??10?10?111110?0100110????
???

Dadagavialis_gunai
00000??000?0?????00??0?1?100?01000101?0????0021021???????1???????111?01???????
?????0????????????????????????????0????????2711120000001010000?0?00???0?0?001????0??????
????????0??????0??????????????3???????????????????????10????????????????????????????????????
???

Deinosuchus_riograndensis
????0??01??0??100000?000?00001100100000?1??001010011?001010?210?01?100?100?0
??111011100????????00?00?00?1?????000130000300000010?00?001???0000?????0???????1??1

????????????00???????????????100210 2???000???00100210?10?10001?111???0??010??????????
???????0?1???1??????0??????????1?????????????????????10????

Diplocynodon_darwini 00000-?00010??0000012000?000?01[0
1]0000000????000010110000001 0?1111010100000 0?0110100110000101100100000000010001000
00100010300011010000000110000 10?11??????0??0?111120110102 0000?00?????????????100210
20??10010?00110100110?0100111101 0?10000?010001001 0?0100000111?1???1?100100000110
1110000???????00??112100201

Diplocynodon_deponiae 00000-
?00010??101001200??000?0110?00000????000?10110001001??[0 1]111010100000??01 -
?00021?0???0????0000???0???????0???0??????300?11010000?00110???????1??????0????111120
1?00-
2??00?????????????????100210 2????0010?001???000???0???1?1?0??????????????????????????????
1???1??????0??????0??101111000???????????0?2101211

Diplocynodon_hantoniensis 000110000010??0001012000?000?0100000000????00111011[0
1]0000010??111010100000 0?0110100110000101100100000000010001000001000003000110100000
00011000010?011000000110011112011010200000000???1110??1?0?10021020??100100001101001
01201001110010?10??????00????1??0100000011?21???0??0??????001101111000??????????????
1002??

Diplocynodon_muelleri
00?010000010????1101201??000?0100?00100????001?101100000010?2?1????100??0??0
11?????1?0?01011??10?0000???10?0?0?0?0??00??300??10?0000?00110??00???1100?000????101
12011010???00?00??????????????10?2?021???0????0?1????????????0??100?????????????????????
?????????????1??????????????0??101??00?????????????????1012??

Diplocynodon_ratelii
000110000010??0000001000000 0?01000001001001001100010000001 0?11110101000000?
0110?002100000011001000000000100000000010001030001101000000011000000?111010000110
01011201101020000000 1001110?11?1110021020??00010?00110100001001001 0110?0??0???????
?0???1??0100000?11??1??????0??????001101111100???????????????1002??

Diplocynodon_remensis
000110000010??0000012000?000?0100010100 1???000?1011100000 10?2111010000000??
0??0100110000?011011000000000100010000 0100010300 01?01000000 0110?000??01??0??00?000
[0
1]0112011010200000 0????1??0????011002100?0??0010?00110100100?0000111001 0??0????????
????????????????1??????????0???????????????????????????????????1002??

Dollosuchoides_densmorei
00000??00010??1?0001?001?001?0100000000????00100201010 0?0????????1?????????0?
??????1?0???00???1??0???0??1?????000?1111?21001200000000111 00?0000?01102?000?????011
20000??00000?????????????????1103?20?10?0??0?00110200001100?100110????0???????????????
0??

Dongnanosuchus_hsui
01010??00010??1000001001?000?0010000100????00101211 10000000?0?1101?000?010?1
1?10001100000001101000000000 100000000000000101000100101000101 0000000?12111?000?????
0112001?10??100010??????????????11????1???????????0??????????????????????????????????????
???

Eocaiman_cavernensis
0000111000?0??????????????00???????????00????????02010000?0?????1??102?00????????

????1????????????0?0??0?????????????1????20000?00000000?10??00111001000000?00??0?12??
????1?????????????????????112102 1???00???00110100?10???????????????????????????????????
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Eocaiman_palaeocenicus
???
??0?0?????????????????????????????????????
????????????????????1110102 1???0????001101?00???0?001110000???????????????????????????
???

Eogavialis_africanum
00000??00000??100001?001?000?0100000?00100000110201011000 10?0100111101 0100?
0??11111100000000201000011011100001 00001[2
3]011271112000000101000000000?0111200000000000112100010000000 11???00?0????0?1103030
?30?0000?00110100001111000 0110?0?0????????????????????1????????????????????????0?????1
??????????????????000???

Eosuchus_lerichei
00000??00000??1?00012001?000?01001000101?0?00010001?0000010?0100?100100010?0
00?000110000110020100000000?1000000000020003701120000000000110000100?010000000 0100
0011200001000000000???0?????????11030?0?21?00?0?00??????????????????????????????????????
?1????11101?1??????????????????????????11???????????????????011???

Eosuchus_minor
00000??00010??100001?001?000?010000001 0??0?00010100?1000010?0?00?100100?0???
??0?10110000?1002010000010001000000000000100037011200000010011 00?0000?0110000000000
0?112?000??000?001??0?1??0??01111103120?21?00?0?0011010000??0000011 0010?00?????????
???1??0001?11?1???1??????0??????0?0100110??????????????????1010???

Eothoracosaurus_mississippiensi
00000??00000??1?0001?001?000?01?00?01?0???00010011?100001????0??1?1?????????
???1?0100?00000??10000??0?0100000000001200027?10200000010100 00?000??0?000000??0????1
12?0?00?000?000????0?????????1003030?2??0????0?1001?001??10?0??1?010??????????????????
?????????1???1?????1???????00??????????????????????????000???

Eurycephalosuphus_gannanensis
00000??00?10??000001?001?010?1000??0110???000010012 0001010?011101?000?010?1
111001210000000 0?00000000000010101000?01?000?100011010100?1??00000???10????????????0
112000?100??00000?????????????110?202??010010???11011001??01?0??110?0?10?????????????
?????????0?1???1??????????????0??10???????????????????????????

Euthecodon_arambourgi
00010??00010??0?00012101?000?01000000001101001?02111000001 0??1110100000010?
1??000011001010002010000 0?0????????00001?00127000 20000??000?11??0?0????0?2000?02011
????????????????0?0???1?????????11???
??

Gavialis_browni
00000??00000??100??1?2?1?100?1100010?0????002?021???0001???0010?11??1?????
???111100?00000?01??0??????????010?????????70112000000101 0000?1100?01010?001?0???011
210?0??0???10??
???

Gavialis_gangeticus
00000??00000??110001220101 01?11000101000000021011101100010002001013110100?

00001111100000000001000011111101001000014111270112000000101100001100?010100001000
00011210000?000010110000110?01?201103040?31?0100?01110210001201000011000?00000100
10000010000111111110110100010000110000010110010010100000010210?0000

Gavialis_lewisi
???00??00000?????????????10???100010?00??0?0021???101000010???0010?3110100?00
001111100?000000?10000110111111001??????????7??12???000101?00000?00?011100001?00?001
1212000?30101011??????????????1?????0??1?01?0?01110?1000120100001?0???0??????????????
???

Gavialosuchus_eggenburgensis
00000??00010??1?0001?001??00?10000100?0????001?02110000001????1?01110001????
1???101100?????0??1000000001000??0??03101?2411120000?00?10100?000?????0?????0200???
????????????0??
??????????1??

Glen_Rose_form
000010000000??0000000000?0111?120000001?0?1010000100000100?0?110100000?????
???100??0?0?????????0?0100000000100?0000001?00000010000000010000000?010000000010?00
10000000?00000?1??0?1??0??????0102120?20?0000?000???????0??????????????00????????????
???????????????1????????????????????????????????????1???????????

Globidentosuchus_brachyrostris
0000???00010??10000??01??001?0??10010?0????000112112001001???????1?200?00????
??????1?0?????????0???????????????000??00002?00010?0100???????001110???0???????????12?
???????????????????????????11021001??11????0?120100110??0?0??10001?111?????????????????
???

Gnatusuchus_pebasensis
0?000??100?0??1?0??01010?0????1?0001000????0000120120010011??????1??0??????0?
??????1?0?010120??00?001000100010???0??000?000001000100?????1???????0??0??00???00011
20100101100?10???????????????0100?20?1??0????00120?00110??0001?1100??0????????????????
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Gryposuchus_colombianus
00000??00000??1100012001?000?0100010000????0021011101100?10?0200100311110??0
??011?02000000000001000011101111001000?2211?2701120000??101000000100?011100000?0?0?
0?12?????????0?0???0?00?0??01001103030?20?001??0011?1?000100?0000111?0??0000100?????
???

Gryposuchus_croizati
00000??000?0??100001??01???????????????0?????02100?0?1?00?1????00?113??0???????
?1???1???????0??1??0??11??111???010?1?01??7?1120000??1?????????????????????1???00?11???
????????1?1???????????????1103030?21?0????00??
???

Gryposuchus_neogaeus
00000??00000??1?00012101????????0??0???????002?0??1?1?0001???2????????????0????
??1102?00????00?1?00011111111001000?2211?27?1?20000001?????????????????????????????????
??????????01?????????????????0???????????????110100?0??0?0?001?0???0?????????????????????
???????????????????????????????????0???????????????????

Gryposuchus_pachakamue
00000??00000??1?00012001?000?0100010100????001101010110001????0011?1??110??0
00??1?01000?0000?010?0?01101111???011?2111?2711120000001010000?0100?0???0???100?000

112???0??000?101????0?????????1103030?20?0?00?0011110000120101000111???0?????????
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Hassiacosuchus_haupti

10000??00010??000??01010?001?01201010001?0?000?010??0000010?21110101000000?0
1?1100110?0???1???0?000??0???????????????0??2000010?0100?00??10?????0????????????????
?????????????????????????????11??2?0?????000?0?1?010101??010??0100???????????10????????
???????1???1??????0??????00???111?0???????????????3111111

Hylaeochampsa_vectiana

00000??00000?????????????1100?120101000????0011?01101001000?0?00??10?00?0????
??10110010????0??0110110000100010??????????60??0???0?0?000100011?0?01?12?0100?0??0?1
2?0000?0000010????10?0??
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Iharkutosuchus_makadii

00000??00010??1000001011?1100?12010010?????0?010?11100200?????0??????00000?01
???00?0010??0103001101?100?000?00???03300016001010?020000011001000?01112001000?0?0
1120001??00000101???1????????0?104110?1??0?00?000????0010?00?00000000????????0??????
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Ikanogavialis_gameroi

00000??00000??1?0001?101?000?01000?0100???00110111?1?0001??0?0010?31??????0?
???11?1?0?????0??1??0?1?1?0??1???0????501?2701120000???010000??100?0?0000001?0?00011
2???00?000?0?11???????????????1?3040?30????????1??????0????????1????????????????????????
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Isisfordia_duncani

00000??00010??1?00001010?001?0100100000???0000010100000110?01000101100000?0
00??0011?00??00000000000000000001002?0032000070010100200000001000000??10000000?????
010000001000000?00?????????????????3???????0????0?1101000???01????00?????????????1?0???
???1100??1011??1???0?00??????000??10010?0???????????102111100

Jiangxisuchus_nankangensis

0000100000?0????00001000?000?0100000000???000?10111000001??0111?1?00??010?0
00?00011?000?00?2?1000000?00?000??0?00110000100?10010000?002?000000?11?000000???1?
01120010110000000??????????????11021020??10?10?001?01???01???????????????????????????
????????????????1???11???

Kambara_implexidens

00000??00110??1?00001001000???100000000???001?020110000010?011101000000000?0
000000011000000010?1000000000010000?0000010013100020010000?????0?0?00?01101010000001
0?120000102?11000????1??0??1?01?1021020??000???00110100?01?0?000?1?0110000???1??????
???

Kambara_murgonensis

00000??001?0??1?0000100???00?01000000?0????001??2011000?0?0???1??1?00??0???10
0??0011?0?????10??0???????????????0?0?????????0??12??
??????1???????????????????11???12???0???????1??1?0????0?1??????11???????????????????????????
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Kambara_taraina

00?00??00110??1000001001?000?01000?0000???000?12111000001???????1?000?0???1?
???0021?00??0010010000??000100?0?00000?00121000200?0000?00100?0000?01110??00????01

120??0??2?1100?0?????????????1102102????00???001?01?00?11001???110????????????????????
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Kentisuchus_spenceri 00000??00000??1?00001001?001?01[1
2]0000100????0011020101001010???1001?0000?00??????111100??????????0??000001000??0000
?10112100120000000001?100?0000?011020000?2???0?12???0????100?0????????????????????????
???????????????00???0011001?100?0???
???????????????????

Kinyang_mabokoensis
00000??00010??10000?1??01?????????????0??1??0010121???100000???1101?00???0??2??
??001100??00012000000000000100?1?00000100111000100100000?0000000000?0111?10000????01
1200000?00100000?????????????11021120???0?10?001101000011?001001111???0000110??????
???

Krabisuchus_siamogallicus
00000??00010??000000100??000?0?00010100????000012011?00001???????1?00??????1?
??????1?????00??0000?0???????????00?01?00??2???00??0100?0?10???????11?0??????????0112
000???????????????????????????11?02010???0?1????111110??????????00????????????????????????
?????1??????????????????0??????????????????????????1?????

Kuttanacaiman_iquitosensis
00?0110000?0??1?00001010?0??????0001000????0000121????1?011?2????1?????????0??
?????1????10121??000000000?000?????00?000?20000100010 0?00??10?????00??0???01??000112
0111??1100??0??????????????1??2?121???00?????1??1?????????????1?0??????????????????????????
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Leidyosuchus_canadensis
000010000010??00000110000000?0100000000100000101011010000 10?011101000?0000?
001010011000010110000010000000100010[0 1]0001000033000000000000000[0 1]0[0
1]0010?01100000000000011200101020000000???11010?001?1002100?0??0000?00110100111101
?01?10000?00?000????0?????????????????????????????????????001??????0??????????????1111??

Lohuecosuchus_megadontos 000010100010??0000001000?000?111??0?100????0011111??000[0
1]00??011001000000010100?10011010??010301010000?00?00?100000010011200000000000002
0000000?0111200000??10011200?00?00000000???1?????????11021020??10?10?000????0001000
?1??11010?00???00??00???????????????????

Maomingosuchus_petrolica
00000??00010??1000011001?000?01000000001???001102?10000010?0111010000100?
000??0011000??00??010000000001000010010?001?310112000000000110000[0
1]00?01100000002010011200 00??30000000???1??0????0?110?020?2??00?0?0?1202000011?1?10
0110????000000????????0011100000 1???1??????????????0??001??1??????????????????1011??

Maroccosuchus_zennaroi
00000??00010??1000001001?001?01000000001???001?0210?0001010?011001000??010?0
001010110001 1000??100000000100??100?00?011?1000200?0000?01100?0000?01??????02?1?0
11200000?001000?????0?????????110212 0?1??000??00110200001?100???10000?0??????????????
????????????????1?????10????????????????????????????????????111???

Mecistops_cataphractus
00000??00010??10000110010000?0100000000110100000201100000100011101 00000010?
1001000110000100020100000000010010100101101131000200000000101000010 0?1[0
1]1111010201101120000100000000011011110 01?0111021120??10010?001102000010100000110
1100100011010010010001101000110111011110001010001 10?111200??0111000001121110?0

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Mekosuchus_inexpectatus
	????0??00010??0?0001?00???0???120101?021???101???11????00?????1??000000????1??
??0021?????0010??0?0??0?00?000?????00?000?????1???0??0??????????????2????????0100??????
?????????0???????????????01021120???0010?1010100110??000?10000110001?0110?????????11
0010??11??1??????0???????????????????????????????????????

Mekosuchus_sanderi
	?0??0????010????????????????????01??1?2????101??20110000110?0?1??100000????1??
??012?00?0?0010010?0??????????????????????100?1?010?001???????00????????1???0100??????
?????????0????????????????????????????????????????????????????????????????????????????
?????????????????????????????????????????????????????

Mekosuchus_whitehunterensis
	?0??0???0????????????????????????010??02????001???0????????????????????????????????
??????????????????????????????????0????100?1?010??01???????0????????????????????????????
??????????????????????01021120???001??10101011100?0?0??????10?000??110???????????????
?????????????????????????????????????????????????????

Melanosuchus_niger	010011100010??10000010100001?00[1
2]0001000110000101201200100011?21110101000011201?11001100011012111000000001100100
1000100102000010000000000000100010?000000000110001112011111101000000100111[0
1]?0??0011021021??000110001201000110?0000111000111110110110111001111001?001?111???0
1102101000111011110000??1011000100231112?1

Mourasuchus_amazonensis
	000010101011001?0?01?011?0100?121101000????002?1201200111????1?010300?00??0
1????011001110100110010??01110????0010??00????0001??0?00?0?0110??10?00?00??0?0000?0
112????????0?00?0?1??1110?????11?3?02???10????0?1202?0???????0?????011????????????????
????????????????????????????????????????????????????????????

Mourasuchus_arendsi	000011101011001?0101?011?01?1?121101000????002?12112001[0
1]11??211?01?30??001101?110011000110100110010000111010??0000?30003??0001??0??0?000?
1??010?1?100?000???0?01120??????????00??00111?211?01??030??????0????0?1????0?????????
???0????010?1????11???110???100?1???1??????????????01????????????1??????????????????

Mourasuchus_atopus
	00?011101?????1?010???1??0????1?1101000????002?????????????????1?0103000???????
?????????????????????????1?010?0?0?03?000??1?001??0??000??11???10??01?00?0??000001120
2111?11100?0??????????????1103002???100?10001??10011120100111100111?????????????????
????????????????????????001101??1110???????????????????

Navajosuchus_mooki	000010000010??0?00001000?000?0120110000????000?[0 1][1
2]0100000010?2?110101000????0??110011?????012111000?0000?1000?01??00200032000010001
0000010?00010???110000012000??12?0?11?10???0?????1?????????1111210?1??1011000111000
11100100??1???0??010001?????????????????????????????????????10111??????????????????1
?????

Necrosuchus_ionensis
	??????????????????????????????????????????????????????????????????????????????
?????????11???????????????0???????????????????0?0?????????????????????????????????????
?????????????????????11021021??000???00????????????????????????????????????????????1?
??1???0?????????01?101111100??????????????111???

Orientalosuchus_naduongensis
	01010??00010??1001001001?000?0010000000????0000121120000010???1101?000?000?0
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1?010??1?????00??1100000?0???0?00?00000000101000110 10?000010000000?12??0??00?????0
112000?1?0?100011?????????????11022020???001??0?111110?10?????0?100?????1??10???1????
??01??0?0?1???1???

Osteolaemus_tetraspis
00010??00010??1001000000000?0100000100110100100201000 1001?001110101000010?
200000021001010002000000000000100010001101000210002001000000 0211[0
1]00110111020000120110112000010301000000101110?11?0111021020??10010?0011010110 1000
0100110110000001101000001000010000011011101111000102000?101111110100111[0
1]1000102111100

Paleosuchus_palpebrosus 10000??00010??1000001000000 0?0100[0
1]00000110000100211100200 1?1??1101020000111 01?1100200001101211100000000010001001 11
1[0
1]00?32000010110000011110 0010?0110000000110001112001110110000000100 1110?01?001102102
1??1001210012010 1110?00001110000?1110100100111101100 00100110121???01100101210 1110
1111110??101111110022111211

Paleosuchus_trigonatus
00000??00010??10010010000000?100010000010000010021110020 01?1??1101020000111
01?110020000[0
1]101211100000000010001001111000?320000101100000111100010?0110000000110001112011 11
011000000100 1110?01?0011021021??1001210012010 1110?00001111000?1110100100111101100
00100110121???0110?1012101110 1111100??101111111022111211

Paratomistoma_courti
00000??00000??????????????00?010001010?1?0?001??201010000 1??011??????????0????
1?1?1??0???????????0?0000001000????????????????2???0????????????????????????????????????
???????????????01010???11??????0????????????1?01000???00010?1?000?0??????????????????????
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Penghusuchus_pani
00000??000?0?????00????1?001?0120000000 1???000102?????0?01????0101?00001?????
???1111000?1??0201000000?001?0001???????????50112000000000 10100?0000?0100000000????00
1213000?00100000???011???????1100130?20?00?0?0012?000?01????0?????10?0???????1000??1
1?0?1111011??211??0110??????0??01111 0010???????????????000???

Piscogavialis_jugaliperforatus
00000??00000??1?00012101?00?????0?101001???000102010110 0010?010011111 01010?0
00001102000000003010000111111 1?010?0?1501?27111200000010100000 0100?0111100010000
0011210?10?2?0000?1??000?0????0?1103040?21?00?0?0011010001110???????1???0?????0?????
?????????????????????????0?0??????1????????????????????????001???

Planocrania_datangensis
10000??00010??0?00001001?0??????0000000????001?000100000 01??011101?00000?????
???0???0???0???????0?00?0??1??0?????02?00??3000100?2000?0?100?0000?????????????????12
?0????????0?????????????????110???0????00???
???

Planocrania_hengdongensis
???00??00010??????????????0??????0000000????000???010000001??011??1??000???????
??0???0???00010?1?00???0?????0????????1????300?000?2000???10000?0?????????????????112?
?????????00????????????????110?1120??10????????????????????000110?0??????????????????????
????????1???

Portugalosuchus_azenhae
????0???0010?????????????1????1?0??01001???0001?0110000001??00001101000100????
010????????????????0??0?0??1????0???????????0??????000?0???1000000?01000000?00???0?12?
0000?00000?1?001?0?0????11?????????????0?0?0010??00?010???????????????1???00????????????
???

Procaimanoidea_utahensis
10000??00010??0?00001010?0100?120100000????0000120100000010??11101010000???0
??1?0011000100121110000000000?00010000000100002000010110000????0?1?10?010000000?0?0?
011200011?10000000?????????????1110200?0??000??0?11110000???1001010000???10000??????
???

Prodiplocynodon_langi
000010000010??100000100??0??????0????00????00111??100000010???11010000?000??0
00?0111010??0000010000?00001010110000010001100000000?0010020000100?01102000012??01
112000???00000000??
???

Protoalligator_huiningensis
000????0??????1000?0000??0???01??0???????????
???????????????????????????????????0?00??[3
4]?00?1??0?00??111210??????0?????
110??0?1???
?????????

Protocaiman_peligrensis
?????????010??????????????????????????????????0?1??00100010011??11?0??????????????1
100110001?01111100000?0???
???????0??
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Purussaurus_brasiliensis
01000??10020??1000001110?0110?1210010001???0010121120010010?211101020000?11
011110011100?001211100000000110001000001200022000010?0?00?0?1???0010?00??0???0??00
0??1?????????????0?????????????????11001021??0000100012010011??010?1110000?1????????????
????????????1???1??????????????1?1101??????????????????????111???

Purussaurus_mirandai
01000??10020??1000001110??101?1110010?0????001012011??1001????1??1??0000???0?
??1???1?0????????????????????????0??00000200?2??0001??0000?????1?0010?00??0???0???0?1112
02?11?????0?????????????????11?2?02????0?0??001202?0????11?01?100??????????????????????
???

Purussaurus_neivensis
000010000020??1000001010?0110?1210010001???001012011001001??2111010200001??
011110011100100121110000000001000100?00?10000200001000?0000010100010?001000000100
001112020111111000001001110??1?0???????????????100?120100110?1?001?10000?11?01?01??
10100110000000?101?1??????????????0?11???????????????????????????????

Qianshanosuchus_youngi
000110100010??1000001000?0000011000010?1100001111111000101010111010001000???
0??1000?100001????01?000??0????????0?0?11001?1000?0??10001???0?00100?1?101000?1[1
2]000???????????????0?????????????????????????????????1[1
2]?1?000??0?00???
?????????

Quinkana [0 1]0010??00?????0000001001000[0
1]?01?0?00??0????????????????????0?1??100010?????????00???0????????????????????????0??
00[0 1]0012[1 3]001[0 1 2][0 1]0[0 1][0 1 2]0[0
1]000?2???0000???0?00000?2011??????????????????????????????11??102???10??????????????
1??
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Shamosuchus_djadochtaensis
00000??00000??0??????000?0101?100000000????00110010?0000110?001001000000100
1??100?101?000????1000000000000010?????????0000010?0?00?101?0?1????01?????????????01
0000000?00000?1?????0????????????1?0?????01??0?0????1?1??00????000?????????????0??????
01?0??1?11??1??????1???????????111??????????????????1?01??

Siquisiquesuchus_venezuelensis
00000??00000??1?0001??01????????????????????110?????100?1???????1?1???????????
????2?00?0??03?1??0??11?11????????????????7?11200?0??1?10000?1?????1?10???????????12???
???????00???????????????1103040?30?0?????0?????00????????0111?????????0???????????????
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Stangerochampsa_mccabei
00000??00010??1?00101011??101?120100000????0000?1011000001??2111?10101?00100
11?10011?0??1??111100000??00?000?02000020003200001000100000001?1110?00010000012?00
011200111011000000???????????0?1101110?0??1001000110100010??100??10?00?010100??????
?????010000001???1???0???????001??101111100??????????????0111??

Thecachampsa_antiquus
00000??00010??100001?001?001?0000010100????00110200?1000010?010?0111001??0??
????10?1?00??????????????0????????000012000210112000000000010000?0?00?0?0?2000002001??
12????????????????????????????1102020?20?00????0???
??????????????????????????????????10?0??????????????001???

Thecachampsa_sericodon
00000??00010??100001?001?001?1000010100????00010100?1000010?01010111001110?0
10101011000100?02010010000001000010000120102101120010??011000000100?0101200000200
10112130010000000010?00110????1?110??20?20?0??????1?01?00????0??????????????????????
??1??????????????????00????

Theriosuchus_pusillus
00010??00000??0000000000000???000001000????10100011?0000100?111111000000???0
1?1?0011??0??00030101000000?000010???030000030000000100000000100100?01??1??????0??0
1001000100000000????1?????????1102210?20?000??000????1100?010???000??????????????????
??????????1???0???0?????????0??00?11????????????11????010011?

Thoracosaurus_isorhynchus
00000??00000??1?0001??01?000?0100000010????0011001100000010?00000111110100?0
00??10110000?000301000000000110000000001301027011201000000010000?0100??1?0??????????
0?1210000?00000?0??
????1?1??????1?????????????????0?0?????????????????????0?????

Thoracosaurus_neocesariensis
00?00??0?000??1?000???01??00?0?00??????????00??001101000010??0???????????????
0?1011???0?000????0?0?010010000?????????????11???????????????????????????????????????1???
?00???0??0?????0??1?1
??????1?????????????????0?0???????????????????????????

Tomistoma_cairense
00000??00010??100001??0??00?????0?0??00??0?00110201?0001010??10?0100100????0?
???00120000?0010010000000000100001??????????711120000?000100000100?11?0??????0???01
121000??00000000???0???????????030?0?20?00?0?001????00???0001?011010?0???????????????
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Tomistoma_dowsoni
00000??00000??1000012001?000?01000101001???001?020100000010?01???????00?0???
????1111000???????00?0000011100??0????101?3711120000??101?00??0100???1????00????1??
???????????????1???000?0??1??
???

Tomistoma_lusitanica
00000??00010??100001?001?000?11?00?0100????00110210???0001??010?01?100111??0
1???101200?01??02010?000?000100?010000120112111?200?0000?1??00?01???01???????0????0
112030010000?0?????????????????1102020?20?00???0012?10000??00?0??110???????????????????
???1?????

Tomistoma_schlegelii 00000??00010??10000120010001?01000000001[0
1]010011020101001010001110100000100?000110011000010002010000000001000010010120113
1001200000000010100000000?110000000020110112100010000000000101101001?201103030?20?0
010?00110200001200010011000?00000000100000100001010011?01110101100000100011011111
00010111000000022101000

Toyotamaphimeia_machikanensis
00000??00010??1?00012001?000?0100000000????0010021??1?0001????0101100001?0?0
001?1011000?1??02010000000011100010010000103500120000000000?00??0100?010000000002011
?1120??00??0???00??????????????????0???0?20?0000?001?020000110000?011000?0???????10010
01??111111111?0111001110??0010001101110010???????????????000???

Trilophosuchus_rackhami
???00??00010??????????????1??????0100?011?0?1011?21111000110?01111100000010?1?
?00001100011001000000000000000000??0??????????0?0????0??01??1000?011002112?0000011001
12??0?????0?0?00?101110?01?01???
??

Tsoabichi_greenriverensis
00000??00010??0?1000100??000?0110100000????001?12111001001???11?1?1???????01
???00?1?????????????????????????????01?000???0??1??0?0????????????????????????????????
?????????????????????????11?21021???0????001????01???????1?????????????????????????????
???????1?????????01??????????????????????1??0?2100111

UCMP_39978
0100???0??????1?00011000??111?0???0???0????????0??????????????????102000????????
??????????01211?0?0???????????0010001001320000100000000001010?010?001000000?1000?112
0001??11000???
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Ultrastenos_willisi
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Wannaganosuchus_brachymanus
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  -[/100 325    -[/100 326    -[/100 327    -[/100 328    -[/100 329
;
cnames
{0 Snout_length_to_total_skull_length;
{1 width_at_the_anterior_orbital_margin_to_cranial_table_wi;
{2 external_naris_proportion;
{3 anterior_margin_thickness_of_the_external_nares_to_leng;
{4 dorsoventral_height_to_medioventral_width_at_the_5th_a;
{5 minimum_width_between_orbits_to_maximum_width_of_cr;
{6 infratemp_fenestra_length_to_cranial_table_length;
{7 cranial_table_length_to_its_width;
{8 minimum_angle_subtended_by_posterolateral_margin_of_;
{9 supratemp_fenestra_length_to_cranial_table_length;
{10 supratemp_fenestra_width_to_its_length;
{11 incisive_foramen_width_to_width_ofthe_rostrum_at_pm-msutu;
{12 suborbital_fenestra_width_to_its_length;
{13 choanal_width_to_its_length;
{14 pterygoids_width_to_its_length;
{15 basioccipital_tubera__width_to_occipital_condyle_width;
{16 number_of_maxillary_alveoli;
```

{17 EMF_length_to_its_height;

{18 minimum_angle_subtended_by_dorsal_margin_of_EMF_a;

{19 retroarticular_process_length_to_its_width;

{20 angle_subtended_by_anteroposterior_flare_of_the_scapul;

{21 coracoid_length_to_scapula_length;

{22 expansion_of_distal_coracoid_to_proximo-distal_coracoid_len;

{23 proximodistal_ulna_length_to_proximodistal_humeral_lengt;

{24 femur_length_to_humeral_length;

{25 expansion_of_distal_ischial_blade_to_length_of_ischium;

{26 canthi_rostralii;

{27 anterolaterally_ridges_on_lateral_surface_of_rostrum;

{28 Dorsal_boss_on_sagittal_axis;

{29 sup_preorbital_ridges absent present;

{30 sup_spectacle absent present;

{31 sub_spectacle_fossa lacking deep;

{32 sub_spectacle_to_level_to_anterior_margin_of_orbit posterior anterior;

{33 fossa_from_frontal_to_external_naris;

{34 prominence_at_anteromedial_orbital_margin;

{35 fossa_at_intersection_of_postorbital_frontal_and_parietal;

{36 angle_subtended_by_posterolateral_skull_table_adges_to;

{37 sup_squamosal_horn absent present;

{38 sub_squamosal_horn_position posterior anterior;

{39 sub_squamosal_horn_direction dorsally dorsally_and_laterally;

{40 external_nares_orientation;

{41 ghara_in_external_nares;

{42 crest_circumscribing_narial_margin;

{43 premaxilla_notch_posterolateral_to_naris;

{44 fossa_on_naris_lateral_margin;

{45 nasal_into_naris absent present;

{46 nasal_into_naris_extension bisect protrude_partially excluded_internally;

{47 contact_between_nasal_and_premaxilla;

{48 anterior_limit_of_pm_and_m_suture_relative_to_naris_post;

{49 premaxilla_dorsal_process_extent;

```
{50 cecal_recesses_on_narial_canal;
{51 maxilla_posterior_extent_relative_to_postorbital_bar;
{52 sup_contact_between_lacrimal_and_nasal present absent;
{53 maxilla_posterior_process_in_lacrimal;
{55 sub_contact_between_lacrimal_and_nasal_maxilla absent present;
{76 sup_dorsal_supraoccipital_exposure absent present;
{77 sub_dorsal_supraoccipital_exposure_shape small moderate large;
{151 notch_for_4th_dentary_tooth absent present;
{192 sup_choanae_septum absent present;
{193 sub_choanae_septum_external_projection within project;
{206 sup_lateral_laterosphenoid_bridge absent present;
{207 sub_lateral_laterosphenoid_bridge_morphology short robust;
{208 sup_caudal_laterosphenoid_bridge absent present;
{209 sub_caudal_laterosphenoid_bridge_morphology short long hypertrophied;
{210 sub_lateral_laterosphenoid_bridge_ascending_process absent present;
{211 sup_epipterygoid present absent;
{212 sub_epipterygoid_retraction_from_the_cavum_epitericum overhanging isolated;
{229 sup_perforation_of_spl_for_ramus_of_CNV absent present;
{230 sub_perforation_of_spl_for_ramus_of_CNV_number one two;
{233 sup_EMF absent present;
{234 sub_EMF_size narrow moderate large;
{235 sub_EMF_intersection_with_surangular_dentary_suture anterior posterodorsal;
{236 sub_EMF_intersection_with_surangular_angular_suture posterodorsal posterior ventral;
{237 dentary_posterior_process_in_an_to_EMF present absent;
{241 sup_surangular_anterodorsal_process absent present;
{242 sub_surangular_anterodorsal_process_anterior_extent one onetwo three;
{253 sup_articular_ant_process_in_adductor_chamber absent present;
{254 sup_articular_ant_process_in_adductor_chamber_pos dorsal ventral;
{324 dorsal_osteoderms_keel absent present;
{325 dorsal_osteoderms_shape rectangular square;
;
;
Ancstates
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-20 -21 -22 -23 -24 -25 -26 -27 -28 +29

+30 -31 -32 -33 -34 -35 -36 +37 -38 -39

-40 -41 -42 -43 -44 -45 -46 -47 -48 -49

-50 -51 -52 -53 -54 -55 -56 -57 -58 -59

-60 -61 -62 -63 -64 -65 -66 -67 -68 -69

-70 -71 -72 -73 -74 -75 +76 -77 -78 -79

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-90 -91 -92 -93 -94 -95 -96 -97 -98 -99

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xgroup



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agroup



;
taxcode
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+24  +25  +26  +27  +28  +29  +30  +31
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proc/;
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5. Dataset: Walter et al., supplementary dataset (modified Chabrol et al. (2024); discrete and rediscretised characters; .tnt)

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xread

330 156

Bernissartia_fagesii
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Asiatosuchus_nanlingensis
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Australosuchus_clarkae
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??????????1??100000????????????????????????????????????????00000000101000000000000?1020
000010?011110[0
1]00?????011200????0??10??0??????????????1??2112???10????001????00?????????11 ??????????
???????????????????????????????????????????????????????????????????????????

Baru_huberi
        ??1?0??????0??????????????00010??00?????0?000010000?00?01?0000??0??????????????
?????????????????????????????????????????????????????????0?000000101000100100001???0??
001????1?2?1?????????????????????????????????????????11021020??10?1???????????????????????
???????????????????????????????????????????????????????????????????????????????????

Baru_wickeni
        ??0?0???1??00???00?1??????00010??00010??0000001000?001?0110000100????0010?111
1000001??0?1??100010????0????001100???????0??0?000000100100001?0000?010001001000010
0100?0010?011110100020?001120011??00110000?????????????11021120??1001??0?1101000011
0001001101100??????????????????????????????????????????????????????????????????????
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Borealosuchus_acutidentatus
101??0?0010?????1?????????00000??00010??0?0001?00??000?0110000000????000?0101
0?00001???????1000000???000?????10???0?????1??0???0??????????001?001?300120000000?00
110?0000????00??00???0????????????????00???
???

Borealosuchus_formidabilis
101??0?00110001010l?011?0100000??00010??0?0001?000?000?0110000000100l000?001
10000001??0?1?010000000??000??001100001011301000000000100010000011000330012001000
0101000000?0110000000??000112001010000000000??????0?????01002120?1??0000?001101001
10?0010101l000?00000?0?100000100110000101101l??11110?00100100001000001?????????????
10002??

Borealosuchus_griffithi
1000?0?00110??10110???????00000??00010??000001?000?00000110100000????0000001
1???0001??1?1?01?000?0100011?1?0?1?????00??0?000??000010101?00001[0
1]0013300010010??0?0010??0000???101??0?1??11?1120?1???0?0?000??????????????100210100
?00?00?001?010010??00001?11000?????0?????0???1???????0?010021?0?1?10??????1??????????
???????????????000???

Borealosuchus_sternbergii 101000[0 1]00[0
1]0000101100???1??00000??00010??0000012000000?011000000010010000000100000010?0110
0100000000?000110011000010110010000000001000100000l[0 1]001[0 3]300010010000000l[0
1]000000?[0
1]11000000120110112001 00?00000000?001??0??00111002110?1??0000?00120100100?00100011
000?0???0?00??10101??0??0?0101?0?1?????????00??000001000?????????????????0002?0

Borealosuchus_threensis
???
??0?0???????????0
?0??10021020??00????0?10120010??00?00011010?
0?????????0???????????????1???1??????0?????????????0????????????????????0002??

Borealosuchus_wilsoni
1?00?010?11?????1??10??11000000??00010??000001?001??????110000???????000?0101
0?0000???0?00?1??????0??0???????10??00??????00?0????????????0??01?001?300020010000????
?0?0?00?????????0???????1????010000????0???????????????0?????????????????101100100?00??0
?110???????0?0???????????????????1???1??????000????00?0??010001??????????????000200

Bottosaurus_harlani
?????010000??????01????????????10000010????????????????????0000?0?1???001??21110
0100?????1?0002100????0???????1?0?1101???10?1???0????????????????0??????????100????????
?0?0?01?0?000?????1??12?????????0???0???1??????????10210?????0????0011010011??01?0??1
?00111?????????????????????????1???1??????????????0??101111110???????????????1?????

Boverisuchus_magnifrons
?????????????????0?????????10?10??00010???000001000?00????00?0???0????0?1?0101??
0000????????1?0????0??00??????10???00000?1???????????????000000001030100001201000?1??
?0000??1111000?0??00??12?0?0??0?1????0??????????????1102100????0????0?1????0?0?????0??
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Boverisuchus_vorax
1000?000010000??0???1??11010010??00010??0000001000000O?0100100000??0?1010020
100000010?01110100000000?0???100110001000100100l0?0000100???00003100003010000l2010
00010000000?011110000020000112001 0??000??000???1?????????1102110?0??0000?001??1?11?

??0?000010010?0?????????0???1??110010??11?11????110??????001101110100??????????????10
1???

Brachychampsa_montana
100000001101001100000???0?00000??00010??1000101011?0101?1101000001?0?000012
0111000011?1111010100000?0111100110001001111100000000010000020?0130003100001 0001
000011010001 0?1001000001?0000112000110100000000?0?1110?01?10110?1121??1?010?0?12010
001??0100111 0000?0???????001110?101000??0011????????????00000010111???????????????0
241111??

Brochuchus_pigotti
100000000000000100?0???????00010??00010??0?00001000?000?1100000100????0010121
0?0000010?0111010100011 0?0????0011001010002010000000000100?000010010012100020010000
01010000000?10102100002011111200 10??30100000???1110????0?110?102????0????0?11020000
10????0?1??110???????????????????1???????1???1???11?0??????001???11????????????????????111?
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Caiman_brevirostris
????0??????????0??????????010011100??0??1000001010??01?0?20001?0?????001??????
??1?????????????10???????????0011?????????1?????????00?000??????0?00??200?010?0100?000??
???????????????0?1000??12??1??????0?0???????????????11001121??0001??001??????10???001??
??????????????????????????????1???1??????0?????????????????????????????????111???

Caiman_crocodilus 10[0 1]0?0[0 1]00000001000[0 1][0 1]1?11[0 1]1000011[0
1]00010??10000[0 1]10000001?000000000110000100201[1
2]00100111211101020000111011110011000110121110000000001000 1001[0 1]0010013200[0
1]110100000001 0100[0 1]10?0[0 1]10[0 1
2]000011000111201111111000000100111 0??1?0011021021??00011000120[1 2]00110?00[0
1]0111100111110100111111001111001000101111010110110100011101111000111011100100231
11211

Caiman_gasparinae
??1100?0100???????????????000????0?010??1?0001?000??01?0??????????????0???2112
0011?1??211?0??????????????11001100??????????0?00?0???????????01?001?200?010????0?????
???1??10???
???0???????????????????

Caiman_latirostris 101[0 1]0000000011100010?011?1010011100010??10000010100001?002[0
1]0000001100001012012[0
1]0110111211101020000111 01?110011000110121110000000001000 1001100[1
2]001320000101000000110100010?0[0
1]10000001100011120111111100000010011110?1?0011021121??0001100012 1200110?000011100
0111110[0 1]0011110100111100100010 1?1???0110110100?1110111??????1011[0
1]0010023111211

Caiman_lutescens_MACN
?????0?0100???????????????????110?0020????????????????????1001???????001??21120
01101????????????????????????0011??
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Caiman_wannlangstoni
00???0?0000?????0?????????0101110001 0??0?00001010?001??1110010001???00100201
2001001????1?010?0??01???????001100?110121?100000?00?1???????????1???3200001000100???

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??????111001000000???0011120?0?????00?00????????????????????????????????????????????????
??????????????????????????????????????????????????????????????????????????????????????

Caiman_yacare 10100000[0 1]0000[0 1]1000[0 1]01??1[0 1]?000010100010??10000[0
1]10000001?00210010001000001002012001001112111010[1
2]00001110111100110001101211100000000010001001100100132000[0
1]101000000010100010?001000000110001112011111110000001001110?01?0011021021??00011[
0 1]00120[1
2]00110?000011110011111000001??11100111100000010111???1110110100011101111100??1011[
0 1]001?0?3111211

Ceratosuchus_burdoshi
          100??0?0?111???00?????????00000??00011100?00001010?001?0001101000????00000???
?000001???1???101?00?????????00?1?00??????110000?000?1000?????0320003200001010?0000?
0?10101??0?0100000??0????12??????????00???????????????1101210?0??0????0?1?????????0???
1?????????????????????????????????1?????????????????????????????????????????????1?????

Crocodylus_acutus
          100101001000001000111??10?00100??00010??10000010001001?01000000001101101102
0100000010001110100000010?[1
2]0000001100001000201000000000100101001001001310002000000000010010000?11112[0
1]000020110112000010001000000101111001?0111021020??00010?0011020000101001001101100
001011010000010011001001110?1???1110001010001101110200??011000001111111000

Crocodylus_affinis          10[0 1]00[0 1][0 1]000[0
1]0000000100?1???000010000010??1000001000?000?0120000000??0?0001[0
1]20100000010?011101000000?0?10?0100110000000002?1000000000010010001001[0 1]000[0
1]100010000000010020000000?01101100002000011200101000000000???11110?1?0111021110??0
0010?00110100001010[0
1]10011000?00000110??0???1?????????????0???????????????001101??0100??????????????111???

Crocodylus_anthropophagus
          ??0????????0????000?1?????00000??00?1111000000010001?0????00000?0?11010?1??201
????0??????1??10?0???0??2????00?1000010002??000000?0?1101010?00?10?1310002001000000
0100???????11?2?0????011??1?????????0??00???????????????11021020??10?10?0?11010000??10
110?110110???00?1???0???1??????10??1??????????????????0??101?????????????????????11????

Crocodylus_checchiai
          1001010010000??0001???????00100??00010??1000001000?000?010000000011010010120
10000001000?11010000?00??0???00011000000002010000?000010???10000010011100020010000
00001000000?00102[0
1]00000?100?120000??000000010?11?????????1?0?1??????????????11???????????????11?????????
???????????????????????????????????????????????????????????????????????

Crocodylus_falconensis
          ??????????????????????????00100??00010??100001?000?000?0100010000?????00012?10
??00010???1101000???????????0?11?0????????100?0??0????????????00???????00?0??0?0??????0
?0?00??1???????????????????????????????????????????1?0?1??????????????11?????????????????
???????????????????????????????????????????????????????????????????????????????????

Crocodylus_intermedius          100100[0 1]000[0
1]000100011??????00100??00010??10000010001000?0120000[0
1]00110100110201000000010001110100000010?20000001100000000201000000000100101000001
0013100020010000000010010000?11112[0
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1]00002011011200001000000000111111001?1111021120??00010?0011010000101001001101100
0010110??00001001100100 1110?1???1110?01010??????????????011100001112111?00

Crocodylus_johnstoni   10000000010000100011110[0
1]0000000??00010??10000110001000?01000[0 1]0[0
1]001101001102011000001000111010000011 0?[1
2]00000011000110000010000000001001010110110012101020000000010[0 1]0000[0
1]00?11111[0 1][0
1]000201101120000100000000011111110 1?1111021120??00010?00110200001010010011011000
000110100000100001010011 10?1???1110?010000011011112000?011100001112111100

Crocodylus_megarhinus
          100000000000??1000????????00000??00010??10000010000000?0100010100??0?0010120
110000010?01110100010010?2000000110000100020100000000010000101100100111000200 1000
000020000000?1111100000201101120000100010000 0?1?111??1??1111021120??00010?00110100
000?0?110011011000??????????????????????1???1?????????????????????????????????????????
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Crocodylus_mindorensis
          1001?0001010001000 11??????00010??00010??1000001000100 1?0100000000110100 1102
010000001000111010000001 0?2000000110000100020100001000010010100100200121000200100
000001000010 0?1111210000201101120000100000000001111110 01?0111021020??00010?001101
00001110010011011000000110??????????????????1?0?1????????0??????????????????0110000011
12111000

Crocodylus_moreletii
          1001010010000010001 0???10?00100??00010??1000001000100 1?010000000110100 1012
010000001000111010000001 0?100000011000010002010000000001001010010030011100020000 0
0000010000000?111121000020110112000010001000000101111001?0111021020??00010?001101
0000111001001101100000 0110??????1??????????1?0?1????????0??????????????????0110000011
12111000

Crocodylus_niloticus      1000000000000000100010100[0 1]0100000??00010??100[0
1]0010001001?0100000000 1101[0
1]011120100000010001110100000010?20000001100001000201000000000010010100100[1
2]0013100020010000000100[0 1]0000?01112[0 1]00002011011200001000[0
1]0000001011111 01?0111021020??00010?00110200001110010011011000000110100000100111 01
0011101110111 10?0101000110111120010011100001113111000

Crocodylus_novaeguineae
          1001000010000010001 0???11?00010??00010??1000001000100 0?010000000110100 1002
010000001000111010000001 0?100000011000010002010000000001001010010020013100020 0100
00010100001 00?1111210000201101120000100000000001111110?1?0111021020??00010?001101
00001110010011011000000110??????????????????1?0?1????????0??????????????????0111000011
13111000

Crocodylus_palaeindicus            1011000010[0
1]000?000?0??1???00000??00010??1000001010?00?????0????00????0[0
1]101??100000010???11010000001??2000?0111000??000?010000000001001010 00?01001110002
00100000000100 00000?011021000?2?1?01120000??001?00???????????????11021020??00010?0?1
10100001?10?1001100110 ????????????????????????1???1???1?10????????1101????????????????
????111???

Crocodylus_palustris
          1001000000000 11?00101011000000 0??00010??10000010101001?010000010011010[0
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1]10120100000010001110100000010?[1
2]000000110000100020100000000010010100000000101000200100000000100000000?[0 1]1102[0
1]0000201101120000100010000001011111101?0111021020??00010?0011010000111001001101100
00001101100001000010100111 0?1???1110?010100011011111200??01110000111211 1000

Crocodylus_porosus      10[0 1]10[0 1][0 1]0[0 1]0000[0
1]10001010000100010??00010??10000010[0 1]0100[0 1]?010000000011010[0 1]10[0
1]20100000001000111010001 0010?[1 2]000000110000100020100000000010010100100[1
2]00131000200100000000 10000000?11112[0 1]000020110112000 01000[0
1]000001101111101?0111021020??00010?0011020000101001001101 1000[0 1]00110100000100[0
1]00010011102110?111000101000010111 1200??0110000011121 11000

Crocodylus_rhombifer   1000?00?[0
1]000001000101001110010 0??00010??100000100010 00?0100000100110100101201000000100011
10100000010?[1
2]00000011000010002010000000001001010010010010100020010000000010010000?11112100002
0110112000010000000000101111001?0111021020??00010?001101000010100100110110000001 1
0110000100111010011101110111100010100011011111 10??01110000111211 1000

Crocodylus_siamensis   10010[0 1]001[0
1]0000100010100 10?00010??000111110000010001000?0100000100110111101201000000 1000111
0100010000?2000000110000100020100000000010010100100100131000200100000000 11000000?1
1102100002011011200001000100000010 1111101?0111021020??00010?00110200001010010 0110
11000000010??000010001001000110?1???1110?010100011011111210??011000001112 11000

Crocodylus_thorbjarnarsoni
          10100100100010 1?0010?????00000??00010??0000001000?000?01100000001???1010120
??110001????1?01?00??000?1????00110000100?20?00?0000??10?10?000002001310002001 00000
0010000000?1111200000????011200000?001?0000???1?????????11021020???0?10?0?11020000?
?10?10?111110?0100110???????????????????????????????????????????????????????????????????????
?

Dadagavialis_gunai
          ?0???????????????1?????????00000??000?0?????00??0?1?100?01000101?0????021021??
?????1???????111?01????????????0??????????????????????????0????????2711120000001010000
?0?00???0?0?001????0??????????????0??????0????????????3???????????????????????10????????
?????????????????????????????????????????????????????????????????????????????????????????

Deinosuchus_riograndensis
          1001?1?02010???02010??1???????0??01??0??100000?000?00001100100000?1??00101001
1?001010?210?01?100?100?0??111011100????????00?00?00?1?????00001300003000000 10?00?0
01???0000?????0???????1??1????????????00???????????????1002102???000???00100210?10?10
001?111???0??010??????????????????0?1???1??????0???????????1?????????????????????10????

Diplocynodon_darwini   0000?0[0 1]00[0 1]0?001?111?0?010?00000-
?00010??0000012000?000?01[0
1]0000000???000010110000001 0?1111010100000 0?0110100110000101100100000000010001000
001000103000110100000000110000 10?11??????0??0?1111201101020000?00??????????????100210
20??10010?0011010 0110?01001111010?10000?010001 0010?0100000 0111?1???1?1001000000110
1110000???????00??112100201

Diplocynodon_deponiae           0?0?????0[0 1]0???0?0??????11?00000-
?00010??101001200??000?0110?00000????000?10110001001??[0 1]11101010 0000??01-
?00021?0???0????0000???0???????0???0??????300?11010000?00110???????1??????0????111120
1?00-
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2??00????????????????1002102????0010?001???000???0???1?1?0?????????????????????????????
1???1??????0??????0??101111000???????????0?2101211

Diplocynodon_hantoniensis 10[0 1]000[0 1]0[0
1]10000000010??????00011000001O??0001012000?000?0100000000????00111011[0
1]0000010??1110101000000?01101001100001011001000000000100010000010000030001101000O
00011000010?0110000001100111120110102000000???1110??1?0?1002102O??100100001101001
0120100111001O?10??????00????1??0100000011?21???0??0??????001101111000??????????????
1002??

Diplocynodon_muelleri
10???0?0010?????1???0?????00?010000010????1101201??000?0100?00100????001?1011
00000010?2?1????100??0??011?????1?0?01011??10?0000???10?0?0?0?0??00??300??10?0000?00
110??00???1100?000????10112011010???00?00?????????????10?2?021???0????0?1????????????
0??100?????????????????????????????????1?????????????0??101??00????????????????1012??

Diplocynodon_ratelii
1010?000000?00000???0?0???000110000010??0000001000000O?0100000100100100110O
0100000010?1111010100000O?0110?002100000011001000000000100000000010001030001101OO
000001100000O?1110100001100101120110102000000010O1110?11?1110021020??00010?001101
000010010010110?0??0????????0???1??0100000?11??1??????0??????00110111110O????????????
??1002??

Diplocynodon_remensis
?????0????0?????0010??????000110000010??0000012000?000?01000101001???000?1011
10000010?2111010000000??0??0100110000?0110110000000001000100000100010300O1?010000
000110?000??01??0??00?000[0
1]01120110102000000????1??0????011002100?0??0010?00110100100?00001110010??0????????
???????????????1???????????0????????????????????????????????????1002??

Dollosuchoides_densmorei
1000?000011100O?0?????????00000??00010??1?0001?001?001?010000000O????0010020
10100?0????????1?????????0???????1?0???00???1??0???0??1?????000?1111?2100120000000011
100?0000?01102?000?????01120000??00000????????????????1103?20?10?0??0?00110200001100
?100110????0????????????????0???

Dongnanosuchus_hsui
0010?000?0100?10??????????01010??00010??1000001001?000?0010000100????0010121
110000000?0?1101?000?010?11?100011000000011010000000001000000000000010100010010 10
0010100000O0?12111?000?????0112001?10??100010??????????????11????1????????????0????????
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Eocaiman_cavernensis
?????????????1???001???????0000111000?0??????????????00??????????00????????020100
00?0?????1??102?00?????????????1????????????0?0??0??????????????1????20000?00000000?10??
001110010000O0?00??0?12??????1??????????????????????1121021???00???00110100?10????????
??

Eocaiman_palaeocenicus
??????????????????000??
??0?0????????????
???11101021???0????001101?00???0?001110000?
??

Eogavialis_africanum 10[0 1]110[0 1]0[0 1][0 1][0
1]000?01?0???0??000000??00000??100001?001?000?0100000?0010000011020101100010?010011
11010100?0??1111110000000020100001101110000100001[2
3]0112711120000001010000000000?011120000000000112100010000000011???00?0????0?1103030
?30?0000?0011010000111100001 10?0?0?????????????????????1??????????????????????0?????1
?????????????????000???

Eosuchus_lerichei
1?0???0?010000000????????00000??00000??1?00012001?000?0100100010 1?0?0001000
1?0000010?0100?100100010?000?00011000011002010000000?10000000000200037011200000 0
000110000100?0100000000100001120000100000000???0??????????11030?0?21?00?0?00???????
?????????????????????????????1????11101?1???????????????????????11??????????????????011
???

Eosuchus_minor
1???????0???????0?0???????00000??00010??100001?001?000?0100000010??0?00010100
?1000010?0?00?100100?0?????0?10110000?100201000001000100000000001000370112000000 10
01100?0000?01100000000000?112?000??000?001??0?1??0??01111103120?21?00?0?0011010000
??00000110010?00?????????????1??0001?11?1???1??????0??????0?0100110????????????????101
0???

Eothoracosaurus_mississippiensi 101??00001[0
1]????01?????0???00000??00000??1?0001?001?000?01?00?01?0????00010011?100001????0??1?
1?????????????1?0100?00000??10000??0?01000000000120002 7?102000000101 0000?000??0?0000
00??0????112?0?00?000?000????0??????????1003030?2??0????0?1001?001??10?0??1?010???????
????????????????????1???1?????1???????00?????????????????????????000???

Eurycephalosuphus_gannanensis
1?1????0?11?0???001??0????00000??00?10??000001?001?010?1000??0110????00001001
20001010?011101?000?010?111100121000000000?00000000000101 01000?01?000?100011010100?
1??00000???10?????????????0112000?100??00000??????????????110?202??010010???11011001??
01?0??110?0?10??????????????????????0?1???1??????????????0??10??????????????????????????

Euthecodon_arambourgi
1001?0000000????0?????????00010??00010??0?00012101?000?01000000001101001?021
110000010??1110100000010?1??00001100101000201 00000?0????????00001?0012700020000??0
00?11??0?0????0?2000?02011????????????????0?0???1?????????11?????????????????????????????
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Gavialis_browni
?0???000111?0?1?1?????????00000??00000??100??1?2?1?100?1100010?0?????002?021?
???0001????0010?11??1????????111100?00000?01??0??????????010?????????7011200000001010
000?1100?01010?001?0???011210?0??0???10???
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Gavialis_gangeticus 10[0 1]010[0 1]00110[0 1][0
1]0020010100010000 0??00000??11000122010101?110001010000000021011101100010002001013
110100?0000111110000000000100001111110100100000141112701120000001011000011 00?01010
0001000000011210000?000010110000110?01?201103040?31?0100?011102100012010000110 00?0
00001001000001000011111111011010001000011000001011001001010000001021 0?0000

Gavialis_lewisi
?0???000000?0111??1??????????00??00000?????????????10???100010?00??0?0021???10
1000010???0010?3110100?00001111100?000000?10000110111110 01??????????7??12???000101?

00000?00?011100001?00?0011212000?30101011?????????????1?????0??1?01?0?01110?1000120
100001?0???0??

Gavialosuchus_eggenburgensis
100?1000111????00?????????00000??00010??1?0001?001??00?10000100?0????001?0211
0000001????1?01110001????1???101100?????0??10000000001000??0??03101?2411120000?00?1
0100?000?????0?????0200???????????????0???
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Glen_Rose_form
?????0?0010?10110?????????000010000000??0000000000?0111?120000001?0?1010000
100000100?0?110100000???????100??0?0?????????0?0100000000100?0000001?0000001000000
0010000000?01000000010?0010000000?00000?1??0?1??0??????0102120?20?0000?000???????0
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Globidentosuchus_brachyrostris
???????0100??????????????0000???00010??10000??01??001?0??10010?0????000112112
001001???????1?200?00??????????1?0?????????0??????????????000??00002?00010?0100?????
??001110???0???????????12??????????????????????????11021001??11????0?120100110??0?0??
10001?111???

Gnatusuchus_pebasensis
00???0?0000???0?0??????????0?000??100?0??1?0??01010?0????1?0001000???00001201
20010011??????1??0??????0???????1?0?010120??00?001000100010???0??000?000001000100???
??1???????0??0??00???0001120100101100?10??????????????0100?20?1??0????00120?00110??0
001?1100??0???

Gryposuchus_colombianus
?0???0?00???0???10?0??????00000??00000??1100012001?000?0100010000????00210111
01100?10?0200100311110??0??011?020000000000100001110111001000?2211?2701120000??10
1000000100?011100000?0?0?12?????????0?0???0?00?0??01001103030?20?001??0011?1?0001
00?0000111?0??0000100??
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Gryposuchus_croizati
??11????1??????11?????????00000??000?0??100001??01?????????????0?????02100?0?1
?00?1????00?113??0????????1???1???????0??1??0??11??111???010?1?01??7?1120000??1??????
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Gryposuchus_neogaeus
1?1110?00110???0?10??????00000??00000??1?00012101????????0??0???????002?0??1?
1?0001???2???????????0??????1102?00???00?1?00011111111001000?2211?27?1?20000001????
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1?0???0??0???????????????????

Gryposuchus_pachakamue ?00010?0111?[0
1]0??101???????00000??00000??1?00012001?000?0100010100????001101010110001????0011?1
??110??000??1?01000?0000?010?0?01101111???011?2111?2711120000001010000?0100?0???0??
?100?000112???0??000?101????0?????????1103030?20?0?00?001111000012010100111???0?????
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Hassiacosuchus_haupti [0
1]01??000?10?????00100??11?10000??00010??000??01010?001?01201010001?0?000?010??0000
010?21110101000000?01?1100110?0???1???0?000??0???????????????0??2000010?0100?00??10?

????0???11??2?0?????000?0?1?010101??010??0100
???????????10????????????????1???1??????0??????00???111?0????????????????3111111

Hylaeochampsa_vectiana
?0???0?1000?00?1??????????00000??00000?????????????1100?120101000????0011?0110
1001000?0?00??10?00?0??????10110010????0??0110110000100010??????????60??0???0?0?0001
00011?0?01?12?0100?0??0?12?0000?0000010????10?0??????????????????????????????????????
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Iharkutosuchus_makadii
0010?0?01???00?00?????????00000??00010??1000001011?1100?12010010?????0?010?11
100200?????0??????00000?01???00?0010??0103001101?100?000?00???03300016001010?020000
011001000?01112001000?0?01120001??00000101???1????????0?104110?1??0?00?000????0010?
00?00000000????????0??

Ikanogavialis_gameroi
?0???010111?0??02?????????00000??00000??1?0001?101?000?01000?0100????00110111
?1?0001??0?0010?31??????0????11?1?0?????0??1??0?1?1?0??1???0????501?2701120000???0100
00??100?0?0000001?0?000112???00?000?0?11???????????????1?3040?30????????1??????0??????
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Isisfordia_duncani
1000000001010000????0??10?00000??00010??1?00001010?001?0100100000????0000010
100000110?010001011000000?000??0011?00??000000000000000000001002?00320000700101002000
00001000000??10000000?????0100000010000000?00????????????????3???????0????0?1101000??
?01????00?????????????1?0??????1100??1011??1???0?00??????000??10010?0???????????102111
100

Jiangxisuchus_nankangensis
10???0000101??1?0?????????0000100000?0????00001000?000?0100000000????000?1011
1000001??0111?1?00??010?000?00011?000?00?2?1000000?00?000??0?00110000100?10010000?
002?000000?11?000000???1?01120010110000000??????????????11021020??10?10?001?01???01
??1??11???

Kambara_implexidens
?000?0000000?0?0010???????00000??00110??1?00001001000???100000000????001?020
110000010?01110100000000?000000011000000010?1000000000010000?000001001310002001000
0?????0?0?00?0110101000000010?120000102?11000????1??0??1?01?1021020??000???00110100?
01?0?000?1?0110000???1???
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Kambara_murgonensis
?????????????????0?????????00000??001?0??1?0000100???00?01000000?0????001??2011
000?0?0???1??1?00??0???100??0011?0?????10??0???????????????0?0??????????0???????????????
??????????????????????12?????????1???????????????????11???12???0???????1??1?0????0?1?????
?11??

Kambara_taraina ???????0[0
1]00???1?0??????????00?00??00110??1000001001?000?01000?0000????000?12111000001???????
1?000?0???1????0021?00??0010010000??000100?0?00000?00121000200?0000?00100?0000?0111
0??00?????01120??0??2?1100?0??????????????1102102????00???001?01?00?11001???110???????
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Kentisuchus_spenceri ?00??0?0[0 1]1[0
1]?00?000????????00000??00000??1?00001001?001?01[1

2]0000100????0011020101001010???1001?0000?00??????111100??????????0??000001000??0000
?101121001200000001?100?0000?011020000?2???0?12???0????100?0???????????????????????
???????????????00???0011001?100?0???
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Kinyang_mabokoensis
??????????????????????????00000??00010??10000?1??01????????????0??1??0010121???
100000???1101?00???0??2????001100??00012000000000000100?1?00000100111000100100000?00
00000000?0111?10000????011200000?00100000?????????????11021120???0?10?001101000011?
001001111???0000110??

Krabisuchus_siamogallicus
??????????????????????????00000??00010??000000100??000?0?00010100????000012011
?00001???????1?00??????1???????1?????00??0000?0???????????00?01?00??2???00??0100?0?10
???????11?0??????????0112000????????????????????????11?02010???0?1????111110?????????
00??????????????????????????????1??????????????????0??????????????????????????1?????

Kuttanacaiman_iquitosensis
?000?0?000???01?0?????????00?0110000?0??1?00001010?0??????0001000????0000121?
???1?011?2????1?????????0???????1????10121??000000000?000?????00?000?200001000100?00
??10?????00??0???01??0001120111??1100??0???????????????1??2?121???00?????1??1?????????
??1?0??

Leidyosuchus_canadensis
1010?000?10100001?1???????000010000010??00000110000000?010000000010000010101
101000010?011101000?0000?00101001100001011000001000000100010[0
1]00010000330000000000000000[0 1]0[0
1]0010?01100000000000011200101020000000???11010?001?1002100?0??0000?0011010011101
?01?10000?00?000????0??????????????????????????????????????001??????0??????????????1111??

Lohuecosuchus_megadontos
0010?0?00000100?0??0??????000010100010??0000001000?000?111??0?100????0011111
??000[0
1]00??0110010000000010100?10011010??010301010000?00?00?1000000100112000000000000002
0000000?01112000000??10011200?00?00000000???1?????????11021020??10?10?000????0001000
?1??11010?00???00??00???????????????????

Maomingosuchus_petrolica 1000?0[0 1]00[0
1]0??0??0?0?0?????00000??00010??1000011001?000?01000000001???001102?100000010?01110
100000100?000??0011000??00??010000000000100001001 0?001?3101120000000000110000[0
1]00?0110000000201001120000??30000000???1??0????0?110?020?2??00?0?0?1202000011?1?10
0110????000000????????00111000001???1??????????????0??001??1??????????????????1011??

Maroccosuchus_zennaroi ??1100?0[0
1]11?????0000??????00000??00010??1000001001?001?0100000001???001?0210?0001010?0110
01000??010?000101011000110000??1000000000100??100?00?011?1000200?0000?01100?0000?01
???????02?1?011200000?001000?????0??????????1102120?1??000??0011020001?100???10000?0
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Mecistops_cataphractus 1001100000000001000111101[0
1]100000??00010??100001100100000?0100000000110100000201100000100011101000000010?1001
000110000100020100000000001001010010110113100020000000001010000100?1[0
1]11111010201101120000100000000001101111001?0111021120??10010?0011020000101000000110
110010001101001001000110100011011101111000101000110?111200??0111000000112111 0?0

Mekosuchus_inexpectatus
??00???????????0?010??????????0??00010??0?0001?00???0???120101?021???101???11?
???00?????1??000000????1????0021?????0010??0?0??0?00?000?????00?000?????1???0??0?????
????????2????????0100???????????????0???????????????01021120???0010?1010100110??000?1
0000110001?0110?????????110010??11??1??????0???????????????????????????????????????

Mekosuchus_sanderi
?????0?0?00????0???????????0??0????010???????????????????01??1?2????101??20110
000110?0?1??100000????1????012?00?0?0010010?0??????????????????????100?1?010?001?????
??00????????1???0100???????????????0???
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Mekosuchus_whitehunterensis
?????????????????01????????0??0???0?????????????????????010??02????001???0????
???0????100?1?010??01???????0
???01021120???001??10101011100?0?0??????1
0?000??110???

Melanosuchus_niger 00010000100011100010100111010011100010??10000010100001?00[1
2]000100011000010120120010011?21110101000011201?110011000110121110000000011000100
100010010200001000000000000100010?000000000110001112011111101000000100111[0
1]?0??0011021021??00011000120100110?0000111000111110110110111001111001?001?111???0
110210100011101111000??1011000100231112?1

Mourasuchus_amazonensis
1110?0100??1??????????????000010101011001?0?01?011?0100?121101000????002?1201
2001111????1?010300?00??01????011001110100110010??01110????0010??00????0001??0?00?0
?0110??10?00?00??0?0000?0112????????0?00?0?1??1110?????11?3?02???10????0?1202?0??????
?0?????011???

Mourasuchus_arendsi ?1???0?0?00???1[0
1]2?????????000011101011001?0101?011?01?1?121101000????002?12112001[0
1]11??211?01?30??001101?110011000110100110010000111010??0000?30003??0001??0??0?000?
1??010?1?100?000???0?01120??????????00??00111?211?01??030??????0????0?1????0????????? ?
???0????010?1????11???110???100?1???1??????????????01????????????1??????????????????

Mourasuchus_atopus
??????????????10??1?01?????00?011101?????1?010???1??0????1?1101000????002???????
?????????1?0103000??????????????????????????????????1?010?0?0?03?000??1?001??0??000??11?
??10??01?00?0??0000011202111?11100?0??????????????1103002???100?10001??100111201001
11100111??001101??1110????????????????????

Navajosuchus_mooki
0?0???????0?????000??011??000010000010??0?00001000?000?0120110000????000?[0
1][1
2]0100000010?2?110101000????0??110011?????012111000?0000?1000?01??00200032000010001
0000010?00010???110000012000??12?0?11?10???0?????1?????????1111210?1??1011000111000
11100100??1???0??010001?????????????????????????????????????10111??????????????????1
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Necrosuchus_ionensis
??????????????????????1?00??
??????????????????????????????????11???????????????0????????????????????0?0????????????
??11021021??000???00???????????????????????
????????????????????????1???1???0?????????01?101111100??????????????111???

Orientalosuchus_naduongensis
1?1??001?01???????????????01010??00010??1001001001?000?0010000000????00001211 20000010???1101?000?000?01?010??1?????00??1100000?0???0?00?0000000010100011010?0000 010000000?12??0??00????0112000?1?0?100011?????????????11022020???001??0?111110?10?? ???0?100?????1??10???1??????01??0?0?1???1??

Osteolaemus_tetraspis 1010000000000[0 1]10001[0 1]1011[0 1]000010??00010??10010000000000?01000001001101001002010001001?001110101000010?2000 000210010100020000000000010001000110100021000200100000000211[0 1]001101110200001201101120000103010000000101110?11?0111021020??10010?0011010110100 0 01001101100000011010000010000100000110111011110001020 00?10111111010 0111[0 1]1000102111100

Paleosuchus_palpebrosus
1000?00000?00110001010111110000??00010??10000010000000?0100[0 1]000001100001002111002001?1??11010200001 1101?1100200001101211100000000010001001111[0 1]00?320000101100000111100010?011000000110001112001110110000001001110?01?001102102 1??1001210012010111 0?00001110000?11101001001111011000010011 0121???0110010121011 10 1111110??10111111 0022111211

Paleosuchus_trigonatus10[0 1]000[0 1]000?00[0 1]10001000111100000??00010??1001001000000 0?1000100000100000100211100200 1?1??110102 000011101?110020000[0 1]1012111000000000100010011110 00?32000010110000011110001 0?0110000000110001112011110110000001001110?01?0011021021??1001210012010111 0?00001111000?1110100100111101100 00100110121???0110?101210111011111 00??10111111 1022111211

Paratomistoma_courti
?????0?0010????0??????????00000??00000?????????????00?010001010?1?0?001??2010 100001??011?????????0???1?1?1??0??????????0?0000001000???????????????2???0????????? ??01010???11??????0???????????1?01000???00010?1? 000?0??

Penghusuchus_pani
10??00?0111?00100????0001100000??000?0?????00????1?001?01200000001???000102?? ???0?01????0101?00001???????1111000?1??0201000000?001?0001?????????501120000000010 100?0000?010000000????001213000?00100000???011???????1100130?20?00?0?0012?000?01?? ??0?????10?0???????1000??11?0?1111011??211??0110??????0??011110010??????????????000?? ?

Piscogavialis_jugaliperforatus
1011?000101000002?0???0???00000??00000??1?00012101?00?????0?101001???0001020 101100010?010011111010?00000110200000000301000011111111?010?0?1501?271112000000 101000000100?01111000100000011210?10?2?0000?1??000?0????0?1103040?21?00?0?00110100 01110???????1???0?????0??????????????????????????????0?0??????1???????????????????????00 1???

Planocrania_datangensis
101??0?0?10?????1?????????10000??00010??0?00001001?0??????0000000????001?0001 0000001??011101?00000????????0???0???0???????0?00?0??1??0?????02?00??3000100?2000?0? 100?0000?????????????????12?0????????0?????????????????110???0????00???????????????????? ??

Planocrania_hengdongensis
1???000?00????1???0?????????00??00010?????????????0??????0000000????000???0100
00001??011??1??000?????????0???0???00010?1?00???0?????0???????1????300?000?2000???100
00?0??????????????????112?????????00???????????????110?1120??10???????????????????0001
10?0???????????????????????????????1???

Portugalosuchus_azenhae
?0???0?0010?00???01???????????0???0010?????????????1????1?0??01001???0001?0110
000001??00001101000100???010???????????????0??0?0??1????0???????????0??????000?0???1
000000?01000000?00???0?12?0000?00000?1?001?0?0???11????????????0?0?0010??00?010????
??????????1???00??

Procaimanoidea_utahensis
0?00?0?0?100?0??0?0???????10000??00010??0?00001010?0100?120100000????00001201
00000010??11101010000???0??1?0011000100121110000000000?0001000000100002000010110000
????0?1?10?010000000?0?0?011200011?10000000?????????????1110200?0??000??0?11110000??
?1001010000???10000???

Prodiplocynodon_langi
1000?000000000100?????????00010000010??100000100??0??????0???00???00111??1
00000010???11010000?000??000?0111010??0000010000?0000101011000001000110000000?001
0020000100?0110200012??01112000???00000000???
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Protoalligator_huiningensis
??????????????????????????000????0??????1000?0000??0????????????????????????????
??????????01??0???0?00??[3
4]?00?1??0?00??111210??????0?????
110??0?1???
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Protocaiman_peligrensis
?????0?0110????????????????????????010????????????????????????????????0?1??001000
10011??11?0?????????????1100110001?0111100000?0???????????????????????????????????????
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Purussaurus_brasiliensis
10000110010011?000?01????01000??10020??1000001110?0110?1210010001???0010121
120010010?211101020000?11011110011100?001211100000000110001000001200022000010?0?0
0?0?1???0010?00??0???0??000??1????????????0??????????????1100102 1??000010001201001 1?
?010?1110000?1????????????????????????1???1?????????????1?1101????????????????????111??
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Purussaurus_mirandai
????????????0???0?????????01000??10020??1000001110??101?1110010?0????00101201
1??1001????1??1??0000???0???1???1?0?????????????????????0??00000200?2??0001??0000????
?1?0010?00??0???0???0?111202?11?????0????????????????11?2?02????0?0??001202?0????11?0
1?100??

Purussaurus_neivensis
10000010000001100?001????000010000020??1000001010?0110?1210010001???0010120
11001001??2111010200001??011110011100100121110000000001000100?00?10000200001000?0
000010100010?0010000000100001112020111111000001001110??1?0???????????????100?1201001

10?1?001?10000?11?01?01??10100110000000?101?1?????????????0?11??????????????????????
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Qianshanosuchus_youngi
?????????????????????????000110100010??1000001000?0000011000010?110000111111
100010101011101000100???0??1000?100001????01?000??0???????0?0?11001?1000?0??10001?
??0?00100?1?101000?1[1 2]000????????????????0????????????????????????????????1[1
2]?1?000??0?00??
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Quinkana ??11[0 1]???????????0?????????[0 1]0010??00?????0000001001000[0
1]?01?0?00??0?????????????????????0?1??100010?????????00???0????????????????????????0??
00[0 1]0012[1 3]001[0 1 2][0 1]0[0 1][0 1 2]0[0
1]000?2???0000???0?00000?2011??????????????????????????????11??102???10??????????????
1???
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Shamosuchus_djadochtaensis
?0??0000010???01??????????00000??00000??0??????000?0101?100000000????00110010
?0000110?00100100000001001??100?101?000????10000000000000010?????????0000010?0?00?1
01?0?1????01????????????010000000?00000?1?????0????????????1?0?????01??0?0????1?1??00
????000?????????????0??????01?0??1?11??1??????1????????????111???????????????????1?01??

Siquisiquesuchus_venezuelensis
10?????0?11???????????????00000??00000??1?0001??01??????????????????????110?????
100?1???????1?1????????????????2?00?0??03?1??0??11?11???????????????7?11200?0??1?10000?
1?????1?10???????????12??????????00???????????????1103040?30?0?????0?????00????????011
1?????????0??

Stangerochampsa_mccabei
0000?0000100000?001?0??1??00000??00010??1?00101011??101?120100000????0000?10
11000001??2111?10101?0010011?10011?0??1??111100000??00?000?02000020003200001000100
000001?1110?00010000012?000112001101100000??????????0?1101110?0??10010001101000
10??100??10?00?010100???????????01000000 1???1???0???????001??101111100??????????????0
111??

Thecachampsa_antiquus
?0?1?0?0101?????0?????????00000??00010??100001?001?001?0000010100????00110200
?1000010?010?0111001??0??????10?1?00???????????????0????????000012000210112000000000 10
000?0?00?0?0?2000002001??12???????????????????????????1102020?20?00????0?????????????
???10?0???????????????001???

Thecachampsa_sericodon
100??0001100000?0?????????00000??00010??100001?001?001?1000010100????0001010
0?1000010?01010111001110?010101011000100?02010010000001000010000120102101120010??
011000000100?0101200000200101121300100000000010?00110????1?110??20?20?0??????1?01?0
0????0??1?????????????????00?
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Theriosuchus_pusillus
?0???0?0?10??00?0??????1??00010??00000??0000000000000???000001000????10100011
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Tomistoma_cairense

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Tomistoma_lusitanica

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Toyotamaphimeia_machikanensis

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Voay_robustus
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Wannaganosuchus_brachymanus
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Wannchampsus_kirpachi
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213 219.221 223 234 242 283 292 296 307 322 323 *;



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APPENDIX 4: Complete list of *Diplocynodon* specimens examined for the thesis

Institutional abbreviations:

GMH: Geiseltal Museum of Martin-Luther-University Halle-Wittenberg, Halle (Saale), Germany;

HLMD: Hessisches Landesmuseum Darmstadt, Darmstadt, Germany;

IPS: Institut de Paleontologia Miquel Crusafont of Sabadell, Sabadell, Spain (= **ICP**; Institut Català de Paleontologia Miquel Crusafont);

MNHM: Museum National d'Histoire Naturelle, Paris, France;

NHMB: Naturhistoriches Museum Basel, Basel, Switzerland;

NHMUK : Natural History Museum United-Kingdom, London, United-Kingdom;

SMNK: Staatliches Museum für Naturkunde Karlsruhe, Karlsruhe, Germany;

SMF: Senckenberg Museum Frankfurt, Frankfurt, Germany.

Table 1

Institution	Specimens no	Species
NHMB	NHMB Rz. 33	"gervaisi"
NHMB	NHMB Ro. 106	"gervaisi"
IPS	IPS 36361	"tormis"
DGP	DGP 11407	cf. muelleri
DGP	DGP 26814	cf. muelleri
DGP	DGP 26815	cf. muelleri
DGP	DGP 26816	cf. muelleri
DGP	DGP 26837	cf. muelleri
DGP	DGP 26839	cf. muelleri
DGP	DGP 26843	cf. muelleri
DGP	DGP 26844	cf. muelleri
DGP	DGP 26846	cf. muelleri
DGP	DGP 26849	cf. muelleri
DGP	DGP 26850	cf. muelleri
DGP	DGP 26858	cf. muelleri
DGP	DGP 26862	cf. muelleri
DGP	DGP 28164	cf. muelleri
DGP	DGP 26854	cf. muelleri
NHMB	NHMB Nb. 6	cf. muelleri
GMH	GMH-3654-1932	darwini
GMH	GMH 6026	darwini
GMH	GMH 6039	darwini
GMH	GMH 6040	darwini
GMH	GMH 6041	darwini
GMH	GMH 6043	darwini
GMH	GMH 6072	darwini
GMH	GMH 6028	darwini
GMH	GMH 6049	darwini
GMH	GMH 6073	darwini
GMH	GMH 6074	darwini
GMH	GMH 6075	darwini
GMH	GMH 6077	darwini
GMH	GMH 6784	darwini
GMH	GMH LVIII-28-1981	darwini
GMH	GMH XIV-761	darwini
GMH	GMH XIV-4549-1956	darwini
GMH	GMH XLI-96-1966	darwini
GMH	GMH XLI-313-1968	darwini
GMH	GMH XLIII-2	darwini
GMH	GMH XLVI-3-1969	darwini
GMH	GMH XXII	darwini
GMH	GMH XXII-555	darwini

GMH	GMH XXII-563	darwini
GMH	GMH XXII-571-1965	darwini
GMH	GMH XXII-580-1965	darwini
GMH	GMH XXII-587-1965	darwini
GMH	GMH XXII-588-1965	darwini
GMH	GMH XXII-700-1965	darwini
GMH	GMH XXII-720-1965	darwini
GMH	GMH XXII-754a-1966	darwini
GMH	GMH XXVI-55-1961	darwini
GMH	GMH XXXV-223a-1963	darwini
GMH	GMH XXV-474	darwini
GMH	GMH XXV-491-1963	darwini
GMH	GMH XXXVI-524-1966	darwini
GMH	GMH XXXVI-526	darwini
GMH	GMH XXXVII-32-1964	darwini
GMH	GMH XXXVII-54-1964	darwini
GMH	GMH XXXVII-55-1961	darwini
GMH	GMH XXXVIII-9-1964	darwini
GMH	GMH XXXVIII-35-1964	darwini
GMH	GMH XXXVIII-36a-1964	darwini
GMH	GMH XXXVIII-37-1964	darwini
GMH	GMH XXXVIII-47-1964	darwini
GMH	GMH XXXVIII-55-1964	darwini
GMH	GMH XXXVIII-57-1964	darwini
HLMD	HLMD-Be 233	darwini
HLMD	HLMD-Be 236	darwini
HLMD	HLMD-Me 10262	darwini
HLMD	HLMD-Me 10496	darwini
HLMD	HLMD-Me 10974	darwini
HLMD	HLMD-Me 13729	darwini
HLMD	HLMD-Me 14600a	darwini
HLMD	HLMD-Me 14926	darwini
HLMD	HLMD-Me 14929	darwini
HLMD	HLMD-Me 16990	darwini
HLMD	HLMD-Me 20336	darwini
HLMD	HLMD-Me 3014	darwini
HLMD	HLMD-Me 3015	darwini
HLMD	HLMD-Me 3016	darwini
HLMD	HLMD-Me 3018	darwini

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HLMD	HLMD-Me 5642	darwini
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HLMD	HLMD-Me 5651	darwini

HLMD	HLMD-Me 5698	darwini
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HLMD	HLMD-Me 5886	darwini
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HLMD	HLMD-Me 5908-09	darwini
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HLMD	HLMD-Me 7426	darwini
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HLMD	HLMD-Me 7493	darwini
HLMD	HLMD-Me 7497	darwini
HLMD	HLMD-Me 7500	darwini
HLMD	HLMD-Me 7571	darwini
HLMD	HLMD-Me 7818	darwini

HLMD	HLMD-Me 9747	darwini
SMF	SMF-Me 10876	darwini
SMF	SMF-Me 1137	darwini
SMF	SMF-Me 1142	darwini
SMF	SMF-Me 11560A	darwini
SMF	SMF-Me 1158	darwini
SMF	SMF-Me 1341	darwini
SMF	SMF-Me 1467	darwini
SMF	SMF-Me 1538	darwini
SMF	SMF-Me 213	darwini
SMF	SMF-Me 222	darwini
SMF	SMF-Me 2748	darwini
SMF	SMF-Me 3780	darwini
SMF	SMF-Me 896	darwini
SMF	SMF-Me 898	darwini
SMF	SMF-Me 900	darwini
SMNK	SMNK-PAL 6517	darwini
HLMD	HLMD-Be 147	deponiae
HLMD	HLMD-Me 7496	deponiae
HLMD	HLMD-Me 8080	deponiae
SMF	SMF-Me 899	deponiae
SMF	SMF-Me 1114	deponiae
SMF	SMF-Me 1348abcde	deponiae
SMF	SMF-Me 2609	deponiae
SMF	SMF-Me 11053	deponiae
NHMUK	NHMUK-OR 30393	hantoniensis
NHMUK	NHMUK-OR 30396	hantoniensis
NHMUK	NHMUK-OR 30397	hantoniensis
NHMUK	NHMUK-OR 25178	hantoniensis
NHMUK	NHMUK-OR 30394	hantoniensis
NHMUK	NHMUK-OR 25166	hantoniensis
NHMUK	NHMUK-OR 30392	hantoniensis
NHMUK	NHMUK-OR 29694	hantoniensis
NHMUK	NHMUK-OR 30243	hantoniensis
NHMUK	NHMUK-OR 25242	hantoniensis
NHMUK	NHMUK-OR 30239	hantoniensis
NHMUK	NHMUK-OR 30336	hantoniensis
NHMUK	NHMUK-OR 30234	hantoniensis
NHMUK	NHMUK-OR 30241	hantoniensis
NHMUK	NHMUK-OR 30227	hantoniensis
NHMUK	NHMUK-R 1042	hantoniensis
NHMUK	NHMUK-R 5267	hantoniensis
NHMUK	NHMUK-R 1045	hantoniensis
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NHMUK	NHMUK-R 1043	hantoniensis

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NHMUK	NHMUK-OR 30402	hantoniensis
NHMUK	NHMUK-OR 30251	hantoniensis
NHMUK	NHMUK-OR 30389	hantoniensis
NHMUK	NHMUK-OR 25188	hantoniensis
NHMUK	NHMUK-OR 25164	hantoniensis
NHMUK	NHMUK-OR 25174	hantoniensis
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NHMUK	NHMUK-OR 25252	hantoniensis
NHMUK	NHMUK-OR 25186	hantoniensis
NHMB	NHMB Bc. 6	monsvialensis
NHMB	NHMB Spa 73	muelleri
NHMB	NHMB Spa 4	muelleri
MNHN	MNHN SG-539	ratelii
MNHN	MNHN SG-541	ratelii
MNHN	MNHN SG-13728ab	ratelii
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MNHN	MNHN SG 636	ratelii
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MNHN	MNHN SG 12853	ratelii
MNHN	MNHN BR 13105	remensis
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MNHN	MNHN BR 1694	remensis
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MNHN	MNHN BR 3488	remensis
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MNHN	MNHN BR 4153	remensis
MNHN	MNHN BR 13203	remensis
MNHN	MNHN BR 9027	remensis
MNHN	MNHN unnumbered	remensis

APPENDIX 5: Publications of the candidate during the PhD period

1. *The impact of molecular data on the phylogenetic position of the oldest crown crocodilian and the age of the clade*

Published as:
Darlim, G., Lee, M. S., **Walter, J.**, & Rabi, M. (2022). The impact of molecular data on the phylogenetic position of the putative oldest crown crocodilian and the age of the clade. *Biology Letters*, *18*(2), 20210603.

2. *A shark turns into an undetermined crocodylian: the case of* Acanthias bicarinatus *Sismonda, 1849*

Published as:
Walter, J. D., Marramà, G., Pavia, M., Carnevale, G., & Delfino, M. (2024). A shark turns into an undetermined crocodylian: the case of *Acanthias bicarinatus* Sismonda, 1849. *Bollettino della Società Paleontologica Italiana*, *63*(1), 0083-87.

3. *First record of Metriorhynchidae (Crocodylomorpha, Thalattosuchia) from the Lower Cretaceous of northeastern Italy: high-resolution biostratigraphy, morphological description and comparative pelagic taphonomy*

Published as:
Mongiovì, F., **Walter, J. D.**, Bizzarini, F., Cobianchi, M., Giusberti, L., Martire, L., ... & Delfino, M. (2024). First record of Metriorhynchidae (Crocodylomorpha, Thalattosuchia) from the Lower Cretaceous of northeastern Italy: high-resolution biostratigraphy, morphological description and comparative pelagic taphonomy. *Historical Biology*, 1-11.

4. *Expanded phylogeny elucidates Deinosuchus relationships, crocodylian osmoregulation and body-size evolution*

Published as:
Walter, J. D., Massonne, T., Paiva, A. L. S., Martin, J. E., Delfino, M., & Rabi, M. (2025). Expanded phylogeny elucidates Deinosuchus relationships, crocodylian osmoregulation and body-size evolution. *Communications Biology*, *8*(1), 611.