# Crocodylian diversity peak and extinction in the late Cenozoic of the northern Neotropics



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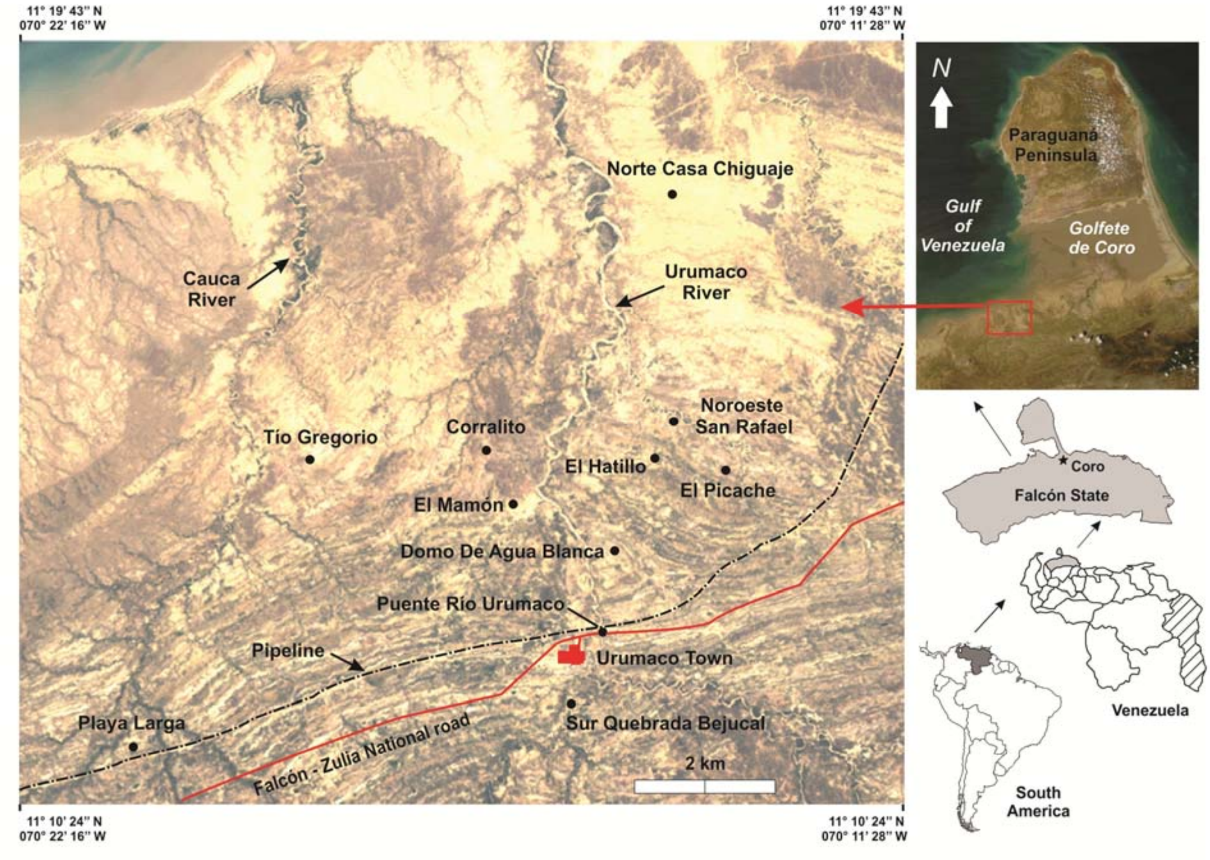
**Supplementary Information for:**

# Crocodylian diversity peak and extinction in the late Cenozoic of the northern Neotropics

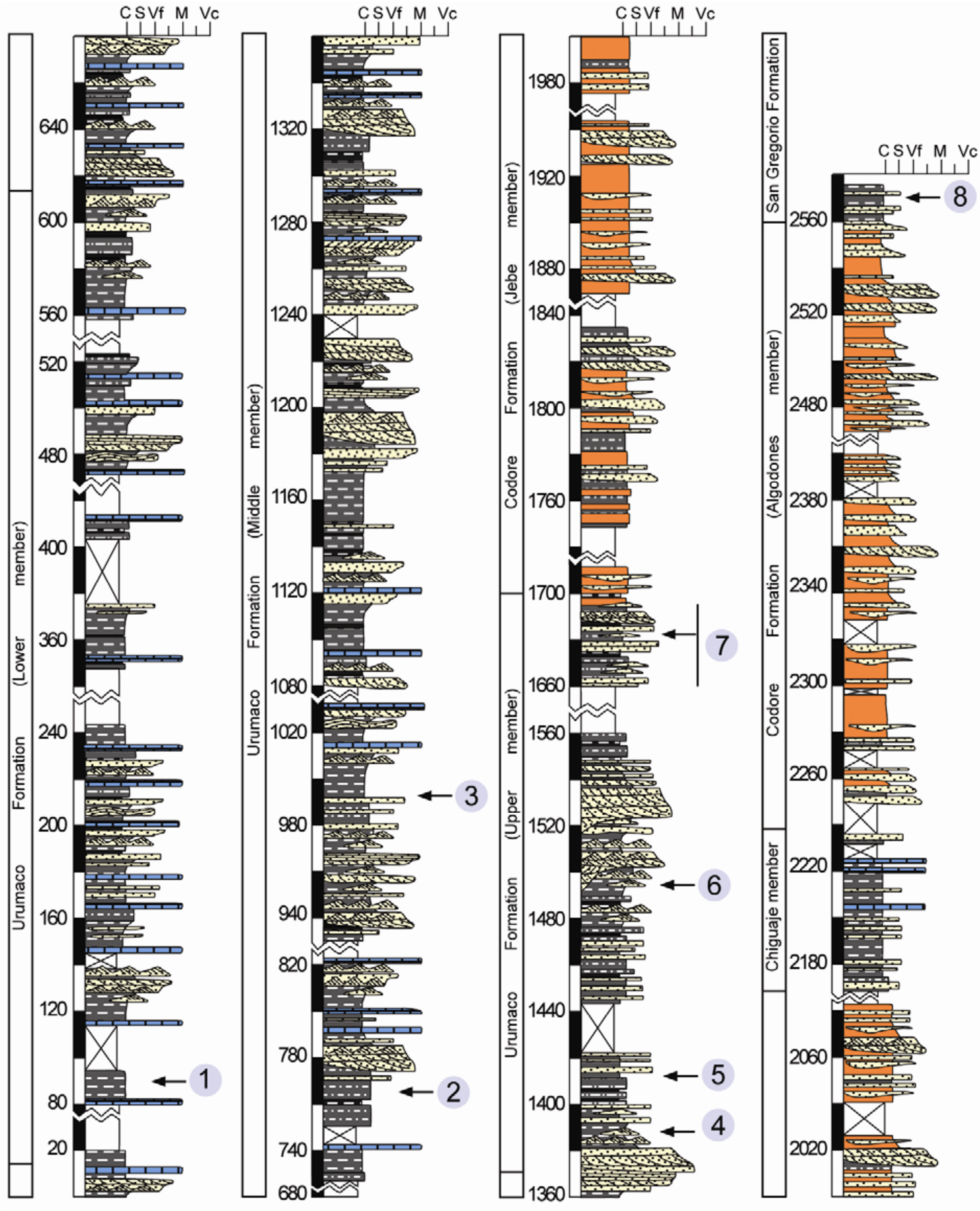
Scheyer, T. M., Aguilera, O. A., Delfino, M., Fortier, D. C., Carlini, A. A., Sánchez, R., Carrillo-Briceño, J. D., Quiroz, L. & Sánchez-Villagra, M. R.

## Supplementary Figures

### Supplementary Figure S1. Satellite image of Urumaco region with localities.

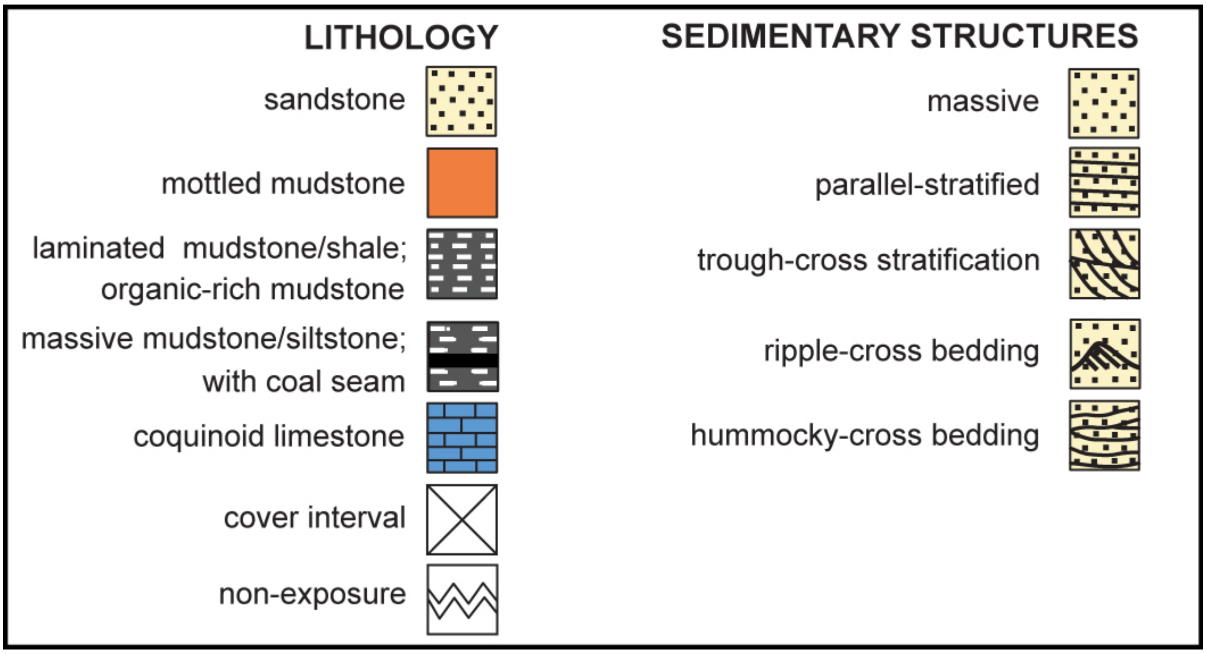


**Supplementary Figure S2. Detailed stratigraphic log showing the localities in the Urumaco and San Gregorio Formations used herein.**



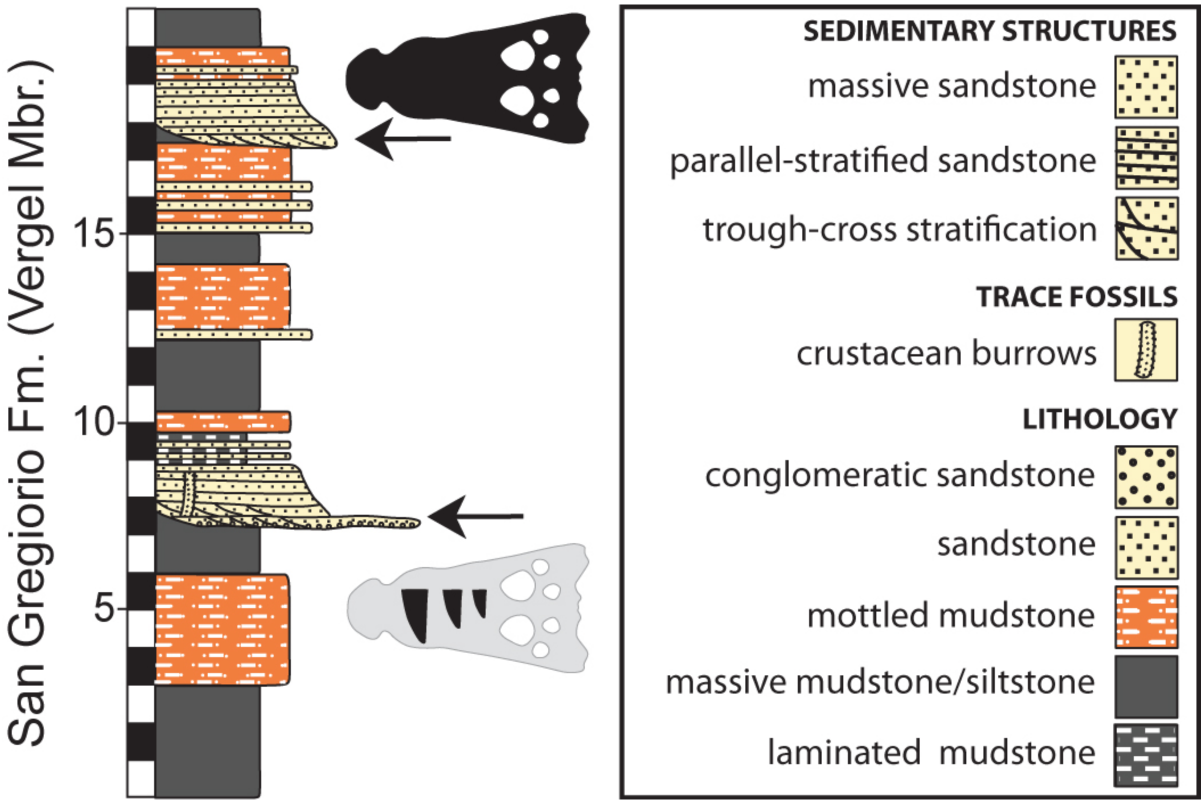

Modified from Quiroz and Jaramillo[54]. Locality names and coordinates are compiled in Supplementary Table 1. For legend see Supplementary Figure 2.

**Supplementary Figure S3. Legend accompanying stratigraphic log in Figure S2.**




Modified from Quiroz and Jaramillo[54].

**Supplementary Figure S4. Detailed stratigraphic log of the Vergel Member of the San Gregorio Formation and its accompanying legend.**




Note that the horizons where the holotype (black skull outline, adapted from Brochu[55]) and referred material (teeth in grey skull outline) were found in, are marked by black arrows.

**Supplementary Figure S5. Series of isolated teeth from the early Pliocene Vergel Member of the San Gregorio Formation.**

The specimens (AMU-CURS-302) were collected 1 km from the holotype (11º 17’ 56.4” N, 70º 13’ 52.8” W) of *Crocodylus falconensis* sp. nov. Scale bar = 1.0 cm.

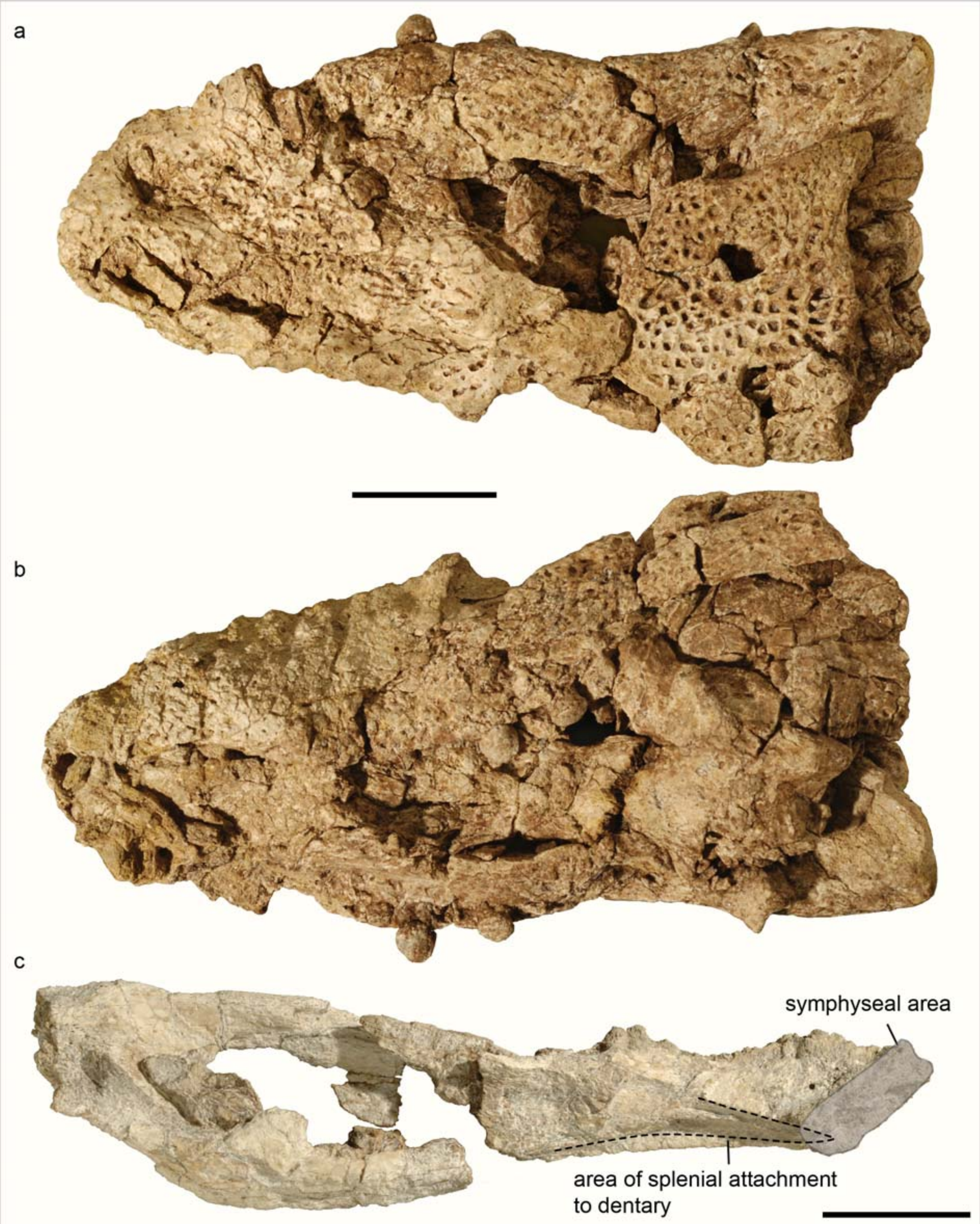
**Supplementary Figure S6. Holotype skull AMU-CURS-300 of *Crocodylus falconensis* sp. nov.**


(**a**) Rostral view of skull. (**b**) Left lateral view of rostrum. (**c**) Occipital view of skull. Note that even though the skull is damaged, the ventral extension of the supraoccipital (so) is visible, reaching or almost reaching the foramen magnum (fm). Scale bars = 5.0 cm.

**Supplementary Figure S7. Paratype material AMU-CURS-224 of *Globidentosuchus brachyrostris* gen. et sp. nov.**

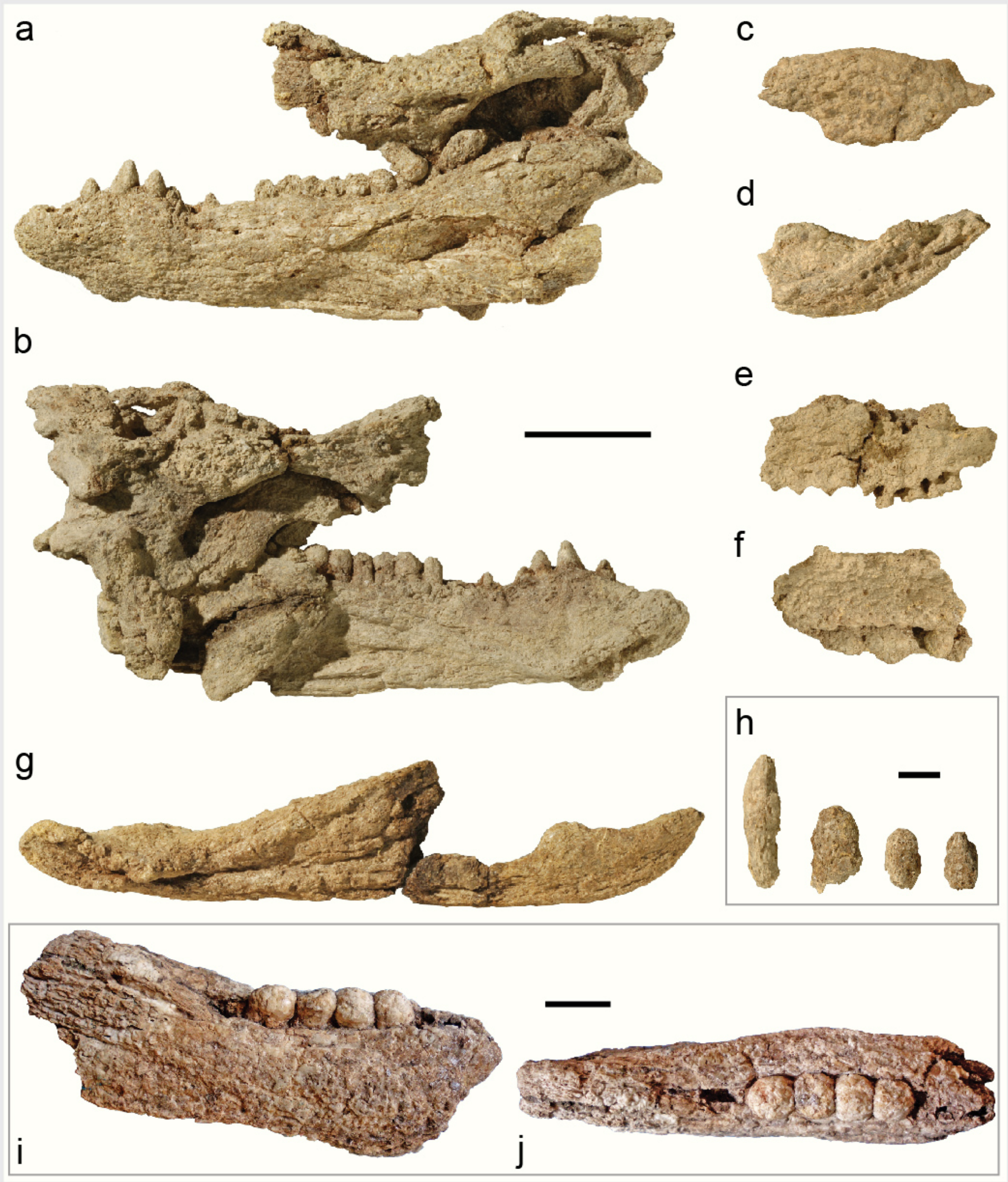

(**a**) Skull table/braincase, frontals and tooth-bearing elements and their assumed position in palatal view. (**b**) Skull table and braincase in occipital view. (**c**) Skull table and braincase in dorsal view. (**d**) Frontals in dorsal view. (**e**) Left jugal in lateral view. (**f**) Left jugal in medial view. (**g**) Left ectopterygoid in lateral view. (**h**) Left ectopterygoid in medial view. (**i**) Assembled right mandible in lateral view. (**j**) Assembled left mandible in lateral view. (**k**) Assembled left mandible in medial view. Scale bars = 5.0 cm.

**Supplementary Figure S8. Selected holotype and paratype material of *Globidentosuchus brachyrostris* gen. et sp. nov.**



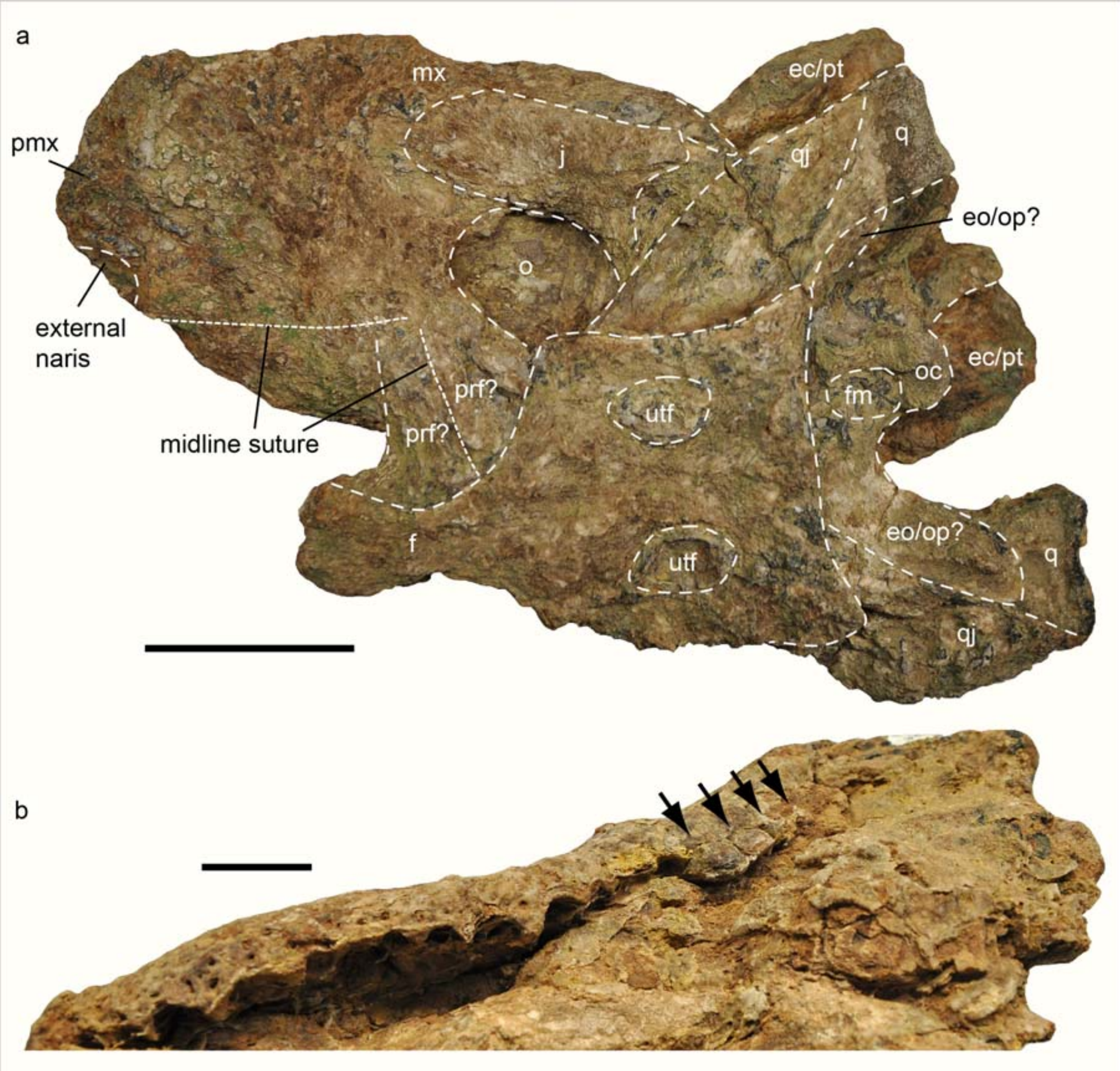

(**a**) Holotype skull (AMU-CURS-222, not mirror-imaged) in dorsal view. (**b**) Holotype skull in ventral view. (**c**) Left mandible of paratype (AMU-CURS-224) in which the extension of the splenial scar and the symphyseal area is indicated (compare to Supplementary Figure S7k). Scale bars = 5.0 cm.

**Supplementary Figure S9. Referred material of *Globidentosuchus brachyrostris* gen. et sp. nov.**



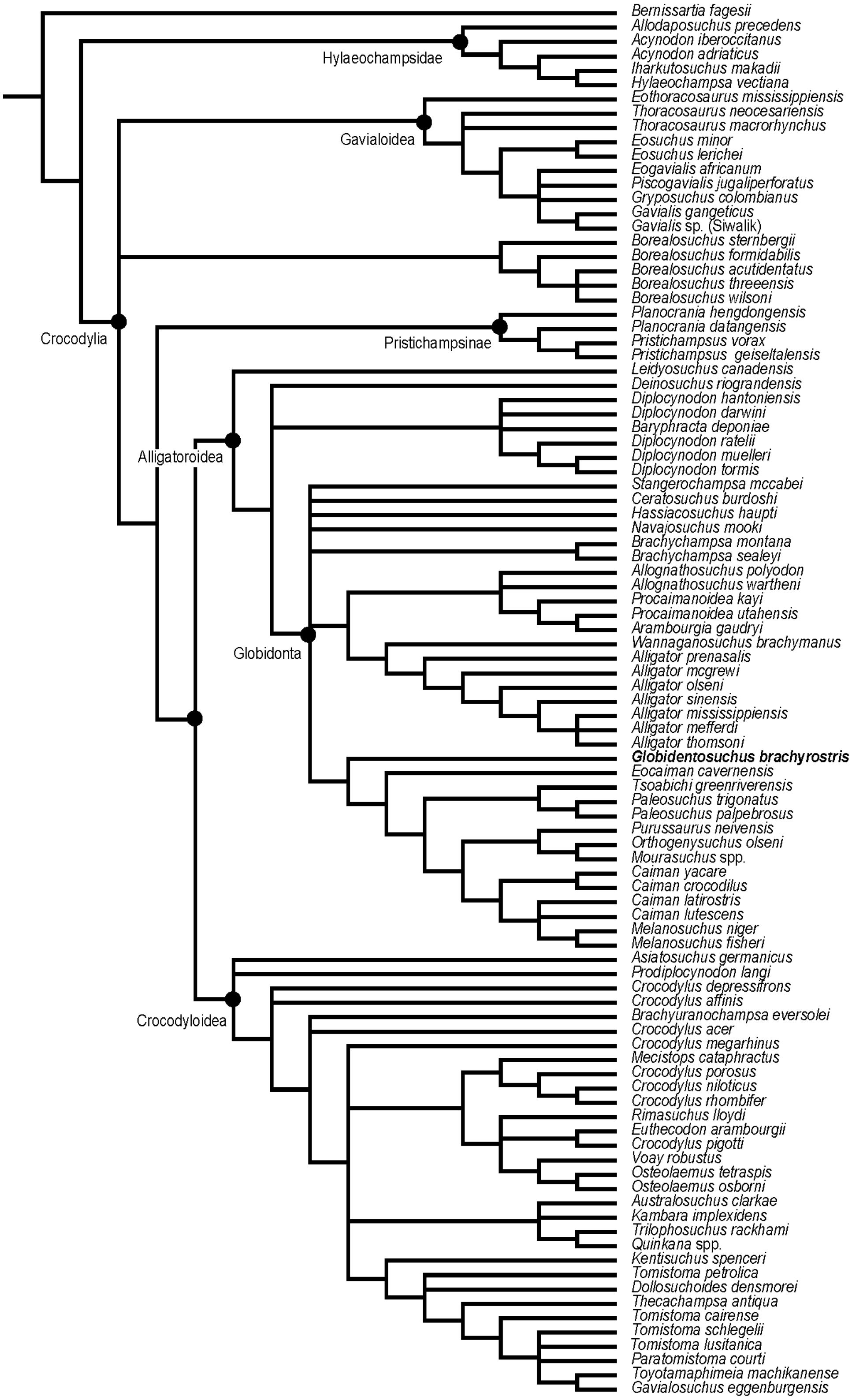

(**a-h**) Associated fragmentary cranial and mandibular remains (AMU-CURS-223). (**i, j**) Posterior part of right mandible showing four bulbous crushing teeth (AMU-CURS-301) in (**i**) lateral and (**j**) dorsal view. Part of skull roof and anterior part of left mandible in **a**) lateral view and (**b**) medial view. (**c**) Left surangular in lateral view. (**d**) Left angular in lateral view. (**e**) Maxillary fragment showing alveoli in palatal view. (**f**) Maxillary fragment with bulbous tooth in lateral view. (**g**) Assembled right mandible fragment in medial view. (**h**) Series of teeth associated with the cranial remains. Scale bars = 5.0 cm in (**a-f**), 1.0 cm in (**h**) and 2.0 cm in (**i, j**).

**Supplementary Figure S10. Referred material of *Globidentosuchus brachyrostris* gen. et sp. nov.**



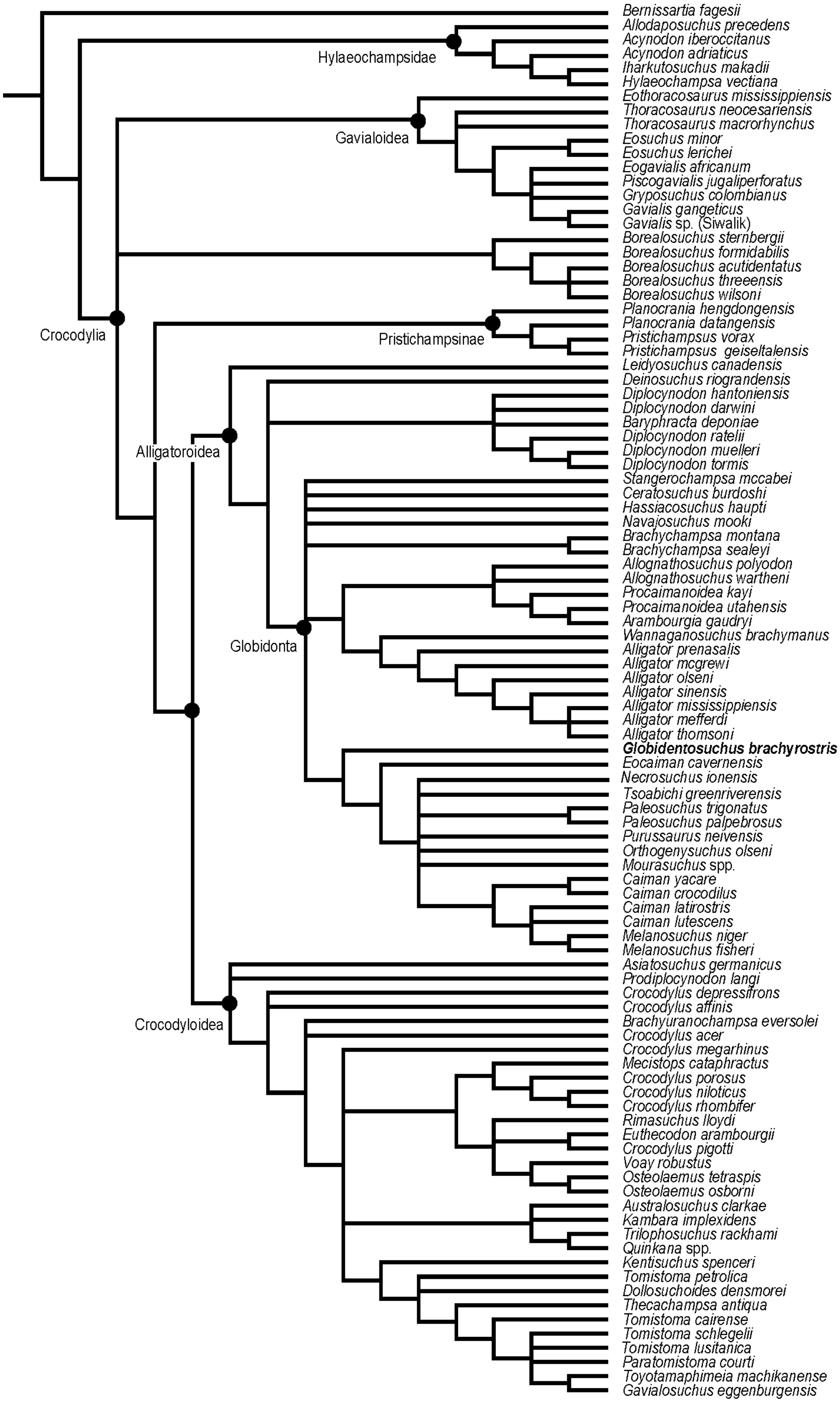

(**a**) Distorted skull (AMU-CURS-383) in dorsal view. Note that size of specimen is comparable to paratype specimen AMU-CURS 224 (based on skull table proportions). The rostrum is dislocated from the skull table and most of the tip of the snout and left side of rostrum has been folded and displaced ventrally. Due to strong weathering of the skull, most sutures are not traceable. (**b**) Left side of skull in oblique ventral view. The lateral walls of 13 alveoli of the anterior part of the left maxilla (maybe including also posterior end of premaxilla?) are visible. In the posterior part of the maxilla four closely spaced crushing teeth are still partly preserved (black arrows). Abbreviations: eo/op: exoccipital/opisthotic; f, frontal; fm, foramen magnum; j, jugal; mx, maxilla; o, orbit; oc, occipital condyle; pmx, premaxilla; prf, prefrontal; ec/pt, ectopterygoid and pterygoid; q, quadrate; qj, quadratojugal. Scale bars = 5.0 cm in (**a**) and 2.0 cm in (**b**).

**Supplementary Figure S11. Phylogenetic analysis including the new caimanine taxon.**




Strict consensus tree of 20160 most parsimonious trees (tree length=650 steps) recovered by TNT analysis. The new taxon is marked in bold.

**Supplementary Figure S12. Phylogenetic analysis including the new caimanine taxon and *Necrosuchus ionensis*.**




Strict consensus tree of 24100 most parsimonious trees (tree length=650 steps) recovered by TNT analysis. The new taxon is marked in bold. Note loss of resolution within Caimaninae.

**Supplementary Table S1. Locality coordinates.**

| | |
|---|---|
| Socorro Formation localities | |
| Quebrada Honda (Llano Largo) | 11° 11' 35.00" N; 70° 10' 49.00" W |
| Quebrada Honda (Cerro Maniaero) | 11° 11' 00.90" N, 70° 09' 44.00" W |
| Quebrada Honda (Cerro Alto) | 11° 12' 30.00" N; 70° 08' 12.00" W |
| Urumaco Formation localities | |
| Sur Quebrada Bejucal (1) | 11° 11' 18.46" N; 70° 15' 03.00" W |
| Puente Río Urumaco (2) | 11° 12' 24.66" N; 70° 14' 59.27" W |
| Playa Larga (2) | 11° 10' 58.00" N, 70° 20' 50.00" W |
| Domo de Agua Blanca (3) | 11° 13' 25.00" N; 70° 14' 50.00" W |
| El Hatillo (4) | 11° 14' 34.00" N; 70° 14' 20.00" W |
| El Mamón (5) | 11° 13' 60.00" N; 70° 16' 06.00" W |
| El Picache (6) | 11° 14' 25.00" N; 70° 13' 27.00" W |
| Noroeste (NW) San Rafael (6) | 11° 14' 52.00" N; 70° 14' 06.00" W |
| Corralito (7) | 11° 14' 40.00" N; 70° 16' 26.00" W |
| Tío Gregorio (7) | 11° 14' 33.13" N; 70° 18' 38.00" W |
| San Gregorio Formation localities | |
| Norte Casa Chiguaje (8) | 11° 17' 52.00" N; 70° 14' 07.80" W |

Numbers in brackets behind location names correspond to the number system used for the study (see locality numbers in Supplementary Figure 2). In the case of Puente Río Urumaco/Playa Larga, El Picache/ Noroeste (NW) San Rafael and Tío Gregorio/Corralito, the localities have been combined under numbers (2), (6) and (7) respectively, because of their close proximity in the stratigraphic column. Coordinates of Urumaco town for reference: 11º 17’ 53.9” N, 70º 14’ 33.7” W.

**Supplementary Table S2. List of fossil material examined.**

| Formation/Locality | Specimen Number | Taxon | Material present |
|---|---|---|---|
| **Socorro Formation (pooled localities)** | | | |
| | AMU-CURS-031 | *Purussaurus* sp. | Right mandible |
| | AMU-CURS-034 | ?cf. *Thecachampsa* sp. 1 | Cranium and rostrum |
| | AMU-CURS-095 | *Mourasuchus sp.* | Partial rostrum |
| | AMU-CURS-141 | *Mourasuchus* sp. | Mandible |
| | AMU-CURS-151 | *Caiman* sp. | Cranium |
| | AMU-CURS-433 | *Ikanogavialis gameroi* | Rostrum |
| **Urumaco Formation** | | | |
| Sur Quebrada Bejucal (1) | | | |
| | AMU-CURS-018 | *Caiman* sp. | Mandible |
| | AMU-CURS-020 | *Purussaurus* sp. | Cranial and postcranial remains |
| | AMU-CURS-unnumbered | *Mourasuchus* sp. | Partial cranial remains |
| Puente Río Urumaco/ Playa Larga (2) | | | |
| | AMU-CURS-001 | *Hesperogavialis cruxenti* | Cranium and rostrum |
| | AMU-CURS-113 | *Caiman* sp. | Cranium |
| | AMU-CURS-217 | *Melanosuchus fisheri* | Cranium |
| | AMU-CURS-218 | *Mourasuchus nativus* | Cranium |
| | MCN-URU-2002-unnumbered | *Ikanogavialis gameroi* | Cranium and rostrum |
| Domo de Agua Blanca (3) | | | |
| | AMU-CURS-012 | ?cf. *Thecachampsa* sp. 2 | Cranium and mandible |
| | AMU-CURS-132 | *Hesperogavialis cruxenti* | Rostrum |
| | AMU-CURS-301 | *Globidentosuchus brachyrostris* (referred material) | Posterior part of right mandible with four crushing teeth |
| | AMU-CURS-450 | *Globidentosuchus brachyrostris* (referred material) | partial mandibular remains |
| El Hatillo (4) | | | |
| | AMU-CURS-134 | *Gryposuchus croizati* | Rostrum |
| | AMU-CURS-135 | *Purussaurus mirandai* (paratype) | Cranium with associated mandibles |
| | AMU-CURS-234 | *Melanosuchus fisheri* | Cranium and mandibles (also postcranium) |
| | AMU-CURS-unnumbered | *Charactosuchus mendesi* | partial cranial remains |

| | | | |
|---|---|---|---|
| | AMU-CURS-unnumbered | *Mourasuchus arendsi* | partial cranial remains |
| El Mamón (5) | | | |
| | AMU-CURS-212 | *Mourasuchus nativus* | Cranial fragment |
| | AMU-CURS-429 | *Caiman brevirostris* | Cranial/mandibular fragments |
| | UNEFM-CIAPP-319 | *Hesperogavialis cruxenti* | Rostrum |
| | UNEFM-CIAPP-320 | *Hesperogavialis cruxenti* (holotype) | Partial cranium and rostrum |
| El Picache (6) | | | |
| | AMU-CURS-222 | *Globidentosuchus brachyrostris* (holotype) | Cranium and mandibles |
| | AMU-CURS-223 | *Globidentosuchus brachyrostris* (referred material) | Associated fragmentary cranial and mandibular remains |
| | AMU-CURS-224 | *Globidentosuchus brachyrostris* (paratype) | Fragmentary cranial remains associated with mandibles |
| | AMU-CURS-unnumbered | *Purussaurus* sp. | Cranium and mandibular remains |
| | MCN- unnumbered | *Caiman brevirostris* | Cranium with associated mandibles |
| NW San Rafael (6) | | | |
| | AMU-CURS-383 | *Globidentosuchus brachyrostris* (referred material) | Cranium and mandibles |
| | AMU-CURS-384 | *Purussaurus* sp. | Left mandible |
| | AMU-CURS-390 | *Mourasuchus sp.* | Mandibular fragment |
| | AMU-CURS-395 | *Mourasuchus* sp. | Cranial fragments |
| | AMU-CURS-396 | *Mourasuchus* sp. | Cranial fragments |
| | AMU-CURS-399 | *Gryposuchus* sp. | Cranial fragments |
| Corralito (7) | | | |
| | AMU-CURS-049 | *Caiman lutescens* | Partial rostrum |
| | AMU-CURS-090 | *Caiman* sp. | Cranium and rostrum |
| | AMU-CURS-unnumbered | *Purussaurus* sp. | Cranial remains |
| | MCN-243 | *Melanosuchus fisheri* (holotype) | Cranium and rostrum |
| | UNEFM-CIAPP-617 | *Gryposuchus jessei* | Rostrum |
| | UNEFM-CIAPP-1297 | *Mourasuchus arendsi* (holotype) | Skull and mandible |
| | UNEFM-CIAAP-1440 | *Gryposuchus croizati* (paratype) | Mandible |
| Tío Gregorio (7) | | | |
| | AMU-CURS-057 | *Purussaurus* sp. | Mandible |
| | AMU-CURS-058 | *Gryposuchus croizati* (paratype) | Cranium and rostrum and postcranial material |
| | AMU-CURS-073 | *Mourasuchus* sp. | Right mandible and incomplete rostrum and |

| | | | |
|---|---|---|---|
| | | | postcranial material |
| | AMU-CURS-105 | *Caiman brevirostris* | Cranium |
| | AMU-CURS-106 | *Caiman brevirostris* | Mandible |
| | AMU-CURS-unnumbered | *Purussaurus* sp. | partial cranial remains |
| | MCN-URU-2002-143 | *Ikanogavialis gameroi* | Cranium and rostrum |
| | UCV-VF-1165 | *Ikanogavialis gameroi* (holotype) | Cranium |
| | UCV-VF-1166 | *Ikanogavialis gameroi* (holotype) | Mandible |
| **San Gregorio Formation locality** | | | |
| Norte Casa Chiguaje (8) | | | |
| | AMU-CURS-300 | *Crocodylus falconensis* (holotype) | Almost complete skull with mandibles |
| | AMU-CURS-302 | Crocodylia indet. | Series of isolated teeth |

Abbreviations: UNEFM-CIAAP, Universidad Nacional Experimental Francisco de Miranda, Coro, Venezuela; MCN, Museo de Ciencias Naturales de Caracas, Venezuela; AMU-CURS, Colección de Paleontología de Vertebrados de la Alcaldía de Urumaco, Estado Falcón, Venezuela; UCV, Universidad Central de Venezuela, Maracay, Venezuela.

**Supplementary Table S3. Length estimations I.**

| New *Crocodylus* species | DCL = 59.0 [cm], SL = 42.5 [cm], ODCL = 165.0 [mm] | |
|---|---|---|
| *Gavialis gangeticus* formula | (modif. from Sereno et al.[56]) | |
| TL = (7.4 * DCL) – 69.369 | TL = (7.4 * 59.0) – 69.369 | TL = 367.23 |
| *Crocodylus porosus* formula | (modif. from Sereno et al.[56]) | |
| TL = (7.717 * DCL) – 20.224 | TL = (7.717 * 59.0) – 20.224 | TL = 435.08 |
| *Crocodylus moreletii* formula | (modif. from Platt et al.[57]) | |
| TL = (10.48 * SL) + 6.20 | TL = (10.48 * 42.5) + 6.20 | TL = 451.60 |
| *Crocodylus acutus* formula | (modif. from Platt et al.[58]) | |
| TL = (9.01 * SL) + 10.80 | TL = (9.01 * 42.5) + 10.80 | TL = 393.73 |
| *Alligator mississippiensis* formula | (modif. from Hurlburt et al.[59]) | |
| Log TL = (log ODCL * 1.259) + 0.793 | Log TL = (log 165.0 * 1.259) + 0.793 | TL = 384.43 |
| Log TL = (log DCL * 0.970) + 0.954 | Log TL = (log 590.0 * 0.970) + 0.954 | TL = 438.25 |
| | | Mean = 411.72 |

| New caimanine species | DCL = 29.0 [cm], SL = 14.0 [cm] ODCL = 150.0 [mm] | |
|---|---|---|
| *Gavialis gangeticus* formula | (modif. from Sereno et al.[56]) | |
| TL = (7.4 * DCL) – 69.369 | TL = (7.4 * 29.0) – 69.369 | TL = 145.23 |
| *Crocodylus porosus* formula | (modif. from Sereno et al.[56]) | |
| TL = (7.717 * DCL) – 20.224 | TL = (7.717 * 29.0) – 20.224 | TL = 203.57 |
| *Crocodylus moreletii* formula | (modif. from Platt et al.[57]) | |
| TL = (10.48 * SL) + 6.20 | TL = (10.48 * 14.0) + 6.20 | TL = 152.92 |
| *Crocodylus acutus* formula | (modif. from Platt et al.[58]) | |
| TL = (9.01 * SL) + 10.80 | TL = (9.01 * 14.0) + 10.80 | TL = 136.94 |
| *Alligator mississippiensis* formula | (modif. from Hurlburt et al.[59]) | |
| Log TL = (log ODCL * 1.259) + 0.793 | Log TL = (log 150.0 * 1.259) + 0.793 | [TL = 340.96*] |
| Log TL = (log DCL * 0.970) + 0.954 | Log TL = (log 290.0 * 0.970) + 0.954 | TL = 220.05 |
| | | Mean = 171.74 [199.95*] |

Total body length (TL) estimations in [cm] using dorsal cranial length (DCL), snout length (SL) and orbito-cranial length (ODCL). Note that for the *Alligator*-based formula[59], values have to be entered in millimeters. Results are rounded to the nearest [mm].

**Supplementary Table S4. Length estimations II.**

| New *Crocodylus* species | DCL = 59.0, SL = 42.5 | |
|---|---|---|
| *Crocodylus porosus* formula | (modif. from Webb and Messel[60]) | |
| SVL = (3.60 * DCL) - 4.30 | SVL = (3.60 * 59.0) - 4.30 | SVL = 208.10 |
| *Crocodylus moreletii* formula | (modif. from Platt et al.[57]) | |
| SVL = (5.32 * SL) + 1.61 | SVL = (5.32 * 42.5) + 1.61 | SVL = 227.71 |
| *Crocodylus acutus* formula | (modif. from Platt et al.[58]) | |
| SVL = (4.68 * SL) + 4.57 | SVL = (4.68 * 42.5) + 4.57 | SVL = 203.47 |
| | | Mean = 213.09 |

| New caimanine species | DCL = 29.0, SL = 14.0 | |
|---|---|---|
| *Crocodylus porosus* formula | (modif. from Webb and Messel[60]) | |
| SVL = (3.60 * DCL) - 4.30 | SVL = (3.60 * 29.0) - 4.30 | SVL = 100.10 |
| *Crocodylus moreletii* formula | (modif. from Platt et al.[57]) | |
| SVL = (5.32 * SL) + 1.61 | SVL = (5.32 * 14.0) + 1.61 | SVL = 76.09 |
| *Crocodylus acutus* formula | (modif. from Platt et al.[58]) | |
| SVL = (4.68 * SL) + 4.57 | SVL = (4.68 * 14.0) + 4.57 | SVL = 70.09 |
| | | Mean = 82.09 |

Snout-vent length (SVL) estimations in [cm] using dorsal cranial length (CL) and snout length (SL); results are rounded to the nearest [mm].

**Supplementary Table S5. Mass estimations.**

| New *Crocodylus* species | mean SVL = 213.09, mean TL= 411.72 | |
|---|---|---|
| *Crocodylus porosus* formula | (modif. from Webb and Messel[60]) | |
| log BM = (3.2613 * log SVL) - 2.0894 | log BM = (3.2613 * log 213.09) - 2.0894 | BM = 319.70 |
| *Crocodylus moreletii* formula | (modif. from Platt et al.[57]) | |
| ln BM = (ln TL – 2.05) / 0.32 | ln BM = (ln 411.72 – 2.05) / 0.32 | BM = 244.58 |
| ln BM = (ln SVL – 1.25) / 0.33 | ln BM = (ln 213.09 – 1.25) / 0.33 | BM = 257.75 |
| *Crocodylus acutus* formula | (modif. from Platt et al.[58]) | |
| ln BM = (ln TL – 2.06) / 0.31 | ln BM = (ln 411.72 – 2.06) / 0.31 | BM = 353.38 |
| ln BM = (ln SVL – 1.27) / 0.32 | ln BM = (ln 213.09 – 1.27) / 0.32 | BM = 357.40 |
| | | Mean = 306.56 |

| New caimanine species | mean SVL = 82.09, mean TL = 171.74 [mean TL = 199.95*] | |
|---|---|---|
| *Crocodylus porosus* formula | (modif. from Webb and Messel[60]) | |
| log BM = (3.2613 * log SVL) - 2.0894 | log BM = (3.2613 * log 82.09) - 2.0894 | BM = 14.25 |
| *Crocodylus moreletii* formula | (modif. from Platt et al.[57]) | |
| ln BM = (ln TL – 2.05) / 0.32 | ln BM = (ln 171.74 – 2.05) / 0.32 | BM = 15.91 [25.59*] |
| ln BM = (ln SVL – 1.25) / 0.33 | ln BM = (ln 82.09 – 1.25) / 0.33 | BM = 14.32 |
| *Crocodylus acutus* formula | (modif. from Platt et al.[58]) | |
| ln BM = (ln TL – 2.06) / 0.31 | ln BM = (ln 171.74 – 2.06) / 0.31 | BM = 21.05 [34.39*] |
| ln BM = (ln SVL – 1.27) / 0.32 | ln BM = (ln 82.09 – 1.27) / 0.32 | BM = 18.14 |
| | | Mean = 16.73 [21.34*] |

Body Mass (BM) estimations in [kg] using total length (TL) and snout-vent length (SVL) in [cm]; results are rounded to the nearest [mm].

## Supplementary Notes

### Supplementary Note 1: Stratigraphic and Palaeoenvironmental Context of New Taxa

**New *Crocodylus* species**

The new *Crocodylus* species comes from outcrops that have only recently been discovered to be fossiliferous and described, so we provide here a context for future reference in explorations, or in stratigraphical, taphonomical or palaeoecological studies. The San Gregorio Formation is the upper-most part of the large Urumaco sequence[54]. The contact between the Codore and San Gregorio Formations is transitional near the Urumaco River area, and the age is early Pliocene. It is exposed in the north-central area of the Falcon State coastal plain, 10 km north of the Urumaco Town. The fossiliferous outcrops are of the lower part of the Vergel Member of the San Gregorio Formation (Supplementary Figure 4), consisting of brown to dark gray, massive mudstone and mottled muddy sandstone, interbedded with massive to cross-bedded conglomeratic sandstone with lenticular geometry and erosive base, grading to parallel-stratified, fine to medium grained sandstone. This succession represents flood plain deposits and associated crevasse splays, with low sinuosity ephemeral channels mostly filled during river flooding, in an alluvial fan setting.

The lateral outflow of the channels during inundate events form a sub-aerial savannas, such as, wetlands. The results of these inundate soils are palaeosols over sandy deposits, characterized by the presence of a terrestrial and semi-aquatic fossil assemblage, including mammals[61]. The faunal assemblage represents the last testimonies of the hydrographic and climate change around the Miocene/Pliocene boundary.

**New caimanine species**

The type and most of the referred material of the new caimanine come from the El Picache locality, Upper Member of the Urumaco Formation, whereas the isolated mandible (AMU-CURS-223) was recovered from the Middle Member of the Urumaco Formation. The sedimentary environments of the Urumaco Formation have been described in Quiroz and Jaramillo[54] (see stratigraphic logs in Fig. 1 and Supplementary Figures 2-4). According to the authors, both the Middle and Upper Member are composed of siliciclastic sequences and intercalated limestone beds deposited in a prograding delta and strand plain environment.

**Supplementary Note 2: Major Expeditions to the Fossiliferous Outcrops around Urumaco**

Expeditions to the Urumaco region were conducted by Royo y Gómez from Universidad Central de Venezuela in Caracas (1958-1959), C. González de Juana at Universidad Central de Venezuela together with Bryan Patterson from Harvard University (1972), Jean Bocquentin-Villanueva (1982 and following years in the 1980s) and by Orangel Aguilera (1992-2012) at the Universidad Francisco de Miranda in Coro, R. Sánchez at Alcaldía de Urumaco and Smithonian Tropical Research Institute (1990-2012), M. Sánchez-Villagra from University of Tübingen (2002-2004), The Natural History Museum in London (2004-2006), and from University of Zürich (2007-2012).

**Supplementary Note 3: Phylogenetic Analyses**

**New *Crocodylus* species**

The dataset for the testing the position of the new *Crocodylus* species comprised 32 characters in total (coding 29 characters that vary inside Crocodylinae[62] plus two new characters), 14 ingroup taxa and the outgroup consisting of the basal crocodiline "*Crocodylus*" *megarhinus* and the three osteolaemines "*Crocodylus*" *pigotti*, *Rimasuchus lloydi* and *Voay robustus*.

**Character description**

1. Ventral tubercle of proatlas more than one-half (0) or no more than one half (1) the width of the dorsal crest. (Brochu et al.[62], character 1)
2. Fused proatlas boomerang-shaped (0), strap-shaped (1), or massive and block-shaped (2). (Brochu et al.[62], character 2)
3. Anterior half of axis neural spine oriented horizontally (0) or slopes anteriorly (1). (Brochu et al.[62], character 6)
4. Axis neural spine crested (0) or not crested (1). (Brochu et al.[62], character 7)
5. Posterior half of axis neural spine wide (0) or narrow (1). (Brochu et al.[62], character 8)
6. Hypapophyseal keels present on eleventh vertebra behind atlas (0), twelfth vertebra behind atlas (1), or tenth vertebra behind atlas (2). (Brochu et al.[62], character 9)
7. Third cervical vertebra (first postaxial) with prominent hypapophysis (0) or lacks prominent hypapophysis (1). (Brochu et al.[62], character 10)
8. Neural spine on third cervical long, dorsal tip at least half the length of the centrum without the cotyle (0) or short, dorsal tip acute and less than half the length of the centrum without the cotyle (1). (Brochu et al.[62], character 11)
9. Scapulocoracoid facet anterior to glenoid fossa uniformly narrow (0) or broad immediately anterior to glenoid fossa, and tapering anteriorly (1). (Brochu et al.[62], character 14)
10. Proximal edge of deltopectoral crest emerges smoothly from proximal end of humerus and is not obviously concave (0) or emerges abruptly from proximal end of humerus and is obviously concave (1). (Brochu et al.[62], character 15)
11. Dorsal margin of iliac blade rounded with smooth border (0) or rounded, with modest dorsal indentation (1) or rounded, with strong dorsal indentation ("wasp-waisted;" 2) or narrow, with dorsal indentation (3) or rounded with smooth border; posterior tip of blade very deep (4). (Brochu et al.[62], character 19)
12. Supraacetabular crest narrow (0) or broad (1). (Brochu et al.[62], character 20)

13. Dentary symphysis extends to fourth or fifth alveolus (0) or sixth through eighth alveolus (1) or behind eighth alveolus (2.) (Brochu et al.[62], character 28)
14. Angular-surangular suture contacts external mandibular fenestra at posterior angle at maturity (0) or passes broadly along ventral margin of external mandibular fenestra late in ontogeny (1). (Brochu et al.[62], character 34)
15. Dorsal surface of rostrum curves smoothly (0) or bears medial dorsal boss (1). (Brochu et al.[62], character 52)
16. Preorbital ridges absent or very modest (0) or very prominent (1) at maturity. (Brochu et al.[62], character 53)
17. Surface of maxilla within narial canal imperforate (0) or with a linear array of pits (1.) (Brochu et al.[62], character 55)
18. Anterior ectopterygoid process tapers to a point (0) or forked (1). (Brochu et al.[62], character 63)
19. Palatine process generally broad anteriorly (0) or in form of thin wedge (1). (Brochu et al.[62], character 65)
20. Palatine-pterygoid suture nearly at (0) or far from (1) posterior angle of suborbital fenestra. (Brochu et al.[62], character 67)
21. Pterygoid surface lateral and anterior to internal choana flush with choanal margin (0) or pushed inward anterolateral to choanal aperture (1) or pushed inward around choana to form "neck" surrounding aperture (2) or everted from flat surface to form "neck" surrounding aperture (3). (Brochu et al.[62], character 69)
22. Lacrimal makes broad contact with nasal; no posterior process of maxilla (0) or maxilla with posterior process within lacrimal (1) or maxilla with posterior process between lacrimal and prefrontal (2). (Brochu et al.[62], character 71)
23. Quadratojugal extends to superior angle of infratemporal fenestra (0) or does not extend to superior angle of infratemporal fenestra; quadrate participates in fenestra (1). (Brochu et al. [62], character 80; adapted from Buscalioni et al.[63] according to Brochu et al.[64])
24. Posterolateral margin of squamosal horizontal or nearly so (0) or upturned to form a discrete "horn" (1.) (Brochu et al.[62], character 86)
25. Squamosal does not extend (0) or extends (1) ventrolaterally to lateral extent of paraoccipital process. (Brochu et al.[62], character 87)
26. Supraoccipital exposure on dorsal skull table small (0), absent (1), large (2), or large such that parietal is excluded from posterior edge of table (3). (Brochu et al.[62], character 88)

27. Sulcus on anterior braincase wall lateral to basisphenoid rostrum (0) or braincase wall lateral to basisphenoid rostrum smooth; no sulcus (1). (Brochu et al.[62], character 89)
28. Extensive exposure of prootic on external braincase wall (0) or prootic largely obscured by quadrate and laterosphenoid externally (1). (Brochu et al.[62], character 91; adapted from Norell[65] according to Brochu et al.[64])
29. Lateral eustachian canals open dorsal (0) or lateral (1) to medial eustachian canal. (Brochu et al.[62], character 96; adapted from Norell [66] according to Brochu et al.[64])
30. Posterior process of palatines with nearly parallel sides (0) or expands posteriorly (1). (This character was not used by Brochu et al.[62], it is adapted, however, from character 2 of Norell[66] according to Brochu[67])
31. Posterior margin of skull roof concave (0) or with a developed medial convexity (1) late in ontogeny. (NEW)
32. Anteriormost width of the intersuborbital bar wider than (0) or as wide as (1) the posteriormost width. (NEW)

**Character codings**

Unknown or non-applicable characters were coded as question marks. Polymorphisms are noted in brackets.

| | |
|---|---|
| *“Crocodylus” megarhinus* | ????? ??0?? ??100 00001 02100 ?100? 00 |
| *“Crocodylus” pigotti* | ??00? ?0011 ??1?0 10111 1??01 0?100 11 |
| *Rimasuchus lloydi* | ????? ????? ????0 1?00? ?1101 0110? 00 |
| *Voay robustus* | ????? ????? 11100 10001 10111 1?100 01 |
| *Mecistops cataphractus* | 10000 00011 20110 00011 00100 01100 10 |
| *Crocodylus palaeindicus* | ????? ????? ??010 00100 00100 1011? 1? |
| *Crocodylus porosus* | 11001 10101 20010 11(01)01 00100 01111 01 |
| *Crocodylus palustris* | 10001 01111 21010 11(01)01 00100 01111 01 |
| *Crocodylus siamensis* | 11111 00010 20010 11(01)01 00110 01111 00 |
| *Crocodylus johnstoni* | 11001 10101 20?10 11(01)11 00100 01110 00 |
| *Crocodylus mindorensis* | 11001 10101 20010 11(01)01 00100 01111 10 |
| *Crocodylus novaeguineae* | 11001 10101 20010 11(01)01 00000 01010 00 |
| *Crocodylus niloticus* | 10101 00111 20010 01(01)01 01100 01110 00 |
| ***Crocodylus falconensis* sp. nov.** | ????? ????? ??011 01000 ?1?00 ????0 00 |
| *Crocodylus acutus* | 00101 00111 20011 01(01)00 21100 01111 11 |
| *Crocodylus intermedius* | 00101 00111 20111 01(01)00 20100 01111 11 |

| | |
|---|---|
| *Crocodylus moreletii* | 00101 00111 20011 01(01)00 21100 01111 10 |
| *Crocodylus rhombifer* | 00101 00111 10011 01(01)00 21110 01111 10 |

**Apomorphy List**

The apomorphy list was constructed based on the tree shown in Figure 5a. ACCTRAN optimization in bold and DELTRAN optimization underlined.

Osteolaeminae: 12(1), 16(1), 22(1), 26(1)

*Rimasuchus lloydi*: 23(1)

*"Crocodylus" pigotti* + *Voay robustus*: 21(1), 32(1)

*"C". pigotti*: 18(1), 19(1), 30(1)

*Voay robustus*: 12(1), 24(1), 26(1)

*Mecistops cataphractus* + *Crocodylus*: 11(2), 14(1), 30(1)

*Mecistops cataphractus*: 19(1), 30(1)

*C. palaeindicus* + Crown *Crocodylus*: 5(1), 8(1), 13(0), 29(1)

*C. palaeindicus*: 18(1), 20(0), 26(1), 26(0), 30(1)

Crown *Crocodylus*: 5(1), 8(1), 17(1), 30(0)

Indopacific *Crocodylus*: 16(1), 31(1)

*C. palustris*: 7(1), 12(1), 30(1), 32(1)

*C. siamensis* + *C. porosus* + *C. mindorensis* + *C. johnstoni* + *C. novaeguineae*: 2(1)

*C. siamensis*: 3(1), 4(1), 8(0), 10(0), 24(1)

*C. porosus* + *C. mindorensis* + *C. johnstoni* + *C. novaeguineae*: 6(1), 9(0)

*C. porosus*: 32(1)

*C. mindorensis*: 30(1)

*C. johnstoni* + *C. novaeguineae*: 31(0)

*C. johnstoni*: 19(1)

*C. novaeguineae*: 23(0), 28(0)

*C. niloticus* + New World *Crocodylus*: 3(1), 22(1)

*C. niloticus*: no autapomorphies

New world *Crocodylus*: 1(0), 15(1), 20(0), 21(2)

*C. falconensis*: no autapomorphies

*C. moreletii* + *C. rhombifer* + *C. acutus* + *C. intermedius*: 1(0), 21(2), 30(1), 31(1)

*C. moreletii*: no autapomorphies

*C. rhombifer*: 11(1), 24(1)

*C. acutus* + *C. intermedius*: 32(1)

*C. acutus*: no autapomorphies

*C. intermedius*: 13(1), 22(0)

**New caimanine species**

The phylogenetic analysis including *Globidentosuchus brachyrostris* gen. et sp. nov. resulted in a total of 20160 most parsimonious trees (minimum length=650; Fig. 5b; Supplementary Figure S11). Note that character (97) for *Alligator thomsoni* (=althom in matrix file) in the original matrix of Brochu et al.[64] was incorrectly scored with ”9“ instead of “0” and character (156) was scored with (2) in *Piscogavialis jugaliperforatus* and *Gryposuchus colombianus*, although (0) or (1) should have been the only possible character states following the character description. Both taxa are scored with (1) herein based on personal observation of holotypes by one of us (DCF). The original score (0) for character (150) and (3) for character (158) in *Eocaiman cavernensis* (=eocai in matrix file) by Brochu et al.[64] were changed to (?), based on the poor preservation of that region of the skull in the holotype specimen.

The results of the TNT analysis could be verified by a second analysis using the heuristic search option in PAUP v. 4.0b10 for Microsoft Windows[68]. For the latter, a setting of MaxTrees=15000 was enforced as previous tries with an open, step-wise automated increase of the number of trees retained led to a critical termination of the analysis. The statistics of this analysis were: tree length = 650; consistency index (CI) = 0.3477; homoplasy index (HI) = 0.6523; CI excluding uninformative characters = 0.3426; HI excluding uninformative characters = 0.6574; retention index (RI) = 0.8110; rescaled consistency index (RC) = 0.2820. The strict consensus of the first 1000 MPTs shows exactly the same topology and tree length (650 steps) as in the TNT analysis.

Re-running the analysis after incorporating *Necrosuchus ionensis*[69] in the matrix basically recovered the same results as the previous analysis (tree length remained at 650; total number of MPTs = 24100), but with less resolution among basal caimanines (see Supplementary Figure S12). The previous sister group relationship between *Tsoabichi* and *Paleosuchus* was not recovered in this second run and the tree configuration with the polytomy among caimanines resembles that of the strict consensus shown in figure 9B in Brochu[70]. Following that previous work, we thus tentatively treat *Tsoabichi* as a caimanine herein as well.

Note that fundamental differences exist between the morphology-based matrices like the one from Brochu et al.[64] used herein and molecular analyses[71-74], especially pertaining to the hotly debated relationship between true and false gharials and crocodylines. However, assuming that tomistomines (the material tentatively assigned to ?*Thecachampsa*) are included in the

Crocodylidae as suggested by anatomy and the palaeontological record[62], as well as developmental data[75], it is possible to include the latter clade in the crocodilian fauna of Urumaco as well.

**Character codings**

The following coding based on and modified from the matrix of Brochu et al.[64] was used (unknown or non-applicable characters were coded as question marks; the coding of *Necrosuchus ionensis* follows Brochu[69]):

*Bernissartia fragesii*

??????0???0111102100?00?0?000???0000?100010???0010?000???????10?0?00?001?1????000?0?0000?00030?00?????1000????1?0000?000??0100?0??000100?0?0??0?0?0010?0??00??0????????000?0000?000

*Allodaposuchus precedens*

??????????????????????????????????????????????????????????????????????????????00010?000000123000000?100000????00000001010300011000101100???0100000001100010000?????1??01?010001?000

*Acynodon iberoccitanus*

??????????????????????????????????????????????10104101????????0???????0?0?????00010?000000106000000??00100????0000000101?00???20000?0100?110?0000??010100000?1?????????1???0????010

*Acynodon adriaticus*

?????1?????????????01?100?1??????????010?10?????????01????????0???0??100??00??00010?000?0?1060000?0????110????00?00011010000?1?11?0?0100???0????0??010?0?0010?????????????1???01?0

*Iharkutosuchus makadii*

??????????????????????????????????????????????10124?????????110???00??10?1????0001??0000011061000?0???0110????0000001001100001201001?100?1?0?00?0???12???100?2?????1???1000000??110

*Hylaeochampsa vectiana*

????????????????????????????????????????????????????????????????????????0?????0??????????0?0?1000?00??0110?0?00000001001000?0?2110000120????1?0?000010100000000????1?001001000?0110

*Eothoracosaurus mississippiensis*

??????0????????????01??000????????00?00???0????122???3??????0?????00?011?0????001
20?000??102500000??000000????0000101001000????00?000100???01???10000010?001?00
????????100010000000

*Thoracosaurus neocesariensis*

??????0??????111?1?010????0011??0??0?00???0???1122???3????????10?000?01?0?????00
120?0000?1025000000??000000?0?0000101001000 0?00000000110?00010??1?0000100001
00000000?00100?10000000

*Thoracosaurus macrorhynchus*

??????0???0?1111?1?01?????00????0????00???0???1?22???3??????0?100000001100????00
120?00?0?1025000000??000000?0?00001010010000110000000110?000100?10001010?001
0000???0??0100010000000

*Eosuchus minor*

??????0???0??111???01?00?0?01???0000?000??0???1122??0300?0000?10?000001100????0
0120?0000?1025?00000?000000?00000001010010000?10000000110???0100?10?10010000
1?0100??1???101010101003

*Eosuchus lerichei*

??????0??????01????01???????1????????0????????1122???3??????????????????0?????0012
0?0000?1025000000?0000000???00001010010000010000 0?0110?000?0??10?2001000010?1
????????10?01?101003

*Eogavialis africanum*

????????1?????11???010??????????0?????????0???1122??03?????10?100000??1101????001
20?000?01025?00000?0000000000000010100100000100000000121?000100?1001001000010
100?000??0101010100000

*Piscogavialis jugaliperforatus*

?????????????????????????????????1??????????????11?2???3?????0001???????10??????00120
?001001025000000?000000????0000101001000000?000000111?1?00010100200100000100?
0?1?0?0?12??1?10?000

*Gryposuchus colombianus*

????0?0???001??????01??000????????????????0???11223?030100?0001000000001100????00
12010000?1025?00000?0?0000??0?0000101001000001100000 0121?000100?100110100001
00000100?00121010100000

*Gavialis* sp. (Siwalik)

???????????????????010??????????????????????????22???3??????0?100000??1?0?????00?3
0?0??????2??0???0?0?0000??0?0000?0?00100?0?1???0000121?000100?100??0?000010000
?????00121010100000

*Gavialis gangeticus*

020000000?00111101101000000011100000?000000001122300300000000100000001100
10000130100000102 5?0000000000000000000101001000001100000012100001000100110
10000100000000000121010100000

*Borealosuchus threeensis*

????0??????????????01???????0??????1?00??20???01002??1?????10?11?000001000???????
?????????????????????????????????????????????????????????????????????????????????
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*Borealosuchus formidabilis*

000?000?0?11001001001000000101000001?000?20???0110200000?000?110000000100001
??00020?0000?0023100000?000000100000001010010001010020 1?11000000?00?00001010
0101000??????00100110000000

*Borealosuchus wilsoni*

??????0??????????1001000000101??00?1?000?20???01002??100?0?001100000201000????0
0020?0?0???0231000?????00001?0?0?001010010001010020101100?000100??00110100101
0000?00???010011?0?0000

*Borealosuchus acutidentatus*

????????????????????????????0???????????????????002????????????000??????0?????00020
?0?00??0231000?????0000????0?0??0???????1??002?1?1100?0?0?0??0?011010?101000???
????010??1?0?0000

*Borealosuchus sternbergii*

000000000?110010?1001000000101000001?00???0???011020000000?0001000000000100000
??00020?00000001310000001000001?0?000001110100010100001111 00?000100?00000010
0101000000?1?00100110000000

*Pristichampsus vorax*

????0?0???01001001?01?00000111??0100?10???1???1110?000?????0??1000001?1?0?????2
1010?0000?0003000100?000000??0?0000001001000101000011111 0???0100?01000010010
1000???01??1100110000002

*Pristichampsus geiseltalensis*

?????????????0?0???01?000?0??1??0100?1???1????11102000??????0?1????0??1?1?????21?
20?000000030001???000000????000000100101O??10000111110?0?0?00?0?010010?10100
?????????1???10000002

*Planocrania hengdongensis*

???????????????????1?????????????????????????1110???1????????1????0?01?0?????20010
?0?????01300??????0?000????0????01001???????0??1?1100????????0?0?00100?0100?????
1???1???10?10001

*Planocrania datangensis*

???????????????????????????????????????????????11?????0????????????????????????20010?
000??1003000000??0?000???????000??01???????0??1?1110????????0?000010010??0??????
???????10??0?0?

*Leidyosuchus canadensis*

????0?0???????1????010000011?1??10?0?11??11???0110?00000?0?01?100000011101????0
0010?000000003000000000100010001000011101000101000011110O?0101001001000100l
0100000001?00100110010001

*Deinosuchus riograndensis*

??????0????????????01????????????????00???1???0110???001?0?11?10??0??11?0?????00??
1?0??????0?0000???0??00011?00?0??????????????000111120?012210?1110001001?1000??
000?0?????1??100?1

*Diplocynodon ratelii*

??????0??????000???010?00?1111001400?10??21???01002101?????0111000001?1101????0
0120?000000123000000010100O??0?000000111100010100001111OO??10100100000010110
100000001?10100110010001

*Diplocynodon hantoniensis*

100???1?1?010000100010000011111??1400?101?21???011021010????01110000011110l???
?00120?0?000?11300?000?1010001?0?000000101100010100001111OO?110100?001010101
101000??0?1??010011?010001

*Diplocynodon muelleri*

????????????????????1?01??1?????14?0?10??21???01002??2?????01110??10011100????00
120?100000123000000010100O????000001111000001000?1?1100?110??0?01?010101101
00????????0100110010001

*Diplocynodon tormis*

????????????????????1?????1??????????10??21???01?021?1?????01?1?00????11??????0?12
0??00000123000000?1010001???000000111100?0?10000111100?1101000001010101101000
?0???1?001?0110010001

*Diplocynodon darwini*

100001001?010000?00010000?1111??1400?101121???011020010??0?01?10000011110100?
?00020?0000?0103000000?0??000??0?0000001111?00101000?111100?110100?0110101011
01000???????0100110010001

*Baryphracta deponiae*

100?0?0???????0????01?0???1?????14?0?10??21????1?02??0?????01?10??0??1110?????00
1???000??01030000?0????000?????0?0001?11000?01000?111100?110100?0??011?0?101?0
0????????1???1??10001

*Brachychampsa montana*

101011001?1100???0001??000111100?000?103111???11101101?????01110?00001110100?
?00110?0002?1101000000?0010001?0?01000001111001012001111100?110200?011100101
10102000101?00100110010001

*Brachychampsa sealeyi*

??????????????????????????????????????10???1???11101??0???????11??0000111?1????001?
0?0002?110100000???010?????????00????????10?2001101?00???????????100????????2????
?????????1??10??1

*Stangerochampsa mccabei*

????110???010010?0001000001111001000?01??11???111010100????0111110000?110?????
00110?0002?1102000000?001000????000000011110010120011111100?110200?0?11001021
01000??1?1??0100110010001

*Ceratosuchus burdoshi*

????????????????????????????????????0?1????????11111??0?????01?10??00?11?01????0001
0?0?01?0102000000???1000??0????00???01???1?1??0?111100????????0????010?111??????
?????10??10010001

*Hassiacosuchus haupti*

001?1?0?1??????0???01?000?1111?????0??11?11???111110?0?????01?10??0??11101????00
010?00???010?0000??????0001?0??????0?????????1100?111100?1?0200?011200102101001?
???????01???10010001

*Navajosuchus mooki*

??????0?1??????0???0?00???1111??1??0?111111???11111010?????01?10??00??110?????00
010?0001?01020000???0?1000??0???00?00?111001011001111100???020??0112?01021010
00????1??010??10010001

*Allognathosuchus polyodon*

?????????????????????????????????????????????11111010?????01?11??00?111?1????0001
0?000??01020000?0?????00??0?00?00?0?111001?1?01?111100????????0??20010?101?????
??????1???1??1???1

*Allognathosuchus wartheni*

????1?0????????????0?0000?1111??1000?11???1???11111010?100?011110000011101????0
0010?0000?010200000000010001?0?000000?0111001?11011111100?110200?01120010210
10000?1?1?0010011001?001

*Procaimanoidea kayi*

????110?1??????0???010?00?1111??10?0?112121?????010?1??100?01?11000001110?????1
0?????0???010?0000???0?1000??0?0000000011100?0110111111000??0200?011200102101
010???????0100110010001

*Procaimanoidea utahensis*

?????????????????????????????????????????????110100?00??01011110??0011101????101
10?0100?01020?0000??01000????0000000?11100101101?111100?1?0200?01120010?10100
0???????0100110010001

*Arambourgia gaudryi*

?????????????????????????????????????????????11010??0?????01?100?0??1110?????1001
??010??01020000?0???10001000??000????11?0??1101?111100?1102?0?0?1210?0210100??
???????10011?010?01

*Wannaganosuchus brachymanus*

????1?0???1?00?0???010000?1111001000?11???1???111110?0?????0??100?00?11?0?????0
0110?0000??10200??00???1000??0?100000???1??01?1101?111100????????0?12001??1010
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*Alligator sinensis*

101011101?110010100010110111110011000112111110110000120?0010112000001111101??
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*Alligator mississippiensis*

101011001?0100100000101101111100110001121011001100011201001011200010111101001100100001000010200000000010001110000000011110010110111111100110200101121010210101000111100100110010001

*Alligator mefferdi*

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*Alligator thomsoni*

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*Alligator olseni*

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*Alligator mcgrewi*

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*Alligator prenasalis*

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*Eocaiman cavernensis*

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*Tsoabichi greenriverensis*

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*Purussaurus neivensis*

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*Orthogenysuchus olseni*

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*Mourasuchus* spp.

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*Caiman yacare*

101111001?1000100000101011111100110001112211101100211210101110101102011 0010
11100110000000011200000000010001100100000011110121111011111100110201101 1201
1121010300010110010011021 0001

*Caiman crocodilus*

101111001?1000100000101011111100110001112211101100211210101110101102011 0010
11100110000000011200000000010001100100000011110121110011111100110201101 1201
1121010300010110010011021 0001

*Caiman latirostris*

101110001?10001000001010?11111001100011122121011002112101011 1?10110201100???
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121010300010110010011021 0001

*Caiman lutescens*

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*Melanosuchus fisheri*

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*Melanosuchus niger*

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1210103000101100100110210001

*Paleosuchus trigonatus*

100111111?01001010001000111111211300011132112011002122211111111011000110010
111101100001000102000000000100011000100010111101111000111111011102011011211
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*Paleosuchus palpebrosus*

100111111?010010101010001111112113000111321120110021222111?11?10110001100?01
111011000010001020000000001000110001000101111011110001111110111020110112111
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*Mecistops cataphractus*

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0010012000000100210000000010000011010000101101000101000011111000010111001200
10010100011101011110010000003

*Crocodylus niloticus*

101000001?10101000101110011111201200011120110111002101010001011000111010111
0010011000000100210000000110000011010010001101000101100011111000010111001200
10010100011101011110011000003

*Crocodylus porosus*

111000001?00101010101110001111201200011120110111002101010001011000111010111
001001100000010021000100110000011010010001101000101000011111000010111001200
10010100011101011110011000003

*Crocodylus rhombifer*

001000001?10101000101110011111201100011120110111002101010001011000111010111
001001100000010021010000110000011010010001101000101100011111000010111001200
10011100011101011110011000003

*Euthecodon arambourgii*

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*Osteolaemus tetraspis*

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*Osteolaemus osborni*

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0110110000101002100010001000001101100100100101010100001111101001010100121 11
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*Voay robustus*

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*Rimasuchus lloydi*

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*Crocodylus pigotti*

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*Crocodylus megarhinus*

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*Australosuchus clarkae*

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*Kambara implexidens*

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*Trilophosuchus rackhami*

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*Quinkana* spp.

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*Tomistoma schlegelii*

021000001?0010100010110001111110110001013011011122?1040000010010000000010100
001001200000011021000001010000011010001001001000101100011111000001101001210
10010100011001011110010000003

*Tomistoma lusitanica*

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*Toyotamaphimeia machikanense*

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*Gavialosuchus eggenburgensis*

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*Paratomistoma courti*

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*Tomistoma cairense*

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*Thecachampsa antiqua*

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00120?000011021000000?100000??0?0000101?010001011000011110???011??1012001001
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*Tomistoma petrolica*

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*Dollosuchoides densmorei*

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0120?00?0?1021000000??00000????01?0101001000101100?011110????????1??20010?1010
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*Kentisuchus spenceri*

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*Brachyuranochampsa eversolei*

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*Crocodylus acer*

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*Crocodylus depressifrons*

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00110?0000?1011000000?1100001?0?0001001?01000101?000111100?010200?0012001001
0100011001?11100010000003

*Crocodylus affinis*

001001001?10001000011100001111001100?10???1???111021010100000110000000101100
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*Asiatosuchus germanicus*

001?0?0?1?001010?0101?000?1111??1??0??????1???11102000?????00110000??0101?00??00010?0000?000100000???10000??0?00010???01000101000?111100???0100?001110100101000???????1100?10000003

*Prodiplocynodon langi*

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*Necrosuchus ionensis*

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***Globidentosuchus brachyrostris* gen. et sp. nov.**

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## Supplementary References


54 Quiroz, L.I. & Jaramillo, C.A., Stratigraphy and sedimentary environments of Miocene shallow to marginal marine deposits in the Urumaco Trough, Falcón Basin, western Venezuela in *Urumaco and Venezuelan Palaeontology – The Fossil Record of the Northern Neotropics*, (eds. M. R. Sánchez-Villagra, O. A. Aguilera, & A. A. Carlini) 153-172 (Indiana University Press, Bloomington, 2010).

55 Brochu, C.A. Crocodylian snouts in space and time: phylogenetic approaches toward adaptive radiation. *Am. Zool.* **41,** 564-585 (2001).

56 Sereno, P.C., Larsson, H.C.E., Sidor, C.A., & Gado, B. The giant crocodyliform *Sarcosuchus* from the Cretaceous of Africa. *Science* **294,** 1516-1519 (2001).

57 Platt, S.G. *et al.* Size estimation, morphometrics, sex ratio, sexual size dimorphism, and biomass of Morelet's crocodile in northern Belize. *Caribb. J. Sci.* **45,** 80-93 (2009).

58 Platt, S.G., Rainwater, T.R., Thorbjarnarson, J.B., & Martin, D. Size estimation, morphometrics, sex ratio, sexual size dimorphism, and biomass of *Crocodylus acutus* in the coastal zone of Belize. *Salamandra* **47,** 179-192 (2011).

59 Hurlburt, G.R., Heckert, A.B., & Farlow, J.O. Body mass estimates of phytosaurs (Archosauria: Parasuchidae) from the Petrified Forest Formation (Chinle Group: Revueltian) based on skull and limb bone measurements. *New Mexico Mus. Nat. Hist. Sci. Bull.* **24,** 105-114 (2003).

60 Webb, G.J.W. & Messel, H. Morphometric analysis of *Crocodylus porosus* from the north coast of Arnhem Land, northern Australia. *Austr. J. Zool.* **26,** 1-27 (1978).

61 Vucetich, M.G., Carlini, A.A., Aguilera, O., & Sánchez-Villagra, M.R. The Tropics as reservoir of otherwise extinct mammals: the case of rodents from a new Pliocene faunal assemblage from northern Venezuela. *J. Mammal. Evol.* **17,** 265-273 (2010).

62 Brochu, C.A., Njau, J., Blumenschine, R.J., & Densmore, L.D., A new horned crocodile from the Plio-Pleistocene hominid sites at Olduvai Gorge, Tanzania. *PLoS ONE* **5(2),** e9333. doi:10.1371/journal.pone.0009333 (2010).

63 Buscalioni, A.D., Sanz, J.L., & Casanovas, M.L. A new species of the eusuchian crocodile *Diplocynodon* from the Eocene of Spain. *N. Jb. Geol. Pal., Abh.* **187,** 1-29 (1992).

64 Brochu, C.A., Parris, D.C., Grandstaff, B.S., Denton Jr., R.K., & Gallagher, W.B. A new species of *Borealosuchus* (Crocodyliformes, Eusuchia) from the Late Cretaceous–early Paleogene of New Jersey. *J. Vertebr. Paleontol.* **32,** 105-116 (2012).

65 Norell, M.A. The higher level relationships of the extant Crocodylia. *J. Herpetol.* **23,** 325-335 (1989).

66 Norell, M.A. *Cladistic approaches to paleobiology as applied to the phylogeny of alligatorids.* (PhD Thesis, Yale University, New Haven, CT, 1988).

67 Brochu, C.A. Phylogeny, systematics, and historical biogeography of Alligatoroidea. *Soc. Vertebr. Paleontol. Memoir* **6,** 9-100 (1999).

68 Swofford, D.L. *PAUP*. Phylogenetic analysis using parsimony (*and other methods). Version 4*. (Sinauer Associates, Sunderland, Massachusetts, 2002).

69 Brochu, C. A. Phylogenetic relationships of *Necrosuchus ionensis* Simpson, 1937 and the early history of caimanines. *Zool. J. Linnean Soc.* **163,** S228-S256 (2011).

70 Brochu, C.A. A new alligatorid from the lower Eocene Green River Formation of Wyoming and the origin of caimans. *J. Vertebr. Paleontol.* **30,** 1109-1126 (2010).

71 Harshman, J., Huddleston, C.J., Bollback, J., Parsons, T.J., & Braun, M.J. True and false gharials: a nuclear gene phylogeny of Crocodylia. *Syst. Biol.* **52,** 386-402 (2003).

72 Oaks, J.R. A time-calibrated species tree of Crocodylia reveals a recent radiation of the true crocodiles. *Evolution* **65,** 3285-3297 (2011).

73 Meganathan, P.R., Dubey, B., Batzer, M.A., Ray, D.A., & Haque, I. Molecular phylogenetic analyses of genus *Crocodylus* (Eusuchia, Crocodylia, Crocodylidae) and the taxonomic position of *Crocodylus porosus*. *Mol. Phylog. Evol.* **57,** 393-402 (2010).

74 McAliley, L.R. *et al.* Are crocodiles really monophyletic?-Evidence for subdivisions from sequence and morphological data. *Mol. Phylog. Evol.* **39,** 16-32 (2006).

75 Piras, P. *et al.* The *Gavialis–Tomistoma* debate: the contribution of skull ontogenetic allometry and growth trajectories to the study of crocodylian relationships. *Evol. Dev.* **12,** 568-579 (2010).