Supplementary Material for

Expanded Sampling Across Ontogeny in Deltasuchus motherali (Neosuchia, Crocodyliformes): Revealing Ecomorphological Niche Partitioning and Appalachian Endemism in Cenomanian Crocodyliforms

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Part of

Elements of Paleontology
edited by
Colin D. Sumrall
University of Tennessee

ISBNs: 9781009005814 (PB), 9781009042024 (OC)

Information on this title: www.cambridge.org/9781009005814

DOI: 10.1017/9781009042024

SUPPLEMENTARY MATERIAL FOR: EXPANDED SAMPLING ACROSS ONTOGENY IN *DELTASUCHUS MOTHERALI* (NEOSUCHIA, CROCODYLIFORMES) REVEALS ECOMORPHOLOGICAL NICHE PARTITIONING AND APPALACHIAN ENDEMISM IN CENOMANIAN CROCODYLIFORMS

APPENDIX S2: UPDATED AND EXPANDED DATASET BY YOUNG ET AL. (2016)

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List of characters used in the phylogenetic analyses

Character list (387 characters) used for the phylogenetic analysis. The characters are organised in anatomical order: skull geometry and dimensions; craniomandibular ornamentation; rostral neurovascular foramina; cranial rostrum; skull roof; orbit and temporal region; palate and perichoanal structures; occipital; braincase, basicranium and suspensorium; mandibular geometry; mandible; dentition and alveolar morphologies; axial post-cranial skeleton; pectoral girdle and forelimbs; pelvic girdle and hind limbs; osteoderms; gastralia; and then soft tissue and physiology. Comments on the characters and scoring are in italics, and precede the description of states. Characters that are not applicable (i.e. cannot be scored) for all taxa are marked with an asterisk **(*)** following the character description. Characters treated as additive for the ordered-character analysis are denoted by **(ORDERED)** following the character description.

Abbreviation: ch., character.

Skull geometry and dimensions (Ch. 1 – 6)

#	Description
1	**Skull width to length ratio:** *Young et al. (2012, ch. 1); Young et al. (2016, ch. 1).* *= maximum width between the lateral-most points of the quadrates : basicranial length* 0. 0.26 or lower 1. between 0.27 and 0.4 2. 0.4 or greater
2	**Snout elongation:** *Jouve (2005, ch. 5 modified); Hastings et al. (2010, ch. 1 modified).* *State (2) can only be scored for taxa where snout elongation is the result of the anteroposterior elongation of the maxilla (with the maxillae contact along their medial margins along the dorsal surface).* *State (1) occurs in most pholidosaurids, most dyrosaurids and gavialoids.* *State (2) occurs in Thalattosuchia and* Meridiosaurus.

	0. both the nasals and maxillae not elongated 1. nasals and maxillae both elongated (having the sublongirostrine or longirostrine condition) 2. maxillae elongated, contacting each other along their medial margins. No elongation of the nasals (having the sublongirostrine or longirostrine condition)
3	**Rostrum, relation between height and width: (ORDERED)** *Clark (1994, ch. 3 modified); Young (2006, ch. 8 modified); Wilkinson et al. (2008, ch. 25 modified); Young & Andrade (2009, ch. 25 modified); Andrade et al. (2011, ch. 6 modified); Young et al. (2012, ch. 2 modified); Young et al. (2016, ch. 2 modified).* *State (0) does not imply the platyrostral condition, although that is the most likely morphology.* *State (1) does not imply the rostrum will be tubular, although a tubular rostrum is most likely (1) in proportion.* *State (2) does not imply the oreinirostral condition, although that is the most likely morphology.* 0. wider than high (lateromedial axis greater than dorsoventral axis, by more than 10%) 1. height and width subequal (lateromedial & dorsoventral axes subequal ±10%) 2. higher than wide (dorsoventral axis greater than lateromedial axis, by more than 10%)
4	**Rostrum, in dorsal view – amblygnathy ("bullet-shaped", with the rostrum retaining its width along almost all its length):** *Young et al. (2012, ch. 3); Young et al. (2016, ch. 3).* *State (1) is a putative apomorphy of* Dakosaurus + *Mr Leeds' Dakosaur* 0. no 1. yes

5	**Rostrum narrows markedly in dorsal view, immediately in front of the orbits** *Young et al. (2016, ch. 4).* *In Thalattosuchia, state (1) occurs in* Aeolodon priscus, Mycterosuchus nasutus, Teleosaurus megarhinus *and* Teleosaurus cadomensis. *Note that in many* Steneosaurus bollensis *specimens the dorsoventral compression of the skulls exaggerates the width of the temporal region.* 0. no 1. yes
6	**Skull geometry, relative position of quadrate and occipital condyles:** *Wu & Sues (1996, ch. 24 modified); Sereno et al. (2003, ch. 46 modified); Pol (2003, ch. 104 modified); Turner & Buckley (2008, ch. 105 modified); Andrade et al. (2011, ch. 4); Young et al. (2016, ch. 148).* *State (1) occurs in Neosuchia (with reversals in Dyrosauridae and* Terminonaris*).* 0. unaligned, quadrate condyle at a lower level than the occipital condyle 1. quadrate and occipital condyles aligned in the same plane

Craniomandibular ornamentation (Ch. 7 – 10)

#	Description
7	**Ornamentation (maxilla in dorsal view = external surface):** *Young & Andrade (2009, ch. 84 modified); Young et al. (2012, ch. 4 modified); Young et al. (2016, ch. 5).* 0. no conspicuous ornamentation, or ornamented with an irregular pattern of ridges, rugosities and anastomosing grooves 1. conspicuous circular-to-polygonally pitted pattern

	2. conspicuous grooved-ridged pattern 3. conspicuous pits and grooves
8	**Ornamentation (frontal):** *Young (2006, ch. 1 modified); Wilkinson et al. (2008, ch. 1 modified); Young & Andrade (2009, ch. 1 modified); Young et al. (2012, ch. 55 modified); Young et al. (2016, ch. 65).* *In metriorhynchids, the main body of the frontal can be largely or entirely 'smooth', while the anteromedial process is ornamented. If this process is ornamented, the taxon was still scored from states (0–2).* 0. yes, with shallow to deep elliptical pits and shallow to deep grooves 1. yes, shallow to deep elliptical pits 2. yes, shallow to deep grooves 3. no
9	**Ornamentation (intertemporal bar):** *Jouve et al. (2005b, ch. 30 modified); Jouve et al. (2008, ch. 30 modified); Hastings et al. (2010, ch. 8 modified).* 0. ornamented 1. unornamented
10	**Ornamentation (parietal in dorsal view):** *Jouve et al. (2005b, ch. 27 modified); Jouve et al. (2008, ch. 27 modified); Hastings et al. (2010, ch. 45 modified).* 0. no conspicuous ornamentation 1. slight ornamentation 2. strongly ornamented with deep and/or numerous pits

Rostral neurovascular foramina (Ch. 11 – 12)

#	Description
11	**Neurovascular foramina, presence of an expanded network of openings on the dorsal surface of the rostrum and ventral-lateral surfaces of the mandible:** *Andrade et al. (2011, ch. 22).* *Based on the data by Soares (2002), where neurovascular foramina are related to the presence of dome pressure receptors.* *Teleosaurids score as state (1), even though usually only basal single line of foramina is evident on the maxillae. In all thalattosuchians the dentary foramina are greater in number, and are easier to score for. In teleosaurids with no/little premaxillary/maxillary ornamentation, the accessory foramina are visible on the premaxilla and on the anterior maxillae. In Machimosaurini these foramina are much more numerous, and therefore easier to identify.* *Metriorhynchids however clearly have accessory foramina on the premaxillae, maxillae and dentaries, although they do not have the 'beehive-like' arrangement mentioned for extant taxa. The maxillary foramina can be observed across the element, and are not restricted to the anterior maxilla as in teleosaurids.* Pelagosaurus typus *has clear accessory foramina on the premaxillae and anterior dentaries, and is here scored as (1).* *It is unclear whether the thalattosuchian condition is homologous to that seen in neosuchians.* 0. absent, neurovascular openings limited to a single line, near the ventral margin of the rostrum and dorsal margin of dentary 1. present at least at the premaxillae, maxillae and dentaries
12	**Neurovascular foramina (posterior maxilla), distribution on the alveolar margin:** *Andrade et al. (2011, ch. 26); Young et al. (2016, ch. 26).*

	State (1) occurs in goniopholidids 0. ventral-most foramina not high on the maxillary margin, either close or next to the alveoli 1. ventral-most foramina high on the maxilla (up to twice the distance from other foramina), very distant to the alveoli

Cranial rostrum (Ch. 13 – 67)

[orientation of tooth row, incisive foramen, external nares, dermatocranial bones (= premaxilla, nasals, maxilla and lachrymals), antorbital cavity]

#	Description
13	**Tooth row, premaxillary alveoli and posterior maxillary alveoli:** *Young & Andrade (2009, ch. 129); Young et al. (2012, ch. 5); Young et al. (2016, ch. 6).* 0. upper tooth row largely in the same plane (excludes maxillary deflections) 1. posterior maxillary alveoli ventral to all other alveoli (caused by the ventroposterior curvature of the posterior maxillae)
14	**External nares orientation:** *Turner & Pritchard (2015, ch. 6; modified from Clark 1994, ch. 6); Young et al. (2016, ch. 8).* 0. orientated anteriorly, anterodorsally, or anterolaterally 1. orientated mainly dorsally, or dorsolaterally
15	**External nares, shape in dorsal view:** *Young (2006, ch. 6 modified); Wilkinson et al. (2008, ch. 23 modified); Young & Andrade (2009, ch. 23 modified); Young et al. (2012, ch. 6 modified); Young et al. (2016, ch. 9).* *State (4) is a putative apomorphy of Susisuchidae.*

	0. subcircular (diameter in any direction does not vary by more than ± 10%) 1. oval (dorsal width >10% longer than anteroposterior length) 2. 'D-shaped', with posterior edge straight 3. spoon-shaped elongate ellipse (dorsal width <40% of anteroposterior length) 4. pear-shaped 5. external nares not exposed in dorsal view
16	**Medial tubercles of external nares on the posterior margin:** *Hastings et al. (2010, ch. 2 modified).* *States (1+2) are putative apomorphies of Dyrosauridae.* 0. absent 1. dorsal 2. ventral
17	**Thickness of the anterior margin of the external nares: (*)** *Hastings et al. (2010, ch. 3 modified).* *State (1) occurs in basal dyrosaurids.* *This character is not applicable for taxa that have posterodorsally retracted external nares (i.e. rhacheosaurin metriorhynchids).* 0. less than half anteroposterior length 1. greater than half anteroposterior length, or in species with a broad snout the anterior premaxilla is noticeably thick with the external nares posterior to the P1 alveoli
18	**External nares, posterodorsal retraction in relation to the tooth-row: (ORDERED)**

	Young (2006, ch. 16 modified); Wilkinson et al. (2008, ch. 38 modified); Young & Andrade (2009, ch. 38 modified); Young et al. (2012, ch. 7 modified); Young et al. (2016, ch. 10). *This character was designed to quantify the degree of posterodorsal retraction of the external nares in Metriorhynchidae. Its level relative to the tooth-row is used in this regard.* *Previous states (4–6) of this character were removed by Young et al. (2016) as the maxillary tooth count is too variable.* 0. at the tip of the snout, with its posterior-margin not exceeding the first premaxillary alveolus 1. at the tip of the snout, but its posterior-margin does exceed the last premaxillary alveolus 2. the posterior-margin reaches to the beginning of the 1st maxillary alveolus 3. posterodorsally displaced, anterior-margin begins posterior to the 1st premaxillary alveolus while the posterior-margin exceeds the beginning of the 1st maxillary alveolus
19	**Perinarial crests, presence and morphology:** *Andrade et al. (2011, ch. 29).* *State (1) is present within Goniopholididae (*Anteophthalmosuchus, Goniopholis *and* Amphicotylus*).* 0. absent, surface even or bearing a perinarial fossa 1. present as well defined and distinct ridges, cornering the lateral to posterior borders of the naris
20	**Intranarial fossa, presence at the lateral walls, inside narial cavity, at the vestibulum:** *Andrade et al. (2011, ch. 42).*

	State (1) is putative apomorphy of Thalattosuchia. *The internarial fossa is an additional chamber that creates an internal border of the external naris; must not be mistaken with the naso-oral fossa, or with the perinarial fossa.* *Note, unlike Andrade et al. (2011), we consider this to present in all thalattosuchians. A distinct fossa within the nasal cavity is seen in all teleosaurids and* Pelagosaurus*, however due to dorsoventral crushing the fossa can be obscured.* 0. absent 1. present
21	**Premaxilla, dorsal/anterodorsal projection of the anterodorsal margin (anterior to the external nares):** *Young et al. (2016, ch. 11).* *State (1) occurs in pholidosaurids, as well as extant species.* 0. present 1. absent
22	**Premaxilla, lateral expansion anterior to the premaxilla-maxilla suture due to the enlargement of the P3 alveoli, with a constriction immediately posterior to the expansion:** *Hastings et al. (2010, ch. 14 modified).* *State (1) occurs in basal dyrosaurids.* *Note that unlike other lateral expansions of the premaxilla, this does not correlate with a lateral expansion of the dentary.* 0. absent 1. present

23	**Premaxilla, length compared to width: (*)** *Jouve et al. (2008, ch. 41 modified); Hastings et al. (2010, ch. 22 modified).* *State (1) occurs in derived dyrosaurids.* *This character is not applicable for taxa that have posterodorsally retracted external nares.* 0. slightly longer than wide 1. nearly three times longer than wide, or more than three times longer than wide
24	**Premaxilla, ventral surface, presence of large depressions/notches for reception of the D1 teeth:** *State (1) occurs in the pholidosaurids* Terminonaris, Meridiosaurus, Sarcosuchus *and* Oceanosuchus, *goniopholidids* Anteophthalmosuchus epikrator, Amphicotylus stovalli *and* Calsoyasuchus, *and basal dyrosaurids* (e.g. Cerrejonisuchus). *State (2) occurs in* Elosuchus cherifiensis *and* E. broinae. 0. absent 1. occurs posterior to either the P1–P2 (or just the P2) alveoli, and are ventral to the external nares 2. occurs between, and separates, the P1–P2 alveoli from the P3–P4 alveoli
25	**Premaxilla, tooth row: (ORDERED)** *Young et al. (2016, ch. 12 modified).* *State (1) occurs in the pholidosaurids* Chalawan, Sarcosuchus, Pholidosaurus schaumburgensis *(based on the German natural mould specimens) and* Meridiosaurus. *The morphology in* Elosuchus *approaches this condition, however the P5 is directed posteriorly and the premaxilla has definitive lateral margins rather than a curved anterolateral curve. We have scored it as (0).* *State (2) is a modification seen in* Terminonaris *and* Oceanosuchus.

	0. alveoli along the anterior and lateral margins 1. in a slight semi-circle, resulting in the premaxillary alveoli being restricted to the anterior and anterolateral margins 2. the premaxillary tooth row is restricted to an even tighter curve, resulting in the P5 alveoli being lateral to the P4 alveoli and being somewhat laterally oriented (compared to the other four alveoli). The tighter curve means the normally very transversely wide premaxilla of pholidosaurids is now much less wide (with the maximal width at the P5)
26	**Premaxilla, when seen in lateral view: (ORDERED)** *Young et al. (2016, ch. 13 modified).* *This character scores the 'pholidosaurid beak'. However,* Elosuchus cherifiensis *and* Meridiosaurus *do not have a fully sub-vertical 'beak', but do have an intermediate morphology. This morphology is herein considered homologous to the ventral alveolar row of goniopholidids and basal dyrosaurids.* *State (1) occurs in* Elosuchus *and* Meridiosaurus, *and in the goniopholidids* Anteophthalmosuchus epikrator, Amphicotylus stovalli *and* Goniopholis kiplingi, *and the basal dyrosaurid* Cerrejonisuchus. *State (2) occurs in the pholidosaurids* Chalawan, Sarcosuchus, Terminonaris *and* Oceanosuchus, 0. the anterior and anterolateral margins are not sub-vertical, and do not extend ventrally when compared to the rest of the premaxilla (i.e. the dentigerous margins) 1. the anterior and anterolateral margins are slightly sub-vertical, and slightly extend ventrally to the rest of the element 2. the anterior and anterolateral margins are fully sub-vertical and extend ventrally to the rest of the element.
27	**Premaxilla, when seen in lateral view:**

	State (1) occurs in the teleosaurids Mycterosuchus nasutus, Peipehsuchus teleorhinus*,* Platysuchus multiscrobiculatus*,* Steneosaurus brevior *and* Teleosaurus megarhinus. *This character is not homologous to the pholidosaurid ventral verticalisation of the premaxilla, as in this sub-set of teleosaurids the premaxilla is strongly orientated anteroventrally in lateral view.* 0. the anterior and anterolateral margins are either not sub-vertical, or do not extend ventrally when compared to the rest of the premaxilla (i.e. the dentigerous margins) 1. the anterior and anterolateral margins are orientated anteroventrally and extend ventrally to the rest of the element.
28	**Premaxilla, proportion of total length posterior to the external nares:** *Wilkinson et al. (2008, ch. 21); Young & Andrade (2009, ch. 21); Young et al. (2012, ch. 8); Young et al. (2016, ch. 14).* 0. greater than 67% of premaxilla total length is posterior to the external nares 1. between 50–65% 2. between 36–45% 3. 28% or less
29	**Premaxilla, posterior process: (*)** *Young et al. (2016, ch. 15).* *State (1) occurs in* Tyrannoneustes lythrodectikos, Torvoneustes, 'Metriorhynchus' hastifer *and Mr Passmore's specimen.* *This character is not applicable for taxa that retract their external nares (i.e. rhacheosaurin metriorhynchids).* 0. short, terminates level to the fourth maxillary alveolus, or more anteriorly 1. long, terminates level to the end of the fourth maxillary alveolus, or more posteriorly

30	**Premaxilla, development of premaxillary septum:** *Young (2006, ch. 7 modified); Wilkinson et al. (2008, ch. 24 modified); Young & Andrade (2009, ch. 24 modified); Young et al. (2012, ch. 9); Young et al. (2016, ch. 16).* *State (1) scores the premaxillary septum of Metriorhynchidae.* *Terminonaris currently scored as '?', as it is unclear whether there was also a separating septum present.* *Young et al. (2012) changed this character from a multi-state to its present binary form.* *Currently, only Rhacheosaurini metriorhynchids are definitively known to have had a full premaxillary septum, however specimens of* Metriorhynchus superciliosus*, '*M.*'* brachyrhynchus, *Mr Passmore's Specimen and* Tyrannoneustes lythrodectikos *have preserved: the proximal end of the bar, and the raised distal articulation region on the premaxilla associated with the anterior end of the bar in Rhacheosaurini.Thus, they have been scored as (1). It is possible that only Rhacheosaurini has a fully ossified premaxillary bar, or the incomplete bar could be due to post-mortem damage.* *It is not homologous with other crocodylomorph septa, which are either partially formed by the nasals, or do not originate on the external surface of the premaxilla immediately anterior to the nasal fossa.* 0. no septum, with a single undivided external naris, or a divided external naris not formed solely by a premaxillary septum 1. external nares dorsally divided by a midline premaxillary septum
31	**Rostrum, morphology of the external surface of premaxilla and maxilla:** *based on Pol (1999, ch. 153); Andrade et al. (2011, ch. 55).* *State (1) is putative apomorphy of Notosuchidae + Sphagesauridae.* *Most commonly in state (1), the ventral plane will face laterally and slightly ventrally; the dorsal plane will face laterodorsally.*

	0. rostrum with a continuous surface, either convex or plain 1. rostrum with distinct ventral and dorsal surfaces, plain and separated by a somewhat distinct anteroposterior ridge or edge
32	**Rostrum, type of contriction at the premaxilla-maxilla suture:** *Clark (1994, ch. 9 modifed); Wilkinson et al. (2008, ch. 20 modified); Young & Andrade (2009, ch. 20 modified); Andrade et al. (2011, ch. 57); Young et al. (2012, ch. 88 modified); Young et al. (2016, ch. 108 modified).* *State (0) is a putative apomorphy of* Araripesuchus. *The vast majority of crocodylomorphs can be considered as (1), but highly predaceous forms will show a well-defined notch at suture (2).* 0. narrow slit 1. wide, poorly-defined concavity, or not constricted at all 2. well-defined notch
33	**Premaxillae anterior to naris, morphology:** *Clark (1995, ch. 5 modified); Andrade et al. (2011, ch. 62).* *State (0) is putative apomorphy of Notosuchidae + Sphagesauridae.* *State (1) is a putative apomorphy of* Araripesuchus + Libycosuchus. 0. anterior rami of premaxillae do not meet medially, anterior/ventral to naris, with both premaxillae in contact only through palatine rami 1. anterior rami of premaxillae meet anterior to naris, through a very narrow band, but not projecting vertically 2. anterior rami of premaxillae broadly meet anterior to naris, forming a vertical wall, which may be straight or slightly convex
34	**Premaxilla, type of contact with maxilla:**

	Clark (1994, ch. 8); Andrade et al. (2011, ch. 63). *State (1) is a putative apomorphy of Crocodyliformes.* 0. premaxilla loosely overlies maxilla on face 1. premaxilla and maxilla suture together along butt joint
35	**Distance between premaxilla and nasal:** *Young (2006, ch. 5 modified); Wilkinson et al. (2008, ch. 22 modified); Young & Andrade (2009, ch. 22 modified); Young et al. (2012, ch. 10); Young et al. (2016, ch. 17).* *State (2) occurs in* Meridiosaurus *and* Gavialis. *States (1+2) are putative apomorphies of Thalattosuchia. But with reversals, some specimens of* 'Metriorhynchus' brachyrhynchus *have contact between these elements, and the posterodorsal retraction of the external nares in* 'Cricosaurus' macrospondylus *results in contact between these elements.* 0. none, premaxilla and nasal contact 1. small, less than half the midline length of the premaxilla 2. large, approximately 80% to more than 100% of the midline length of the premaxilla
36	**Nasal contribution to the margin of the external nares:** *Young et al. (2012, ch. 11); Young et al. (2016, ch. 18).* 0. present 1. absent
37	**Anterior process of the nasals, anterior margin relative to the first maxillary alveoli: (*)** *Jouve et al. (2008, ch. 42 modified); Hastings et al. (2010, ch. 33 modified).* *State (0) occurs in pholidosaurids and derived dyrosaurids.*

	Note that this character scores the posterior-ward position of the anterior margin of the nasal anterior process, due to the elongation of the premaxillary posterior process only. *This character is not applicable for taxa that have posterodorsally retracted external nares, or have the maxillae elongated and contacting along their midline.* 0. posterior 1. anterior
38	**Nasals, morphology in dorsal view: (ORDERED)** *Andrade & Bertini (2008a, ch. 21); Young & Andrade (2009, ch. 160 modified); Andrade et al. (2011, ch. 73); Young et al. (2012, ch. 12 modified); Young et al. (2016, ch. 19 modified).* *State (0) is a putative apomorphy of both Thalattosuchia and Notosuchia.* *State (2) is present in* Simosuchus. 0. triangular, lateral margins strongly confluent anteriorly 1. rectangular or subrectangular, lateral margins mostly parallel, or lateral margins poorly confluent anteriorly 2. triangular, lateral margins diverging anteriorly
39	**Nasal, lateroposterior processes:** *Young et al. (2016, ch. 20).* *State (1) is a putative apomorphy of Metriorhynchidae.* *These processes suture with the anteroventral and anterior margin of the prefrontal, and the posterodorsal margin of the lachrymal.* 0. absent 1. present
40	**Nasals, fusion at maturity:**

	Gasparini et al. (2006, ch. 257); Sereno & Larsson (2009, ch. 10); Hastings et al. (2010, ch. 32 modified). *Andrade et al. (2011, ch. 77); Tennant et al. (2016, ch. 65).* *State (1) is putative apomorphy of Dyrosauridae, but with some species having individuals with fused and unfused nasals, and some specimens with only the anterior nasals fused. Due to this variability, the character from Hastings et al. (2010) has been changed from an ordered multistate into the current binary character.* *In Thalattosuchia state (1) also occurs in '*Steneosaurus*'* obtusidens*. As in Dyrosauridae, some individuals have fused nasals, while specimens have partially fused nasals. It is currently unclear whether the variation is ontogenetic or individual.* *State (1) is also present in Mahajangasuchidae.* 0. absent, nasals unfused 1. present, nasals at least partially fused (note that some species have variability in this character, such as in dyrosaurids)
41	**Nasals, posterior portion at the midline:** *Nesbitt (2011, ch. 34); Young et al. (2012, ch. 13 modified); Young et al. (2016, ch. 21).* *This character tests the homology of the metriorhynchoid and (most) teleosauroid "midline trench" and "depression" features, with a similar depression (state 1) seen in "rauisuchians" and "sphenosuchians".* *The morphology of* Calsoyasuchus *might be distinct, as it has two raised ridges running parallel, at either side of the midline depression, beginning on the frontal.* *Note that in some 'sphenosuchians' (i.e.* Sphenosuchus *and* Junggarsuchus*) the raised frontal ridge can continue onto the posterior nasal, and result in this depression forming around it.* 0. lacks a midline concavity or 'midline trench' - nasals are flat or convex

	1. has a concavity at the midline, or a 'midline trench'
42	**Nasal contact with the prefrontal, in dorsal view: (*)** *Young & Andrade (2009, ch. 92); Young et al. (2012, ch. 14); Young et al. (2016, ch. 22).* *This character is not applicable for taxa that lack a sutural contact between the nasals and the prefrontals.* *State (1) is a putative apomorphy of the* Cricosaurus araucanensis. 0. irregular 1. smooth curve with a concavity directed posterolaterally
43	**Nasal-prefrontal contact:** *Young et al. (2012, ch. 15); Young et al. (2016, ch. 23).* *State (1) occurs in crocodylomorphs.* 0. absent 1. present
44	**Premaxilla–maxilla lateral fossa excavating alveolus of last premaxillary tooth:** *Young & Andrade (2009, ch. 163); Young et al. (2012, ch. 16); Young et al. (2016, ch. 24).* 0. no 1. yes
45	**Maxilla, ventrolateral edge:** *Young & Andrade (2009, ch. 115); Young et al. (2012, ch. 17); Young et al. (2016, ch. 25).* 0. straight

	1. single convexity 2. double convexity (‘festooned’)
46	**Position of the posterior-most maxillae: (ORDERED)** *Hastings et al. (2010, ch. 29 modified).* *State (1+2) are putative apomorphies of Dyrosauridae.* *State (2) is a putative apomorphy of* Cerrejonisuchus. 0. anterior to, or even with, the postorbital bars 1. even with the anteroposterior midlength of the supratemporal fenestrae 2. even with, or posterior to, the posterior margins of the supratemporal fenestrae
47	**Maxilla/jugal, presence of enlarged foramina and associated fossae on the lateral margin of the posterior maxillae and/or the anterior process of the jugal. These foramina are positioned near the maxillojugal suture. These structures are anteroposteriorly aligned (note that the foramina and associated fossae are not always contiguous):** *State (1) occurs in goniopholidids and most tethysuchians (in dyrosaurids the foramen is only present on the jugal). Note that the anterior position of the ‘maxillary depressions’ in* Calsoyasuchus *are not consistent with this character.* 0. absent 1. present
48	**Posterior maxilla, presence of lateral fossa/fossae next to the alveolar margin, anterior to the jugal and ventral to the lachrymal:** *Young & Andrade (2009, ch. 135 modified); Andrade et al. (2011, ch. 86 modified); Young et al. (2012, ch. 18 modified); Young et al. (2016, ch. 27).* *This character is a modification of the goniopholidid+tethysuchian enlarged foramina + associated fossae character, in which there are paired depressions on either maxilla,*

	which are anteroposteriorly elongated, dorsoventrally high, complex and entirely supported by the maxilla. *State (1) occurs in Goniopholididae.* *As noted for the maxilla/jugal presence of an enlarged foramina character, the anterior position of the 'maxillary depressions' in* Calsoyasuchus *are also not consistent with this character.* 0. absent, maxillary bony surface convex or flat 1. present
49	**Maxilla, morphology of anterior border of maxillary depressions:** *Andrade et al. (2011, ch. 90).* *State (1) is present within Goniopholididae (*Anteophthalmosuchus *and* Goniopholis*).* 0. shallow, anterior edge of depression usually poorly defined, or maxillary depression is absent 1. deep, anterior border always well-defined relative to dermal surface of maxilla
50	**Posterior maxilla, presence of a lateral fossa/fossae that crosses the maxillojugal suture:** *Young et al. (2016, ch. 28 modified).* *This character is a modification of the goniopholidid+tethysuchian enlarged foramina + associated fossae character, in which there are paired depressions on either maxilla-jugal, which are anteroposteriorly elongated, dorsoventrally narrow, and contiguous on both the maxilla and jugal.* *State (1) occurs in Pholidosauridae* 0. absent, maxillary bony surface convex or flat 1. present

51	**Maxilla, aligned set of large foramina extending posteroventrally from the antorbital/preorbital fossa:** *Young et al. (2012, ch. 19 modified); Young et al. (2016, ch. 29).* *State (1) is a putative apomorphy of Mr Leeds* Dakosaurus + Dakosaurus. 0. absent 1. present
52	**Maxilla-lachrymal, contact: (*)** *Pol (1999, ch. 145); Young & Andrade (2009, ch. 141); Young et al. (2012, ch. 20); Young et al. (2016, ch. 30).* *This character is not applicable for taxa that lack the antorbital/preorbital fossae.* 0. partially included in antorbital/preorbital fossa 1. completely included
53	**Lachrymal, contact with the nasal:** *Young & Andrade (2009, ch. 97); Young et al. (2012, ch. 21); Young et al. (2016, ch. 31).* 0. nasal only contacts the dorsal margin of the lachrymal 1. nasal primarily contacts the anterior margin of the lachrymal 2. no contact between the nasals and lachrymals
54	**Nasal-lachrymal suture, length compared to nasal-prefrontal suture (in dorsal view):** *Young & Andrade (2009, ch. 136 modified); Young et al. (2012, ch. 22 modified); Young et al. (2016, ch. 32 modified).* *Here, a new character state is added.*

	0. short – nasolachrymal suture is approximately 60% of the nasoprefrontal suture 1. the two sutures are sub-equal (± 25%) 2. long – nasolachrymal suture is approximately twice the length of the nasoprefrontal suture (i.e. elongation of the lachrymals)
55	**Lachrymal, dorsal exposure:** *Young (2006, ch. 13); Wilkinson et al. (2008, ch. 33); Young & Andrade (2009, ch. 33); Young et al. (2012, ch. 23); Young et al. (2016, ch. 33).* 0. present, can be observed in both dorsal and lateral view 1. absent, only visible in lateral view (lachrymal vertically orientated)
56	**Lachrymal, dorsal surface lateral development:** *This character scores a slight lachrymal overhang of the orbits. These structures are the anterior palpebral sutural attachements, which are medially positioned.* *State (1) occurs in goniopholidids + tethysuchians (except dyrosaurids,* Terminonaris *and* Oceanosuchus*)* 0. flush with the rim of the orbit 1. enlarged, extending laterally over the orbit
57	**Lachrymal, size:** *Young (2006, ch. 14); Wilkinson et al. (2008, ch. 34); Young & Andrade (2009, ch. 34); Young et al. (2012, ch. 24); Young et al. (2016, ch. 34).* 0. large, in lateral view at least 45% of orbit height 1. small, less than 40% of orbit height
58	**Antorbital fenestra, size and presence:** *Young & Andrade (2009, ch. 88); Young et al. (2012, ch. 23); Young et al. (2016, ch. 35).*

	The absence of the antorbital fenestra (state 2) occurs independently numerous times in the evolution of Crocodylomorpha. Within Thalattosuchia, all Early Jurassic taxa have antorbital fenestrae. By the Callovian (Middle Jurassic) these fenestrae become rare, and are much smaller when present. 0. at least half the diameter of the orbit 1. much smaller than the orbit 2. absent
59	**Antorbital fenestra, bones enclosing (nasal): (*)** *Young (2006, ch. 18); Wilkinson et al. (2008, ch. 40); Young & Andrade (2009, ch. 40); Young et al. (2012, ch. 26); Young et al. (2016, ch. 36).* *Modified by Young et al. (2012) as the metriorhynchid character states relating to the antorbital fenestra/fossa have been excluded. This is due to hypothesis 2 of Fernández & Herrera (2009), in which the antorbital cavity is internalised in metriorhynchids. The opening classically referred to as the "*antorbital fenestra*" in this clade is in fact a neomorphic preorbital opening for the excretion of salt.* *This character is not applicable for taxa lacking antorbital fenestrae.* 0. nasal does not contribute to the antorbital fenestra 1. nasal does contribute to the antorbital fenestra
60	**Antorbital fenestra, bones enclosing (jugal): (*)** *Young et al. (2012, ch. 27); Young et al. (2016, ch. 37).* *Similar to the previous character, except it scores for the jugal participation in the antorbital fenestrae rather than the nasal.* *This character is not applicable for taxa lacking antorbital fenestrae.* 0. jugal does not contribute to the antorbital fenestra 1. jugal does contribute to the antorbital fenestrae

61	**Antorbital fossa, shape: (*)** *Young (2006, ch. 19 modified); Wilkinson et al. (2008, ch. 41); Young & Andrade (2009, ch. 41); Young et al. (2012, ch. 28); Young et al. (2016, ch. 38).* *Modified by Young et al. (2012) as the metriorhynchid character states relating to the antorbital fenestra/fossa have been excluded. This is due to hypothesis 2 of Fernández & Herrera (2009), in which the antorbital cavity is internalised in metriorhynchids. The opening classically referred to as the "*antorbital fenestra*" in this clade is in fact a neomorphic preorbital opening for the excretion of salt.* *This character is not applicable for taxa lacking antorbital fenestrae.* 0. subcircular, subtriangular or lozenge-shaped 1. anteroposteriorly elongated
62	**Antorbital fossa, bones enclosing (nasal): (*)** *Young et al. (2012, ch. 29); Young et al. (2016, ch. 39).* *This character is not applicable for taxa lacking antorbital fenestrae.* 0. nasal does not contribute to the antorbital fossa 1. nasal does contribute to the antorbital fossa
63	**Antorbital fossa, bones enclosing (jugal): (*)** *Young (2006, ch. 17); Wilkinson et al. (2008, ch. 39); Young & Andrade (2009, ch. 39); Young et al. (2012, ch. 30); Young et al. (2016, ch. 40).* *Similar to the previous character, except it scores for the jugal participation in the antorbital fossa rather than the nasal.* *This character is not applicable for taxa lacking antorbital fenestrae.* 0. jugal does not contribute to the antorbital fossa 1. jugal does contribute to the antorbital fossa

64	**Preorbital fenestra (not homologous with archosaurian antorbital fenestra), presence:** *Young et al. (2012, ch. 31); Young et al. (2016, ch. 41).* *Herein we follow hypothesis 2 of Fernández & Herrera (2009), in which the antorbital cavity is internalised in metriorhynchids. The opening classically referred to as the "*antorbital fenestra*" in this clade is in fact a neomorphic preorbital opening for the excretion of salt. This opening is connected via ducts to a chamber that housed large salt-glands (see Fernández & Herrera, 2009). This fenestra is bound by an elongate, narrow and obliquely orientated fossa bound by the lachrymal, nasal and maxilla.* 0. absent 1. present
65	**Antorbital fenestra, height: (*)** *Young & Andrade (2009, ch. 134); Young et al. (2012, ch. 32); Young et al. (2016, ch. 42).* *This character is not applicable for taxa lacking antorbital fenestrae. It also cannot be scored for metriorhynchids due to following hypothesis 2 of Fernández & Herrera (2009).* 0. approximately as tall as the height between the tooth row to the ventral rim of the fenestra (±10%) 1. less than the height between the tooth row to the ventral rim of the fenestra
66	**Antorbital cavity, position relative to the rostrum: (*)** *Andrade et al. (2011, ch. 51 modified).* *State (1) is putative apomorphy of Thalattosuchia.* *Here we modified state (1) to say 'approximately equidistant…', as in some teleosaurids (*e.g. Steneosaurus brevior, Platysuchus*) the cavity is almost equidistant between the orbits and alveolar margin. But, these taxa still have the antorbital cavity being*

	noticeably anterior to the orbits as with other thalattosuchians that have not closed these cavities. *This character is not applicable for taxa lacking antorbital fenestrae.* 0. closer to the orbit than to the alveolar margin 1. closer to the alveolar margin than to the orbit, or approximately equidistant (but with the cavity still noticeably anterior to the orbit)
67	**Prefrontal-lachrymal fossae:** *Young & Andrade (2009, ch. 150); Young et al. (2012, ch. 33); Young et al. (2016, ch. 43).* *Andrade et al. (2011, ch. 30) scores for a similar character, namely the presence of a lachrymal crest anterior to the orbit.* *The prefrontal-lachrymal fossa (sensu Young & Andrade, 2009) refers to a shallow depression immediately anterior to the orbit, present on both the prefrontal and lachyrmal. It is situated posterior to the preorbital fenestra, and never contacts the preorbital fossa. There is a crest within this fossa that is present along the prefrontal-lachrymal contact (scored for by Andrade et al. 2011, ch. 30).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. absent 1. present, with ridge following the sutural contact between these elements

Skull roof (Ch. 68 – 117)

[skull roof proportions and arrangement, supratemporal fenestrae, dermatocranial bones (= prefrontals, frontal, postorbitals, squamosals and parietal)]

#	Description
68	**Supratemporal skull roof, dorsal surface:**

	Clark (1994, ch. 24); Young (2006, ch. 10 modified); Wilkinson et al. (2008, ch. 29); Young & Andrade (2009, ch. 29); Andrade et al. (2011, ch. 118); Young et al. (2012, ch. 34); Young et al. (2016, ch. 44). *State (1) is a putative apomorphy of Crocodyliformes (reversal in Thalattosuchia).* 0. surface complex 1. flat skull table present, formed by flattened and levelled surfaces of frontal, postorbital, squamosal and parietal
69	**Posterior skull table:** *Young & Andrade (2009, ch. 99); Young et al. (2012, ch. 35); Young et al. (2016, ch. 45).* *Note that* Sphagesaurus *scores differently in this character, and for the preceding character.* 0. non-planar (squamosal ventral to horizontal level of postorbital and parietal) 1. planar (postorbital, squamosal, and parietal on same horizontal plane)
70	**Cranial table width relative to ventral portion of skull:** *Young & Andrade (2009, ch. 113); Young et al. (2012, ch. 36); Young et al. (2016, ch. 46).* 0. nearly as wide 1. narrower
71	**Supratemporal skull roof, dorsal curvature and elongation of squamosal prongs, at maturity:** *Brochu (1999, ch. 140); Young & Andrade (2009, ch. 148); Andrade et al. (2011, ch. 119); Young et al. (2012, ch. 37); Young et al. (2016, ch. 47).* 0. short posterolateral process of the squamosal

	1. mature skull table with nearly horizontal sides; significant posterolateral process of the squamosal
72	**Supratemporal fossa, presence of "infratemporal flanges":** *Young & Andrade (2009, ch. 142 modified); Nesbitt (2011, ch. 144 modified); Young et al. (2012, ch. 44 modified); Young et al. (2016, ch. 48).* *This character tests the homology of metriorhynchid "infratemporal flanges" and the teleosauroid anteromedial supratemporal fossae, with the anterior extension seen in basal crocodylomorphs.* *State (0) is a putative apomorphy of Crocodyliformes (reversal in Thalattosuchia)* *Note, this character scores for the 'flat platform' formed by the frontal, and not the concavity that can form in crocodyliforms.* 0. absent anterior to, and anteromedially to, the supratemporal fenestra 1. present anterior to, or anteromedially to, the supratemporal fenestra
73	**Supratemporal fossa, anterior margin in dorsal view:** *Young (2006, ch. 9 modified); Wilkinson et al. (2008, ch. 28); Young & Andrade (2009, ch. 28); Young et al. (2012, ch. 38); Young et al. (2016, ch. 49).* *This character was designed to quantify the anterior extent of the supratemporal fossae. In Metriorhynchidae, the fossae begin to invade the dorsal surface of the orbital region. In* Dakosaurus*,* Cricosaurus saltillensis, *and* C. schroederi *the supratemporal fossae extend as far anteriorly as the minimum interorbital distance (state 3).* 0. anterior margin terminates posterior to the postorbital 1. anterior margin terminates between the anterior and posterior points of the frontal-postorbital suture 2. anterior margin terminates level to the postorbital anterior margin

	3. anterior margin projects more anteriorly than the postorbital and reaches the interorbital minimum distance
74	**Supratemporal fossae, overall shape:** *Young & Andrade (2009, ch. 110 + 120 part modified); Andrade et al. (2011, ch. 111 modified);* *Young et al. (2012, ch. 39 + 40 + 41 modified); Young et al. (2016, ch. 50 + 51 + 52 modified).* *This character is an amalgam of character 111 from Andrade et al. (2011), and characters 50, 51 and 52 from Young et al. (2016).* *In Thalattosuchia, state (1) is a putative apomorphy for* Teleosaurus cadomensis *and* Maledictosuchus ricalensis. *State (2) occurs in* Elosuchus *and* Vectisuchus. *In Thalattosuchia, state (4) is a putative apomorphy of* Cricosaurus araucanensis *and* C. vignaudi. *State (6) is a putative apomorphy of Machimosaurini*. 0. longitudinal ellipsoid/sub-rectangular (anteroposterior axis more than 10% longer than the lateromedial axis) 1. square-shaped to sub-rectangular (anteroposterior axis more than 10% longer than the lateromedial axis) 2. transverse triangle-shaped, with the axis converging medially (lateromedial axis more than 10% longer than the anteroposterior axis 3. circular to sub-circular 4. triangle-shaped, axis converging anteromedially 5. parallelogram: lateral and medial margins, and anterior and posterior margins are sub-parallel

75	**Supratemporal fossa/fenestra, anterior margin shape, anterolateral expansion:** *State (1) occurs in the teleosaurids* Mycterosuchus nasutus, Peipehsuchus teleorhinus*,* Platysuchus multiscrobiculatus*,* Teleosaurus cadomensis *and* Steneosaurus brevior. 0. no anterolateral expansion of the supratemporal fenestrae/fossae 1. anterior margin of the supratemporal fossae are noticeably inclined anterolaterally, such that the anterolateral corners of the supratemporal fossae are noticeably more anterior than the anteromedial corners of the supratemporal fossae
76	**Supratemporal fenestra, overall anteroposterior elongation:** *State (1) occurs in derived teleosaurids.* *This character is not homologous to the anteroposterior elongation of the supratemporal fenestrae in other clades, as it is caused by the extreme anteroposterior elongation of the proötics, laterosphenoids, postorbital posterior processes, parietal anterior process and frontal posterior process.* 0. length is either less than, or approximately sub-equal to the anterior width 1. length is twice as long as the anterior width, or more. In *Machimosaurus*, the width of the supratemporal fenestrae increases, however the extreme elongation of the bones is still present.
77	**Supratemporal fenestra, overall anteroposterior elongation:** *State (1) occurs in dyrosaurids.* *This character is not homologous to the anteroposterior elongation of the supratemporal fenestrae in teleosaurids, as it is caused by the anteroposterior elongation of the laterosphenoids, postorbital posterior processes, squamosal anterior processes and parietal anterior process.* 0. length is either less than, or approximately sub-equal to the width at the middle of the fenestra (±25%)

	1. length is greater than the width of the fenestra (>125%)
78	**Supratemporal fenestra, in dorsal view, size relative to orbits:** *Young (2006, ch. 11); Wilkinson et al. (2008, ch. 30); Young & Andrade (2009, ch. 30); Young et al. (2012, ch. 42); Young et al. (2016, ch. 53).* 0. longer in length than the orbit (supratemporal length 110% or more of orbit length) 1. subequal in length as the orbit (± 5%) 2. smaller than the orbits (supratemporal length less than 90% of orbit length)
79	**Supratemporal fenestra, in dorsal view, posterior limit:** *Wilkinson et al. (2008, ch. 31 modified); Young & Andrade (2009, ch. 31 modified); Young et al. (2012, ch. 43); Young et al. (2016, ch. 54).* *State (2) is a putative apomorphy of the* Dakosaurus+Plesiosuchus *sub-clade.* *Note, scoring of this character should be done carefully, it may not be possible to score for skulls that have suffered taphonomic dorsoventral compression/shearing.* 0. terminates well before the posterior-most point of the parietal 1. either terminates near the posterior-most point of the parietal or exceeds it, but never reaches the supraoccipital 2. more posterior than intertemporal bar
80	**Supratemporal fenestra/fossae, posterior margin in dorsal view: (*)** *Jouve et al. (2005b, ch. 10 modified), Jouve (2005, ch. 6 modified), Jouve et al. (2008, ch. 10 modified), Hastings et al. (2010, ch. 10 modified).* *State (1) occurs in derived dyrosaurids.* *This character is not applicable for taxa that lack the 'skull table' temporal morphotype.*

	0. supratemporal fenestral posterior wall largely vertical and barely visible in dorsal view 1. supratemporal fenestral posterior wall posterodorsally inclined, creating a posterior fossa that is visible in dorsal view
81	**Supratemporal arch, medial margin in dorsal view:** *Young & Andrade (2009, ch. 91); Young et al. (2012, ch. 45); Young et al. (2016, ch. 55).* *State (1) is a putative apomorphy of* 'Dakosaurus' lissocephalus + Cricosaurus. 0. not convex 1. convex
82	**Supratemporal arch, dorsal margin in lateral view:** *Young & Andrade (2009, ch. 98); Young et al. (2012, ch. 46); Young et al. (2016, ch. 56).* 0. concave 1. straight 2. convex
83	**Supratemporal arch, width in dorsal view: (*)** *Jouve et al. (2005b, ch. 16 modified), Jouve et al. (2008, ch. 16 modified), Hastings et al. (2010, ch. 11 modified).* *State (1) scores the thin supratemporal arches of Dyrosauridae (with some reversals).* *This character is not applicable for taxa that lack the 'skull table' temporal morphotype.* 0. thick

	1. thin
84	**Prefrontal, dorsal surface lateral development: (ORDERED)** *Gasparini et al. (2006, ch. 247 modified); Young (2006, ch. 2 modified); Wilkinson et al. (2008, ch. 12); Jouve (2009, ch. 255 modified); Young & Andrade (2009, ch. 12); Andrade et al. (2011, ch. 125 modified); Young et al. (2012, ch. 47); Young et al. (2016, ch. 57).* *The transverse development of the prefrontal is a classic characteristic of Metriorhynchidae.* *State (1) is a putative apomorphy of* Eoneustes. *State (2) is a putative apomorphy of Metriorhynchidae.* 0. reduced, flush with the rim of the orbit 1. incipient enlargement (extending laterally over the orbit by approximately 5% of its width) 2. enlarged (extending laterally over the orbit by >15% of its width)
85	**Prefrontal, lateral development relative to the posterolateral corner of the supratemporal fossa in dorsal view:** *Wilkinson et al. (2008, ch. 13 modified); Young & Andrade (2009, ch. 13 modified); Young et al. (2012, ch. 48); Young et al. (2016, ch. 58).* 0. prefrontal does not expand laterally so that it is in the same plane as the posterolateral corner of the supratemporal fossa 1. prefrontal expands further laterally than the posterolateral corner of the supratemporal fossa
86	**Prefrontal, shape in dorsal view:** *Wilkinson et al. (2008, ch. 14 modified part); Young & Andrade (2009, ch. 14 modified part); Young et al. (2012, ch. 49); Young et al. (2016, ch. 59).*

	State (1) is a putative apomorphy of Metriorhynchidae. 0. quadrilateral with irregular outline 1. teardrop-shaped
87	**Prefrontal, morphology of the lateral border in dorsal view:** *Wilkinson et al. (2008, ch. 14 modified part); Young & Andrade (2009, ch. 14 modified part); Young et al. (2012, ch. 50); Young et al. (2016, ch. 60).* *This character describes the shape of the prefrontal in Metriorhynchidae.* Plesiosuchus, Geosaurus *and* Torvoneustes *score as state (1). State (2) is a putative apomorphy of* Dakosaurus. 0. continuous convex curve, inflexion point approximately 80–90 degree angle from the anteroposterior axis of the skull 1. continuous convex curve, inflexion point approximately 60–70 degree angle from the anteroposterior axis of the skull 2. continuous convex curve, inflexion point approximately 50 degree angle from the anteroposterior axis of the skull
88	**Prefrontal, dimensions in dorsal view:** *Wilkinson et al. (2008, ch. 15); Young & Andrade (2009, ch. 15); Young et al. (2012, ch. 51); Young et al. (2016, ch. 61).* 0. longer than wide 1. length/width is subequal (± 5%)
89	**Prefrontal, anterior to the orbits:** *Wilkinson et al. (2008, ch. 16); Young & Andrade (2009, ch. 16); Young et al. (2012, ch. 52); Young et al. (2016, ch. 62).* 0. elongate, oriented parallel to antero-posterior axis of the skull

	1. short and broad
90	**Prefrontal, nasal-prefrontal suture has a pronounced, rectangular 'concavity' (directed posteriorly):** *Young & Andrade (2009, ch. 93); Young et al. (2012, ch. 53); Young et al. (2016, ch. 63).* *State (1) is a putative apomorphy of* Eoneustes. 0. absent 1. present
91	**Prefrontal, nasal-prefrontal suture has a posteriorly directed 'V'-shape:** *Young & Andrade (2009, ch. 140); Young et al. (2012, ch. 54); Young et al. (2016, ch. 64).* *State (1) is a putative autapomorphy of* Cricosaurus macrospondylus. 0. absent 1. present
92	**Frontal, dorsal surface along the midline:** *Nesbitt (2011, ch. 42 modified); Young et al. (2016, ch. 66).* *State (0) is a putative apomorphy of Crocodyliformes (although there is a reversal in numerous neosuchian clades)* 0. flat 1. an incomplete longitudinal ridge along the midline 2. a longitudinal ridge that proceeds along the entire length of the midline
93	**Frontal, dorsal surface:** *Young et al. (2016, ch. 67).*

	State (1) occurs in Hesperosuchus *cf.* agilis, Dromicosuchus grallator, *and among many tethysuchians (except derived dyrosaurids)* 0. slightly convex or flat 1. concave, with the medial borders of the orbit upturned
94	**Frontal, anteromedial process length: (*)** *Jouve et al. (2008, ch. 31 modified), Hastings et al. (2010, ch. 38 modified).* *This character is not applicable for* Anthracosuchus *and* Cerrejonisuchus *as the anterior region of the frontal is elongated and the prefrontals are reduced (i.e. there is no elongation of the anteromedial process).* 0. the anteromedial process is approximately level to, or slightly posterior to, the prefrontals 1. the anteromedial process is noticeably posterior to the prefrontals
95	**Frontal, anteromedial process:** *Young et al. (2016, ch. 68).* *State (1) is a putative apomorphy of Sebecia, also occurs in some basal dyrosaurids and bernissartiids* 0.frontal anteromedial process has an acute anterior margin, which separates the left and right nasals along their posterior margin 1. frontal anteromedial process lacks an acute anterior margin, with the nasal posterior margin with the frontal being either transversely straight, or is slightly convex or concave (in taxa where the prefrontals expand anterolaterally, there can sometimes be posteromedial processes of the nasals)
96	**Frontal, angle between posteromedial and posterolateral processes:**

	Wilkinson et al. (2008, ch. 26 modified); Young & Andrade (2009, ch. 26 modified); Andrade et al. (2011, ch. 98 modified); Young et al. (2012, ch. 56); Young et al. (2016, ch. 69). *See diagrammatic explanation for this character in Wilkinson et al. (2008, p.1311, Fig. 4).* 0. approximately 90 degree angle, or obtuse 1. approximately 70–60 degree angle 2. approximately 45 degree angle, or more acute
97	**Frontal, minimum width between orbits in dorsal view compared to the supratemporal fossa:** *Young & Andrade (2009, ch. 121); Young et al. (2012, ch. 57); Young et al. (2016, ch. 70).* 0. greater than, or equal to, the width of one supratemporal fossa and the intertemporal bar 1. subequal to width of one supratemporal fossa
98	**Frontal, minimum width between orbits in dorsal view compared to the orbits:** *Young & Andrade (2009, ch. 137); Young et al. (2012, ch. 58); Young et al. (2016, ch. 71).* 0. broader than orbital width 1. subequal with orbital width 2. narrower than orbital width
99	**Frontal-parietal, between supratemporal fossa in dorsal view (intertemporal bar):** *Wilkinson et al. (2008, ch. 2); Young & Andrade (2009, ch. 2); Young et al. (2012, ch. 59); Young et al. (2016, ch. 72).*

	0. frontal and parietal subequal in width (± 5%) 1. frontal width is wider than the parietal. Can be extreme (greater than 75%)
100	**Frontal-postorbital suture:** *Wilkinson et al. (2008, ch. 27 modified); Young & Andrade (2009, ch. 27 modified); Young et al. (2012, ch. 60); Young et al. (2016, ch. 73).* 0. level with the intertemporal bar 1. lower than the intertemporal bar
101	**Frontal-postorbital suture, in dorsal view:** *Wilkinson et al. (2008, ch. 3 modified); Young & Andrade (2009, ch. 3 modified); Hastings et al. (2010, ch. 40 modified); Young et al. (2012, ch. 61 modified); Young et al. (2016, ch. 74 modified).* *This character is an amalgam of the Hastings et al (2010) and Young et al. (2016) characters.* *State (1) is a putative apomorphy of Metriorhynchidae.* *State (2) scores the dyrosaurid morphotype.* 0. irregular and straight or gently curved 1. frontal overlaps the postorbital, creating a 'V'-shape directed posteriorly. 2. strongly interdigitating in dorsal view (largely in one plane)
102	**Postorbital, shape in dorsal view:** *Young & Andrade (2009, ch. 118); Young et al. (2012, ch. 62); Young et al. (2016, ch. 75).* 0. the outer margin is convex where the postorbital curves posteriorly forming the supratemporal arch 1. forms a 90 degree angle

	2. anterior extension from the corner
103	**Postorbital, anterolateral extension:** *Young & Andrade (2009, ch. 138); Young et al. (2012, ch. 63); Young et al. (2016, ch. 76).* *State (1) of this character, and state (2) of the character "anterior extension from the postorbital corner" do not necessarily occur in the same taxon (e.g.* Oceanosuchus*).* 0. small or absent 1. very large, appearing in lateral view to contact the dorsal surface of the jugal
104	**Postorbital and squamosal, relative lengths in dorsal view:** *Young (2006, ch. 15); Wilkinson et al. (2008, ch. 37); Young & Andrade (2009, ch. 37); Young et al. (2012, ch. 64); Young et al. (2016, ch. 77).* 0. squamosal is longer 1. postorbital is longer
105	**Supratemporal arch (= upper temporal bar), relative participation of the postorbital:** *Ortega et al. (2000, ch. 33 modified); Andrade et al. (2011, ch. 151).* *Young & Andrade (2009, ch. 127); Young et al. (2012, ch. 66); and Young et al. (2016, ch. 79) score for the same morphology, however they used the squamosal contribution to the supratemporal arch.* *State (1) is putative apomorphy of Thalattosuchia.* *Note that a similar morphology also evolves in some derived dyrosaurids (elongatation of the postorbital posterior processes). In these taxa however, the character relating to the relative participation of the postorbital is not affected (i.e. the squamosal in dorsal view is still longer anteroposteriorly than the postorbital).*

	The postorbital being longer overall, and makes a greater proportional contribution to the supratemporal arch than the squamosal, only co-occurs in Thalattosuchia. 0. small, postorbital represents approximately 30% of the bar 1. extensive, postorbital represents approximately 50% (or more) of the bar
106	**Posterior margin of the squamosal lateral to post-temporal fenestrae:** *Jouve et al. (2005b, ch. 29), Jouve et al. (2008, ch. 29), Hastings et al. (2010, ch. 48).* *State (1) occurs in derived dyrosaurids.* 0. straight 1. anteriorly concave
107	**Squamosal, projects further posteriorly than the occipital condyle:** *Young & Andrade (2009, ch. 125); Young et al. (2012, ch. 65); Young et al. (2016, ch. 78).* 0. no 1. yes
108	**Squamosal dorsolateral edge, longitudinal groove:** *Young & Andrade (2009, ch. 112 part); Nesbitt (2011, ch. 53); Young et al. (2012, ch. 67 part); Young et al. (2016, ch. 80).* *State (1) is a putative apomorphy of Crocodyliformes (reversal in Thalattosuchia), but occurs in some 'sphenosuchians'.* 0. absent 1. present
109	**Squamosal dorsolateral edge, longitudinal groove margins: (*)**

	Young & Andrade (2009, ch. 112 part); Young et al. (2012, ch. 67 part); Young et al. (2016, ch. 81). *This character is not applicable for taxa that lack the squamosal longitudinal groove.* 0. ventral margin of the groove projects more laterally than the dorsal margin 1. ventral margin is directly underneath the dorsal margin
110	**Parietals, in presumed adults:** *Nesbitt (2011, ch. 58); Young et al. (2016, ch. 82).* 0. separate 1. interparietal suture partially or completely absent
111	**Parietals, supratemporal (= dorsotemporal) fenestrae separated by:** *Nesbitt (2011, ch. 59 modified); Young et al. (2016, ch. 83 modified).* *State (3) added here.* *State (3) occurs in* Dromicosuchus *and* Hesperosuchus "agilis". 0. broad, flat area 1. supratemporal fossa separated by a mediolaterally thin strip of flat bone 2. supratemporal fossa separated by a ''sagittal crest'' (which may be divided by the interparietal suture) 3. supratemporal fossa separated by a median longitudinal groove between paired parietal crests
112	**Intertemporal bar (=frontoparietal), modification of the "sagittal crest":** *Character following Jouve et al. (2005a: figure 8), Hastings et al. (2010, ch. 9).*

	Note this character scores the distinct thin intertemporal bar of derived dyrosaurids. In Thalattosuchia the bar is not consistently thin along its entire length (being noticeably broad anteriorly). 0. either not a "sagittal crest", or does not have the derived dyrosaurid morphotype 1. has the derived dyrosaurid morphotype: the intertemporal bar is composed of the frontal posterior process anteriorly and the parietal anterior process in the middle-and-posterior region, with a consistently thin bar along its entire length, and lateral margins deeply excavated creating a broad lateral supratemporal fossa
113	**Parietal, bifurcation of the parietal in dorsal view, immediately posterior to the intertemporal bar:** *Young et al. (2016, ch. 84).* *State (1) is found in* 'Dakosaurus' lissocephalus, Cricosaurus araucanensis*,* C. elegans, C. lithographicus, C. schroederi *and* C. vignaudi. *This character replaces the character that described the posterior margin of the parietal-squamosal in dorsal view – Wilkinson et al. (2008, ch. 42); Young & Andrade (2009, ch. 42); Young et al. (2012, ch. 68).* 0. absent 1. present
114	**Parietals, posterodorsal margin:** *Jouve (2005, ch. 7 modified), Jouve et al. (2005b, ch. 11 modified), Jouve et al. (2008, ch. 11 modified), Hastings et al. (2010, ch. 42 modified).* *State (1) occurs in derived dyrosaurids.* 0. transversely oriented 1. indented anteriorly
115	**Parietals, posteroventral edge:**

	Nesbitt (2011, ch. 60); Young et al. (2016, ch. 85). *State (1) is a putative apomorphy of Crocodyliformes.* 0. extending more than half the width of the occiput 1. extending less than half the width of the occiput
116	**Post-temporal fenestrae obscured in dorsal view by an overhanging posterior extension of the parietal:** *Jouve et al. (2008, ch. 34 modified); Hastings et al. (2010, ch. 46 modified).* *State (1) occurs in derived dyrosaurids.* 0. absent 1. present
117	**Parietal in occipital view:** *Jouve et al. (2008, ch. 32 modified); Hastings et al. (2010, ch. 44 modified).* 0. 'W-shaped' 1. concave 2. flat or convex

Orbit and temporal region (Ch. 118 – 144)

[orbit, circumorbital contributions, palpebrals, sclerotic ossicles, dermatocranial bones (jugals, postfrontals, postorbital bars, quadratojugals), infratemporal fenestrae]

#	Description
118	**Orbit, position:** *Young (2006, ch. 3 modified); Wilkinson et al. (2008, ch. 18 modified); Young & Andrade (2009, ch. 18 modified); Andrade et al. (2011, ch. 157 modified); Young et al. (2012, ch. 69); Young et al. (2016, ch. 86).*

	Note, when scoring the orientation of the orbits, the palpebrals must not be considered. 0. fully dorsal 1. mainly dorsal, but with slight inclination 2. lateral, but slightly inclined dorsally, usually visible in dorsal view 3. fully lateral with orbit shape only clear in lateral view
119	**Orbit, shape:** *Young & Andrade (2009, ch. 96); Young et al. (2012, ch. 70); Young et al. (2016, ch. 87).* 0. circular, anteroposterior and dorsoventral axes subequal (± 5%) 1. longitudinal ellipsoid, anteroposterior axis more than 10% longer than mediolateral axis 2. transverse ellipsoid, mediolateral axis more than 10% longer than anteroposterior axis
120	**Orbit, anterodorsal margin and the lachrymal:** *Young & Andrade (2009, ch. 124 part); Young et al. (2012, ch. 71); Young et al. (2016, ch. 88).* *In Thalattosuchia, state (1) is a putative autapomorphy of* Teleidosaurus calvadosii 0. lachrymal is excluded from the orbit anterodorsal margin 1. lachrymal reaches the orbit anterodorsal margin
121	**Orbit, posterodorsal margin and the postorbital:** *Young & Andrade (2009, ch. 124 part); Young et al. (2012, ch. 72); Young et al. (2016, ch. 89).* *In Thalattosuchia, state (1) is a putative apomorphy of the clade* Teleidosaurus + *Metriorhynchidae*

	0. postorbital is excluded from the orbit posterodorsal margin 1. postorbital reaches the orbit posterodorsal margin
122	**Orbit, anteroventral margin and the lachrymal:** *Young & Andrade (2009, ch. 95 part); Young et al. (2012, ch. 73); Young et al. (2016, ch. 90).* 0. lachrymal is excluded from the orbit anteroventral margin 1. lachrymal reaches the orbit anteroventral margin
123	**Orbit, anterior margin and the jugal anterior process:** *State (1) is a putative apomorphy of* Goniopholis *and* Anteophthalmosuchus. 0. the jugal anterior process does not contribute to the anterior margin of the orbit 1. the jugal anterior process, along with the lachrymal, forms the anterior margin of the orbit. Note that the broad anterior expansion of the jugal anterior process only occurs in *Goniopholis*, as *Anteophthalmosuchus* has a narrow jugal anterior process.
124	**Orbit, anterior margin and the broadening of the jugal anterior process:** *State (1) is a putative apomorphy of* Goniopholis 0. the jugal anterior process does not help form the anterior margin of the orbit, or as in *Anteophthalmosuchus*, it does help for the anterior margin of the orbit – but the jugal anterior process is still narrow 1. the jugal anterior process, along with the lachrymal, forms the anterior margin of the orbit, but it is distinctly broad dorsoventrally – expanded having a broad contact with the lachrymal dorsally and the maxilla anteriorly, much more so than in other derived goniopholidids.
125	**Orbit, posteroventral margin and the postorbital:**

	Young & Andrade (2009, ch. 95 part); Young et al. (2012, ch. 74); Young et al. (2016, ch. 91). *In Thalattosuchia, state (1) occurs in basal teleosaurids (*Steneosaurus brevior, Peipehsuchus teleorhinus, Platysuchus multiscrobiculatus & Teleosaurus cadomensis). *Note that some dorsoventral crushed skulls also look as though they have state (1), e.g.* S. bollensis. 0. postorbital is excluded from the orbit posteroventral margin, or only present in the posteroventral margin 1. postorbital reaches the orbit posteroventral margin (with the postorbital overlapping the jugal), and extensively forms part of the orbit ventral margin (in some instances excluding the jugal)
126	**Orbit, ventral margin and the jugal:** *Mueller-Töwe (2006, ch. 139 modified); Young & Andrade (2009, ch. 95 part); Andrade et al. (2011, ch. 171 modified); Young et al. (2012, ch. 75); Young et al. (2016, ch. 92).* *In Thalattosuchia, state (1) is a putative autapomorphy of* Platysuchus multiscrobiculatus 0. jugal participates in the orbit ventral margin 1. jugal excluded from the orbit by lachrymal-postorbital contact
127	**Supraorbital notch in dorsal view, deeply excavated creating an approximately semi-circular shape, resulting in the frontal being broadly exposed along the lateral margin of the orbits: (*)** *Young et al. (2016, ch. 93).* *State (1) is a putative apomorphy of a subclade within Rhacheosaurini.* *This character is not applicable for non-metriorhynchids, due to the unique formation of the supraorbital notch in Metriorhynchidae.*

	0. absent 1. present
128	**Supraorbital notch in dorsal view, very small, being a tight "U"-shape, created by the prefrontal being expanded posteriorly. This results in the prefrontal making a larger contribution to the orbit dorsal margin and the frontal contribution to the orbit dorsal margin is greatly reduced, and in some taxa being excluded from the centre of the orbital dorsal margin: (*)** *Young et al. (2016, ch. 94).* *State (1) is occurs in* Metriorhynchus palpebrosus*,* Cricosaurus saltillensis *and* C. macrospondylus. *This character is not applicable for non-metriorhynchids, due to the unique formation of the supraorbital notch in Metriorhynchidae.* 0. absent 1. present
129	**Palpebrals, presence and number:** *Clark (1994, ch. 65 modified); Young (2006, ch. 52 modified); Turner & Buckley (2008, ch. 65); Wilkinson et al. (2008, ch. 17 modified); Young & Andrade (2009, ch. 17 modified); Andrade et al. (2011, ch. 186); Young et al. (2012, ch. 76 modified); Young et al. (2016, ch. 95 modified).* *Modified to exclude information about size, which can be sampled as a separate character. The presence and morphology of palpebrals is here considered to be highly devious within the analysis, always poorly sampled and including assumptions (e.g., putative fusion with prefrontals X putative loss in thalattosuchians). Preservation and incomplete descriptions contribute to a poor use of information as a character. Scores were considered only for taxa that actually show meaningful information. The putative absence of palpebrals in thalattosuchians has long been assumed (e.g., Fraas, 1901;*

	Andrews, 1913), but it is actually not possible to exclude that this element may be deeply fused with prefrontal, leading to this modified version of state (0). *Can be determined by the sutural contacts along the periorbital margin.* 0. absent, or (anterior) palpebral is deeply fused with prefrontal 1. one large (anterior) palpebral present 2. two large palpebrals (anterior and posterior) present
130	**Sclerotic ossicles (composing the sclerotic ring) within the orbit:** *Young (2006, ch. 4); Wilkinson et al. (2008, ch. 19); Young & Andrade (2009, ch. 19); Andrade et al. (2011, ch. 159); Young et al. (2012, ch. 77); Young et al. (2016, ch. 96).* *Within Thalattosuchia, state (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* 0. absent 1. present
131	**Jugal, width of anterior process relative to posterior process:** *Young & Andrade (2009, ch. 111); Young et al. (2012, ch. 78); Young et al. (2016, ch. 97).* 0. subequal 1. about twice as broad
132	**Jugal, anterior process is sigmoidal with a noticeable convexity along its dorsal margin:** *State (1) is found in* Dakosaurus + *the Vaches Noire Dakosaur*. 0. absent 1. present

133	**Jugal, extends anteriorly in front of the prefrontal:** *Young & Andrade (2009, ch. 94); Young et al. (2012, ch. 79); Young et al. (2016, ch. 98).* 0. no 1. yes
134	**Postorbital bar, inclination:** *Jouve et al. (2008, ch. 35 modified); Young & Andrade (2009, ch. 85 modified); Hastings et al. (2010, ch. 50 modified); Young et al. (2012, ch. 80 modified).* 0. strongly anterodorsally inclined 1. slightly anterodorsally inclined 2. nearly vertical 3. posterodorsally inclined
135	**Jugal, well-developed (i.e. greatly enlarged) foramen on the anterior ramus:** *State (1) occurs in derived dyrosarids.* 0. no 1. yes
136	**Postfrontal:** *Nesbitt (2011, ch. 44); Young et al. (2012, ch. 81); Young et al. (2016, ch. 100).* *State (1) is a putative apomorphy of Crocodylomorpha.* 0. present 1. absent
137	**Postorbital bar, morphology of dorsal end:**

	Young & Andrade (2009, ch. 90); Young et al. (2012, ch. 82); Young et al. (2016, ch. 101). 0. dorsal end of the postorbital bar broadens dorsally, continuous with dorsal part of the postorbital 1. dorsal part of the postorbital bar constricted, distinct from the dorsal part of the postorbital
138	**Postorbital bar (postorbital), presence of a vascular opening at the lateral edge of the bar, close to the dorsal surface of the postorbital:** *Clark (1994, ch. 27); Young & Andrade (2009, ch. 114); Andrade et al. (2011, ch. 202); Young et al. (2012, ch. 83); Young et al. (2016, ch. 102).* *Note that scoring of state (0) can be highly influenced by preservation.* 0. absent 1. present
139	**Postorbital bar, morphology of postorbital-jugal contact:** *Wilkinson et al. (2008, ch. 35); Young & Andrade (2009, ch. 35); Young et al. (2012, ch. 84); Young et al. (2016, ch. 103).* 0. postorbital medial to jugal 1. postorbital lateral to jugal
140	**Postorbital bar, structure:** *Clark (1994, ch. 26 modified); Wilkinson et al. (2008, ch. 36 modified); Young & Andrade (2009, ch. 36 modified); Young et al. (2012, ch. 85 modified); Young et al. (2016, ch. 104 modified).* *State (1) occurs in Metasuchia.* *State (2) describes the flattened morphology of tethysuchians.*

	0. dermal bar that is either not columnal or transversely flattened 1. subdermal bar that is distinctly columnar and cylindrical or oval-shaped 2. subdermal bar that is distinctly columnar and transversely flattened
141	**Postorbital bar, composition of lateral surface:** *Gasparini et al. (2006, ch. 244); Andrade et al. (2011, ch. 199).* *State (1) is putative apomorphy of Thalattosuchia* 0. lateral surface formed by the postorbital and jugal 1. lateral surface formed by solely by the postorbital, with the jugal only exposed on the medial face of the bar
142	**Quadratojugal-postorbital, contact:** *Ortega et al. (2000, ch. 49); Nesbitt (2011, ch. 64); Young et al. (2016, ch. 105).* *State (1) is a putative apomorphy of Crocodyliformes.* 0. absent 1. present
143	**Infratemporal fenestra (=laterotemporal fenestra), in lateral view:** *Young (2006, ch. 12); Wilkinson et al. (2008, ch. 32); Young & Andrade (2009, ch. 32); Young et al. (2012, ch. 86); Young et al. (2016, ch. 106).* 0. considerably longer in length than the orbit (greater than 25%) 1. equal/subequal in length than the orbit (± 10%) 2. shorter in length than the orbit (less than 25%)
144	**Quadratojugal, spina quadratojugalis:** *Brochu (1999, ch. 114); Young & Andrade (2009, ch. 133); Andrade et al. (2011, ch. 167 + 170). Young et al. (2012, ch. 87); Young et al. (2016, ch. 107).*

	0. absent 1. either small or low crest 2. prominent

Palate and perichoanal structures (Ch. 145 – 163)

[palate contribution of the dermatocranium facial series (= premaxilla and maxilla), and dermatocranium palatal series (= palatines, pterygoid, ectopterygoids and vomer)]

#-	Description
145	**Premaxillae, presence of a subelliptic naso-oral fossa (= incisive foramen, fossa premaxillaris) at medial contact of ventral rami:** *Brochu (1999, ch. 124 part); Andrade et al. (2011, ch. 66); Young et al. (2012, ch. 89 modified); Young et al. (2016, ch. 109 modified).* *When the palate does not close completely, the passage will involve both premaxilla and maxilla, assuming a diamond-shaped profile, with edges straight to irregular, but never rounded and smooth. When the palate is incompletely closed, it is most likely that the vomer is also exposed at the opening; however, the vomer may not be preserved; or may be covered by sediment and not evident. The use of 'sub-elliptic' allows that simple openings on the palatal surface, considered as non-homologous to the naso-oral fossa, to be scored as (0).* 0. absent, premaxillae fully in contact medially along the palate 1. present as a discrete fossa or foramen, less than half the greatest width of premaxillae 2. large, more than half the greatest width of premaxillae
146	**Premaxillae, shape of naso-oral fenestra (= incisive foramen): (*)** *Young et al. (2016, ch. 7 modified).*

	In Metriorhynchidae, state (1) occurs in Torvoneustes, *Mr Passmore's specimen* + 'M.' hastifer. *This character is not applicable for taxa that lack the naso-oral fenestra.* 0. subcircular or longer than wide (but not an elongate oval) 1. elongate anteroposterior oval-shape (can be as long or longer than the premaxillary alveoli, but not as mediolaterally broad)
147	**Maxilla, palatal processes: (ORDERED)** *Nesbitt (2011, ch. 32).* *Character helps to quantify the development of the secondary palate.* *State (2) occurs in crocodylomorphs.* 0. do not meet at the midline 1. meet at the midline 2. meet at the midline and expand anteriorly and posteriorly
148	**Maxilla, posterior margin of palatal processes contact with the anterior margin of palatine anterior processes:** *Young et al. (2012, ch. 90 modified); Young et al. (2016, ch. 110 modified).* *Character helps to quantify the development of the secondary palate.* *State (1) occurs in Mesoeucrocodylia. Note, for* Calsoyasuchus *we interpret the 'primary choanae' as maxillo-palatine fenestrae.* 0. the maxilla-palatine contact only along a margin medial to the alveolar row 1. the maxilla posterior palatal margin has an extensive contact with the palatine anterior palatal margin. This results in either the vomer being excluded from the palatal surface, or if maxillo-palatine fenestrae are present, the vomer is visible within. The maxillo-palatine contact forms a continuous surface as the two elements contact one another, or

	when maxillo-palatine fenestrae are present, the anterior-most region of the contact is interrupted.
149	**Palate canals, presence: (*)** *Andrade et al. (2011, ch. 220).* *State (1) is a putative apomorphy of Thalattosuchia.* *This character is not applicable for taxa that lack maxillary and palatine palatal processes which meet along the skull midline.* *Palate canals are a paired, parallel, elongated, tubular ducts connecting the internal nasal cavity to the oral cavity, through the palatines. The orientation is almost coincident with the horizontal plane and longitudinal axis, with very little deviation (0-5 degrees). The internal openings are located anterior to the internal end of the nasopharyngeal duct. The external openings are located at the anterior end of palatines and, because of its sub-horizontal orientation, they progress as paired shallow (but well-defined) gutter-like grooves through the palatine laminae of the maxillae, at least to mid-rostrum. In* Pelagosaurus*, the Chinese teleosaurid, specimens attributed to* Steneosaurus latifrons *and* Eoneustes *these passages are located next to the medial line of the palate, very close to each other, while in* Metriorhynchus *the grooves diverge anteriorly (see Andrews, 1913). This anterior divergence is also seen in some well preserved teleosaurids (MTY pers. obs). It is unclear if these canals constitute passages for nerves, vessels, or gland ducts.* *In specimens which have experienced dorsoventral compression, and/or are highly broken, these canals can be very hard to discern.* 0. absent 1. present
150	**Palatine, anterior extent of the palatine relative to the maxillary tooth row:** *Young et al. (2016, ch. 111).*

	State (5) is a putative autapomorphy of Plesiosuchus manselii. 0. palatine anterior margin terminates level to 20th maxillary alveoli, or more distal alveoli 1. palatine anterior margin terminates level to 15th to 19th maxillary alveoli 2. palatine anterior margin terminates level to 11th to 14th maxillary alveoli 3. palatine anterior margin terminates level to 8th to 10th maxillary alveoli 4. palatine anterior margin terminates level to 5th to 7th maxillary alveoli 5. palatine anterior margin terminates level to 4th maxillary alveoli, or more anterior alveoli
151	**Palatine, anterior margin has a mid-line anterior process:** *Wilkinson et al. (2008, ch. 6 part); Young & Andrade (2009, ch. 6 part); Young et al. (2012, ch. 91); Young et al. (2016, ch. 112).* 0. present 1. absent
152	**Palatine, mid-line anterior process shape, in palatal view: (*)** *Wilkinson et al. (2008, ch. 6 part); Young & Andrade (2009, ch. 6 part); Young et al. (2012, ch. 92); Young et al. (2016, ch. 113).* *This character is not applicable for taxa that lack mid-line palatine palatal processes.* 0. lateral margins of the mid-line anterior process converge: anteriorly orientated “V”-shape 1. lateral margins of the mid-line anterior process largely parallel: anteriorly orientated “U”-shape
153	**Palatine, anterior margin has two non-midline anterior processes:**

	Wilkinson et al. (2008, ch. 6 part); Young & Andrade (2009, ch. 6 part); Young et al. (2012, ch. 93); Young et al. (2016, ch. 114). *In Thalattosuchia, state (1) is a putative apomorphy of Metriorhynchinae.* *In* Montealtosuchus *and* Hamadasuchus *the mid-line anterior process has a concave anterior margin, creating two "non-midline" processes.* 0. absent 1. present
154	**Palatine, at the suborbital fenestrae the palatine anterior margin curves anterolaterally towards it, creating two "small processes" projecting laterally:** *Young & Andrade (2009, ch. 161); Young et al. (2012, ch. 94); Young et al. (2016, ch. 115).* *This morphology is variably observed in derived neosuchians and eusuchians.* 0. absent 1. present
155	**Palatine, forms secondary palate:** *Wilkinson et al. (2008, ch. 8); Young & Andrade (2009, ch. 8); Young et al. (2012, ch. 95 modified); Young et al. (2016, ch. 116 modified).* *Character helps to quantify the development of the secondary palate.* *State (1) occurs in Mesoeucrocodylia.* 0. palatines of primary palate do not contact one another secondarily on mid-line, and do not form laminae (palatal plates). (i.e. their lateral margins articulate with the vomer and/or pterygoids) 1. palatines form planar (i.e. largely flat) palatal surface. Typically, they will articulate along the midline (although in taxa with extensive maxillopalatine fenestrae and elongate choanae, they may not)

156	**Palatine, presence of a posterior extension to the choanae:** *Jouve et al. (2005b, ch. 4); Jouve et al. (2008, ch. 4); Hastings et al. (2010, ch. 61).* 0. do not contact or only contact along the anterior margin 1. contact along the anterior and medial margins
157	**Palatine-pterygoid suture, lateral protrusions by palatine into the pterygoids:** *Young & Andrade (2009, ch. 132); Young et al. (2012, ch. 97); Young et al. (2016, ch. 118).* 0. absent 1. present
158	**Ectopterygoid, presence of broad contact with palatine ramus of maxilla:** *based on Brochu (1997, ch. 91 modified); Andrade et al. (2011, ch. 253).* *Basal forms within Sphenosuchia will show no (or very limited) contact between ectopterygoid and maxilla (0). As* Fruitachampsa *has a jugal-ectopterygoid contact (Clark, 2011), here we find this character to be a putative apomorphy of Mesoeucrocodylia* +Hsisosuchus*, rather than Crocodyliformes as in Andrade et al. (2011). Note,* Hsisosuchus *is not in our matrix, but scores as (1) in Andrade et al. (2011)* *State (1) is putative apomorphy of Mesoeucrocodylia* + Hsisosuchus *(reversal in* Zoneait *+ Metriorhynchidae – the ectopterygoid solely contacts the jugal).* *Note that in metriorhynchids the ectopterygoid is rarely preserved and thus hard to score. Can be scored for* Metriorhynchus superciliosus *as it has what looks like the jugal-ectopterygoid articulation in NHMUK PV R 6860. However, the ectopterygoids are complete and in articulation in both* Zoneait *and* Maledictosuchus. 0. absent, ectopterygoid does not contact maxilla, or barely contacts its caudal end, medial to jugal 1. present

159	**Pterygoid flange, orientation (in palatal view):** *Young et al. (2012, ch. 98); Young et al. (2016, ch. 119).* 0. horizontal 1. largely horizontal, but with a distinct posterolateral orientation 2. strongly orientated posteriorly
160	**Choanae, participation of pterygoid in the choanal border: (ORDERED)** *Clark (1994, ch. 43 modified); Brochu (1999, ch. 71 modified); Jouve et al. (2005, ch. 4 modified); Turner & Buckley (2008, ch. 43 modified); Young & Andrade (2009, ch. 131 + 139 modified); Andrade et al. (2011, ch. 242); Young et al. (2012, ch. 96 + 99 modified); Young et al. (2016, ch. 117 + 120 modified).* *Note that the palatines may be excluded from the choanal border either in (2) and (3), but the eusuchian condition is only achieved in (3). State (2) corresponds directly to state (1) of Jouve et al. (2005, ch. 4), apomorphic for* Elosuchus and Terminonaris. *Note that we do not consider* Koumpiodontosuchus *or* Isisfordia *to have the eusuchian condition. Our interpretation for* Isisfordia *follows Turner & Pritchard (2015), and based on the pers. obs. of MTY,* Koumpiodontosuchus *has a similar morphology.* 0. pterygoid only bounds the posterior border of the choanae 1. pterygoid forms at least the posterior and lateral choanal borders 2. anterolateral rami of pterygoid embrace most of the choanae, but do not meet medially, at the anterior choanal border (either by the presence of palatine or ventral exposure and expansion of interchoanal septum) 3. anterolateral rami of pterygoid completely embrace the choanae, meeting medially at its anterior border (eusuchian choanae)
161	**Pterygoids, fusion posterior to choanae:** *Clark (1994, ch. 41); Andrade et al. (2011, ch. 258).*

	State (1) is putative apomorphy of Mesoeucrocodylia. 0. not fused 1. fused
162	**Choanal opening, in palatal view:** *Wilkinson et al. (2008, ch. 9 part); Young & Andrade (2009, ch. 9 part); Young et al. (2012, ch. 100); Young et al. (2016, ch. 121).* *State (1) is observed in extant species.* 0. choanal opening orientated posteriorly, enclosed ventrally by the palatine and by either the pterygoid dorsally or the maxilla 1. choana opens into palate through a deep midline depression (choanal groove)
163	**Choana, anterior margin shape:** *Wilkinson et al. (2008, ch. 9 part); Young & Andrade (2009, ch. 9 part); Young et al. (2012, ch. 101); Young et al. (2016, ch. 122).* 0. semicircular or elliptical 1. ‘V’-shaped with its base directed anteriorly 2. broad ‘U’-shaped with its base directed anteriorly 3. ‘W’-shaped with its base directed anteriorly

Occiptial (Ch. 164 – 177)

[Partial neurocranium = supraoccipital, exoccipitals + opisthotics (= otoccipital)]

#	Description
164	**Occipital tuberosities:**

	Jouve (2005, ch. 1 modified), Jouve et al. (2005b, ch. 3 modified), Jouve et al. (2008, ch. 3 modified), Hastings et al. (2010, ch. 53 modified); Young et al. (2012, ch. 102 modified); Young et al. (2016, ch. 123 modified). *State (1) occurs in teleosaurids, basal dyrosaurids and in the pholidosaurids* Sarcosuchus *and* Chalawan. *State (2) occurs in most dyrosaurids and the teleosaurid* Steneosaurus heberti. 0. absent 1. small and reduced 2. large and well-developed
165	**Supraoccipital, internal presence of the cavity for the intertympantic diverticulum of the pharyngotympanic sinus system (= the "mastoid antrum"):** *Clark (1994, ch. 63 modified); Andrade et al. (2011, ch. 282 modified).* *As discussed by Wilberg (2015b), this character has been scored to unite Pholidosauridae and Dyrosauridae withThalattosuchia. The natural external and internal mould* Pholidosaurus schaumburgensis *Bückeburg specimens held in Berlin show the cavity for this diverticulum (also see Wilberg, 2015b Figure 7c).* *Scoring any OTU as state (1) can come from CT scan datasets, or fossil specimens with a broken supraoccipital which show the cavity. However, scoring an OTU can only reliably come from CT scan datasets, or acid prepared specimens which have the braincase preserved. While this limits the number of OTUs that can be scored, it helps prevent potential mis-scorings.* *Here* Dyrosaurus*,* Sarcosuchus *and* Terminonaris *are scored as (?) until CT scans conclusively show the lack of this diverticulum.* *State (0) occurs in Thalattosuchia.* 0. absent (in Thalattosuchia this diverticulum is lost)

	1. present
166	**Exoccipitals, presence of medial contact between both elements:** *Clark (1994, ch. 62); Ortega et al. (2000, ch. 63); Gower (2002, ch. 19 modified); Andrade et al. (2011, ch. 270); Nesbitt (2011, ch. 126); Young et al. (2012, ch. 103); Tennant et al. (2016, ch. 198); Young et al. (2016, ch. 124).* *Can also be defined as the participation of supraoccipital in the foramen magnum.* 0. do not meet in midline 1. meet on the midline, dorsal to the basioccipital, excluding the supraoccipital from the foramen magnum
167	**Paroccipital processes of the opisthotic, orientation in occipital view:** *Wilkinson et al. (2008, ch. 7); Young & Andrade (2009, ch. 7); Young et al. (2012, ch. 104); Young et al. (2016, ch. 125).* *State (1) is a putative apomorphy of Rhacheosaurini.* *State (2) is a putative apomorphy of Geosaurinae.* *State (3) is a putative apomorphy of Dyrosauridae*, *and also for* 'Dakosaurus' lissocephalus 0. horizontal 1. dorsolaterally orientated, at a 45 degree angle 2. ventral-edge horizontal, then terminal third sharply inclined dorsolaterally at a 45 degree angle 3. ventrally arched
168	**Paroccipital processes of the opisthotic, large ventrolateral region (i.e. the distal lower border is convex and bulges ventrally):**

	Young & Andrade (2009, ch. 116); Young et al. (2012, ch. 105); Young et al. (2016, ch. 126). *State (1) occurs in Crocodyliformes.* 0. present 1. absent
169	**Paroccipital process, overlap by the squamosal:** *Young & Andrade (2009, ch. 119); Young et al. (2012, ch. 106); Young et al. (2016, ch. 127).* 0. small: the squamosal does not extend more posteriorly than the paroccipital process 1. large: it extends further posteriorly than the paroccipital process
170	**Foramen for cranial nerve XII (hypoglossal), position on occipit:** *Wilkinson et al. (2008, ch. 10); Young & Andrade (2009, ch. 10); Young et al. (2012, ch. 107); Young et al. (2016, ch. 129).* 0. above the occipital condyle in line with the foramen magnum 1. below the foramen magnum
171	**Foramen for cranial nerve XII (hypoglossal), sits in the dorsomedial corner of 'occipital fossae' – concave depressions on the exoccipital on either side of the skull midline:** *State (1) occurs in* Torvoneustes. 0. absent 1. present
172	**Foramen for the internal carotid artery, external margin of the foramen is raised relative to the posterior face of the basioccipital, forming a sub-rectangular shape:** *State (1) occurs in* Torvoneustes.

	0. no 1. yes
173	**Foramen for the internal carotid artery, size:** *Wilkinson et al. (2008, ch. 11); Young & Andrade (2009, ch. 11); Young et al. (2012, ch. 108); Young et al. (2016, ch. 130).* *State (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* 0. similar in size to the openings for cranial nerves IX–XI 1. extremely enlarged
174	**Exoccipital, presence of descending flange ventral to subcapsular process:** *Clark (1994, ch. 58); Andrade et al. (2011, ch. 273).* *State (1) is putative apomorphy of protosuchids, but also present at least in* Araripesuchus tsangatsangana*.* 0. absent 1. present, laterally concave
175	**Exoccipital, extent of contact with the quadrate:** *Clark (1994, ch. 48 modifed + 51); Andrade et al. (2011, ch. 274).* *Andrade et al. (2011) merged characters 48 and 51 of Clark (1994), into one ordered series, as both refer to the contact between exoccipitals and quadrate.* *Following the present format, (1) is a putative apomorphy of Mesoeucrocodylia.* 0. absent or narrow 1. broad contact present, stabilising the quadrate
176	**Exoccipital, participation in the occipital condyle:**

	Jouve (2004, ch. 96 modified); Jouve et al. (2005b, ch. 5 modified); Jouve et al. (2006, ch. 104 modified); Jouve et al. (2008, ch. 5 modified); Hastings et al. (2010, ch. 52 modified). *This scores the large contribution of the otocciptials to the occipital condyle seen in dyrosaurids, where the otoccipitals broadly contact the lateral margins of the condyle.* 0. slight to moderate 1. large, such that only a thin strip of the basioccipital is visible between the exoccipitals on the dorsal surface of the occipital condyle
177	**Occipital surface ventral to occipital condyle:** *Young & Andrade (2009, ch. 143); Young et al. (2012, ch. 109); Young et al. (2016, ch. 131).* *State (1) is a putative apomorphy of Crocodylia.* 0. slopes anteroventrally 1. roughly parallel to the transverse plane

Braincase, basicranium and suspensorium (Ch. 178 – 206)

[Partial neurocranium (= laterosphenoids, proötics, basioccipitals, basisphenoids); partial splanchnocranium (= quadrate); pneumatic foramina; cranioquadrate canal]

#	Description
178	**Trigeminal fossa (=fossa for cranial nerve V), development on quadrate and laterosphenoid:** *Young et al. (2012, ch. 110); Young et al. (2016, ch. 132).* *Character based on the discovery by Fernández et al. (2011).* *State (1) is a putative apomorphy of Metriorhynchidae.*

	0. developed anteriorly and posteriorly to the trigeminal fenestra (i.e. fossa present on both laterosphenoid and quadrate) 1. fossa is mainly developed posteriorly to the fenestra (i.e. fossa present on quadrate)
179	**Laterosphenoids, sutures with parietal:** *Hastings et al. (2010, ch. 63 modified)* 0. parallel to the skull table 1. descends posteriorly, relative to the skull table
180	**Laterosphenoids, fossae for the *M. pseudotemporalis superficialis*:** *Young et al. (2012, ch. 111 modified); Young et al. (2016, ch. 133 modifed).* *Character based upon data from Holliday & Witmer (2009) and Fernández et al. (2011).* *State (1) is a putative apomorphy of Metasuchia.* 0. presence of a *pseudotemporalis* fossa on the dorsal surface of the laterosphenoid, and/or continuing on to the frontal 1. either an absence of the pseudotemporalis fossa on the dorsal surface of the laterosphenoid (i.e. only the *M. adductor mandibulae externus profundus* is within the supratemporal fenestra), or scorable by the presence of the fossa on the posteroventral surface of the laterosphenoid (the "subfenestral position")
181	**Parasphenoid ridge/rostrum (?), in palatal view:** *Wilkinson et al. (2008, ch. 4); Young & Andrade (2009, ch. 4); Young et al. (2012, ch. 112); Young et al. (2016, ch. 134).* *The homology of this ridge is unknown. Andrews (1913) considered the midline pterygoid ridge to be the parasphenoid. However, the pterygoids are poorly known for metriorhynchids, and we cannot discount this as a purely pterygoid structure. Until this structure has undergone CT scanning we will provisionally use the term parasphenoid.*

	0. not visible 1. forms a midline ridge along the pterygoids
182	**Basisphenoid, paired ridges located medially on the ventral surface:** *Young & Andrade (2009, ch. 83); Young et al. (2012, ch. 113); Young et al. (2016, ch. 135).* *State (1) occurs in Teleosauridae.* 0. absent 1. present
183	**Basisphenoid, ventral exposure in adults and young individuals, but not immature or hatchlings: (ORDERED)** *Clark (1994, ch. 55 revised+ 56 revised); Ortega et al. (2000, ch. 68 modified); Young & Andrade (2009, ch. 87 + 144 modified); Andrade et al. (2011, ch. 286 modified); Young et al. (2012, ch. 114 modified); Young et al. (2016, ch. 136 modified).* *Original characters by Clark (1994, ch. 55-56) actually reflect the size of basisphenoid and here were combined into one character by Andrade et al. (2011). Note disagreement in the scorings from previous works, e.g., Clark (1994) considered thalattosuchians as (0) and Turner & Buckley (2008) considers them as (1); Turner & Buckley (2008) considers* Mahajangasuchus *as (2), whereas here it is considered as (1). Most authors consider "Sphenosuchians" as (1), but the basisphenoid is well exposed at least in* Gracilisuchus*,* Sphenosuchus *and possibly in* Pseudhesperosuchus *(see Bonaparte, 1971; Romer, 1972; Walker, 1990). Further scorings by Turner & Buckley (2008).* *Note here we have re-ordered the character from Andrade et al. (2011). State (2) is now (0), and state (0) is now (2). State (1) is unaffected.* 0. ample surface exposed ventrally, basisphenoid at least as long as the basioccipital, or longer 1. well-exposed, although basisphenoid surface clearly smaller than basioccipital surface

	2. extremely reduced surface, exposed as a transversal slit, almost obliterated ventrally by the basioccipital and the pterygoids
184	**Basisphenoid, exposure anterior to the quadrates in palatal view:** *Wilkinson et al. (2008, ch. 5 modified); Young & Andrade (2009, ch. 5 modified); Young et al. (2012, ch. 115); Young et al. (2016, ch. 137).* *State (1) is a putative apomorphy of a teleosaurid subclade. This character state is caused by the posterior expansion of the pterygoid's posterior margin, so that the anterior portion of the quadrates is obscured, as are the lateral margins of the basisphenoid. However, there is a distinct basisphenoid 'rostrum' that in some taxa continue to bifurcate the ptergoids anteriorly. This morphology is not observed in* Teleosaurus cadomensis*, the skull referred to* Peipehsuchus teleorhinus, Steneosaurus brevior, Pelagosaurus typus *or Metriorhynchidae.* 0. basisphenoid terminates approximately level to the anterior extent of the quadrates 1. basisphenoid 'rostrum'/cultriform process exposed along the palatal surface anterior to the quadrates, continuing to bifurcate the pterygoids
185	**Basisphenoid rostrum (= cultriform process):** *Jouve (2005, ch. 2), Jouve et al. (2005b, ch. 7), Jouve et al. (2008, ch. 7), Hastings et al. (2010, ch. 54).* *State (1) is observed in some derived dyrosaurids. This character is not homologous with the anterior projection of the basisphenoid oberserved in teleosaurids. Here, the basisphenoid projects anteriorly between the pterygoids and laterosphenoids, rather than bifurcating the former.* 0. short 1. extremely long anteriorly
186	**Basisphenoid, exposure ventral to the basioccipital at maturity in occipital aspect:** *Young et al. (2012, ch. 116); Young et al. (2016, ch. 138).*

	State (1) is a putative apomorphy of Eusuchia. 0. absent, pterygoid dorsoventrally short ventral to medial pharyngeal opening (= “medial Eustachain foramen”) 1. present, pterygoid dorsoventrally tall ventral to medial pharyngeal opening
187	**Basisphenoid, development of basipterygoid processes:** *Clark (1994, ch. 54 revised); Andrade et al. (2011, ch. 289 modified).* *State (1) occurs in Crocodyliformes.* 0. prominent 1. small or absent
188	**Basioccipital, single wide rugosity oriented anteroposteriorly along the midline of the ventral surface of the occipital condyle:** *Hastings et al. (2010, ch. 55 modified).* 0. absent 1. present
189	**Basioccipial, presence of tuberosities (= basal tubera):** *Clark (1994, ch. 57); Lauprasert et al. (2007, ch. 46); Young & Andrade (2009, ch. 151); Andrade et al. (2011, ch. 288); Young et al. (2012, ch. 117); Young et al. (2016, ch. 139).* *State (1) occurs in longirostrine taxa.* 0. reduced 1. large and pendulous
190	**Basioccipital tuberosities, in ventral view:** *Hastings et al. (2010, ch. 56 modified).*

	0. oblong-shaped 1. 'V'-shaped or tear-drop shaped
191	**Paired grooves along ventral surface, extending from base of the occipital condyle to the basioccipital tuberosities:** *Hastings et al. (2010, ch. 57 modified).* 0. absent 1. present
192	**Ventral part of the basioccipital:** *Jouve et al. (2005b, ch. 13), Jouve et al. (2008, ch. 13), Hastings et al. (2010, ch. 59).* 0. vertical, largely visible in occipital view 1. strongly inclined, weakly visible in occipital view
193	**Quadrate, prominent crest on dorsal surface of distal quadrate extending proximally to lateral extent of quadrate–exoccipital contact:** *Young & Andrade (2009, ch. 101); Young et al. (2012, ch. 118); Young et al. (2016, ch. 140).* *State (1) occurs in Metasuchia (with reversals, such as in Crocodylia).* 0. absent 1. present
194	**Quadrate, contact with the proötics:** *Nesbitt (2011, ch. 76); Young et al. (2016, ch. 141).* *State (1) is a putative apomorphy of Crocodylomorpha.* 0. does not contact the proötic 1. contacts the proötic

195	**Quadrate, articulation of dorsal head contact:** *Clark (1994, ch. 47); Young & Andrade (2009, ch. 102 modified); Andrade et al. (2011, ch. 298); Young et al. (2012, ch. 119 modified); Young et al. (2016, ch. 142).* *State (1) is a putative apomorphy of* Junggarsuchus + *Crocodyliformes.* 0. squamosal and exoccipital/opisthotic/otoccipital (can have medial contact with proötics and laterosphenoids) 1. proötic and laterosphenoid
196	**Quadrate, posterior margin:** *Nesbitt (2011, ch. 77); Young et al. (2016, ch. 143).* *State (1) is a putative apomorphy of Metasuchia – note that the ventral/anteroventral margins of the distal ends of the paroccipital processes have a strong sutural contact with the quadrates.* 0. does not have a sutural contact with the paroccipital process of the opisthotic, or the anterior margin of the paroccipital process has a simple contact with the posterior margin of the quadrate 1. has a robust sutural contact with the paroccipital process of the opisthotic
197	**Quadrate, anteroventral process suturing to the braincase:** *Young et al. (2012, ch. 120 modified); Young et al. (2016, ch. 144 modified).* *The scores for the contact of the anteroventral process (referred to as the 'orbital' and 'pterygoid' processes by different authors).* *State (2) represents the 'quadrate incompletely sutured to the braincase' statement in Holliday & Witmer (2009), Jouve (2009) and Fernández et al. (2011).* *The current version of this character aims to quantify two trends: 1) the contact between the quadrate and the laterosphenoid (as part of the stabilisation of the crocodylomorph skull), and 2) the thalattosuchian modification of this trend. In Thalattosuchia, it*

	appears as though the anteromedial region of this process no longer articulates with the lateral surface of the neurocranium, but it is still elongated enough to have, and seems to sit lateral to the laterosphenoid. Perhaps suggesting a soft-tissue contact. *State (1) occurs in Crocodyliformes.* *State (2) occurs in Thalattosuchia.* 0. this process contacts the pterygoid, but little to no contact with the neurocranium 1. this process has extensive contact with the laterosphenoid, basisphenoid and pterygoid (i.e. stabilises the splanchnocranium with the palate and neurocranium) 2. this process is free of bony attachment along its anteromedial surface, but ventrally contacts the pterygoid. Process likely has a posteromedial contact with the basisphenoid, but is free of contact with the laterosphenoid
198	**Quadrate, openings on the dorsal surface at the proximal end (= subtympanic foramina; quadrate fenestrae):** *Young & Andrade (2009, ch. 158 modified); Young et al. (2012, ch. 121 modified); Young et al. (2016, ch. 145 modified).* *This character scores the presence of foramina on the proximal quadrate for the infundibular diverticula, contacting the tympanum.* *State (2) occurs in Thalattosuchia.* 0. multiple subtympanic foramina 1. single subtympanic foramen 2. lacks subtympanic foramina
199	**Quadrate (and articular), foramina aërum presence:** *This character scores the presences of the aërum foramina on the dorsal or mediodorsal surface of the distal quadrate, and the associated opening on the dorsal or medial*

	surface of the retroarticular process of the mandible. These foramina are for the siphonium connecting the quadrate and articular diverticula. *Note that in large adults the articular diverticula can completely regress, thus the quadrate aërum foramen may be the best indictator of the structure's presence.* *Following Nesbitt (2011; discussion on ch. 159), basal crocodylomorphs (i.e. 'sphenosuchians') the large medial articular foramina are not considered to be articular aërum foramina. Whether basal crocodylomorphs had articular diverticula is currently unknown.* *State (0) occurs in Thalattosuchia (basal crocodylomorphs are scored as '?').* *State (1) is currently only known to occur in Crocodyliformes.* 0. absent 1. present
200	**Quadrate, distal articular surface separated into two condyles:** *Young et al. (2016, ch. 147).* *State (1) is a putative apomorphy of Plesiosuchina.* *Character can be scored if the articular is preserved, and no ridge that supports the intercondylar sulcus is present.* 0. yes 1. no
201	**Quadrate-quadratojugal, quadratojugal contributes to the upper jaw joint along with the quadrate (i.e. helps to form the lateral hemicondyle):** *Jouve et al. (2005b, ch. 19 modified); Jouve et al. (2008, ch. 19modified); Hastings et al. (2010, ch. 60 modified).* 0. lateral hemicondyle soley formed by the quadrate

	1. lateral hemicondyle has a quadratojugal contribution
202	**Fossa for the tympanic membrane, anterior extension:** *State (1) occurs in Notosuchia and Sebecia.* *State (2) occurs in Neosuchia.* 0. limited to the squamosal 1. reaches the posterior margin of the postorbital 2. broadly exposed on the postorbital (covering the anterolateral margin) 3. crosses the postorbital and reaches the orbit
203	**Cranioquadrate canal, contact between the quadrate and exoccipital around the opening: (ORDERED)** *Clark (1994, ch. 49 modified); Andrade et al. (2011, ch. 306 modified + ch. 308 modified).* *Cranioquadrate canal (=quadratosquamosootoccipitalis, in Salisbury et al., 1999; or =quadratosquamosoexoccipitalis, in Delfino et al., 2008).* *State (1) occurs in Hallopodidae* (*e.g.* Almadasuchus) *and Mesoeucrocodylia.* *In derived forms the squamosal will also help enclose the cranioquadrate canal.* *Contact between quadrate and exoccipital is extensive (2) in all crown crocodylians, but in all stem metasuchians this contact is feeble (1).* 0. absent (and the quadrate and exoccipital do not meet to enclose the cranioquadrate canal) 1. lateral contact between the quadrate and exoccipital is feeble, but these bones do meet to enclose the cranioquadrate canal 2. lateral contact between the quadrate and exoccipital is broad, and these bones do meet to enclose the cranioquadrate canal

204	**Cranioquadrate canal, bones enclosing:** *Scores for a similar morphology as Andrade et al. (2011, ch. 307), but with distinct differences.* *Cranioquadrate canal does not imply in the presence of a passage, and therefore may be opened laterally. The canal is only considered absent (0) in basal crocodylomorphs and basal crocodyliformes.* *Note at present state (0) here correlates with the state (0) in character quantifying the contact between the quadrate and exoccipital around the cranioquadrate canal. However, here a taxon with an enclosed cranioquadrate canal which does not have a squamosal participation would be scored as (0).* *State (1) occurs in Thalattosuchia.* *State (2) is common among goniopholidids and pholidosaurids.* *State (3) occurs in Metasuchia, but with some losses (especially in Neosuchia).* 0. quadrate, squamosal and exoccipital do not enclose the cranioquadrate canal along its length 1. squamosal laterally encloses the cranioquadrate canal, the quadrate ventrally, and the exoccipital posteriorly, medially and partly ventrally encloses the canal. This results in the canal opening laterally and/or posterolaterally 2. quadrate and squamosal do not laterally enclose the cranioquadrate canal, and it is laterally exposed but still exits on the occipital surface. *This looks to be a modification of state (3), where there is no ossified lateral enclosure, resulting in the 'open morphotype'.* 3. quadrate and squamosal laterally enclose the cranioquadrate canal, and the exoccipital helps enclose it dorsally. This results in the canal opening on the occipital surface
205	**Cranioquadrate canal, presence of a squamosal descending process separating the cranioquadrate canal from the external auditory meatus:**

	State (1) occurs in thalattosuchians. Note that the Teleosaurus cadomensis *specimen figured by Jouve (2009) had a broken squamosal descending lamina, and that the skull had been acid prepared. Here it is scored as (1).* 0. absent, no clear separation of these structures 1. present, the cranioquadrate canal and the external auditory meatus are distinct openings, sharing a common wall (squamosal descending process)
206	**Medial pharyngeal and pharyngotympantc tubes (= "Eustachian tubes"), relation to basioccipital and basisphenoid: (ORDERED)** *Clark (1994, ch. 52 modified); Andrade et al. (2011, ch. 290 modified); Nesbitt (2011, ch. 121 – based on Gower 2002, ch. 13); Young et al. (2012, ch. 126); Young et al. (2016, ch. 152).* *State (1) occurs in* Postosuchus *and 'sphenosuchians'.* *State (2) occurs in Crocodyliformes.* 0. not enclosed by bone 1. partially enclosed between the basioccipital and basisphenoid 2. entirely enclosed between the basioccipital and basisphenoid

Mandible geometry (Ch. 207 – 210)

#	Description
207	**Mandible geometry, relative positions of the dentary tooth-row and coronid process, and development of dorsal curvature of the posterior-end of the mandible:** *Young et al. (2012, ch. 127); Young et al. (2016, ch. 153).* *State (1) is a putative apomorphy of Metriorhynchidae.* *Quantifies the incipient increase of gape at the base of Metriorhynchidae.*

	0. gentle curvature in the dorsal margin of the mandible, from the coronoid process to the end of the tooth-row 1. strong curvature, raising the coronoid process considerably above the tooth-row
208	**Mandible geometry, relative positions of coronoid process, retroarticular process and glenoid fossa:** *Young et al. (2012, ch. 128); Young et al. (2016, ch. 154).* *State (1) is a putative apomorphy of Geosaurini.* *This character quantifies the greater increase in gape associated with macrophagous geosaurines.* 0. coronoid process level to both the retroarticular process and glenoid fossa 1. coronoid process ventral to both the retroarticular process and glenoid fossa
209	**Mandibular rami, presence of a sharp dorsal inclination:** *State (1) is a putative apomorphy of Plesiosuchina.* 0. absent 1. present - immediately posterior to the mandibular symphysis the mandible sharply rises dorsally such that the ventral margin of the dentary (along with angular) is dorsally deflected (resulting in a distinct 'kink' along the mandibular ventral margin)
210	**Mandible, morphology of distal rami in dorsal/ventral views:** *Andrade et al. (2011, ch. 321).* *Note that the broad-Y shape in (1) is not the result of elongation of the symphysis (which is present, but not exclusively in these forms), but by the arched distal rami, meeting at mid-mandible.* *State (1) is putative apomorphy of Notosuchidae + Sphagesauridae.* 0. distal rami mostly straight or poorly curved

	1. distal rami strongly curved medially at mid-mandible, giving the mandible a broad-Y shape

Mandible (Ch. 211 – 239)

[Dermatocranium mandibular series = dentaries, splenials, angulars, surangulars, prearticulars, coronoids; and the mandibular contribution of the splanchnocranium = articular and Meckel's cartilage]

#	Description
211	**Anterior mandible (dentary), dorsal margin of the anterior portion compared to the dorsal margin of the posterior portion:** *Nesbitt (2011, ch. 154); Young et al. (2012, ch. 129); Young et al. (2016, ch. 155).* 0. horizontal (in the same plane) 1. ventrally deflected 2. dorsally expanded
212	**Anterior mandible (dentary), in dorsal or ventral view:** *Young et al. (2012, ch. 130 modified); Young et al. (2016, ch. 156 modified)* *Note, here we have added two new character states. These where added to determine whether the 'spatulate' anterior dentary morphotypes would homologous.* *State (1) occurs in most pholidosaurids, and in some dyrosaurids and eusuchians.* *State (2) is a putative apomorphy of Teleosauridae.* *State (3) is a putative apomorphy of* Sarcosuchus *and* Chalawan. 0. outer margin converging towards tip or parallel 1. distinct spatulate shape, with the maximum transverse width at the D2 alveoli 2. distinct spatulate shape, with the maximum transverse width at the D3-D4 couplet

	3. distinct spatulate shape, with the maximum transverse width at the D4 alevoli
213	**Anterior mandible (dentary), in dorsal or ventral view:** *Young et al. (2016, ch. 157 + 158).* *State (1) occurs in basal dyrosaurids and tomistomine crocodyloids.* *State (2) occurs in* Hamadasuchus, *Peirosauridae and* Baurusuchus. *States (1) and (2) differ in that the 'trowel'-shape has a shorter, broader and deeper symphyseal region; the anteriorly tapering maximal anterior width is more pronounced, and the width at the posterior symphyseal region is greater than the maximal anterior width.* 0. non-'gladius', or 'trowel'-shaped 1. 'gladius'-shaped - i.e. a long symphyseal region with the anterior maximal width near the D3–D5 region, with the dentaries tapering anteriorly. Immediately posterior to the maximal width, the dentaries begin to narrow until they reach a minimal width, and begin expanding again. At the end of the symphyseal region the breadth is now wider than the anterior maximal width 2. 'trowel'-shaped - i.e. a moderate to short symphyseal region with the anterior maximal width near the D3–D5 region, with the dentaries tapering strongly anteriorly. Immediately posterior to the maximal width the dentaries begin to narrow until they reach a minimal width, and begin expanding again. At the end of the symphyseal region the breadth is either narrower or subequal to the anterior maximal width
214	**Mandibular symphysis, length:** *Young (2006, ch. 20 modified); Wilkinson et al. (2008, ch. 43 modified); Young & Andrade (2009, ch. 43 modified); Young et al. (2012, ch. 132); Young et al. (2016, ch. 159).* 0. symphysis less than a third of mandible length (lower than 0.3)

	1. symphysis less than half and more than a third of mandible length (between 0.3 and 0.45) 2. symphysis under half of mandible length (between 0.45 and 0.5) 3. symphysis greater than half of mandible length (more than 0.5)
215	**Mandibular symphysis, depth:** *Young (2006, ch. 21); Wilkinson et al. (2008, ch. 44); Young & Andrade (2009, ch. 44); Young et al. (2012, ch. 133); Young et al. (2016, ch. 160).* 0. deep (9% or more of mandible length) 1. moderate (6.5–8% of mandible length) 2. narrow (4.5–6% of mandible length) 3. very narrow (4% or less of mandible length)
216	**External mandibular fenestra:** *Young (2006, ch. 22); Wilkinson et al. (2008, ch. 45); Young & Andrade (2009, ch. 45); Young et al. (2012, ch. 134); Young et al. (2016, ch. 161).* *State (1) occurs in derived goniopholidids (e.g.* Anteophthalmosuchus *and* Goniopholis *sensu stricto – Andrade et al., 2011), Hylaeochampsidae, Bernissartiidae, Shartegosuchidae, and Metriorhynchidae.* 0. present 1. absent
217	**Dentary, ventral margin strongly curved:** *Young et al. (2016, ch. 162 + 163).* *State (1) occurs in* Junggarsuchus, Dakosaurus, Baurusuchus, *and in 'trematochampsids' and peirosaurids.* *State (2) occurs in Hylaeochampsidae.*

	0. no 1. yes, ventral margin is distinctly curved (convex). It rises sharply dorsally towards the anterior tip (this curvature occurs along the anterior ventral margin of the dentary) 2. yes, ventral margin is curved (concave). It rises dorsally towards the anterior tip (this curvature occurs along the anterior ventral margin of the dentary, from a dorsoventrally deepened region of the dentary, immediately anterior to the dentary-splenial suture)
218	**Dentary foramina, lateral and dorsal surface of the anterior (symphyseal) region of the dentary:** *Young et al. (2016, ch. 164).* *State (1) is a putative apomorphy of* Dakosaurus*.* 0. foramina either small or variable in size. Number is variable. 1. has numerous small to medium-sized foramina
219	**Dentary tooth-row, distinctly sigmoidal:** *Young et al. (2016, ch. 165).* *State (1) occurs in the* Pachycheilosuchus + Pietraroiasuchus *clade.* 0. no 1. yes, with the anterior alveoli orientated slightly anterolaterally and the posterior alveoli orientated posteromedially, between these two orientations the mid-region alveoli become dorsally orientated
220	**Surangulodentary groove, morphology:** *Young (2006, ch. 23 modified); Wilkinson et al. (2008, ch. 46 part); Young & Andrade (2009, ch. 46 part); Young et al. (2012, ch. 135); Young et al. (2016, ch. 166).* *Note taphonomic or preservational damage can obscure state (1).* *State (2) is a putative apomorphy of the clade Geosaurini. Previously it was considered an apomorphy of* Dakosaurus*; however, the type specimens for the genera* Dakosaurus,

	Plesiosuchus *and* Geosaurus *share this morphology. The deep groove is also observed in a* Torvoneustes *specimen held in the Etches Collection. The large specimens of* Tyrannoneustes lythrodectikos *also have a deep groove.* 0. absent 1. present as a subtle, shallow groove 2. deeply excavated
221	**Surangulodentary groove, relative length on both elements: (*)** *Young et al. (2012, ch. 136); Young et al. (2016, ch. 167).* *This character is not applicable for taxa that lack the surangulodentary groove.* 0. groove is longer on the dentary than on the surangular 1. groove is as long on the dentary as on the surangular
222	**Surangulodentary groove, large foramen present at the dentary terminus: (*)** *Wilkinson et al. (2008, ch. 46 part); Young & Andrade (2009, ch. 46 part); Young et al. (2012, ch. 137); Young et al. (2016, ch. 168).* *This character is not applicable for taxa that lack the surangulodentary groove.* *State (1) is a putative apomorphy of* Dakosaurus. 0. absent 1. present
223	**Splenial, involvement in mandibular symphysis:** *Young (2006, ch. 25 modified); Wilkinson et al. (2008, ch. 49 modified); Young & Andrade (2009, ch. 49 modified); Young et al. (2012, ch. 138 modified); Young et al. (2016, ch. 169 modified).* 0. slight (less than 10% of symphysis length)

	1. extensive (greater than, or equal to, 15% of symphysis length) 2. not involved
224	**Angular, in lateral view, extension of the anterior lateral ramus:** *Young (2006, ch. 24 part); Wilkinson et al. (2008, ch. 47 part); Young & Andrade (2009, ch. 47 part); Young et al. (2012, ch. 139); Young et al. (2016, ch. 170).* 0. short, does not extend beyond the orbits 1. long, does extend anteriorly beyond the orbits
225	**Angular, in lateral view, posterodorsal extension:** *Jouve et al. (2008, ch. 39 modified); Hastings et al. (2010, ch. 79 modified).* 0. reaches the retroarticular process 1. does not reach the retroarticular process
226	**Surangular, in lateral view, extension of the anterior lateral ramus:** *Young (2006, ch. 24 part); Wilkinson et al. (2008, ch. 47 part); Young & Andrade (2009, ch. 47 part); Andrade et al. (2011, ch. 346 modified); Young et al. (2012, ch. 140); Young et al. (2016, ch. 171).* 0. short, does not extend anteriorly beyond the orbit 1. long, extends anteriorly beyond the orbit
227	**Surangular, along the dorsal margin of the mandible:** *Wilkinson et al. (2008, ch. 48); Young & Andrade (2009, ch. 48); Young et al. (2012, ch. 141); Young et al. (2016, ch. 172).* *This character does not always covary with the previous character, as in non-Rhacheosaurini metriorhynchines the dentary extensively overlaps the surangular (particularly in lateral view), obscuring its anterior development. The full extent of the*

	surangular anterior development can only be determined by examining the dorsal margin in those taxa (e.g., Metriorhynchus superciliosus*).* 0. does not extend anteriorly beyond the orbit 1. does extend anteriorly beyond the orbit
228	**Surangular, presence of a distinct coronoid process:** *Young & Andrade (2009, ch. 155); Young et al. (2012, ch. 142); Young et al. (2016, ch. 173).* *In Thalattosuchia it appears as though all taxa have a coronoid process. In teleosaurids the coronoid process is medially orientated and is not visible in lateral view, unlike in* Pelagosaurus + *Metriorhynchidae.* 0. absent 1. present
229	**Surangular, presence of extension to the retroarticular process:** *Norell (1988, ch. 42 modified); Brochu (1999, ch. 51 revised); Young & Andrade (2009, ch. 103); Andrade et al. (2011, ch. 350); Young et al. (2012, ch. 143 modified); Young et al. 2016, ch. 174 modifed).* 0. absent, pinched off anterior to tip of retroarticular process, or surangular excluded from process 1. present, extends to posterior end of retroarticular process
230	**Prearticulars, presence:** *Clark (1994, ch. 72 revised); Sereno et al. (2003, ch. 39); Young & Andrade (2009, ch. 89); Andrade et al. (2011, ch. 354); Young et al. (2012, ch. 144); Young et al. (2016, ch. 175).*

	Note, here we follow Andrade et al. (2011) in scoring Pholidosaurus schaumburgensis *and* Sarcosuchus imperator *as lacking prearticulars (as MTY also could not find these elements in first-hand observations). As such they are scored as (?).* *It is not possible to verify the potential prearticular in* Oceanosuchus *(Hua et al., 2007, Fig. 4U) as too much of the angular is not preserved. Thus, this OTU is scored as (?).* *State (1) occurs in Metasuchia.* 0. present 1. absent
231	**Coronoids:** *Jouve et al. (2005b, ch. 6 modified); Jouve et al. (2008, ch. 6 modified); Young & Andrade (2009, ch. 157 part); Hastings et al. (2010, ch. 77 modified); Young et al. (2012, ch. 146 part); Young et al. (2016, ch. 177 part).* *This character is an amalgam of those in Hastings et al. (2010, ch. 77) and Young et al. (2016, ch. 177).* *State (1) occurs in derived Rhacheosaurini metriorhynchids.* *Dyrosaurids have state (2). However, to evaluate the presence of the coronoids requires well preserved specimens.* 0. present, but not exposed on the external (=lateral) surface of the mandible 1. present, and exposed on the external surface of the mandible 2. absent
232	**Coronoid, anterior development along the dorsal margin:** *Wilkinson et al. (2008, ch. 51); Young & Andrade (2009, ch. 51); Young et al. (2012, ch. 145 modified); Young et al. (2016, ch. 176 modified).* 0. does not project as far as the dentary tooth row, or coronoid absent

	1. projects further anteriorly than the posterior-most alveoli
233	**Articular, glenoid fossa orientation:** *Young & Andrade (2009, ch. 154); Young et al. (2012, ch. 147); Young et al. (2016, ch. 178).* 0. anterodorsally 1. dorsally
234	**Retroarticular process, development:** *Clark (1994, ch. 71 part); Andrade et al. (2011, ch. 358).* *For practical purposes, a retroarticular process is here considered as (1) when its orientation can be established.* *State (1) occurs in Mesoeucrocodylia.* 0. absent or poorly developed 1. present and evidently projecting posterior to glenoid fossa
235	**Retroarticular process, length of the attachment surface for the adductor muscles relative to its width: (ORDERED)** *Jouve et al. (2005, ch. 1 modified); Jouve et al. (2008, ch. 1 modified), Andrade et al. (2011, ch. 359); Hastings et al. (2010, ch. 75 modified).* *State (2) is a putative apomorphy of Dyrosauridae. Note, that in dyrosaurids the retroarticular processes also have a strong posterodorsal curvature.* 0. short, subequal 1. moderately elongated, evidently longer than wide 2. extremely elongate, more than twice its width
236	**Retroarticular process, morphology of the surface for the attachment of adductor muscles: (*)**

	Wilkinson et al. (2008, ch. 50 modified); Young & Andrade (2009, ch. 50 modified); Andrade et al. (2011, ch. 363); Young et al. (2012, ch. 148 modified); Young et al. (2016, ch. 179 modified). 0. trianglular 1. ellipsoid, rectangular or spoon-shaped 2. shovel-shaped (or paddle-shaped)
237	**Retroarticular process, width: (*)** *Young & Andrade (2009, ch. 152); Young et al. (2012, ch. 149); Young et al. (2016, ch. 180).* *This character is not applicable for taxa that lack retroarticular processes.* 0. narrower than the glenoid fossa 1. wider than the glenoid fossa (projecting medially past the glenoid fossa)
238	**Retroarticular process, length: (*)** *Young & Andrade (2009, ch. 153); Young et al. (2012, ch. 150); Young et al. (2016, ch. 181).* *This character is not applicable for taxa that lack retroarticular processes.* 0. long (longer than wide, and longer than the glenoid fossa width) 1. short (wider than long, and shorter than the glenoid fossa width)
239	**Retroarticular process, position of the posteromedial wing: (*)** *Jouve et al. (2005b, ch. 2); Jouve et al. (2008, ch. 2); Hastings et al. (2010, ch. 76); Andrade et al. (2011, ch. 365).* *State (1) is a putative apomorphy of Dyrosauridae.* *This character is not applicable for taxa that lack retroarticular processes.*

	0. posteromedial wing dorsally situated, or at mid height on the retroarticular process 1. posteromedial wing ventrally situated on the retroarticular process

Dentition and alveolar morphologies (Ch. 240 – 288)

[Note abbreviations used in this section: P = premaxilla, M = maxilla, D = dentary. Thus, D1 would refer to the first dentary alveolus, while M4 would be the fourth maxillary alveolus, etc. Tooth count numbering starts from the anterior-most alveolus.]

#	Description
240	**Premaxilla, alveolar count:** *Young (2006, ch. 26); Wilkinson et al. (2008, ch. 52); Young & Andrade (2009, ch. 52); Nesbitt (2011, ch. 6 modified); Young et al. (2012, ch. 151); Young et al. (2016, ch. 182).* 0. five alveoli 1. four alveoli 2. three alveoli (or fewer)
241	**Maxilla, alveolar count:** *Young (2006, ch. 27 modified); Wilkinson et al. (2008, ch. 53 modified); Young & Andrade (2009, ch. 53 modified); Young et al. (2012, ch. 152 modified); Young et al. (2016, ch. 183).* 0. 11 or fewer alveoli 1. 12–16 alveoli 2. 17–20 alveoli 3. 21–28 alveoli 4. 29 or more alveoli
242	**Maxilla, end of the alveolar row:**

	State (0) occurs in Dyrosauridae. *State (2) occurs in* Tyrannoneustes lythrodectikos, Purranisaurus, Torvoneustes, 'Metriorhynchus' hastifer *and Mr. Passmore's specimen.* 0. maxillary tooth row terminates posterior to the posterior margin of the orbit, but does not extend beyond the anteroposterior mid-length of the supratemporal fenestrae 1. maxillary tooth row terminates level to, or posterior to, the anterior margin of the orbit 2. maxillary tooth row terminates prior to the anterior margin of the orbit
243	**Third premaxillary alveoli, relative size when more than three premaxillary alveoli are present: (*)** *Hastings et al. (2010, ch. 16 modified).* *This character is not applicable for taxa that have fewer than four premaxillary alveoli.* 0. not enlarged relative to both the second and fourth premaxillary alveoli 1. third alveoli are enlarged relative to both adjacent alveoli
244	**Number of teeth partially supported by both the premaxilla and maxilla:** *Young & Andrade (2009, ch. 162); Young et al. (2012, ch. 153); Young et al. (2016, ch. 184).* *State (1) occurs in* Mariliasuchus *and* Notosuchus. 0. none 1. one
245	**Presence of a premaxillary lamina extending posteriorly along the palatal surface that overlaps the anterior margin of the first maxillary alveoli:** *State (1) occurs in* Tyrannoneustes lythrodectikos, Torvoneustes, 'Metriorhynchus' hastifer *and Mr. Passmore's specimen.* 0. absent

	1. present
246	**Anterior margin of maxillary alveolus one:** *State (1) occurs in* Metriorhynchus superciliosus *and* M. geoffroyii. 0. lacks an interdigitating suture with the premaxilla 1. has an interdigitating suture with the premaxilla, restricted to the anterior margin of the first maxillary alveolus
247	**Dentary, alveolar count:** *Young (2006, ch. 28 modified); Wilkinson et al. (2008, ch. 54 modified); Young & Andrade (2009, ch. 54 modified); Young et al. (2012, ch. 154); Young et al. (2016, ch. 185).* *This character does not covary with the maxillary alveolar count character, as some taxa (e.g.* 'Metriorhynchus' casamiquelai*) have more teeth in the dentary than in the maxilla.* 0. 30 or more alveoli per rami 1. 20–29 alveoli 2. 19–15 alveoli 3. 14 or fewer alveoli
248	**Maxillary anterior alveoli shape:** *Young et al. (2016, ch. 186).* *In Thalattosuchia, state (1) is a putative apomorphy of the clade* 'Metriorhynchus' hastifer *and Mr. Passmore's specimen.* *Note that shearing or crushing of the snout can make this character hard to discern.* 0. sub-circular 1. sub-oval, being wider transversely than anteroposteriorly

249	**Maxillary interalveolar spaces, relative size:** *Young et al. (2016, ch. 187).* *State (1) is a putative apomorphy of* Dakosaurus + Plesiosuchus *sub-clade and* Gracilineustes leedsi. *This character correlates with the dentary interalveolar space character for the metriorhynchids* Gracilineustes leedsi and *the* Dakosaurus + Plesiosuchus *sub-clade*; *however, the maxillary interalveolar spacing does not correlate with the dentary character for the teleosaurid* Machimosaurus hugii. *State (1) does not occur in* Torvoneustes carpenteri, 'Metriorhynchus' hastifer *and Mr. Passmore's specimen as some interalveolar spaces are large, over half the length of the adjacent alveoli and they do not alway share the same alveolar lamina. They appear to evolve an analogous, but slightly different morphology, which has not yet been scored.* 0. Interalveolar spaces are variable in size, some are similar in length to the adjacent alveoli, while others are approximately half the length of the immediately adjacent alveoli (especially towards the end of the maxillary tooth row) 1. Interalveolar spaces are/almost completely uniformly narrow, being approximately one quarter the length of the adjacent alveoli (or even smaller). The adjacent alveoli share the same alveolar lamina.
250	**Dentary alveoli one, orientation:** *Young et al. (2016, ch. 188).* *State (1) occurs in Tethysuchia (e.g. dyrosaurids,* Sarcosuchus, Chalawan) and Hamadasuchus. *State (2) occurs in the* Pachycheilosuchus + Pietraroiasuchus *clade,* Dakosaurus *and* Maledictosuchus riclaensis *This morphology differs from the procumbency of the first dentary alveolus seen in* Cricosaurus aracuanensis*, as they are also partially laterally orientated.*

	0. dorsally orientated 1. mainly dorsally orientated, but with a slight anterior orientation 2. strongly anteriorly orientated (procumbent), resulting in the first dentary tooth being directed anteriorly from the mouth, along anteroposterior axis of the skull
251	**Dentary interalveolar spaces, relative size:** *Young et al. (2012, ch. 131 modified); Young et al. (2016, ch. 189).* *State (1) occurs in the* Dakosaurus+Plesiosuchus *sub-clade,* Gracilineustes leedsi *and* Machimosaurus hugii. *This character correlates with the maxillary interalveolar space character for the metriorhynchids* Gracilineustes leedsi *and the* Dakosaurus + Plesiosuchus *sub-clade, but does not for the teleosaurid* Machimosaurus hugii. 0. interalveolar spaces are variable in size, some are similar in length to the adjacent alveoli, while others are approximately half the length of the immediately adjacent alveoli 1. interalveolar spaces are/almost completely uniformly narrow, being approximately one quarter the length of the immediately adjacent alveoli (or even smaller)
252	**Dentary alveoli, diastema between the first and second alveoli:** *Young et al. (2016, ch. 190).* *State (1) is a putative apomorphy of* Dakosaurus maximus. 0. absent 1. present
253	**Dentary alveoli 1–2, confluence:** *Andrade et al. (2011, ch. 402); Young et al. (2016, ch. 191).* *State (1) is a putative apomorphy of Goniopholis.*

	0. well-separated, usually as much distant from each other as from other dentary teeth 1. alveoli 1–2 confluent, separated by a thin alveolar wall, and clearly apart from neighbouring alveoli
254	**D2 alveoli, size relative to D1 alveoli:** *Hastings et al. (2010, ch. 64 modified); Young et al. (2016, ch, 192).* 0. similar in size 1. reduced in size relative to both adjacent alveoli
255	**D3 alveoli, position:** *Hastings et al. (2010, ch. 66 modified).* 0. interalveolar space between D2 and D3 is approximately equal to that between D3 and D4 1. closer to the D4 alveoli
256	**Interalveolar space between the D2 and D3 alveoli relative to that of the D1 and D2 alveoli:** *Hastings et al. (2010, ch. 65 modified); Young et al. (2016, ch. 193).* 0. approximately equal in proportion 1. the D2–D3 interalveolar space is longer than the interalveolar space between the D1 and D2
257	**D4 alveolar wall:** *Hastings et al. (2010, ch. 68 modified); Young et al. (2016, ch. 194).* 0. level with the adjacent alveoli 1. raised relative to the adjacent alveoli
258	**Dentary alveoli, diastema present between the fourth and fifth alveoli:**

	Young et al. (2016, ch. 195). *State (1) is a putative apomorphy of Thalattosuchia and* Sarcosuchus. *Within Thalattosuchia: state (0) is a putative apomorphy of the* Dakosaurus+Plesiosuchus *sub-clade.* *Note that while the very small dentary interalveolar spaces are putative apomorphies of* Dakosaurus, Plesiosuchus *and* Gracilineustes leedsi*, the D4–D5 diastema is still present in* Gracilineustes leedsi. 0. absent 1. present
259	**D7 alveoli, size:** *Jouve (2004, ch. 153 modified); Jouve (2005, ch. 3 modified); Jouve et al. (2005b, ch. 8 modified); Jouve et al. (2006, ch. 164 modified); Jouve et al. (2008, ch. 8 modified); Hastings et al. (2010, ch. 73 modified); Young et al. (2016, ch. 196 modified).* *State (1) occurs in Dyrosauridae.* 0. comparable in size to the adjacent alveoli 1. reduced in size compared to the adjacent alveoli
260	**D7 alveoli, position:** *Jouve (2004, ch. 153 modified); Jouve (2005a, ch. 3 modified); Jouve et al. (2005b, ch. 8 modified); Jouve et al. (2006, ch. 164 modified); Jouve et al. (2008, ch. 8 modified); Hastings et al. (2010, ch. 73 modified); Young et al. (2016, ch. 197 modified).* *State (1) occurs in Dyrosauridae.* 0. comparable in size to the adjacent alveoli 1. close in position to the eighth alveoli
261	**Dentary alveoli, number of alveoli adjacent to the mandibular symphysis:**

	Young et al. (2016, ch. 198). *Within Thalattosuchia: state (3) is a putative apomorphy of* Dakosaurus. 0. 15 or more 1. 10 to 14 2. 7 to 9 3. 4 to 6 4. Fewer than 4
262	**Premaxilla-anterior maxillary tooth crown apicobasal length to basal width ratio:** *Young et al. (2012, ch. 155); Young et al. (2016, ch. 199).* 0. 3 or greater 1. 2.5 or less
263	**Anterior maxilla, crown size:** *Wilkinson et al. (2008, ch. 56); Young & Andrade (2009, ch. 56); Young et al. (2012, ch. 156); Young et al. (2016, ch. 200).* *It is currently unknown if this character correlates with the character quantifying mandibular symphysis depth across Crocodylomorpha. However, in Geosaurinae this is not the case, as shown by Young et al. (2013), the symphysis is deeper in* 'Metriorhynchus' brachyrhynchus *than* Tyrannoneustes lythrodectikos*, but the latter has tooth crowns with a greater apicobasal length. Moreover, the symphyseal depth of* Dakosaurus maximus *and* Plesiosuchus manselii *noticeably differ, but both taxa have tooth crowns similar in apicobasal length (Young et al., 2012).* *Anterior maxilla = tooth crowns of the anterior half of the maxillary tooth row.* 0. crowns not enlarged (typically less than 3cm in apicobasal length) 1. moderately enlarged (between 3 and 4 cm in apicobasal length)

	2. enlarged (apicobasal length 5 cm or greater)
264	**Anterior maxilla, mediolateral compression/crown cross section:** *Young (2006, ch. 30); Wilkinson et al. (2008, ch. 57); Young & Andrade (2009, ch. 57); Young et al. (2012, ch. 157); Young et al. (2016, ch. 201).* 0. no mediolateral compression 1. weak mediolateral compression (crown midpoint labiolingual width 60–90% distal-medial width) 2. strong mediolateral compression (crown midpoint labiolingual width <60% distal-medial width)
265	**Anterior maxilla, crown cross section:** *Young et al. (2012, ch. 158); Young et al. (2016, ch. 202).* 0. subcircular to elliptical 1. teardrop shaped
266	**Anterior maxilla, constriction at base of crowns:** *Young (2006, ch. 32); Wilkinson et al. (2008, ch. 59); Young & Andrade (2009, ch. 59); Young et al. (2012, ch. 159); Young et al. (2016, ch. 203).* 0. absent 1. present
267	**Maxillary teeth, orientation of the anterior to mid-snout crowns:** *Young & Andrade (2009, ch. 123); Young et al. (2012, ch. 160); Young et al. (2016, ch. 204).* 0. not procumbent 1. procumbent

268	**Posterior maxilla, enamel bands (*sensu* Brusatte *et al*., 2007):** *Young et al. (2012, ch. 161); Young et al. (2016, ch. 205).* *Posterior maxilla = tooth crowns in the posterior half of the maxillary tooth row.* 0. absent 1. present
269	**Anterior maxilla, tooth crown tip:** *Young et al. (2012, ch. 162); Young et al. (2016, ch. 206).* 0. sharp or worn apex 1. blunt and rounded at the tips
270	**Dentary teeth posterior to tooth opposite premaxilla-maxilla contact:** *Wilkinson et al. (2008, ch. 60); Young & Andrade (2009, ch. 60); Young et al. (2012, ch. 163); Young et al. (2016, ch. 207).* 0. equal in size 1. enlarged dentary teeth opposite to smaller teeth in maxillary tooth row
271	**Teeth, presence of apicobasal facets on the labial sufrace:** *Young & Andrade (2009, ch. 130); Andrade et al. (2011, ch. 370); Young et al. (2012, ch. 164); Young et al. (2016, ch. 208).* *State (1) is a putative apomorphy of* Geosaurus giganteus, G. grandis + *Melksham monster*. 0. either lacking, or facetted into 4–5 indistinct planes 1. distinctly facetted into 3 planes (one large medial one, and two smaller planes either side)

272	**Laminar teeth (teeth with cross-section highly elliptical at base of crown, with mesial-distal axis approximately twice the labial-lingual axis, or greater):** *Young et al. (2012, ch. 165); Young et al. (2016, ch. 209).* *State (1) is a putative apomorphy of* Geosaurus + *the Melksham monster*. 0. absent 1. present, laminar teeth dominate dentition
273	**Sphagesauriform teeth (teeth with short triangular crowns covered by a relatively thick enamel layer, with a denticulate keel and thick, high-relief apicobasal enamel ridges, = longitudinal striae) in both the maxillae and dentaries:** *Young et al. (2016, ch. 210).* *State (1) is a putative apomorphy of Sphagesauridae*. 0. absent 1. present
274	**Tribodont teeth (teeth that are 'low crowned', bulbous, mesiodistally compressed, single cusped, and lack carinae) in both the posterior maxillae and dentaries:** *State (1) occurs in Bernissartiidae and in some alligatoroids*. 0. absent 1. present
275	**Tooth wear, macroscopic wear along the carinae/mesiodistal margins:** *Young et al. (2016, ch. 211).* *State (1) is a putative apomorphy of* Dakosaurus + *Mr Leeds Dakosaur.* 0. absent 1. present

276	**Anterior–middle dentition, tooth crown curvature:** *Young (2006, ch. 31); Wilkinson et al. (2008, ch. 58); Young & Andrade (2009, ch. 58); Young et al. (2012, ch. 166); Young et al. (2016, ch. 212).* 0. none, crown apical/subapical (91 – 89 degrees) 1. weakly recurved (88 – 82 degrees) 2. strongly recurved (< 80 degrees)
277	**Carinae, presence of keel along tooth crown mesial and distal margins:** *Young (2006, ch. 29 part modified); Wilkinson et al. (2008, ch. 55 part modified); Young & Andrade (2009, ch. 55 part modified); Andrade et al. (2011, ch. 378); Young et al. (2012, ch. 167 modified); Young et al. (2016, ch. 213 modified).* *Currently, no data suggests differential presence of keels in antero-posterior or upper-lower dentition, therefore a single character is used. Mesial-distal keels may occur independently from denticles in the mesial and distal carinae; denticulated carinae may or may not have keel on denticles.* 0. absent (i.e. lack carinae) 1. present (i.e. carinated, created by a smooth keel [raised ridge] on the mesial and distal margins)
278	**Carinae, presence of 'carinal flanges': (*)** *State (1) occurs in* Plesiosuchus*,* Suchodus *and Mr Leeds Dakosaur*. *State (2) occurs in* Dakosaurus. *This character is not applicable for taxa that lack carinae on all tooth crowns.* 0. absent - the external surfaces of the tooth crowns are still convex/straight when they approach the carinae

	1. poorly-developed - the external surface of the tooth crown becomes concave immediately adjacent to the carinae. However, they are unequally expressed on the labial and lingual surfaces, and are rarely expressed along the entire carina 2. well-developed - the external surface of the tooth crown becomes concave immediately adjacent to the carinae. They are present on both the labial and lingual surfaces, being most noticeably developed at the mid-crown and apex
229	**Carinae, height of the keel in the apical region:** *State (1) occurs in* Torvoneustes. 0. keel is either absent, or not greatly enlarged 1. keel is greatly enlarged in height
280	**Carinae, presence of false zipdont serrations at crown edges: (*)** *Young et al. (2012, ch. 168); Young et al. (2016, ch. 214).* *This character is not applicable for taxa that lack carinae on all tooth crowns.* *False ziphodonty (= conspicuous superficial enamel ornamentation contacting the keel) herein follows the definition described in Prasad & de Lapparent de Broin (2002).* *State (1) occurs in* Theriosuchus pusillus. *State (2) occurs in* Goniopholis, Anteophthalmosuchus, Torvoneustes*, and Machimosaurini.* 0. absent across the dentition 1. present, but restricted to the tooth crowns in the posterior end of the tooth row 2. present across the dentition
281	**Carinae, presence and development of true denticles at crown edges: (*)** *Young (2006, ch. 29 part); Wilkinson et al. (2008, ch. 55 part); Young & Andrade (2009, ch. 53 part); Young et al. (2012, ch. 169); Young et al. (2016, ch. 215).*

	In Thalattosuchia, basal geosaurines are scored as state (1). *Derived genera within Geosaurini are scored as state (2).* *This character is not applicable for taxa that lack carinae on all tooth crowns.* *True ziphodonty herein follows the definition described in Prasad & de Lapparent de Broin (2002).* 0. absent 1. incipient denticles that are poorly defined (hard to discern, in some cases even under Scanning Electron Microscopy). Typically, they either alter the height of the carinal keel very little or not at all (definition described in Young *et al*., 2013) 2. well-defined denticles (can be discerned with or without optical aids)
282	**Carinae (mid-posterior dentition), presence and morphology of denticles at crown edges:** *Buckley et al. (2000, ch. 104 modified); Sereno et al. (2003, ch. 53 modified); Andrade & Bertini (2008a, ch. 132 revised); Andrade et al. (2011, ch. 379 modified – character states re-ordered); Young et al. (2012, ch. 170 modified); Young et al. (2016, ch. 216 modified – new character state added).* *State (1) is putative apomorphy of Notosuchidae + Sphagesauridae.* *In Thalattosuchia, basal geosaurines score as state (2).* *Derived genera within Geosaurini score as state (3).* *Note that this character and the character describing the presence of true denticles appear to correlate. However, the two morphologies are not the same, and it is possible that taxa can score differently for these two characters (i.e., the ziphomorphy condition – see Andrade & Bertini, 2008).* *Moreover, in Metriorhynchidae the development of the denticles, and whether they form a contiguous row along the carina is highly variable. Some taxa have contiguous and well-defined denticles (e.g.* Dakosaurus*,* Plesiosuchus*,* Geosaurus*) while some taxa have*

	*contiguous but incipient denticles (*Torvoneustes*), others non-contiguous incipient denticles (*Tyrannoneustes*,* M. brachyrhynchus*).* 0. carinae and/or denticles are absent (non-ziphodont), or homogenous carina where serrations may appear as the result of superficial enamel ornamentation (false ziphodont) 1. heterogeneous carina, tubercle-like true denticles that do not form a series (ziphomorph) 2. heterogeneous carina, cuneiform or ripple-like true denticles form short rows of 2–10 denticles and do not proceed contiguously along the entire carina (incipient ziphodont) 3. homogeneous carina, cuneiform or ripple-like true true denticles form a contiguous, or near contiguous, series along the entire carina (ziphodont)
283	**Carinae, true denticle shape when observed in lingual or labial view: (*)** *Young et al. (2012, ch. 171); Young et al. (2016, ch. 217).* *In Thalattosuchia,* Plesiosuchus *and* Suchodus are *scored as state (0).* *This character is not applicable for taxa that lack carinae on all tooth crowns, and for those that lack denticles.* 0. "chisel"-shaped or rectangular 1. rounded
284	**Carinae, denticle distribution across the dentition:** *Young et al. (2012, ch. 172); Young et al. (2016, ch. 218).* *In Thalattosuchia, state (2) occurs in* Dakosaurus*.* *At present no taxon is known to combine the microziphodont and macroziphodont conditions. However, it is entirely possible that such a taxon could occur. As such, state (3) was created.* *In Thalattosuchia,* Dakosaurus *scores as (2), while '*Metriorhynchus' brachyrhynchus, Tyrannoneustes lythrodectikos*,* Torvoneustes*,* Geosaurus *and* Plesiosuchus *score as (1).*

	Note that this character appears to correlate with the characters describing the incipient/well-developed denticles and homogeneous/heterogenous carinae (ch. 283). However, these morphologies are not the same, and it is possible that taxa can score differently for these three characters. *In Metriorhynchidae the development of the macroscopic denticles is a putative apomorphy of* Dakosaurus*, giving this genus macroscopic, well-defined contiguous denticles. In contrast,* Plesiosuchus *and* Geosaurus *have microscopic, well-defined contiguous denticles;* Torvoneustes *has microscopic, incipient contiguous denticles; while* Tyrannoneustes *and* M. brachyrhynchus *have microscopic, incipient, non-contiguous denticles.* *Thus, these three characters are describing a different aspect of denticle development and arrangement.* 0. all or most teeth lack denticles 1. all teeth are microziphodont (sensu Andrade et al., 2010) 2. all teeth are macroziphodont (sensu Andrade et al., 2010) 3. teeth show variation in denticle size (with both microziphodonty and macroziphodonty)
285	**Occlusion, relation between maxillary and dentary series:** *Young et al. (2012, ch. 173); Young et al. (2016, ch. 219).* 0. in-line or interlocked 1. maxillary dentition overbites dentary dentition
286	**Morphology of enamel surface ornamentation, apicobasal ridges:** *Young et al. (2012, ch. 174); Young et al. (2016, ch. 220).* *In Thalattosuchia,* Geosaurus*,* Dakosaurus, Rhacheosaurus *and* Cricosaurus *score as state (0).* Tyrannoneustes *scores as state (1).* Plesiosuchus manselii *scores as state (2).*

	0. enamel ornamentation absent macroscopically, although under SEM microscopic ripples may be present 1. enamel ornamentation largely absent, with short, well-spaced, well-defined apicobasally aligned ridges on the basal half of the crown 2. composed of numerous apicobasally aligned ridges that are of low-relief (can only be properly viewed with visual aids), set close to each other, but become shorter and well-spaced towards the carinae 3. composed of numerous well-defined apicobasally aligned ridges, conspicuous and set close to each other
287	**Morphology of enamel surface ornamentation, macroscopic anastomosed pattern:** *Young et al. (2012, ch. 175); Young et al. (2016, ch. 221).* *State (1) occurs in Machimosaurini* (*e.g.* Machimosaurus, 'Steneosaurus' obtusidens), Torvoneustes, Anteophthalmosuchus *and* Goniopholis. 0. absent 1. present and strongly developed, but only in the apical region of the crown
288	**Morphology of enamel surface ornamentation, 'pseudodenticles':** *State (1) occurs in* Machimosaurus hugii *and* M. rex. *The 'pseudodenticles' are denticle-like structures that occur on the enamel ridges, but not on the carinae.* 0. absent 1. present

Axial post-cranial skeleton (Ch. 289 – 314)

[*Vertebrae (= cervical, thoracic, lumbral, sacral and caudal), ribs (= cervical, thoracic, sacral and chevrons)*]

#	Description

289	**Atlas, hypocentrum length:** *Young & Andrade (2009, ch. 122); Young et al. (2012, ch. 176); Young et al. (2016, ch. 222).* 0. long: >15% of odontoid process length 1. short: subequal to odontoid process length (±5%)
290	**Axis, neural arch diapophysis:** *Young & Andrade (2009, ch. 104); Young et al. (2012, ch. 177); Young et al. (2016, ch. 223).* 0. absent 1. present
291	**Presacral vertebrae number:** *Young & Andrade (2009, ch. 156); Young et al. (2012, ch. 178); Young et al. (2016, ch. 224).* 0. 24 1. 25
292	**Number of cervico-dorsal vertebrae where the parapophyses are borne on the centrum ('cervical vertebrae'), including the atlas-axis:** *Young (2006, ch. 35 modified); Wilkinson et al. (2008, ch. 63 modified); Young & Andrade (2009, ch. 63 modified); Young et al. (2012, ch. 179); Young et al. (2016, ch. 225).* 0. 9 or 10 1. 8 2. 7
293	**Cervical vertebrae, hypapophyses:**

	This character scores the presence of distinct hypapophyses on the ventral surface of the cervical centra. *State (1) is a putative apomorphy of Thalattosuchia – where a distinct ventral process is absent (but a reduced anteroposterior keel is still present).* 0. present 1. absent
294	**Cervical vertebrae, shape:** *Clark (1994, ch. 92 modified); Young & Andrade (2009, ch. 145 modified); Young et al. (2012, ch. 180 modified); Young et al. (2016, ch. 226).* *Designed to test the homology of repeated procoely evolution in Crocodylomorpha.* *State (2) is occurs in Eusuchia.* 0. amphicoelous or amphyplatian 1. weakly procoelous (i.e. the *Isisfordia* and *Junggarsuchus* morphotype – posterior condyle is poorly developed, with the rim of the posterior face of the centrum still distinct from the convexity of the condyle) 2. strongly procoelous (i.e. the eusuchian morphotype – well-developed posterior condyle, which is formed by the entire posterior face of the centrum)
295	**Posterior cervical vertebrae, centrum length vs. centrum width:** *Young (2006, ch. 34); Wilkinson et al. (2008, ch. 62); Young & Andrade (2009, ch. 62); Young et al. (2012, ch. 181); Young et al. (2016, ch. 227).* 0. long (centrum length more than 1.5 times the centrum width) 1. moderate (centrum length to width subequal, ±5%) 2. short (centrum length less than 95% of the centrum width)
296	**Middle cervical vertebrae, neural spine height relative to centrum height:**

	Young et al. (2012, ch. 182); Young et al. (2016, ch. 228). *Currently, there is not the information needed to score for most crocodylomorphs. Within Thalattosuchia* Steneosaurus edwardsi *is (0),* St. leedsi *is (1), and metriorhynchids are state (2).* 0. neural spine height is greater than centrum height 1. neural spine and centrum heights are approximately equal 2. neural spine height is less than centrum height
297	**Number of cervico-dorsal vertebrae where the parapophyses are borne on the neural arch ('thoracic vertebrae'):** *Young et al. (2012, ch. 183); Young et al. (2016, ch. 229).* *This character, (along with ch. 299, categorising lumbral vertebrae) was formulated to help understand the regionalisation of the presacral column. Currently, there is not the information needed to score for most crocodylomorphs.* 0. 12 1. 13 2. 14 3. 15
298	**Number of cervico-dorsal vertebrae posterior to the "thoracic vertebrae" and anterior to the sacral vertebrae where the parapophyses are no longer borne on the neural arch ('lumbral vertebrae'):** *Young et al. (2012, ch. 184); Young et al. (2016, ch. 230).* *This character, (along with ch. 298, categorising thoracic vertebrae) was formulated to help understand the regionalisation of the presacral column. Currently, there is not the needed information to score for most crocodylomorphs.* 0. 2

	1. 3 2. 4
299	**Thoracic and lumbral vertebrae, shape:** *Clark (1994, ch. 93 modified); Young & Andrade (2009, ch. 146 modified); Young et al. (2012, ch. 185 modified); Young et al. (2016, ch. 231).* *State (2) is a putative apomorphy of Eusuchia.* 0. amphicoelous or amphyplatian 1. weakly procoelous (i.e. the *Isisfordia* and *Junggarsuchus* morphotype – posterior condyle is poorly developed, with the rim of the posterior face of the centrum still distinct from the convexity of the condyle) 2. strongly procoelous (i.e. the eusuchian morphotype – well-developed posterior condyle, which is formed by the entire posterior face of the centrum)
300	**Thoracic vertebrae, shallow fossa on the anterior margin of the diapophysis immediately lateral to the parapophysis:** *Young & Andrade (2009, ch. 165); Young et al. (2012, ch. 186 modified); Young et al. (2016, ch. 232).* *State (1) is a putative apomorphy of Metriorhynchidae, best observed in thoracic vertebrae mid-to-late in the series.* 0. present 1. absent
301	**Thoracic vertebrae, orientation of parapophysis:** *Young & Andrade (2009, ch. 166); Young et al. (2012, ch. 187); Young et al. (2016, ch. 233).* *State (1) is a putative apomorphy of Metriorhynchidae.*

	0. posteriorly or horizontally 1. anteriorly
302	**Anterior thoracic vertebrae, parapophysis in relation to the diapophysis:** *Young et al. (2012, ch. 188); Young et al. (2016, ch. 234).* *Currently, there is not the information needed to score for most crocodylomorphs. Within Thalattosuchia* Steneosaurus edwardsi *and* St. leedsi *are state 0, and metriorhynchids score as state 1.* 0. parapophysis ventral to, or level with, diapophysis (when observed in lateral view) 1. parapophysis dorsal to diapophysis (when observed in lateral view)
303	**Anterior thoracic vertebrae, neural spine height relative to centrum height:** *Young et al. (2012, ch. 189); Young et al. (2016, ch. 235).* *Currently, there is not the needed information to score for most crocodylomorphs. Within Thalattosuchia* Machimosaurus mosae *and* Steneosaurus edwardsi *are 0, and* St. leedsi *and metriorhynchids score as state 1.* 0. neural spine and centrum heights are approximately equal 1. neural spine height is less than centrum height
304	**Sacral vertebra, number (= sacralisation of the first caudal vertebra):** *Andrade et al. (2011, ch. 432).* *This character scores for a similar character as: Nesbitt (2011, ch. 207); Young et al. (2012, ch. 190); Young et al. (2016, ch. 236). However, those characters referred to an "insertion" of a sacral vertebra between the first and second primordial sacral vertebrae.* *This character scores for the "third" sacral found in certain taxa (e.g.* Machimosaurus*).*

	*Within Thalattosuchia, evidence for three sacral vertebrae is found in Machimosaurini (’*Steneosaurus*’* obtusidens *and* Machimosaurus*).* 0. two 1. three, with the third being the first caudal vertebra
305	**Sacral vertebrae, shape of centra posterior face:** *State (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* 0. circular to sub-circular, with- or without an equatorial bulge 1. distinctly oval, transverse width noticeably greater than dorsoventral height
306	**Caudal vertebra, shape of caudal vertebra 1:** *based on Clark (1994, ch. 94).* *State (1) occurs in* Theriosuchus, *bernissartids and eusuchians.* 0. amphicoelous or amphyplatian 1. biconvex 2. procoelous
307	**Caudal vertebra, shape of the caudal vertebrae posterior to the first caudal:** *based on Clark (1994, ch. 94)* 0. all are amphicoelous or amphyplatian 1. mixture of semi-procoelous, amphicoelous or amphyplatian 2. all are procoelous
308	**Caudal vertebrae, number:** *Young (2006, ch. 36 modified); Wilkinson et al. (2008, ch. 64); Young & Andrade (2009, ch. 64); Young et al. (2012, ch. 191); Young et al. (2016, ch. 239).* 0. less than 46

	1. more than 50
309	**Caudal vertebrae, relative height of neural spine:** *Andrade et al. (2011, ch. 435).* *State (1) occurs in Dyrosauridae.* 0. larger spines are up to 2.5 times the height of vertebral body 1. spines are typically 2.5–4 times the height of vertebral body
310	**Tail, vertebrae morphology near distal end:** *Young (2006, ch. 33); Wilkinson et al. (2008, ch. 61); Young & Andrade (2009, ch. 61); Andrade et al. (2011, ch. 436 – introduced current phrasing of the character); Young et al. (2012, ch. 192); Young et al. (2016, ch. 240).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. non-hypocercal, distal vertebrae isomorphic to poorly heteromorphic 1. hypocercal, caudal series clearly heteromorphic, with a section of the distal vertebrae defining the lower lobe of a tail fin
311	**Axis rib:** *Young et al. (2012, ch. 193); Young et al. (2016, ch. 241).* *State (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* *Callovian teleosaurids have a distinct 'bump' or 'process' where a second articular head would be (see Andrews, 1913). However, in no specimen is there a second articular head preserved.* 0. holocephalous (rib elongate, with one articular head) 1. dichocephalous (rib triradiate, with two articular heads)
312	**Axis rib, tuberculum:**

	Young & Andrade (2009, ch. 149); Young et al. (2012, ch. 194); Young et al. (2016, ch. 242). 0. wide with broad dorsal tip 1. narrow with acute dorsal tip
313	**Sacral vertebrae, relative position of lateral end of the transverse processes (= sacral ribs): (ORDERED)** *Young (2006, ch. 53 + 54); Wilkinson et al. (2008, ch. 81 + 82); Young & Andrade (2009, ch. 81 + 82); Young et al. (2012, ch. 195 + 196); Young et al. (2016, ch. 243 + 244).* *Scores in part the same as Andrade et al. (2011, ch. 434) – but that character does not take into account state (1) of this character.* *States (1+2) occur in Thalattosuchia.* *State (1) occurs in teleosaurids.* *State (2) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* 0. level with the vertebral centrum 1. transverse processes of sacral vertebra 1 lateroventrally directed, ventral relative to the vertebral centrum 2. transverse processes of both sacral vertebrae are lateroventrally directed, ventral relative to the vertebral centrum. In these taxa, the lateral ends of the transverse processes of both sacral vertebrae are typically significantly ventrally arched.
314	**Chevrons (=haemal arches), shape (posterior chevrons have an anterodorsal process):** *Young & Andrade (2009, ch. 164); Young et al. (2012, ch. 197); Young et al. (2016, ch. 245).* *State (1) is a putative apomorphy of Metriorhynchidae.*

	0. either ‘V’ or ‘Y’-shaped, no distinct anterodorsal process 1. posterior chevrons have a ‘W’-shape when observed in anterior view, formed by an anterodorsal process rising between the ‘Y’-shape

Appendicular skeleton: pectoral girdle and forelimbs (Ch. 315 – 331

[pectoral elements: coracoids, scapulae; stylopodia (humeri), zeugopodia (radii & ulnae), mesopodia (radiale/ulnare), metapodia (metacarpals)]

#	Description
315	**Coracoid, shape:** *Young (2006, ch. 40); Wilkinson et al. (2008, ch. 69); Young & Andrade (2009, ch. 69); Young et al. (2012, ch. 198); Young et al. (2016, ch. 246).* *State (1) occurs in teleosaurids and basal metriorhynchoids.* *State (2) occurs in Metriorhynchidae.* 0. neither proximal (i.e. glenoid region) nor distal (i.e. postglenoid process) ends are fan-shaped, having angular margins 1. distal end convex, forming a gentle fan-shape while the proximal end is triangular in shape with blunt ends 2. both proximal and distal ends are convex
316	**Coracoid, postglenoid process:** *Nesbitt (2011, ch. 223); Young et al. (2016, ch. 247).* *State (0) occurs in non-crocodylomorphs.* *State (1) occurs in 'sphenosuchians'.* *State (2) is a putative apomorphy of Crocodyliformes.* 0. short

	1. elongate and expanded posteriorly only 2. elongate and expanded anteriorly and posteriorly
317	**Coracoid, posteroventral edge, deep groove:** *Nesbitt (2011, ch. 224); Young et al. (2016, ch. 248).* *State (1) occurs in Rauisuchiae and most sphenosuchians.* 0. absent 1. present
318	**Scapula blade:** *Young et al. (2012, ch. 199); Young et al. (2016, ch. 249).* *State (1) is a putative apomorphy of* Thalattosuchia. 0. scapula blade very large: more than 200% of the width of the scapular shaft, generally wider than the distal glenoid region 1. scapula blade reduced: being as narrow, or narrower than, the proximal region and less than 150% the width of the scapular shaft
319	**Scapula, anterior and posterior margins in lateral aspect:** *Young & Andrade (2009, ch. 105 modified); Young et al. (2012, ch. 200); Young et al. (2016, ch. 250).* 0. symmetrically concave in lateral view 1. anterior edge more strongly concave than posterior edge 2. posterior edge more strongly concave than anterior edge
320	**Scapula, deltoid crest:** *Young & Andrade (2009, ch. 106); Young et al. (2012, ch. 201); Young et al. (2016, ch. 251).*

	0. present 1. absent
321	**Scapula/Humerus, size:** *Young (2006, ch. 39); Wilkinson et al. (2008, ch. 68); Young & Andrade (2009, ch. 68); Young et al. (2012, ch. 202); Young et al. (2016, ch. 252).* 0. humerus longer than scapula (> 15%) 1. humerus and scapula subequal in length (± 13%) 2. humerus shorter in length than scapula (< 15%)
322	**Limb bones (forelimbs), proportional length of ulna relative to the humerus: (ORDERED)** *Andrade et al. (2011, ch. 452).* *State (2) is a putative apomorphy of Thalattosuchia (not Teleosauridae as putatively put forward by Andrade et al., 2011).* *In Thalattosuchia the ulna is typically between 48%-72% of the length of the humerus (perhaps being longer in juvenile specimens).* *State (2) also occurs in the* Pachycheilosuchus + Pietraroiasuchus *clade.* 0. ulna clearly longer than humerus 1. ulna subequal to humerus (distal/proximal = 75-125%) 2. ulna clearly shorter than the humerus
323	**Humerus, proximal head:** *Nesbitt (2011, ch. 232 modified - added state 2); Young et al. (2012, ch. 203 modified); Young et al. (2016, ch. 253).*

	*In Thalattosuchia, derived teleosaurids (*Aeolodon priscus, S. bollensis, S. leedsi, S. edwardsi*) have state (2) - the posterior deflection being much more pronounced than in other thalattosuchians.* *In Geosaurini and Rhacheosaurini taxa change to state (0).* 0. confined to the proximal surface 1. posteriorly expanded and hooked 2. very strongly posteriorly deflected and hooked, with the posterior proximal head noticeably posterior to the distal head.
324	**Humerus, proximomedial articular surface:** *Young & Andrade (2009, ch. 107); Young et al. (2012, ch. 204); Young et al. (2016, ch. 254).* 0. strongly convex 1. weakly convex
325	**Humerus, deltopectoral crest:** *Young (2006, ch. 38 modfied); Wilkinson et al. (2008, ch. 66 modified); Young & Andrade (2009, ch. 66 modified); Young et al. (2012, ch. 205); Young et al. (2016, ch. 255).* *Young et al. (2012) removed state (2) (absent/vestigial) as metriorhynchids of the subclade Rhacheosaurini do indeed have a deltopectoral crest on their humeri.* 0. present and distinct from the proximal surface 1. present, but continuous with the proximal surface
326	**Humerus, shape:** *Young et al. (2012, ch. 206); Young et al. (2016, ch. 256).* *State (1) is a putative apomorphy of Metriorhynchidae.*

	This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae. 0. has typical long bone morphology (longer than wide at distal end) 1. broadly expanded and plate-like
327	**Humerus, length of the shaft relative to total humerus length:** *Wilkinson et al. (2008, ch. 67); Young & Andrade (2009, ch. 67); Young et al. (2012, ch. 207); Young et al. (2016, ch. 257).* *This character quantifies the reduction in humeral shaft size in Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. shaft contributing more than 50% of total humeral length 1. shaft contributes 35–38% of total humeral length 2. shaft contributes less than 25% of total humeral length
328	**Humerus-antebrachium joint surface:** *Young et al. (2012, ch. 208); Young et al. (2016, ch. 258).* *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. complex, allowing one degree of motion 1. planar, limiting possible motion
329	**Radius and/or ulna, shape:** *Young (2006, ch. 37); Wilkinson et al. (2008, ch. 65); Young & Andrade (2009, ch. 65); Young et al. (2012, ch. 209 + 211); Young et al. (2016, ch. 259 + 261).*

	State (1) is a putative apomorphy of Metriorhynchidae. *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. typical long bone morphology (proximodistal length noticeably greater than width at distal end) 1. broadly expanded and plate-like
330	**Radiale and/or ulnare, shape:** *Young et al. (2012, ch. 210 + 212); Young et al. (2016, ch. 260 + 262).* *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. typical long bone morphology (proximodistal length noticeably greater than width at distal end) 1. broadly expanded and plate-like
331	**Metacarpal 1, shape:** *Young (2006, ch. 41); Wilkinson et al. (2008, ch. 70); Young & Andrade (2009, ch. 70); Young et al. (2012, ch. 213); Young et al. (2016, ch. 263).* *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. elongate, more than twice as long as wide 1. broadly expanded, maximum width at least 60% of total length

Appendicular skeleton: pelvic girdle and hind limbs (Ch. 332 – 359

[Pelvic elements: pubes, ilia, ischia; stylopodia (femora), zeugopodia (tibiae), mesopodia (calcanea), metapodia (metatarsals), digits (phalanges)]

#	Description
332	**Pubis, exclusion from acetabulum:** *Turner & Sertich (2010, ch. 86); Andrade et al. (2011, ch. 445); Young et al. (2012, ch. 214 part); Young et al. (2016, ch. 264 part).* *Following Claesson (2004) state (1) occurs in Crocodyliformes.* *This scores the pubis articulation with the acetabulum (state 0), and the mobile pubis articulating with the ischium anterior process (state 1).* 0. pubis not excluded, participating at least marginally to the anteroventral rim of the acetabulum 1. pubis excluded, acetabulum composed exclusively by the ischium and illium
333	**Pubis, presence of exclusive proximal contact with ischium:** *Andrade et al. (2011, ch. 446) – based on Andrews (1913) and Clark (1994, ch. 86).* *Note that in Metasuchia this character correlates with the pubic exclusion from the acetabulum; however, thalattosuchians also have the pubis excluded from the acetabulum, but the pubis articulates between the ischium pubic process and the ilium anterior peduncle.* 0. absent, pubis supported by both ilium and ischium 1. present, proximal head of pubis contacts only the ischium
334	**Pubis, length:** *Nesbitt (2011, ch. 278); Young et al. (2016, ch. 265).* 0. less than 70% of femoral length 1. 70% or more of femoral length

335	**Pubis, expansion of distal end:** *Clark (1994, ch. 85 modified); Andrade et al. (2011, ch. 447 modifed); Nesbitt (2011, ch. 283 modified).* *Note that* Postosuchus *has a pubic boot (along with other non-crocodylomorph pseudosuchians; Nesbitt, 2011; Weinbaum, 2013). Here we test the homology of this pubic boot with that seen in crocodylomorphs (the* Protosuchus *distal expansion, and the 'fan'-like pubic blade seen in other crocodyliforms). Nesbitt (2011) reports that a small posterior expansion is present in the holotype of* Hesperosuchus agilis*, suggesting the lack of an expansion in* Terristrisuchus *is apomorphic.* 0. absent 1. expanded relative to the shaft (= pubic boot) 2. a "fan-like" expansion creating a distinct pubic blade.
336	**lium, presence of a distinct 'bulge' that fuses the anterior regions of the supraacetabular and dorsal iliac crests: (*)** *State (1) occurs in* Anteophthalmosuchus hooleyi *and* Crocodylus. *This character is not applicable for taxa that lack the dorsal iliac crest.* 0. anterior region of the supraacetabular crest does not fuse with the anterior margin of the iliac dorsal crest, as there is no anterior 'bulge' 1. anterior region of the crest bulges laterally (slightly overhanging the acetabular fossa), and is contiguous with the anterior margin of the iliac dorsal crest
337	**Ilium, postacetabular (=posterior) process presence:** *Young & Andrade (2009, ch. 128 modified), Young et al. (2012, ch. 215 modified); Wilberg (2015b, ch. 368); Young et al. (2016, ch. 266 modified).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. present

	1. absent/extremely reduced
338	**Ilium, postacetabular (=posterior) process expanded into a thin "fan"-shape: (*)** *Young et al. (2012, ch. 216); Wilberg (2015b, ch. 369); Young et al. (2016, ch. 267).* *State (1) is a putative apomorphy of derived teleosaurids (not seen in basal taxa* Platysuchus multiscrobiculatus, Teleosaurus cadomensis, Steneosaurus gracilirostris *and* S. bollensis where the process is still elongate and distinctly process-like*). This structure is a modification of the postacetabular (=posterior) process in these taxa.* *This character is not applicable for taxa that lack the postacetabular process.* 0. no 1. yes, posterior margin is expanded into a mediolaterally thin "fan"-shape, that extends from the iliac crest towards the posterior peduncle
339	**Ilium, postacetabular (=posterior) process, presence of constrictions ('wasp-waisting') on both the dorsal and ventral margins near the distal terminus: (*)** *State (1) occurs in* Anteophthalmosuchus epikrator *and* Crocodylus*.* *This character is not applicable for taxa that lack the postacetabular process.* 0. absent 1. present
340	**Illium, size:** *Young (2006, ch. 42); Wilkinson et al. (2008, ch. 71); Young & Andrade (2009, ch. 71); Young et al. (2012, ch. 217); Young et al. (2016, ch. 268).* 0. large (length of dorsal border more than 28%, and typically at least 30% of femur length) 1. small (length of dorsal border less than 21% of femur length)

341	**Ilium, in lateral view, the orientation of the dorsal margin of the articulation facet that contributes to the acetabulum is:** *Young et al. (2016, ch. 269).* *State (1) is a putative autapomorphy of* Tyrannoneustes lythdrodectikos. 0. ventrally orientated 1. horizontally orientated
342	**Ilium, dorsal border length in lateral view:** *Young et al. (2016, ch. 270).* *State (1) is a putative autapomorphy of* Tyrannoneustes lythdrodectikos. 0. long, terminates at least level to the articulation facet that contributes to the acetabulum 1. short, terminates prior to the articulation facet that contributes to the acetabulum
343	**Ilium, ventral margin:** *State (1) is a putative apomorphy of Metriorhynchidae.* 0. distinct ilium and ischium peduncles separated by an acetabular incision/depression 1. lacks an acetabular depression, with the peduncles being contiguous with the ventral margin
344	**Ischium, pubic (=anterior) process:** *Young (2006, ch. 43); Wilkinson et al. (2008, ch. 72); Young & Andrade (2009, ch. 72); Young et al. (2012, ch. 218); Young et al. (2016, ch. 271).* 0. developed – with clearly defined articulation facets for pubis and ilium; additionally, anterior process is at least half as wide as the posterior process 1. reduced – lacks both articulation facets, and is 30–50% as wide as the posterior process

	2. highly reduced – lacking both articulation facets, and is < 25% as wide as the posterior process
345	**Limb bones, relative length of forelimbs/hindlimbs (= *humerus* + *radius : femur* + *tibia*):** *Brochu (1999, ch. 33 part); Young & Andrade (2009, ch. 109 modified); Andrade et al. (2011, ch. 450 modified); Nesbitt (2011, ch. 212 modified); Young et al. (2012, ch. 230 modified); Young et al. (2016, ch. 284 modified).* *Andrade et al. (2011) modified the crocodylomorph variant of this character to sample relative length of limbs, not robustness or limb/trunk relative length. This current version of the character is an amalgam of that version and the one in Nesbitt (2011), which Young et al. (2016) modified to include extra states to reflect the forelimb reduction in Thalattosuchia.* *This character does not consider the autopodia (manus and pes), only the relation between the stylopodia and zeugopodia (humerus+ulna and femur+tibia, respectively).* *States (3+4) reflects the extreme conditions found in Thalattosuchia. State (4) evolved twice, once in Metriorhynchidae, and also in derived teleosaurids (the Middle Jurassic* 'Steneosaurus' *clade). Note that basal thalattosuchians (e.g.* Steneosaurus bollensis, Platysuchus *and* Pelagosaurus*) have state (2).* *State (3) also evolved in the* Pachycheilosuchus + Pietraroiasuchus *clade.* *Basal crocodylomorphs also share state (2), while the outgroup taxon* Postosuchus *scores for state (3).* *and paralleled by a few other basal forms. Within Eusuchia, Brochu (1999) considers that state (0) only occurs in* Borealosuchus. 0. forelimb and hindlimb subequal in length at maturity 1. forelimb slightly shorter than hindlimb at maturity

	2. forelimb shorter than hindlimb at maturirty (between 90 and 55%) 3. forelimb noticeably shorter than hindlimb at maturity (between 45 and 55%) 4. forelimb significantly shorter than hindlimb at maturity (less than 45%)
346	**Limb bones (hind limbs), proportional length of tibia relative to the femur: (ORDERED)** *Young (2006, ch. 44 modified); Wilkinson et al. (2008, ch. 73 modified); Young & Andrade (2009, ch. 73 modified); Andrade et al. (2011, ch. 453 modified); Young et al. (2012, ch. 225 + 231 modified); Young et al. (2016, ch. 278 modified).* *This version of the character is an amalgam of the ones in Andrade et al. (2011) and Young et al. (2016).* *This character is designed to help elucidate variation in the proportions of the hind limb, and the changes that occur in Thalattosuchia (where the femur can be almost twice the size of tibia, i.e. in Metriorhynchidae). Thus states (1-4) are putative apomorphies of Thalattosuchia.* *In Thalattosuchia, state (3) is a putative apomorphy of both Metriorhynchinae and* Aeolodon priscus*, with derived metriorhynchines being state (4). Middle Jurassic teleosaurids (and the Late Jurassic genus* Machimosaurus*) and Geosaurinae score as state (2).* *Thus, this character is scoring for the independent regression of the tibia (as a proportion of the hind limb) in Teleosauridae and Metriorhynchidae.* 0. tibia subequal to femur, or only slightly shorter (distal/proximal >74%) 1. length uneven, tibia evidently shorter than the femur (distal/proximal c. 50-74%) 2. length uneven, tibia evidently shorter than the femur (distal/proximal c. 40-50%) 3. length uneven, tibia evidently shorter than the femur (distal/proximal c. 30-40%)

	4. length uneven, tibia evidently shorter than the femur (distal/proximal less than 30%)
347	**Femur, general shape:** *Andrade et al. (2011, ch. 464).* *State (1) is a putative apomorphy of Thalattosuchia.* 0. poorly sigmoid 1. strongly sigmoid
348	**Femur, proximal portion, posteromedial tuber:** *Nesbitt (2011, ch. 301 modified – character states re-ordered); Young et al. (2012, ch. 219); Young et al. (2016, ch. 272).* *State (2) is a putative apomorphy of Metriorhynchidae.* 0. absent 1. present and small 2. present and largest of the proximal tubera
349	**Femur, proximal condylar fold:** *Nesbitt (2011, ch. 312); Young et al. (2012, ch. 220); Young et al. (2016, ch. 273).* 0. absent 1. present
350	**Femur, ridge of attachment for the *M. caudofemoralis*:** *Young & Andrade (2009, ch. 108 modified); Nesbitt (2011, ch. 315 modified); Young et al. (2012, ch. 221); Young et al. (2016, ch. 274).* *We follow Young et al. (2016) in scoring thalattosuchians as state (0). They lack a fourth trochanter sensu stricto, as they only have a large flattened rugose area for the*

	muscle attachment, not a distinct process. Thus state (0) is a putative apomorphy of Thalattosuchia. 0. absent, flattened rugose area 1. low and without a distinct medial asymmetrical apex (= fourth trochanter) 2. bladelike with a distinct asymmetric apex located medially
351	**Lateral edge of proximal articular surface of femur (lesser trochanter):** *Young & Andrade (2009, ch. 117); Young et al. (2012, ch. 222); Young et al. (2016, ch. 275).* 0. rounded 1. 'squared' with enlarged scar for *Musculus ischiotrochantericus*
352	**Femur, medial condyle of the distal portion:** *Nesbitt (2011, ch. 320); Young et al. (2012, ch. 223); Young et al. (2016, ch. 276).* 0. tapers to a point on the medial portion in distal view 1. smoothly rounded in distal view
353	**Femur, distal surface between the lateral and medial condyles:** *Nesbitt (2011, ch. 321); Young et al. (2012, ch. 224); Young et al. (2016, ch. 277).* 0. nearly flat or flat 1. groove separating the medial condyle from the lateral condyle
354	**Calcaneum tuber, development:** *Young (2006, ch. 45 modified); Wilkinson et al. (2008, ch. 74 modified); Young & Andrade (2009, ch. 74 modified); Andrade et al. (2011, ch. 466); Young et al. (2012, ch. 226 modified); Young et al. (2016, ch. 279 - rephrased).* *This character scores the regression of the tuber in metriorhynchines.*

	0. well developed with a long neck (typically subequal in length to main body of calcaneum) 1. poorly developed with a short neck (less than half length of calcaneum main body, and projects out in one plane from the calcaneum main body)
355	**Metatarsals, length:** *Young (2006, ch. 46); Wilkinson et al. (2008, ch. 75); Young & Andrade (2009, ch. 75); Young et al. (2012, ch. 227); Young et al. (2016, ch. 280).* 0. metatarsals 1–4 longer than their repective digit phalanges (>20%) 1. metatarsals 2–4 shorter than their respective digit phalanges (< 90%)
356	**Metatarsal I, morphology of proximal end: (ORDERED)** *Young (2006, ch. 47 modified); Wilkinson et al. (2008, ch. 76 modified); Young & Andrade (2009, ch. 76 modified); Andrade et al. (2011, ch. 467 modified); Young et al. (2012, ch. 228); Young et al. (2016, ch. 281).* *This character scores the broadening of metatarsal I seen in metriorhynchines.* 0. proximal end not enlarged (no more than 10% wider than any other metatarsal) 1. proximal end enlarged (20-30% wider) 2. proximal end moderately enlarged (45-55% wider) 3. proximal end greatly enlarged (>75% wider)
357	**Pes, relative length of digits III and IV:** *Young (2006, ch. 48); Wilkinson et al. (2008, ch. 77); Young & Andrade (2009, ch. 77); Andrade et al. (2011, ch. 465); Young et al. (2012, ch. 229); Young et al. (2016, ch. 283).* *Usually in crocodylomorphs digit length (in descending order) is: III-IV-II-I.*

	State (1) is putative apomorphy of Metriorhynchidae, and with digit length arranged as IV-III-II-I (see Young & Andrade 2009, Appendix 2). 0. digit III is longer than digit IV 1. digit IV is longer than digit III (digit IV elongated, helping to create a paddle)
358	**Pedal digit IV, number of phalanges: (ORDERED)** *Nesbitt (2011, ch. 396 modified).* *State (0) is a putative apomorphy of* Postosuchus*.* *State (1) occurs in most archosauriforms.* *State (2) is a putative apomorphy of Crocodylomorpha.* *We added state (0) as six pedal digit IV phalanges has been reported for specimens of* P. alisonae *Peyer et al. (2008) and* P. kirkpatricki *(Weinbaum, 2013).* 0. six 1. five 2. four or fewer
359	**Pedal digit V, metatarsals and phalanges:** *Clark (1994, ch. 88 modified); Nesbitt (2011, ch. 399 re-phrased); Young et al. (2016, ch. 282).* *State (0) occurs in non-crocodylomorphs, state (1) occurs in 'sphenosuchians', while state (2) is a putative apomorphy of Crocodyliformes.* 0. present and ‘‘fully’’ developed first phalanx 1. present and ‘‘poorly’’ developed first phalanx 2. without phalanges and metatarsal tapers to a point

Dermal ossifications: osteoderms (Ch. 360 – 382)

#	Description
360	**Ornamentation (dorsal osteoderms), type of sculpture: (*)** *Ortega et al. (2000, ch. 111); Andrade et al. (2011, ch. 19).* *Ornamentation on the osteoderms is always present, and only in two possible forms. Note that Turner & Buckley (2008) considered that* Araripesuchus gomesii *and (possibly)* A. tsangatsangana *displayed the 'fleur de lys' pattern (anterolaterally and anteromedially directed "ridges"; Osmólska et al., 1997), according to the character by Pol & Norell (2004b, ch188). We consider that this pattern regards the disposition of the sculpturing (fabric), not the type of sculpturing.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. vermiform-dendritic pattern 1. pitted pattern
361	**Ornamentation (dorsal osteoderms), distribution of pits on dorsal surface: (*)** *Young et al. (2012, ch. 239); Young et al. (2016, ch. 297).* *State (2) is a putative apomorphy of Machimosaurini*. *This character is not applicable for taxa that lack dorsal osteoderms.* 0. small round to ellipsoid pits, very densely distributed 1. large round to ellipsoid pits, well separated from one another 2. pits variable in size and length, from small to large, but on osteoderms with a keel, the pits can become elongate grooves, especially along the lateral margins
362	**Osteoderms, dorsal to the vertebral column:** *Young (2006, ch. 51); Wilkinson et al. (2008, ch. 80); Young & Andrade (2009, ch. 80); Nesbitt (2011, ch. 401); Young et al. (2012, ch. 232 part); Wilberg (2015b, ch. 382); Young et al. (2016, ch. 285).* *State (0) occurs in* Junggarsuchus *and Metriorhynchidae.*

	0. absent 1. present
363	**Nuchal armour, relation of nuchal osteoderms with the remaining dorsal armour and skull: (*)** *Brochu (1999, ch. 38 modified, part); Andrade et al. (2011, ch. 469).* *Note that a similar character was devised by Ortega et al. (2000, ch. 109), but to unite the undescribed Itaborai form and* Sebecus*. See also McAliley et al. (2006) for discussion on eusuchians*. *This character is not applicable for taxa that lack dorsal osteoderms.* 0. large nuchal shields continuous from postoccipital region to trunk armour, with any given osteoderm contacting the anterior and posterior elements (except for the first postoccipital shield) 1. large nuchal shields continuous with trunk armour, but not reaching the postoccipital region 2. large nuchal shields discontinuous with dorsal trunk armour and absent from postoccipital region
364	**Nuchal armour, number and arrangement of nuchal shields: (*)** *Brochu (1999, ch. 38 modified & revised in part); Andrade et al. (2011, ch. 470).* *Brochu (1999, ch. 38) modified state (3), and the terminology 'cervical shield' is according to Marinho & Carvalho (2009). See also McAliley et al. (2006) for discussion on eusuchians.* *This character is not applicable for taxa that lack dorsal osteoderms. or that lack a distinct nuchal shield (i.e. thalattosuchians).* 0. four paramedian nuchal shields, sided by two accessory shields, all enlarged relative to the remaining neck dermal armour

	1. four paramedian nuchal shields enlarged relative to remaining neck shields, and no accessory shield enlarged 2. eight (or more) shields, arranged in two paramedian rows, enlarged relative to remaining neck shields, with no accessory shield enlarged 3. ten or more median osteoderms, combined with several lateral osteoderms, composing a distinct cervical shield
365	**Nuchal armour, morphology of nuchal shields relative to the remaining trunk dermal armour: (*)** *Brochu (1999, ch. 38 modified in part); Andrade et al. (2011, ch. 471).* *State (1) occurs in* Armadilosuchus *and Susisuchidae + Eusuchia.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. nuchal and dorsal trunk shields undifferentiated, morphology grading continuously 1. nuchal shields clearly differentiated from dorsal trunk shields by size and general morphology (regardless of contact between nuchal and trunk series)
366	**Presacral dorsal armour, presence of an anterior process (= anterolateral process, stylofoveal process) to articulate with the anterior adjacent osteoderm, in medial dorsal elements: (*)** *Andrade et al. (2011, ch. 477); Young et al. (2012, ch. 233); Young et al. (2016, ch. 286).* *Scores for a similar morphology as Nesbitt (2011, ch. 403).* *Note that this process does not include the lateral processes seen in dyrosaurids, as they articulate with the accessory osteoderms.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent 1. present

367	**Presacral dorsal armour, surface of only the paravertebral osteoderms: (*)** *Andrade et al. (2011, ch. 476); Nesbitt (2011, ch. 404); Young et al. (2012, ch. 235); Young et al. (2016, ch. 287).* *Crocodile-line archosaurs including, basal crocodylomorphs, have state (1).* *In Thalattosuchia* Teleosaurus *and* Platysuchus *also have state (1).* *Crocodyliformes have state (0).* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. either weakly arched or mostly straight, forming a plain flat osteoderm, either keeled or not 1. osteoderm strongly curved, with convex surface, partially embracing the vertebrae from side to side
368	**Presacral dorsal armour, biserial or tetraserial dorsal shield: (*)** *Young & Andrade (2009, ch. 147 part); Young et al. (2016, ch. 289).* *Susisuchidae + Eusuchia have state (1).* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. Biserial dorsal shield (one pair of paramedian osteoderms per row) 1. Tetraserial dorsal shield (two pairs of paramedian osterderms per row)
369	**Presacral dorsal armour, presence of accessory osteoderm columns that do not have a peg-like articulation with the paramedian column, and which are smaller in size than the paramedian column(s): (ORDERED) (*)** *This character is an amalgam of Andrade et al. (2011, ch. 472 + 473) and Young et al. (2016, ch. 290).* *This character does not consider the accessory osteoderms of dyrosaurids to be homologous (see character relating to the osteoderm anterolateral process).*

	This character does not consider the accessory osteoderms of notosuchians to be homologous, as their accessory osteoderms can retain the same size and shape as the paramedian column. *State (1) occurs in Bernissaartidae, Susisuchidae, and Eusuchia.* *State (2) occurs in* Brachychampsa *and* Alligator mississippiensis. *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent (either has: two paravertebral medial columns, the gobiosuchid or notosuchian or dyrosaurid morphology) 1. present, a lateral accessory column on either of the paramedian columns 2. present, two lateral accessory columns on either of the paramedian columns
370	**Presacral dorsal armour, presence of accessory osteoderm column that has a peg-like articulation with the paramedian column (through a 'lateral process' derived from the anterolateral margin of the paramedian osteoderms).** *Jouve et al. (2008, ch. 37 modified); Hastings et al. (2010, ch. 82 modified); Young et al. (2016, ch. 291).* *State (1) occurs in dyrosaurids.* *This character was applied to test the homology of accessory osteoderms in dyrosaurids.* 0. absent 1. present
371	**Presacral dorsal armour, dimensions of the thoracic osteoderms: (*)** *Clark (1994, ch. 95 modified); Nesbitt (2011, ch. 407); Young et al. (2012, ch. 234); Young et al. (2016, ch. 292).* *Crocodile-line archosaurs, including basal crocodylomorphs, have state (1).* *In Thalattosuchia, cervical osteoderms can be either state (0) or (1), so Young et al. (2016) altered this character not to include the cervical osteoderms.*

	Crocodyliformes have state (2). *This character is not applicable for taxa that lack dorsal osteoderms.* 0. square shaped, length and width approximately equal 1. longer than wide 2. wider than long
372	**Presacral dorsal armour, transverse elongation of the thoracic osteoderms: (*)** *State (1) occurs in goniopholidids and pholidosaurids (reversal in dyrosaurids).* *This character can only be scored for those osteoderms that overlay the thoracic vertebrae, and come from the middle region of the trunk.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. transverse width of these osteoderms is either small or sub-equal to the anteroposterior length, or only slightly wider 1. considerably wider than long, such that the transverse width is approximately three times the anteroposterior length
373	**Presacral dorsal armour, type of contact between elements in a row: (*)** *Clark (1994, ch. 98); Andrade et al. (2011, ch. 474).* *State (1) occurs in crown-group Crocodylia.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. imbricated, any given anterior trunk osteoderm partially overlays its following element 1. sutured, osteoderms do not cover adjacent dermal elements, and are sutured if in contact
374	**Presacral ventral osteoderms (= gastral osteoderms), form a carapace in the trunk region:**

	Young (2006, ch. 50 modified); Wilkinson et al. (2008, ch. 79 modified); Young & Andrade (2009, ch. 79 modified); Nesbitt (2011, ch. 409 re-phrased); Young et al. (2012, ch. 236 modified); Young et al. (2016, ch. 294). *Crocodyliformes have state (1).* 0. absent 1. present
375	**Postsacral armour, distribution of dorsal tail osteoderms:** *Clark (1994, ch. 99 modified); Young et al. (2012, ch. 237); Young et al. (2016, ch. 295).* *Young et al. (2012) split the dorsal and ventral tail osteoderm character as* Pelagosaurus *and* Pietraroiasuchus *lack ventral tail osteoderms, but have dorsal tail osteoderms.* 0. present, covering at least half of the tail 1. present, covering less than half of the tail 2. absent
376	**Postsacral armour, distribution of ventral tail osteoderms:** *Young (2006, ch. 49 part); Wilkinson et al. (2008, ch. 78 part); Young & Andrade (2009, ch. 78 part); Young et al. (2012, ch. 238); Young et al. (2016, ch. 296).* *State (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae, and occurs in* Pietraroiasuchus. 0. present 1. absent
377	**Postsacral armour, distribution when present: (*)** *Clark (1994, ch. 99 modified); Young (2006, ch. 49 part); Wilkinson et al. (2008, ch. 78 part); Young & Andrade (2009, ch. 78 part); Andrade et al. (2011, ch. 481).* *This character is not applicable for taxa that lack caudal osteoderms.*

	0. a pair of rows, covering the vertebral column 1. several rows, enclosing the tail surface
378	**Presacral dorsal armour, presence of an anteroposteriorly directed keel on the dorsal surface of paramedial elements:** *Buscalioni et al. (1992, ch. 22); Clark (1994, ch. 101 revised, part); Brochu (1999, ch. 35); Andrade et al. (2011, ch. 478); Young et al. (2012, ch. 240 modified); Young et al. (2016, ch. 298).* *State (0) occurs in* Pelagosaurus. *In Thalattosuchia the cervical and anterior dorsal osteoderms can have reduced keels, which can make it look as though they are absent. Also, in Thalattosuchia the sacral and anterior-mid caudal osteoderms have raised keels.* 0. absent on most/all paravertebral osteoderms 1. present along the entire (or almost all) the paravertebral osteoderms
379	**Presacral ventral armour, presence of ventral collar scales:** *Poe (1997); Brochu (1999, ch. 156); Andrade et al. (2011, ch. 479).* 0. absent, no shield enlarged relative to other ventral scales 1. present, forming a single row of enlarged scales 2. present, forming two parallel rows of enlarged scales
380	**Presacral ventral armour, presence of paired ossifications:** *Buscalioni et al. (1992, ch. 21); Brochu (1999, ch. 39); Andrade et al. (2011, ch. 480).* 0. single or absent 1. present, pairs sutured together
381	**Postsacral armour, presence of an anteroposteriorly directed keel on the dorsal surface of paramedial elements:**

	Clark (1994, ch. 101 part revised); Andrade et al. (2011, ch. 482). 0. absent 1. present
382	**Appendicular armour, presence of osteoderms on the limbs (at least in part):** *Pol & Norell (2004b, ch. 190); Nesbitt (2011, ch. 405); Young et al. (2016, ch. 288).* *Crocodyliformes have state (1), but perhaps with reversals in some clades.* *Limb osteoderms are rarely preserved, but have been mentioned for some dyrosaurids and advanced neosuchians.* 0. absent 1. present

Dermal ossifications: gastralia (Ch. 383)

#	Description
383	**Gastralia:** *Nesbitt (2011, ch. 412).* *State (0) occurs in Postosuchus, 'sphenosuchians', and* Protosuchus. *State (1) occurs in crocodyliforms more derived than* Protosuchus. 0. forming extensive ventral basket with closely packed elements 1. well-separated 2. absent

Soft tissue and physiology (Ch. 384 – 387)

#	Description
384	**Tongue, presence of keratinised surface:** *Brochu (1999, ch. 159); Andrade et al. (2011, ch. 483).* *State (1) is a putative apomorphy of Alligatoridae/Alligatoroidea, but unknown in all fossil taxa (thus '?').* *Originally based on Taplin & Grigg (1989), apud Brochu (1999).* 0. absent 1. presence
385	**Functional lingual salt glands, presence:** *based on Taplin (1985); Taplin & Grigg (1989); Brochu (2007); Andrade et al. (2011, ch. 484).* *State (0) is a putative apomorphy of Alligatoridae, but unknown in all fossil taxa.* 0. absent 1. present
386	**Internal enlarged cephalic (salt excretory) glands, presence:** *Andrade et al. (2011, ch. 485).* *The evidence for internal large cephalic glands is well supported (Fernández & Gasparini, 2000, 2008; Gandola et al., 2006; Fernández & Herrera, 2009), and interpreted as structures for salt excretion. In fossil specimens, lobulations for glands must show a regular pattern, and have no trabecular bones, which othewise indicate the presence of pneumatic cells of air sinuses (Fernández & Herrera, 2009). Internal glands are also associated with gland drainage ducts.* 0. absent 1. present

387	***M. caudofemoralis*, morphology:** *Frey et al. (1989); Brochu (1999, ch. 160); Andrade et al. (2011, ch. 486).* *State (0) is known in* Gavialis. *State (1) is known for all other extant crocodylians.* 0. with single head 1. with double head (*longus* and *brevis*)

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