Electronic Supplementary Material – Text S1

A Miocene hyperdiverse crocodylian community reveals peculiar trophic dynamics in proto-Amazonian mega-wetlands

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Contents:

i) – Bonebed localities, age, stratigraphy, and vertebrate faunal assemblages

Thirty-three localities yield vertebrate remains in the Iquitos area of northeastern Peru, in the northwestern Amazon basin. The fossiliferous deposits range in age from late early Miocene (early Langhian, ca.16 Ma) to early Late Miocene (early Tortonian, ca. 11 Ma), based on pollen, ostracod and molluscan biozones [S1-4]. The bulk of the vertebrate-yielding localities are lignitic bonebeds and date to the Middle to late Middle Miocene (15-12.3 Ma; Molluscan Zones [MZ] 6 and 8) [S1]. They are located in the so-called Iquitos Arch, which corresponds to the modern forebulge of the northwestern Amazonian foreland basin [S5]. The uplift of the Iquitos forebulge started in the Late Miocene and is still active.

Fossiliferous lignite layers are common in the Pebas Formation. For several outcrops [S6,S7] the genesis of such layers is linked to lowstand/early transgression in recurring depositional sequences in the megalake system [S8]. The duration of each such sequence was probably within an orbital cycle scale [S9], and no indication of massive reworking and time averaging has ever been found (extensive wear and ecological incompatible taxa – either vertebrates and invertebrates – are notably lacking in the lignites). Furthermore, the vertebrate fossils are often extremely well preserved and complete, and occasionally include various associated elements of the same individual, indicating lack of transport and in-situ deposition within the concerned bonebeds. We therefore consider the studied fossil assemblages from lignite beds IQ26, IQ114, and IQ116 to be autochthonous.

The rich late Middle Miocene Iquitos lignitic bonebed localities that correspond to MZ8 [S1] are located in the Fernando Lores District (IQ26 and IQ114) and along the Itaya River (IQ116) (figure S1). These three bonebeds each have yielded remains of the new short-snouted, crushing-dentition caimanine crocodylian *Gnatusuchus pebasensis*. *Gnatusuchus* remains in IQ26 were found in the "upper lignite", laterally equivalent to the lignitic deposits of IQ114 a few kilometers farther south (MZ8). IQ26 and IQ114 share the same seven crocodylian taxa, although fossil evidence of a putative eighth taxon is recovered from the former locality (see crocodylian material by field locality). Other fossil vertebrate remains, such as fishes, aquatic turtles, and mammals are abundant.

IQ 26 provides a thick section (~10 m) of MZ7-MZ8 within the Pebas Formation. This sedimentary succession consists of coarsening-upwards parasequences capped by lignites. The bonebed corresponds to the last capping regressive lignite and ~20 m^2 was exposed in the outcrop. This makes this new lignite slightly younger than lignite from which amber faunas were reported. The upper lignite bonebed is referred to the MZ8, contrary to the amber-yielding "lower lignite," referred to MZ7 [S10]. Underlying mud beds include ichnofossils and mollusc shells [S11]. The IQ114 lignite bonebed is laterally equivalent to the IQ26 upper parasequence and is located in the same capping regressive lignite. This lignitic bonebed covers a surface of ~200 m^2 at IQ114. Outcrops at the Itaya River (IQ116) are restricted to a 1-2 meter thick capping lignite level overlying a gray mud with shell beds. They are possibly lateral equivalents of IQ26 and IQ114 sequences.

Early Late Miocene localities at Nueva Union (IQ125) belong to MZ9 or even younger intervals [S1,S12]. Outcrops consist of fine-grained fluvial sandstones, floodplain clays and silts, and paleosols.

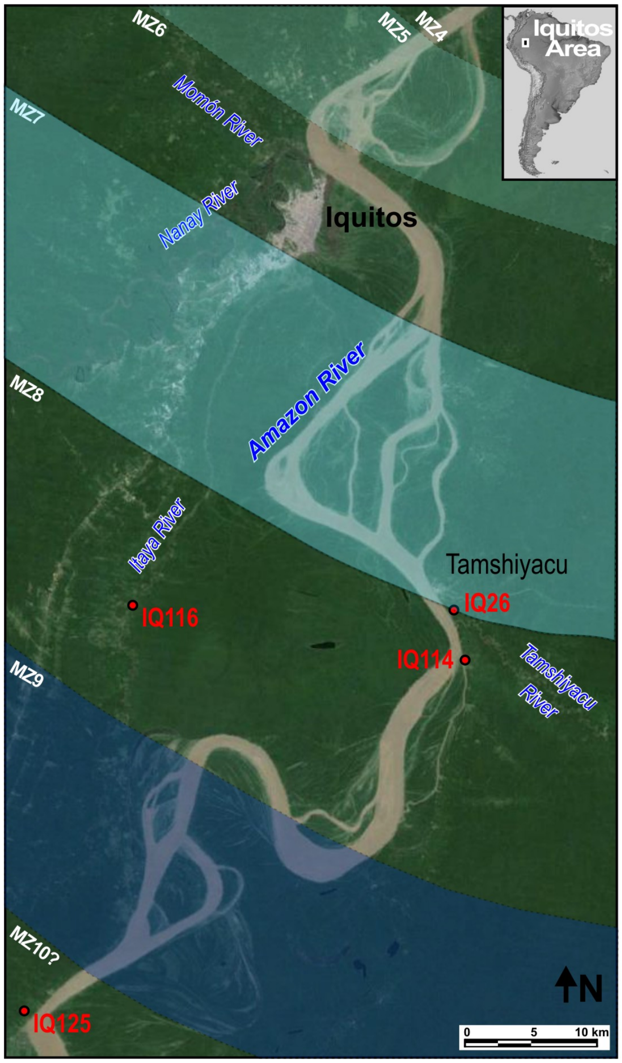

Fig. S1 – Map of the Iquitos area showing principal localities of the crocodylian fauna. Spatial distribution of Molluscan Zones (MZ) within the Pebas Formation is shown. Modified from [S1].

Approximately 50 vertebrate taxa were recovered in-situ during our surveys of the Pebas Formation, between 2002 and 2013. The faunal assemblages, ranging from one to 30 vertebrate taxa at each locality, are widely dominated by chelonians and crocodyliforms, which are found in virtually every outcrop. Fishes (actinopterygians and chondrichthyans) also are common. On the other hand, mammalian remains are scarce, found in only18 localities. Ophidians (snakes and lizards) occur in six localities, and birds (aquatic pelecaniform and gruiform) in two. Among chelonians, pelomedusid (*Podocnemis* and *Stupendemys*) and chelid (aff. *Chelus*) pleurodirans are recorded, as well as testudinid cryptodiran (*Geochelone*).

Crocodyliforms at Iquitos are both extraordinarily diverse and remarkably complete and well-preserved, with the highest single locality crocodylian species diversity ever recorded in a fossil or living assemblage, and four of the seven taxa being represented by almost entire articulated skulls. The crocodyliform fauna is restricted to the crown-clade Crocodylia: no sebecosuchian was identified, in contrast to the taxa recovered in the coeval Fitzcarrald Local Fauna of southeastern Peru [S13]. Within this hyperdiverse crocodylian assemblage, a new gavialoid is the only longirostrine crocodylian recognised in the Iquitos area (four localities), whereas caimanines are represented by six taxa, such as the very large bodied taxa *Purussaurus neivensis* (ten localities) and *Mourasuchus atopus* (three localities), as well as *Paleosuchus* sp. (two localities). These occurrences coincide with the first unambiguous fossil record of the latter genus, previously known only from extant forms. The three new "crusher" caimans (with crushing-dentition, interpreted as durophagous), namely *Gnatusuchus pebasensis* (recovered from five localities), *Kuttanacaiman iquitosensis* (recovered from three localities), and *Caiman wannlangstoni* (recovered from two localities), are formally named and described in the present work (see main text).

ii) – Pebasian crocodylian material by field locality

MUSM= Departamento de Paleontología de Vertebrados, Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Perú

1 – Field Locality IQ26 (MZ8; Iquitos area, Fernando Lores District)

- *Gnatusuchus pebasensis*: MUSM 1722, right mandible lacking the retroarticular process; MUSM 1730, left mandible.
- *Kuttanacaiman iquitosensis*: MUSM 1490, skull and jaws (**holotype**); MUSM 1736, left mandible without splenial; MUSM 1937, portion of left dentary.
- *Caiman wannlangstoni*: MUSM 2377, partial skull (**holotype**); MUSM 926, partial left dentary and splenial; MUSM 1495, partial right dentary and splenial; MUSM 1906, left mandible; MUSM 1935, anterior portion of right dentary; MUSM 2381, juvenile maxilla.
- *Paleosuchus* sp.: MUSM 1724, right maxilla; MUSM 1985, right maxilla; MUSM 1934, partial left premaxilla; MUSM 2380, partial right premaxilla.
- *Mourasuchus atopus*: MUSM 1726, partial left maxilla; MUSM 1734, partial left maxilla; MUSM 1735, left jugal; MUSM 1762, partial left maxilla; MUSM 1933, left premaxilla; MUSM 2077, posterior left maxilla; MUSM

2378, skull table; MUSM 2379, jaw elements, humerus, cervical vertebra, scapula.

- *Purussaurus neivensis*: MUSM 1731, left premaxilla; MUSM 1733, skull table; MUSM 1392, right dentary; MUSM 2413, skull table.
- Caimaninae indet: MUSM 1728, skull table and articular region.
- Pebas gavialoid: MUSM 1428, right mandible; MUSM 1439, juvenile mandibular symphysis; MUSM 1727, partial rostrum.

2 – Field Locality IQ114 (MZ8; Iquitos area, Fernando Lores District)

- *Gnatusuchus pebasensis*: MUSM 990, skull (**holotype**); MUSM 925, anterior portion of right dentary with 1-5 alveoli; MUSM 1437, edentulous right premaxilla; MUSM 1465, edentulous premaxillae; MUSM 1737, left mandible; MUSM 1739, left splenial; MUSM 1761, anterior portion of right dentary with 1-6 alveoli; MUSM 1979, right mandible; MUSM 2040, left dentary and splenial with one globular tooth; MUSM 2051, right squamosal, exoccipital, and quadrate.
- *Kuttanacaiman iquitosensis*: MUSM 1942, associated left mandible, left maxilla, and skull table; MUSM 1928, juvenile partial skull table; MUSM 2394, juvenile partial skull table, MUSM 2078, partial left dentary.
- *Caiman wannlangstoni*: MUSM 928, right maxilla; MUSM 1983, associated maxilla, mandible with teeth, and partial skull table.
- *Paleosuchus* sp.: MUSM 1740, portion of right dentary; MUSM 1927, posterior portion of left maxilla; MUSM 1939, portion of left dentary; MUSM 1945, posterior portion of maxilla; MUSM 1989, partial right maxilla, jugal, and ectopterygoid.
- *Mourasuchus atopus*: MUSM 1966, right quadrate; MUSM 2074, right jugal.
- *Purussaurus neivensis*: MUSM 2075, tooth; MUSM 2076, tooth.
- Pebas gavialoid: MUSM 1981, skull without occipital and pterygoid region; MUSM 1428, right mandible; MUSM 1988, juvenile skull table; MUSM 2407, mandibular symphysis.

3 – Field Locality IQ116 (MZ8; Iquitos area, Itaya River)

- *Gnatusuchus pebasensis*: MUSM 662, left jaw preserved from the anterior tip of the dentary to the posterior process of the angular.
- *Kuttanacaiman iquitosensis*: MUSM 2080, frontal.
- *Purussaurus* sp: MUSM 921, tooth.
- Pebas gavialoid: MUSM 900, skull without snout; MUSM 2032, skull table and portion of the snout.

4 – Field Locality IQ125 (MZ9 or younger intervals; Nueva Union)

- *Gnatusuchus pebasensis*: MUSM 2393, posterior portion of right mandible.

- *Purussaurus* sp.: MUSM 2426, ten associated teeth; MUSM 2262, giant tooth.
- *Mourasuchus* sp.: MUSM 2427, left jugal; MUSM 2428, osteoderm; MUSM 2429, distal femur.
- *Gryposuchus* sp.: MUSM 2430, left postorbital.

iii) – Potential prey of "crusher" (crushing-dentition, durophagous) caimanine crocodylians

The Pebas Mega-Wetlands System hosted taxonomically diverse and abundant molluscan life that would form suitable prey for the diversity of crushing-dentition caimanine species. Especially abundant were pachydontine bivalves, a group of endemic species partially adapted to dysoxic lake floor settings [S14]. The most common species in the Pebas Formation is the highly inflated and thick-shelled *Pachydon obliquus*. This species typically makes up ca. 40-70% of shell numbers in Pebas lacustrine samples; in the Santa Rosa de Pichana site, it represents 47% of the total number of counted shells [S1].

Shell damage as a result of both successful and unsuccessful (healed) crushing predation is common in many samples in the Pebas Formation. Unsuccessful damage is found in a few samples, where specimens of *Pachydon obliquus* survived severe crushing and then resumed growth (figure 3 *h,i*). In sample F539 from Santa Rosa de Pichana, representing a shallow lacustrine floor assemblage [S1], 93% of valves and fragments with hinge remains have sharp edges typical of predation (figure 3 *i*,*k*,*l*). These edges are not the result of compaction, as accompanying gastropods in the same sample were not affected. Neither are they the result of breakage during collecting, as many of the sharp edged surfaces show similar post-depositional etching and discoloration of the shell's outer- and inner surfaces. In another sample (F74) (see Wesselingh et al. [S1] for locality data), 77% of the counted *P. obliquus* specimens contained signs of crushing.

Not only crushing-type of predation by crocodylians can cause sharp-edged fragments; attacks by decapod crustaceans, that also were large and plentiful in the Pebas System, might have caused similar damage. Yet, the characteristic decapod pattern of a scissor-edge is entirely lacking in this sample (and in many others). Thus, the F539 *Pachydon obliquus* sample is severely affected by a non-crustacean, crushing type of predation. As postulated here, based on their craniodental anatomy *Gnatusuchus pebasensis*, *Kuttanacaiman iquitosensis*, and *Caiman wannlangstoni* are all considered to have been durophagous crushing predators, although other potential crushing-type feeders were present in the Pebas System. These include sciaenid fish that were common in the Pebas System, and piranhas, the remains of which are found only very rarely. The pharyngeal jaw system of the former must have had great difficulty dealing with prey that were typically quite large (1/2 to 2 cm across), while the saw-like dentition of the latter is not adapted to durophagy. Given the obliteration of the massive cardinal tooth of the bivalve *Pachydon obliquus* in many instances (In figure 3*l*, compare cardinal tooth with [left] and without damage [right]), the crushing force for this damage must have been formidable, which is consistent only with the strong adductor musculature estimated for crushing-dentition caimanines among potential predators in the Pebas System. Other *Pachydon* species show similar breakage.

Several morphological characters in species of *Pachydon*, and especially in *P. obliquus*, are well suited to defend against crushing predators. These are: (a) very thick shell, (b) massive, tightly interlocking hinge, (c) convex shape of paired valves, (d) smaller left valve fitting well within the larger right valve, and (e) ability of the animal to live well within the shell away from the edges, as indicated by the deep location of the pallial line [S14]. Although we cannot confirm a causal relationship, these characters may well have evolved in conjunction with increased adaption to molluscivory in Miocene Pebas predators such as blunt-snouted crushing-dentition caimans, potamotrygonid rays, and caiman lizards (i.e., *Paradracaena*, *Dracaena*).

In general, *Pachydon* specimens are thickest shelled and largest in shallow lacustrine settings with little dysoxia and become smaller and thinner-shelled in deeper dysoxic lake floor settings [S14]. Predation pressure may have been highest in the shallow lacustrine-wetlands settings from which *Gnatusuchus pebasensis, Kuttanacaiman iquitosensis*, and *Caiman wannlangstoni* have been recovered.

In summary, *Pachydon* bivalves may have been the dominant prey of choice for most crushing-dentition caimanines, and particularly for the highly specialised and anatomically distinctive new taxon *Gnatusuchus pebasensis*. These bivalves were extremely abundant on the shallow floors of the Pebasian lakes, and signs of both successful and failed crushing predation are plentiful. The severity of shell damage indicates extremely powerful predators, such as caimans with strong adductor musculature, massive jaws, and posterior globular teeth.

iv) – Pebasian caimans and crocodylian anatomy

1 - Complete Diagnosis of *Gnatusuchus pebasensis*

Gnatusuchus is a blunt-snouted caimanine diagnosed by the following combination of characters (autopomorphies within Crocodyliformes are demarcated with an asterisk): skull short and broad, parallel-sided with a reduced rostrum and a wide rounded snout; skull table slightly longer than wide; nearly circular orbits; extremely narrow interorbital bridge; upturned orbital rims absent; rostral canthi or "spectacle" absent; thick laterosphenoid; attachment scars on ventral surface of quadrate forming a prominent knob; presence of a notch lateral to external naris; anterior process of ectopterygoids extremely short and truncated; palatine-pterygoid suture far anteriorly from posterior angle of suborbital fenestrae; third maxillary tooth alveolus slightly bigger than fourth; anterior teeth peg-shaped with blunt crowns and posterior teeth globular, both with no carinae*; dentary with an extensive diastema that separates seven anterior alveoli from four close-packed posterior "cheek teeth" alveoli*; anterior dentary teeth strongly procumbent, decreasing progressively in size towards the diastema* (third and fourth in some specimens are nearly of the same size); posterior mandibular teeth completely surrounded by the dentary; shovel-like mandible with a long symphysis reaching the level of the eleventh dentary tooth alveolus (of related taxa); large participation of splenial in symphysis; posterior half of the mandibular ramus tilted lateroventrally*.

2 - Additional remarks on *Gnatusuchus pebasensis* anatomy

The holotype of *Gnatusuchus pebasensis* (MUSM 990; figures 1 *a-b*, 2*a*, and S2) is a nearly complete skull that is partially flattened in the rostrum region. Palatine bones and maxilla are crushed; tooth alveoli are distorted but not badly damaged. Third and fourth maxillary teeth are preserved in their alveoli (figure 1*b*). The skull lacks the postorbital bars, left quadratojugal, and portions of bones associated with the infratemporal fenestrae. The skull measures 220 mm in basal length. It might represent the fully adult morphology and size, considering that it bears prominent crests A, B, and D on the anteroventral surface of the quadrate, because among Crocodylia these crests are well developed in old individuals and almost absent in immature specimens [S15,S16]. Additional material assigned to this taxon comprises cranial fragments and several well-preserved jaws belonging to individuals of equivalent size.

The mandible (MUSM 1979: figure 1 *c*,*d*; MUSM 662: Fig. 3 *a*-*c*) is short, wide, and massive. The symphyseal region is extremely shallow, broad, and flat, as in early alligatoroids and caimanines, such as *Globidentosuchus brachyrostris* [S17] and *Eocaiman cavernensis* [S18]. The symphysis is very long, being about a third of the total length of the mandible, and reaching posteriorly to the level of the eleventh dentary tooth alveolus locus. The dentary bone surrounds all of the mandibular dentition. Splenial participation in the symphysis is extensive. The splenial constitutes a huge flange medial to the level of posterior alveoli, as in basal Globidonta taxa, such as *Brachychampsa*, *Stangerochampsa*, *Allognathosuchus*, and among caimanines, in *Globidentosuchus brachyrostris* [S17,S19,S20]. In MUSM 662, the first, second, and fourth dentary teeth are preserved in their alveoli (figure 3 *a*-*c*). Apart from size differences among them, all are equivalent in morphology; likely represent the morphology of all anterior tooth loci. Anterior alveoli decrease in size posteriorly, with the first alveolus being the largest in the mandible and the third and fourth generally subequal in size. The first four alveoli are aligned along the frontal edge with the tips oriented outwards. Fifth, six, and seventh alveoli are reduced in diameter. Large vascular and neural foramina occur distal to the anterior alveoli. Behind the diastema, the four posterior tooth positions most likely represent the eleventh to fourteenth tooth loci of related taxa. The eleventh and fourteenth alveoli are small and generally comparable in size and shape to the fifth or sixth. The twelfth and thirteenth alveoli are large. Posterior teeth are closely spaced.

Posterior to the tooth series, the rami increase in height and, unlike other crocodylians, the whole bone structure in this position is tilted lateroventrally (figure 1 *c*,*d*). On the other hand, the articular bone, and therefore the mandibular joint, is displaced medially from the longitudinal axis of the rami. The external mandibular fenestra is proportionally larger and more triangular in profile than usually observed in caimans, due to the presence of a posteroventral angle and straighter margins. The surangular bridge above the fenestra is quite robust and flattened transversally, as in longirostrine crocodylians [S15]. The articular fossa is deep and enlarged. The posterior extension of the angular reaches the tip of the retroarticular process, as in extant caimans. The retroarticular process is short and massive.

Dental patterns suggest that specific, distinct roles were performed by the anterior and posterior teeth series. Incisor-like procumbent anterior teeth with apical wear possibly functioned for holding, scooping, or scratching. The posterior dental series bears just four functional globular, molar-like teeth. Although reduced in number relative to other caimanines, they are closely packed and located at the top of the posterior convex arch, in a prominent lateral expansion of the alveolar border (figures 1*c* and 3*d*). These teeth most likely served for crushing or grinding of hard prey.

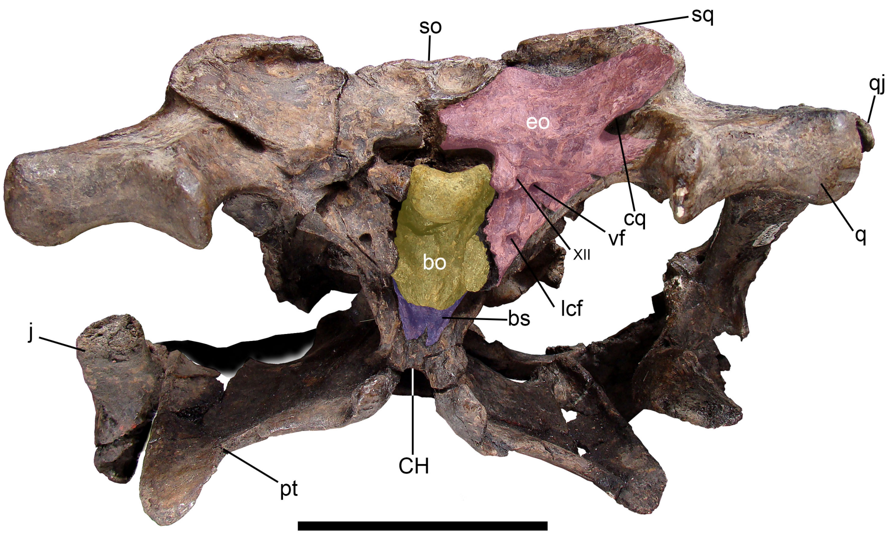

Fig. S2 – *Gnatusuchus pebasensis***.** Holotype, MUSM 990. Skull in posteroventral view. bs, basisphenoid (purple); bo, basiooccipital (yellow); CH, choana; cq, cranio-quadrate canal; eo, exoccipital (red); jugal; lcf, lateral carotid foramen; pt, pterygoid; qj, quadratojugal; q, quadrate; sq, squamosal; so, supraoccipital; vf, vagus foramen; XII, foramen for cranial nerve XII. Scale bar = 5 cm.

Table S1 – Measurements (mm) of holotype of *Gnatusuchus pebasensis*. MUSM 990, skull. Measurements after Langston [S21]. Measurements with missing data are omitted. e, estimate.

	MUSM 990
Transverse diametre of skull, level of jaw articulation	155.9
Basal length of the skull	220.1
Transverse diametre of skull, level of anterior ends of orbits	163.1
Length of the snout, anterior end of the orbits to tip of the snout	105.1
Length of skull, posterior edge of skull table to tip of snout	219.2
Least transverse diametre, interorbital space	12.0
Length of orbits	49.5
Length of skull table	64.6
Transverse diametre of skull table, posteriorly	95.5
Transverse diametre of skull table, anteriorly	68.1
Transverse diametre of skull, level of postorbital bar	159.7
Width of orbits	50.9
Transverse diameter of nares	24.4
Length of nares, exclusive of narial spine	23.5
Length of the choana	11.4
Transverse diameter of the choana	17.9
Length of suborbital fenestra	49.9e
Length of incisive foramen	18.9
Greatest transverse diametre of incisive foramen	20.3
Height of occipital condyle	10.2
Transverse diametre of occipital condyle	13.8

Table S2 – Measurements (mm) of mandibles of *Gnatusuchus pebasensis*. MUSM 662, left mandible without articulars. MUSM 1979, complete right mandible. Mandible width at the end of the symphysis was estimated by duplicating the minimum width measurement of the preserved mandibular ramus. Measurements modified from Langston & Gasparini [S22]. e, estimate.

	MUSM 662	MUSM 1979
Mandible length (as preserved)	263	308.0
Symphysis length	83.3	86.3e
Splenial length in symphysis	24.7	25.7
External fenestra length	--	71.0
External fenestra height	--	35.3
Mandible width at end of symphysis	58.3 x 2 = 116.6	61.0 x 2 = 122.0
Mandible height at d4	18.6	--
Greatest mandible height	--	80.0

3 – Additional data for and figures of other Pebasian caimanines

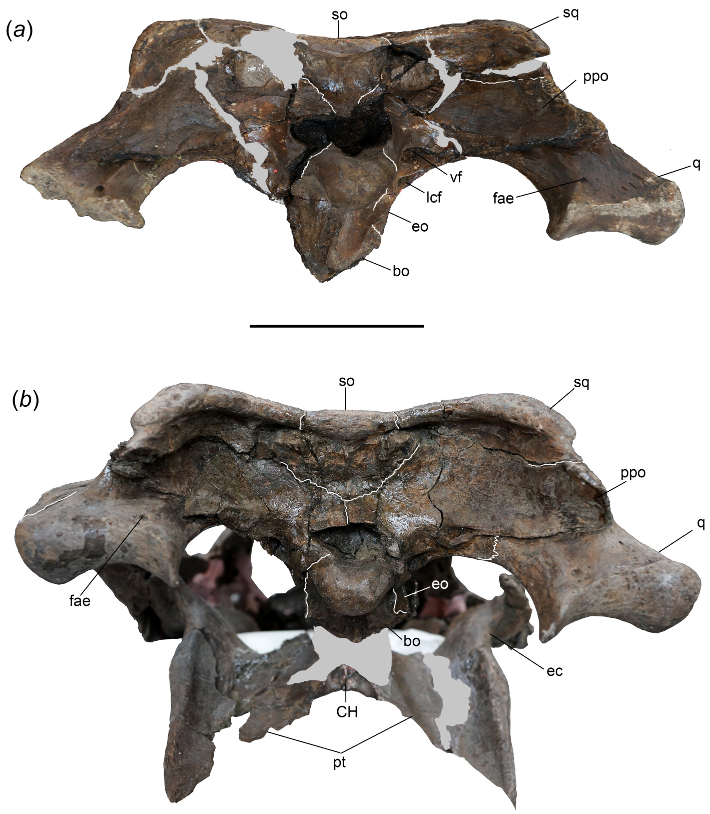

Fig. S3 – Skull material in posterior view of (*a*) *Kuttanacaiman iquitosensis*. MUSM 1942 and (*b*) *Caiman wannlangstoni*, MUSM 2377 (holotype). bo, basioccipital; CH, choana; eo, exoccipital; jugal; fae, quadrate foramen aerum; lcf, lateral carotid foramen; pt, pterygoid; ppo, paraoccipital process; q, quadrate; sq, squamosal; so, supraoccipital; vf, vagus foramen. Scale bar = 5 cm.

Table S3 – Measurements (mm) of holotype of *Kuttanacaiman iquitosensis*. MUSM 1490, skull. Measurements after Langston [S21]. Measurements with missing data are omitted. e, estimate; m4, fourth maxillary alveolus.

	MUSM 1490
Transverse diametre of skull, level of jaw articulation	141.0e
Basal length of the skull	253.0e
Transverse diametre of skull, level of anterior ends of orbits	152.0
Length of the snout, anterior end of the orbits to tip of the snout	125.8
Length of skull, posterior edge of skull table to tip of snout	248.0e
Least transverse diametre, interorbital space	16.1
Length of orbits	67.9
Length of skull table	43.0e
Transverse diametre of skull table, posteriorly	80.0e
Transverse diametre of skull table, anteriorly	78.0e
Transverse diametre of skull, level of postorbital bar	145.0
Width of orbits	54.4e
Transverse diametre of nares	22.4
Length of nares, exclusive of narial spine	32.0
Transverse diametre of choana	28.1
Length of suborbital fenestra	54.0e
Greatest transverse diametre of suborbital fenestra	38.0e
Height of occipital condyle	14.8
Transverse diametre of occipital condyle	18.5
Transverse diametre of snout at m4	133.4
Maxillary teeth series length (13 alveoli)	129.0

Table S4 – Measurements (mm) of skull and mandible elements of *Kuttanacaiman iquitosensis*. MUSM 1942, associated left mandible, maxilla, and skull table. Maxilla and mandible width at the level of the fourth maxillary (m4) and dentary (d4) alveolus, respectively, was estimated by duplicating the minimum width measured on the preserved side. Measurements modified from Langston [S21] and Langston & Gasparini [S22]. Measurements with missing data are omitted. e, estimate.

	MUSM 1942
Transverse diametre of skull, level of jaw articulation	182.0e
Transverse diametre of skull table, posteriorly	111.0
Transverse diametre of skull table, anteriorly	89.1
Length of skull table	52.4
Height of occipital condyle	15.8
Transverse diametre of occipital condyle	24.6
Transverse diametre of snout at m4	71.4 x 2 = 142.8
Maxillary teeth series length (13 alveoli)	138.8
Mandible length (until half-length of external mandibular fenestra)	226.0
Symphysis length	54.5.
External fenestra length	58.9
External fenestra height	31.6
Mandible width at d4	38.5 x 2 = 116.6
Mandible height at d4	27.9
Greatest mandible height	71.6

Table S5 – Measurements (mm) of the holotype of *Caiman wannlangstoni*. MUSM 2377, skull. Measurements after Langston [S21]. Measurements with missing data are omitted. e, estimate; m4, fourth maxillary alveolus.

	MUSM 2377
Transverse diametre of skull, level of jaw articulation	182.0
Basal length of the skull	296.0e
Transverse diametre of skull, level of anterior ends of orbits	146.0
Length of the snout, anterior end of the orbits to tip of the snout	163.0e
Length of skull, posterior edge of skull table to tip of snout	299.0e
Least transverse diametre, interorbital space	29.1
Length of orbits	76.6
Length of skull table	68.1
Transverse diametre of skull table, posteriorly	115.0
Transverse diametre of skull table, anteriorly	95.9
Width of orbits	59.4
Transverse diametre of nares	19.4
Transverse diametre of choanae	20.9
Length of suborbital fenestra	55.5
Height of occipital condyle	17.4
Transverse diametre of occipital condyle	24.2
Transverse diametre of snout at m4	119.0e
Maxillary teeth series length (13 alveoli)	155.1

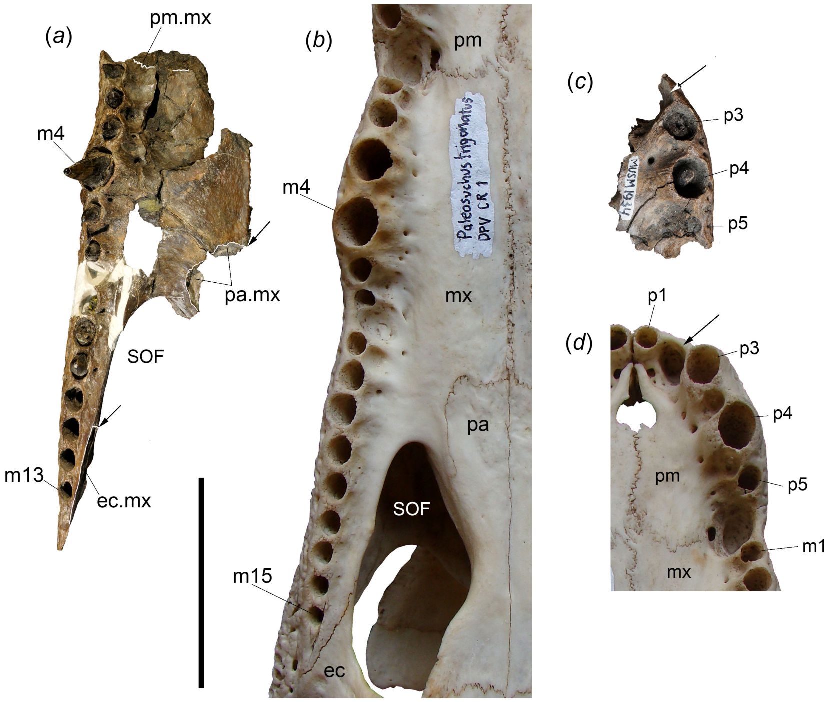

Fig. S4 – Pebas *Paleosuchus* sp. (*a*) Right maxilla (MUSM 1724) and (*c*) left premaxilla (MUSM 1934) compared with homologous parts (*b*,*d*) of extant *Paleosuchus trigonatus*. Arrows in (*a*) show anterior limit of ectopterygoid and notched palatine**.** Arrows in (*c*) and (*d*) show alveolar space between p1 and p3 denoting the absence of p2 of other caimanines and consequently bearing just four premaxillary alveoli. ec, ectopterygoid; ec.mx, maxilla surface for ectopterygoid; m1, m4, m13, m15, maxillary tooth positions; mx, maxilla; p1, p3-p5, premaxillary tooth positions; pa, palatine; pa.mx, maxilla surface for palatine; SOF, suborbital fenestra. Scale bar = 5 cm.

4 – Relative snout width and length assessment

The disparity of rostral shapes of the Pebas crocodylians and 69 other eusuchians were included in a bivariate plot to illustrate relative snout length and width based on size-standardising cranial indices (figure 2). This bivariate plot was modified from Busbey [S23]. Standard measurements for these indices are shown in figure S5 and indices are shown in table S6. Quadrants in figure 2 correspond to the four potential combinations of the bi-dimensional snout-shaped morphospace.

Snout length is expressed by the *rostral length-skull length index* (RL/SL). *Rostral length* is measured from the tip of the snout to the anterior end of the orbits in the mid-sagittal plane. *Skull length* is measured from the tip of the snout to the posterior end of the skull table in the mid-sagittal plane. For this index, we chose to use skull length instead of basal skull length of Busbey [S23] because the former measurement is easier to make consistently, and is less affected by distortion, in fossil crocodyliforms.

Snout width is described by the *rostral width-postorbital width index* (RW/POW). *Rostral width* is the transverse diameter of the snout at the level of the fourth maxillary alveoli. Postorbital width is the transverse diameter of the skull at the level of the postorbital bar. For this index, Busbey [S23] measured rostral width at the level of the external nares. The external nares in crocodylians are located just behind the tip of the snout, thus at this position the snout did not attain its average width, particularly in taxa with rostrums tapering anteriorly. Generally, in crocodylians the rostrum width is well developed at the level of the fourth maxillary alveoli. *Postorbital width* is measured at the level of the base of the postorbital pillar.

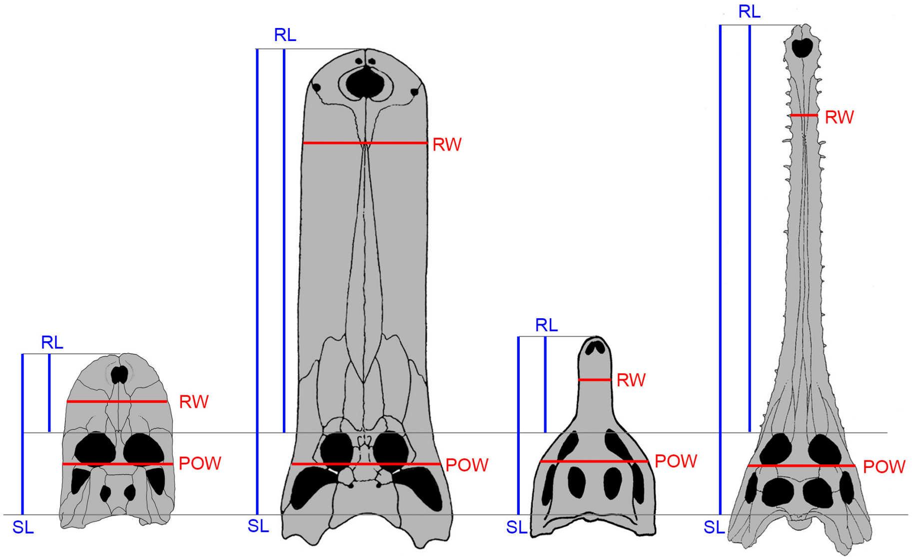

Fig. S5 – Cranial measurements within the four idealised snout eusuchian morphotypes. From left to right: short and wide, long and wide, short and narrow, long and narrow. Abbreviations: POW, postorbital width; RL, rostral length; RW, rostral width; SL, skull length.

Table S6. Cranial indices of Pebas crocodylians (in bold font) and other eusuchians. Potential intraspecific variation is not evaluated. Abbreviations: RL/SL, rostral length-skull length index; RW/POW, rostral width-postorbital width index. For Pebas *Paleosuchus* we used indices of *Paleosuchus trigonatus* as an exemplar.

Taxa	**RL/SL**	**RW/POW**
Bernissartia fagesii	0.72	0.58
Acynodon iberoccitanus	0.46	0.69
Iharkutosuchus makadii	0.39	0.51
Allodaposuchus precedens	0.57	0.64
Eothoracosaurus mississippiensis	0.75	0.23
Thoracosaurus neocesariensis	0.78	0.22
Eosuchus lerichei	0.72	0.33
Eogavialis africanus	0.76	0.29
Gryposuchus colombianus	0.74	0.35
Gryposuchus croizati	0.80	0.31
Pebas gavialoid	**0.75**	**0.27**
Piscogavialis jugaliperforatus	0.83	0.27
Ikanogavialis gameroi	0.84	0.38
Siquisiquesuchus venezuelensis	0.82	0.23
Argochampsa krebsi	0.74	0.31
Gavialis gangeticus	0.76	0.25
Borealosuchus griffithi	0.66	0.56
Borelosuchus acutidentatus	0.67	0.51
Mecistops cataphractus	0.72	0.37
Crocodylus niloticus	0.65	0.76
Crocodylus porosus	0.70	0.67
Crocodylus acutus	0.72	0.67
Osteolaemus tetraspis	0.56	0.60
Australosuchus clarkae	0.65	0.66
Kambara murgoensis	0.59	0.77
Voay robustus	0.61	0.73
Thecachampsa americana	0.76	0.34
Tomistoma schlegelii	0.73	0.33
Crocodylus acer	0.68	0.44
Megadontosuchus arduini	0.73	0.41
Asiatosuchus germanicus	0.64	0.67
Pristichampsus vorax	0.68	0.61
Dollosuchoides desmorei	0.75	0.29
Leidyosuchus canadensis	0.67	0.65
Diplocynodon ratelii	0.63	0.60
Diplocynodon hantoensis	0.67	0.73
Diplocynodon muelleri	0.55	0.80
Diplocynodon darwini	0.57	0.70
Stagerochampsa mccabei	0.51	0.67
Albertochampsa langstoni	0.56	0.77
Brachychampsa montana	0.49	0.69
Alligator sinensis	0.58	0.75
Alligator mississippiensis	0.64	0.79
Alligator mefferdi	0.59	0.79
Alligator thompsoni	0.60	0.76
Alligator olseni	0.55	0.81
Alligator mcgrewi	0.47	0.65
Alligator prenasalis	0.56	0.68
Ceratosuchus burdoshi	0.54	0.62
Navajosuchus mooki	0.47	0.74
Wannaganosuchus brachymanus	0.49	0.65
Procaimanoidea uthaensis	0.49	0.72
Arambourgia gaudryi	0.47	0.59
Tsoabichi greenriverensis	0.59	0.96
Purussaurus brasiliensis	0.70	0.90
Purussaurus neivensis	**0.67**	**0.84**
Orthogenysuchus olseni	0.67	0.61

Mourasuchus amazonensis	0.83	0.70
Mourasuchus atopus	**0.82**	**0.85**
Mourasuchus arendsi	0.82	0.68
Caiman jacare	0.57	0.67
Caiman crocodilus	0.63	0.57
Caiman latirostris	0.58	0.75
Caiman niteroiensis	0.61	0.83
Melanosuchus niger	0.58	0.79
Melanosuchus fisheri	0.48	0.61
Paleosuchus trigonatus	0.59	0.61
Paleosuchus palpebrosus	0.54	0.62
Globidentosuchus brachyrostris	0.49	0.87
Gnatusuchus pebasensis	**0.49**	**0.93**
Pebas *Paleosuchus*	**0.59**	**0.61**
Kuttanacaiman iquitosensis	**0.52**	**0.86**
Caiman wannlangstoni	**0.51**	**0.70**

5 – Body length assessment

Table S7. Length estimates based on (a) Sereno et al. [S24] and Hurlburt et al. [S25]. For (a): *Crocodylus moreletii* formula: TL=(10.48)(SL)-6.20. For (b) *Alligator mississippiensis* formula: Log TL=(LogSL)(0.970)+0.954. For (b) skull length in mm. SL, skull length; TL, estimated total length in cm.

Gnatusuchus pebasensis	cm
Length of skull, posterior edge of skull table to tip of snout (SL)	21.92
(a) TL	148.9
(b) TL	167.7

Kuttanacaiman iquitosensis	
Length of skull, posterior edge of skull table to tip of snout (SL)	24.8
(a) TL	171.2
(b) TL	189.1

Caiman wannlangstoni	
Length of skull, posterior edge of skull table to tip of snout (SL)	29.9
(a) TL	210.5
(b) TL	226.7

v) – Phylogenetic analysis and morphological character list and matrix

To determine the phylogenetic relationships of *Gnatusuchus pebasensis*, *Kuttanacaiman iquitosensis*, and *Caiman wannlangstoni*, we included them in a data matrix of morphological characters mostly based on C. A. Brochu's and S. Jouve's publications on Alligatoroidea [S26,S27] and Gavialoidea [S28] systematics, respectively. A small number of characters are derived from other analyses [S16,S20,S29-40) and four characters are new. The complete data matrix consists of 201 morphological characters and 86 taxa. It was evaluated with a maximum parsimony analysis using TNT 1.1 [S41]. All characters were unordered, non-additive, and had equal weight. Branches with a minimum length of 0 were collapsed. Bremer supports were calculated to assess clade support (figure S6). The analysis retained 70 equally optimal trees with a minimum length of 677 steps. The strict consensus tree (figure S6) calculated from them provided the following statistics: length = 695; consistency index (CI) = 0.377; retention index (RI) = 0.797. This strict consensus tree is the base for the simplified phylogeny of figure 4. We performed other analyses using the same parameters but excluding relatively incomplete and problematic taxa from the heuristic search, such as *Necrosuchus ionensis* and *Allognathosuchus wartheni* (see below). These parsimony analyses recover *Gnatusuchus pebasensis* within the Caimaninae clade (figure 4 and S6), supported by the presence of small supratemporal fenestrae with overhanging rims, surangular extending to the posterior end of the retroarticular process, maxilla with a broad shelf extending into the suborbital fenestra, parietal excluded from posterior edge of skull table, and a slender process of exoccipital ventrally to basioccipital tubera.

Although most previous publications consistently show a close relationship between *Mourasuchus* species and *Orthogenysuchus olseni* [S17,S26,S27], the latter taxon was omitted in the current analysis because ongoing detailed preparation and study of the type specimen revealed different scores for key features than in previous analyses. In this study, specimen UCMP 39978 from the late Middle Miocene of La Venta, Colombia, originally identified as *Caiman* cf. *lutescens* [S21], is referred to as "La Venta *Caiman*" (figures 4 and S6).

This analysis shows low support for relationships within the globidontans alligatoroids, mainly due to the fragmentary condition on some taxa and the inclusion of new basal species. Based on this analysis, caimanines and the Cretaceous globidontans are sister clades and alligatorines lie outside the aforementioned association. Excluding *Necrosuchus ionensis* from the analysis provides the same topology but higher Bremer support for some clades within the Caimaninae. However, character support for this new arrangement is weak since it collapses in trees one step longer or when a problematic taxon, like *Allognathosuchus wartheni*, is excluded from the analyses (dotted lines in figure S6). The clade formed by caimanines and the Cretaceous globidontans is only supported by two ambiguous synapomorphies: proatlas lacks anterior process (Character 3, state 1) and surangular does not extend dorsally beyond anterior end of foramen intermandibularis caudalis, anterior tip blunt (character 65, state 1). As a consequence of this tree rooting, Globidonta and Alligatoridae are taxonomically redundant (figure S6).

Culebrasuchus mesoamericanus is based on a damaged skull from the Lower Miocene Culebra Formation of Panama [S42]. This taxon was considered as the basal-most caimanine [S42], with that position supported by the presence of a large supraoccipital exposure in the skull table and the absence of a splenial symphysis. In our analysis, *Culebrasuchus mesoamericanus* is deeply rooted within the *Alligator* genus as the sister taxon of the clade consisting of *A. thompsoni* + *A. olseni* + *A. mississippiensis* (figure S6). *Culebrasuchus mesoamericanus* lacks both the overhanging rims within the supratemporal fenestrae and the slender ventral process of the exoccipital that characterises caimanines. As a morphologically advanced representative of the *Alligator* clade instead of a basal caimanine, it possesses an external mandibular fenestra enlarged so much that the foramen intermandibularis caudalis is visible laterally. However, character support for this newly hypothesised systematic position is still weak: *Culebrasuchus* jumps back to the caimanines (as the sister taxon of *Necrosuchus ionensis* within an early divergent clade) when excluding *Gnatusushus* and *Globidentosuchus* from the analysis. In this analysis, the non-South American taxa *Tsoabichi greenriverensis* (+ *Necrosuchus ionensis*) and *Centenariosuchus gilmorei* are the sister species of *Paleosuchus* and jacareans, respectively. Previous phylogenetic approaches showed similar results [S42,S43]. Although character support is weak, this tree also provides evidence for a relationship between *Paleosuchus* + *Tsoabichi* + *Necrosuchus* and *Centenariosuchus* + jacareans, with the consequent exclusion of the *Purussaurus*-*Mourasuchus* clade from crown-group caimans. The same analysis, exclusive of *Gnatusuchus* and *Globidentosuchus*, recovers the *Purussaurus*-*Mourasuchus* clade within the crown-group, as was suggested by previous researches.

Although Brochu [S26] stated that in *Necrosuchus ionensis* the ventral process of the exocippital was long and slender, this bone barely exceeds the ventral level of the occipital condyle and does not reach the tubera. Conservatively, we thus coded it as unknown for this taxon in the present analysis. The angular-surangular suture passing along the ventral margin of the mandibular fenestra is present in *Gnatusuchus* but the suture reaches the fenestra higher, close to the posterior angle, in *Globidentosuchus* and *Kuttanacaiman*. The latter condition also pertains to *Eocaiman cavernensis* and scoring of this taxon (based on the holotype) was changed to fit this new interpretation.

The list below includes only osteological characters from the skull and jaws, thus postcranial (i.e., 1-46) and soft tissue characters (i.e., 75-78) of Brochu [S26] are omitted in the list. Modifications in selected characters (i.e., 47, 51, 71, 80, 128, 129, 131, 138, 157, 190, 191, 196), due to revised character definitions, enhanced precision or alternative codings, are indicated in bold font. Characters 198 to 201 are new. The last two characters of our study (i.e., characters 200 and 201) are proposed to record features present in selected advanced gavialoids, including Pebasian gavialoid. These characters deal with variation of orbital proportions and development of a wide premaxilla relative to the minimum transversal diameter at the level of premaxilla-maxilla lateral contact, respectively.

Character 51 of our study differs from that of Brochu [S20] by the omission of state 1 (i.e., largest dentary alveolus immediately caudal to four is 13 or 14 and the series behind it) in the former. This state regards those taxa among blunt-snouted globidontans with enlarged rear alveoli linked by the presence of globular dentition, such as *Brachychampsa* and *Allognathosuchus*. The concept of this state has been incorporated into character 198, a new character concerning the mandibular dental morphology posterior to the twelfth or thirteenth alveoli. In “generalised” and long-snouted crocodylians, teeth in these positions are pointed, slightly blunt, or blunt. This is also true for most caimans including *Melanosuchus*, which presents blunt posterior teeth.

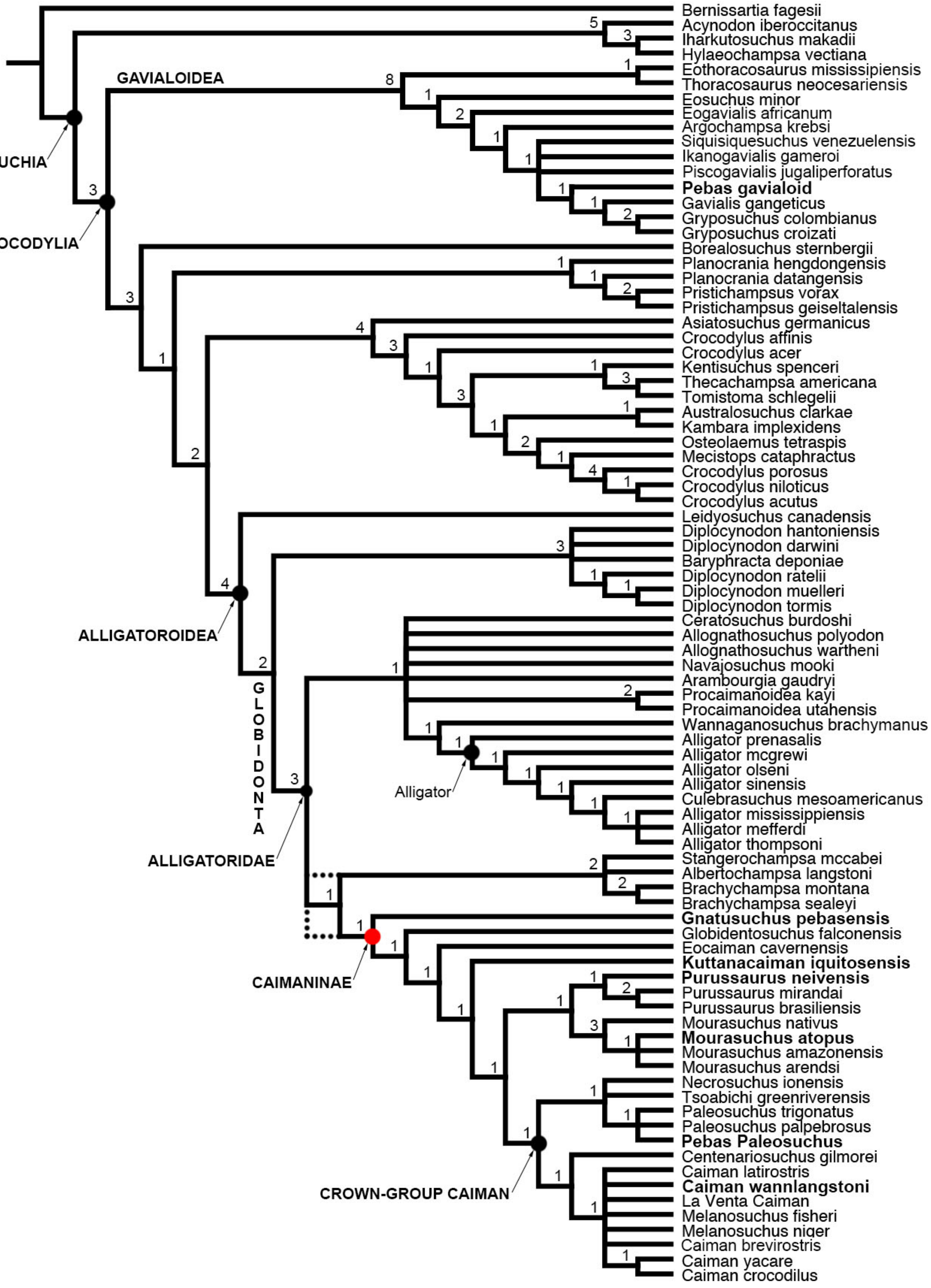

Fig. S6. Strict consensus tree of 70 Most Parsimonious Trees. Tree Length = 695 Consistency Index = 0.377; Retention Index = 0.797. The analysis excluding *Necrosuchus ionensis* yielded the same topology. Numbers at nodes indicate Bremer support values. Dotted lines indicate collapse of the node supporting sister relationships between Cretaceous alligatoroids and caimanines when *Allognathosuchus wartheni* is excluded from the analyses. Pebas taxa are bold typed.

However, new discoveries show that some basal caimanines developed posterior globular dentitions as well. Thus, here we discriminate globular from blunt teeth. Globular teeth bear bulbous or globular crowns, with the crown wider than the root. Generally, these teeth are flattened and closely packed to form a crushing unit. In caimanines with globular teeth, the crushing tooth unit within the dentary is composed of at least four posterior subequal sized teeth, whereas other globidontans have globular teeth notably different in sizes within the crushing unit. Some stem eusuchians bear posterior multicusped teeth. Although *Gnatusuchus* bears globular teeth, loci posterior to fourteenth are lost.

In earlier analyses the relative length of the anterior process of the frontal and the contact/separation of the prefrontals were treated as different characters [S27,S28]. Considering that the morphology of the former determines the condition of the latter, or vice versa, here they are regarded as components of character 129, a combination of character 175 of Jouve et al. [S28] and character 100 of Brochu [S27].

Character 138 describes the presence of a topological discontinuity in the ventral orbital margin relative to the presence or absence of an upturned anterolateral orbital rim. Originally, two clear morphologies were proposed regarding this region, to discriminate the condition seen in most crocodylians from that of advanced gavialoids. In crocodylids and most alligatoroids – exclusive of *Mourasuchus* – the orbit is gently circular, with neither an upturned anterior orbital rim nor a ventral notch. In contrast, in advanced gavialoids such as *Gavialis gangeticus* and *Gryposuchus*, the anterior rim is upturned and terminates abruptly in the anteroventral border of the orbit; thus in lateral view a deep notch is seen immediately anterior to the postorbital pillar [S27]. However, a variation of this morphology is observed in some South American gavialoids and *Eogavialis africanum*. In these taxa, the anterior orbital rim is clearly upturned, but instead of bearing a ventral orbital notch, the rim progressively descends lateral to the postorbital pillar. Character 138 in this analysis is based on character 139 of Brochu [S27].
The squamosal topology on skull table is treated in character 157 of Brochu [S26]. Present research added one state to this character regarding the prominent squamosal eminences observed in some *Mourasuchus* species [S44].

Character 199 of Jouve et al. [S28] expresses the variation in the shape of the supratemporal fenestrae. Additionally to its shape, we observed that the thickness of its posterior bar varies among gavialoids taxa with wide supratemporal fenestrae. For example, in *Eothoracosaurus mississippiensis* and *Eogavialis africanum* this bar is thick, whereas in South American gavialoids and *Gavialis gangeticus* the bar is thin. To recognise these distinct features, in our analysis character 191 is based on character 199 of Jouve et al. [S28].

Finally, we propose a new character, character 199, to document the relative size between anterior and posterior dentary alveoli. In most crocodylians, the first and fourth dentary alveoli are bigger than the second and the third, and neither of them is ever the largest when compared to other mandibular teeth. However, in *Purussaurus* and *Mourasuchus* species, the anterior mandibular dentition has enlarged to a point that the four anterior-most dentary alveoli are larger than any other of the series.

1 – Character list

Skull and mandibles. Modifications/additions and new characters are indicated in bold font. For characters 1-46 see Brochu [S22].

47. Alveoli for dentary teeth 3 and 4 nearly same size and confluent (0), or fourth alveolus larger than third, and alveoli are separated (1), or **3 and 4 are nearly the same size and separated** (2). Modified from Brochu [S27], character 52.
48. Anterior dentary teeth strongly procumbent (0) or project anterodorsally (1).
49. Dentary symphysis extends to fourth or fifth alveolus (0) or sixth to eighth alveolus (1); **or eighth to twelfth alveolus (2); or twelfth to sixteenth (3); beyond the sixteenth (4).** Modified from Brochu [S20], character 166.
50. Dentary gently curved (0), or deeply curved (1), or linear (2) between fourth and tenth alveoli.
51. Largest dentary alveolus immediately caudal to fourth is 13 or 14 (0); 11 or 12 (1); no differentiation (2); or behind 14 (3). Modified from Brochu [S26] character 51; adapted from Brochu [S20], character 167.
52. Splenial with anterior perforation for mandibular ramus of cranial nerve V (0) or lacks anterior perforation for mandibular ramus of cranial nerve V (1).
53. Mandibular ramus of cranial nerve V exits splenial anteriorly only (0) or splenial has singular perforation for mandibular ramus of cranial nerve V posteriorly (1) or splenial has double perforation for mandibular ramus of cranial nerve V posteriorly (2).
54. Splenial participates in mandibular symphysis; splenial symphysis adjacent to no more than five dentary alveoli (0), or splenial excluded from mandibular symphysis; anterior tip of splenial passes ventral to Meckelian groove (1), or splenial excluded from mandibular symphysis; anterior tip of splenial passes dorsal to Meckelian groove (2), or deep splenial symphysis, longer than five dentary alveoli; splenial forms wide V within symphysis (3), or deep splenial symphysis, longer than five dentary alveoli; splenial constricted within symphysis and forms narrow V (4).
55. Coronoid bounds posterior half of foramen intermandibularis medius (0), or completely surrounds foramen intermandibularis medius at maturity (1), or obliterates foramen intermandibularis medius (2) at maturity.
56. Superior edge of coronoid slopes strongly anteriorly (0) or almost horizontal (1).
57. Inferior process of coronoid laps strongly over inner surface of Meckelian fossa (0), or remains largely on medial surface of mandible (1).
58. Coronoid imperforate (0), or with perforation posterior to foramen intermandibularis medius (1).
59. Process of splenial separates angular and coronoid (0) or no splenial process between angular and coronoid (1).
60. 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).
61. Anterior processes of surangular unequal, little or no ventral process (0) or subequal to equal, well development ventral process (1).
62. Surangular with spur bordering the dentary tooth row lingually for at least one alveolus length (0), or lacking such spur (1).

63. External mandibular fenestra absent (0), or present (1), or present and very large; most of foramen intermandibularis caudalis visible in lateral view (2).
64. Surangular–dentary suture intersects external mandibular fenestra anterior to posterodorsal corner (0), or at posterodorsal corner (1).
65. Angular extends dorsally toward or beyond anterior end of foramen intermandibularis caudalis; anterior tip acute (0) or, does not extend dorsally beyond anterior end of foramen intermandibularis caudalis; anterior tip very blunt.
66. Surangular–angular suture lingually meets articular at ventral tip (0), or dorsal to tip.
67. Surangular continues to dorsal tip of lateral wall of glenoid fossa (0), or truncated and not continuing dorsally (1).
68. Articular–surangular suture simple (0), or articular bears anterior lamina dorsal to lingual foramen (1), or articular bears anterior lamina ventral to lingual foramen (2), or bears laminae above and below foramen (3).
69. Lingual foramen for articular artery and alveolar nerve perforates surangular entirely (0), or perforates surangular-articular suture (1).
70. Foramen aereum at extreme lingual margin of retroarticular process (0), or set in from margin of retroarticular process (1).
71. Retroarticular process projects posteriorly (0), projects posterodorsally, **not higher than the posterior edge of the articular fossa (1), or projects posterodorsally higher than the posterior edge of the articular fossa (2)**. Modified from Brochu [S26], character 71; and Jouve et al. [S28], character 190; adapted from Brochu [S27], character 50; adapted from Benton & Clark [S32]; Clark [S31], character 71; Norell & Clark [S33], character 7.
72. Surangular extends to posterior end of retroarticular process (0), or pinched off anterior to tip of retroarticular process (1).
73. Surangular–articular suture orientated anteroposteriorly (0), or bowed strongly laterally within glenoid fossa (1).
74. Sulcus between articular and surangular (0), or articular flush against surangular within the adductor fossa (1).

For characters 75-78 see Brochu [S26].

79. Teeth and alveoli of maxilla and/or dentary circular in cross-section (0), or posterior teeth laterally compressed (1), or all teeth compressed (2).
80. Maxillary and dentary teeth with smooth carinae (0), or serrated (1), **or with neither carinae nor serrations (2).** Modified from Brochu [S26], character 80.
81. Naris projects anterodorsally (0), or dorsally (1).
82. External naris bisected by nasals (0), or nasals contact external naris, but do not bisect it (1), or nasals excluded, at least externally, from naris; nasals and premaxillae still in large contact (2), or nasals excluded from naris and nasals and premaxillae in weak contact (3), or nasals and premaxillae not in contact (4).
83. Naris circular or keyhole-shaped (0), or wider than long (1), or anteroposteriorly long and prominently teardrop-shaped (2).
84. External naris of reproductively mature males remains similar to that of females (0), or develops bony excrescence (ghara) (1).

85. External naris opens flush with dorsal surface of premaxillae (0), or circumscribed by a crest (1).
86. Premaxillary surface lateral to naris smooth (0), or with deep notch lateral to naris (1).
87. Premaxilla has five teeth (0) or four teeth (1) early in posthatching ontogeny.
88. Incisive foramen small, less than half the greatest width of premaxillae (0), or extremely reduced and thin (1), or large, more than half the greatest width of premaxillae (2), or large, and intersects premaxillary–maxillary suture (3).
89. Incisive foramen completely situated far from premaxillary tooth row, at the level of the second or third alveolus (0), or abuts premaxillary tooth row (1), or projects between first premaxillary teeth (2).
90. Dorsal premaxillary processes short, not extending beyond third maxillary alveolus (0), or long, extending beyond third maxillary alveolus (1).
91. Dentary tooth 4 occludes in notch between premaxilla and maxilla early in ontogeny (0), or occludes in a pit between premaxilla and maxilla; no notch early in ontogeny (1).
92. All dentary teeth occlude lingual to maxillary teeth (0), or occlusion pit between seventh and eighth maxillary teeth; all other dentary teeth occlude lingually (1), or dentary teeth occlude in line with maxillary tooth row (2).
93. Largest maxillary alveolus is no. 3 (0), or no. 5 (1), or no. 4 (2), or nos. 4 and 5 are same size (3), or no. 6 (4), or maxillary teeth homodont (5), or maxillary alveoli gradually increase in diameter posteriorly toward penultimate alveolus (6).
94. Maxillary tooth row posterior to first six maxillary alveoli curved medially or linear (0), or curves laterally broadly (1).
95. Dorsal surface of rostrum curves smoothly (0), or bears medial dorsal boss (1).
96. Canthi rostralii absent or very modest (0), or very prominent at maturity (1).
97. Preorbital ridges absent or very modest (0), or very prominent at maturity (1).
98. Antorbital fenestra present (0), or absent (1).
99. Vomer entirely obscured by premaxilla and maxilla (0), or exposed on palate at premaxillary–maxillary suture (1).
100. Vomer entirely obscured by maxillae and palatines (0), or exposed on palate between palatines (1).
101. Surface of maxilla within narial canal imperforate (0), or with a linear array of pits (1).
102. Medial jugal foramen small (0), or very large (1).
103. Maxillary foramen for palatine ramus of cranial nerve V small or not present (0), or very large (1).
104. Ectopterygoid abuts maxillary tooth row (0), or maxilla broadly separates ectopterygoid from maxillary tooth row (1).
105. Maxilla terminates in palatal view anterior to lower temporal bar (0), or comprises part of the lower temporal bar (1).
106. Penultimate maxillary alveolus less than twice the diameter of the last maxillary alveolus (0), or more than twice the diameter of the last maxillary alveolus (1).
107. Prefrontal dorsal surface smooth adjacent to orbital rim (0) or bearing discrete knob-like processes (1).
108. Dorsal half of prefrontal pillar narrow (0) or expanded anteroposteriorly (1).

109. Medial process of prefrontal pillar expanded dorsoventrally (0) or anteroposteriorly (1).
110. Prefrontal pillar solid (0) or with large pneumatic recess (1).
111. Medial process of prefrontal pillar wide (0) or constricted at base (1).
112. Maxilla has linear medial margin adjacent to suborbital fenestra (0) or bears broad shelf extending into fenestra, making lateral margin concave (1).
113. Anterior face of palatine process rounded or pointed anteriorly (0) or notched anteriorly (1).
114. Anterior ectopterygoid process tapers to a point (0) or forked (1).
115. Palatine process extends (0) or does not extend (1) significantly beyond anterior end of suborbital fenestra.
116. Palatine process generally broad anteriorly (0) or in form of thin wedge (1).
117. Lateral edges of palatines smooth anteriorly (0) or with lateral process projecting from palatines into suborbital fenestrae (1).
118. Palatine–pterygoid suture nearly at (0), or far anteriorly from posterior angle (1) of suborbital fenestra.
119. Pterygoid ramus of ectopterygoid straight, posterolateral margin of suborbital fenestra linear (0) or ramus bowed, posterolateral margin of fenestra concave (1).
120. Lateral edges of palatines parallel posteriorly (0) or flare posteriorly, producing shelf (1).
121. Anterior border of the choana is comprised of the palatines (0) or choana entirely surrounded by pterygoids (1).
122. Choana projects posteroventrally (0) or anteroventrally (1) at maturity.
123. Pterygoid surface lateral and anterior to internal choana flush with choanal margin (0) or pushed inward anterolateral to choanal aperture (1).
124. Posterior rim of internal choana not deeply notched (0), or deeply notched (1).
125. Internal choana not septated (0), or with septum that remains recessed within choana (1), or with septum that projects out of choana (2).
126. Ectopterygoid–pterygoid flexure disappears during ontogeny (0), or remains throughout ontogeny (1).
127. Ectopterygoid extends (0), or does not extend (1) to posterior tip of lateral pterygoid flange at maturity.
128. No posterior process of maxilla **within lacrimal or within lacrimal and prefrontal** (0), or maxilla with posterior process within lacrimal (1), or maxilla with posterior process between lacrimal and prefrontal (2). From Brochu [S27], character 93; modified from Jouve et al. [S28], character 93.
129. Prefrontals separated by **the** frontal and nasals, **anterior process of frontal extending far anterior to the anterior margin of the orbit** (0), **prefrontals separated by the frontal and nasals, anterior process of frontal around the same level or posterior to the anterior margin of the orbit** (1), or prefrontals meet medially, **anterior process of frontal around the same level or posterior to the anterior margin of the orbit** (2). Based on Jouve et al. [S28], character 175, and Brochu [S27], character 100; Norell [S29], character 27.
130. Lacrimal longer than prefrontal (0), or prefrontal longer than lacrimal (1), or lacrimal and prefrontal both elongate and nearly the same length (2).

131. Anterior tip of frontal forms simple acute point (0), or forms broad, complex sutural contact **either** with the nasals **or prefrontals** (1). From Brochu [S26], character 131.
132. Ectopterygoid extends along medial face of postorbital bar (0), or stops abruptly ventral to postorbital bar (1).
133. Postorbital bar massive and anteroposteriorly oval in cross section (0), or slender and rounded in cross section (1).
134. Postorbital bar bears process that is prominent, dorsoventrally broad, and divisible into two spines (0), or bears process that is short and generally not prominent (1).
135. Ventral margin of postorbital bar flush with lateral jugal surface (0), or inset from lateral jugal surface (1).
136. Postorbital bar continuous with anterolateral edge of skull table (0), or inset (1).
137. Margin of orbit flush with skull surface (0), or edges of orbits upturned (1), or orbital margin telescoped (2).
138. Anterior margin of orbit not upturned, ventral margin gently circular (0)**, or anterior margin upturned, ventral margin gently circular (1), or anterior margin upturned,** ventral margin with a prominent notch (2)**.** Based on Brochu [S27], character 139.
139. Palpebral forms from single ossification (0), or from multiple ossifications (1).
140. Quadratojugal spine prominent at maturity (0) or greatly reduced or absent at maturity (1).
141. Quadratojugal spine low, near posterior angle of infratemporal fenestra (0), or high, between posterior and superior angles of infratemporal fenestra (1).
142. Quadratojugal forms posterior angle of infratemporal fenestra (0), jugal forms posterior angle of infratemporal fenestra (1), or quadratojugal–jugal suture lies at posterior angle of infratemporal fenestra (2).
143. Postorbital neither contacts quadrate nor quadratojugal medially (0), or contacts quadratojugal, but not quadrate, medially (1), or contacts quadrate and quadratojugal at dorsal angle of infratemporal fenestra (2), or contacts quadratojugal with significant descending process (3).
144. Quadratojugal bears long anterior process along lower temporal bar (0), or bears modest process, or none at all, along lower temporal bar (1).
145. Quadratojugal extends to superior angle of infratemporal fenestra (0), or does not extend to superior angle of infratemporal fenestra; quadrate participates in fenestra (1).
146. Postorbital–squamosal suture orientated ventrally (0), or passes medially ventral to skull table (1).
147. Dorsal and ventral rims of squamosal groove for external ear valve musculature parallel (0), or squamosal groove flares anteriorly (1).
148. Squamosal–quadrate suture extends dorsally along posterior margin of external auditory meatus (0), or extends only to posteroventral corner of external auditory meatus (1).
149. Posterior margin of otic aperture smooth (0), or bowed (1).
150. Frontoparietal suture deeply within supratemporal fenestra; frontal prevents broad contact between postorbital and parietal (0), or suture makes modest entry into supratemporal fenestra at maturity; postorbital and parietal in broad contact (1), or suture on skull table entirely (2).

151. Frontoparietal suture between supratemporal fenestrae concavoconvex (0), or linear (1).
152. Supratemporal fenestra with fossa; dermal bones of skull roof do not overhang rim at maturity (0), or dermal bones of skull roof overhang rim of supratemporal fenestra near maturity (1), or supratemporal fenestra closes during ontogeny (2).
153. Shallow fossa at anteromedial corner of supratemporal fenestra (0), or no such fossa; anteromedial corner of supratemporal fenestra smooth (1).
154. Medial parietal wall of supratemporal fenestra imperforate (0), or bearing foramina (1).
155. Parietal and squamosal widely separated by quadrate on posterior wall of supratemporal fenestra (0), or parietal and squamosal approach each other on posterior wall of supratemporal fenestra without actually making contact (1), parietal and squamosal meet along posterior wall of supratemporal fenestra (2).
156. Skull table surface slopes ventrally from sagittal axis (0), or planar at maturity (1).
157. Squamosal **on skull table** is horizontal or nearly so (0), or upturned to form a **posterolateral** discrete horn (1)**; or producing a high transversely oriented eminence at the posterior margin (2) late in ontogeny.** Modified from Brochu [S26], character 157.
158. Mature skull table with broad curvature; short posterolateral squamosal rami along paroccipital process (0), or with nearly straight sides; significant posterolateral squamosal rami along paroccipital process (1), or with nearly straight sides; posterolateral squamosal processes form long “prongs” (2).
159. Squamosal does not extend (0), or extends ventrolaterally to lateral extent of paraoccipital process (1).
160. Supraoccipital exposure on dorsal skull table small (0), or points posteriorly to the caudal margin of the parietal (1), or absent (2), or large (but parietals still in posterior border) (3), or large such that parietal is excluded from posterior edge of table (4).
161. Anterior foramen for palatine ramus of cranial nerve VII ventrolateral (0), or ventral (1) to basisphenoid rostrum.
162. Sulcus on anterior braincase wall lateral to basisphenoid rostrum (0), or braincase wall lateral to basisphenoid rostrum smooth; no sulcus (1).
163. Basisphenoid not exposed extensively (0), or exposed extensively (1), on braincase wall anterior to trigeminal foramen.
164. Extensive exposure of prootic on external braincase wall (0), or prootic largely obscured by quadrate and laterosphenoid externally (1).
165. Laterosphenoid bridge comprised entirely of laterosphenoid (0), or with ascending process of palatine (1).
166. Capitate process of laterosphenoid orientated laterally (0), or anteroposteriorly toward midline (1).
167. Parietal with recess communicating with pneumatic system (0), or solid, without recess (1).
168. Significant ventral quadrate process on lateral braincase wall (0), or quadrate–pterygoid suture linear from basisphenoid exposure to trigeminal foramen (1).
169. Lateral carotid foramen opens lateral (0), or dorsal (1) to basisphenoid at maturity.
170. External surface of basioccipital ventral to occipital condyle orientated posteroventrally (0) or posteriorly (1) at maturity.

171. Posterior pterygoid processes tall and prominent (0), or small and project posteroventrally (1), or small and project posteriorly (2).
172. Basisphenoid thin (0), or anteroposteriorly wide (1) ventral to basioccipital.
173. Basisphenoid not broadly exposed ventral to basioccipital at maturity; pterygoid short ventral to median eustachian opening (0), or basisphenoid exposed as broad sheet ventral to basioccipital at maturity; pterygoid tall ventral to median eustachian opening (1).
174. Exoccipital with very prominent boss on paroccipital process; process lateral to cranioquadrate opening short (0), or exoccipital with small or no boss on paroccipital process; process lateral to cranioquadrate opening long (1).
175. Lateral eustachian canals open dorsal (0) or lateral (1) to medial eustachian canal.
176. Exoccipitals terminate dorsal to basioccipital tubera (0), or send robust process ventrally and participate in basioccipital tubera (1), or send slender process ventrally to basioccipital tubera (2).
177. Quadrate foramen aereum on mediodorsal angle (0), or on dorsal surface of quadrate (1).
178. Quadrate foramen aereum is small (0), or comparatively large (1), or absent (2) at maturity.
179. Quadrate lacks (0), or bears (1) prominent, mediolaterally thin crest on dorsal surface of ramus.
180. Attachment scar for posterior mandibular adductor muscle on ventral surface of quadrate ramus forms modest crests (0), or prominent knob (1).
181. Quadrate with small, ventrally reflected medial hemicondyle (0), or with small medial hemicondyle; dorsal notch for foramen aereum (1), or with prominent dorsal projection between hemicondyles (2), or with expanded medial hemicondyle (3).
182. Edge of the maxillary tooth alveoli lower or at the same level than the space between toothrow (0) or edge of maxillary tooth alveoli higher than the space between toothrow (toothrow underlined) (1).
183. Ventral border of exoccipital: convex and ventrally projected, hiding the posterior opening of the cranioquadrate passage from the occipital view (0), or straight, sharpen or smoothly convex and does not hide the posterior opening of the cranioquadrate passage from the occipital view (1).
184. Occipital surface sloped, visible in dorsal view (0), or vertical or not visible in dorsal view (1) at maturity.
185. Ventral premaxilla-maxilla suture short and ends posteriorly before the 3rd maxillary alveoli (0) or elongated and extends or exceeds the 3rd maxillary alveoli (1).
186. Less than 18 teeth (0), 18 to 22 teeth (1), or more than 22 teeth (2) on maxilla.
187. Lateral edge of the skull table at the level of the postorbital-squamosal suture situated laterally or at the same level as (0), or medially to (1) the quadrate condyle in dorsal view at maturity.
188. Frontal ends at the same level or posterior (0) or extends well anterior (1) to the anterior extension of the prefrontal.
189. Maxilla posterior process without tooth, short or absent (0), or long, longer to the distance between the three last teeth (1) in ventral view.
190. **Interorbital bridge narrower to equivalent (0), or broader (1) than the width of the orbit.** Modified from Jouve et al. [S40], character 181.

191. **Supratemporal fenestra longer than wide or rounded, posterior bar of supratemporal fenestra thick (0), or wider than long, posterior bar of supratemporal fenestra thick (1), or wider than long, posterior bar thin (2) at maturity.** Modified from Jouve et al. [S28], character 199.

192. Presence (0), or absence (1) of a medial crest on the basioccipital.

193. Absence (0), or presence (1) of a posterior dentary process between splenial and angular on the ventral side.

194 Dorsal margin of the articular on the retroarticular process largely visible in lateral view (0), or slightly or not visible in lateral view (1).

195 Posterior margin of the orbit anterior to the posterior margin of the suborbital fenestra (0), or posterior or at the same level than the posterior margin of the suborbital fenestra (1) **measured at the level of the postorbital-frontal suture in the orbital margin** From Jouve et al. [S28], character 186; modified from Jouve [S40], character, 195.

196 Basioccipìtal-exoccipital process ventral to occipital condyle (basioccipital plate) with parallel or ventrally convergent sides (0) or ventrally divergent sides (1) in posterior view. Rephrased from Jouve [S28], character 176.

197. Absence (0) or presence (1) of a smooth medial depression ventral to the basioccipital and posterior to the medial Eustachian foramen.

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

199. First four alveoli in the dentary are the same size or smaller than other dentary alveoli (0) or are the largest within the dentary (1). [New]

200. Orbits longer than wide (0) or wider than long to rounded (1) late in ontogeny. [New]

201. The series composed by the last three premaxillary teeth diverge posteriorly to paraxial (0) or tend to converge posteriorly, straight among them (1). [New]

2 – Character matrix

This data matrix is based on Brochu [S26]. Character score coding has been updated by direct examination of original fossil and recent material, as well as by adopting character scores from recent publications. Scores for *Mourasuchus* species are mainly from Bona et al. [S44]. *Piscogavialis jugaliperforatus* and *Gryposuchus croizati* are scored after Delfino et al. [S45] y Riff & Aguilera [S46], respectively. *Culebrasuchus mesoamericanus* and *Centenariosuchus gilmorei* were mainly scored after Hastings et al. [S42], complemented by personal observations. *Caiman brevirostris* is scored after Fortier et al. [S47]. Finally, *Argochampsa krebsi* is scored after Jouve et al. [S28].

Bernissartia fagesii

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Acynodon iberoccitanus

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Iharkutosuchus makadii

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Hylaeochampsa vectiana

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Borealosuchus sternbergii

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01000 001?0 ?0000 01110 10001 01000 00111 100?0 00100 ?0000
00100 10100 0000? 1?001 00110 00000 00100 11000 00011 00000 0
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Eothoracosaurus mississippiensis

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Thoracosaurus neocesariensis

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Eosuchus minor

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Eogavialis africanum

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Gryposuchus colombianus

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Gavialis gangeticus

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00000 00000 00000 10100 10000 01100 00000 12200 00100 01001
10100 00101 00000 00001 21010 10000 01001 20111 21100 11001 1
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Gryposuchus croizati

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Piscogavialis jugaliperforatus

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00100 00201 ?0?1? 0?0?1 2??1? 10000 01001 20110 2?000 1?000 1
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Ikanogavialis gameroi

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Siquisiquesuchus venezuelensis

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Argochampsa krebsi

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Pristichampsus vorax

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Pristichampsus geiseltalensis

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Planocrania hengdongensis

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Planocrania datangensis

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Leidyosuchus canadensis

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Diplocynodon ratelii

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Diplocynodon hantoniensis

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Diplocynodon muelleri

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Diplocynodon tormis

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Diplocynodon darwini
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Baryphracta deponiae
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Stangerochampsa mccabei
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Albertochampsa langstoni
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Brachychampsa montana
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Brachychampsa sealeyi
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Alligator sinensis
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Alligator mississippiensis
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Alligator mefferdi
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Alligator thompsoni
????? ????? ????? ????0 1???? ????1 ????? 0?1?? ????? ?1100
00?2? ????0 11200 01001 1101? ???00 100?0 100?0 10200 0010?
?0010 001?1 ?0000 00??? ?1??2 ??1?1 11111 110?1 ?0200 101?2
10102 10102 ?001? 11?01 00110 01000 10??? 01?00 0???? ?0000 0

Alligator olseni
????? ?0?1? ????1 0???0 1?100 11111 ???10 0?11? ????? ?1101
0010? ????0 11200 00001 1101? ???00 100?0 10010 10200 ??100
???10 00??0 ?0?00 01011 11102 01111 11111 110?1 10200 ?0112
00102 10102 0???? ??001 00?1? 01000 10?10 01000 00011 ?0000 0

Alligator mcgrewi
10001 0001? 01001 0?000 10000 111?1 101?? 0?11? ??1?? ?1111
0010? 100?0 11100 00011 1101? ???00 000?0 10010 10200 00100
?0010 001?0 01000 00011 11002 01111 11111 10001 10200 ?0112
00102 10102 0?01? ??001 00110 01000 10110 010?0 00011 00000 0

Alligator prenasalis
10001 ?0?1? ????1 0?0?0 10000 11111 ??100 0?112 111?? ?1111
0010? ????0 11100 00011 11010 0??00 000?0 10010 10200 00100
?0010 00110 01000 00011 11002 01111 11111 100?1 10200 ?0112
00102 10100 0001? 1?001 00110 01000 10110 01000 0?01? 00000 0

Ceratosuchus burdoshi
????? ????? ????? ????? ????? ????? ????? 0?1?? ????? ?1111
0??0? ????0 1?10? ?00?1 ??01? ???00 010?0 ?0210 10200 00100
???10 00??0 ????0 0???0 1???? ?1??0 ??111 100?? ????? ?0???
?010? 111?? ????? ????1 0??10 01000 10??? 010?0 0???? ??100 ?

Allognathosuchus polyodon
????? ????? ????? ????? ????? ????? ????? ????? ????? ?1111
0010? ????0 1?11? ?00?1 ?1?1? ???00 010?0 00?10 10200 001?0
????? 00??0 ?00?0 0?0?1 1100? ?1??1 1?111 100?? ????? ?0??2
0010? 101?? ????? ????1 ???1? ?1??? 10??? ??0?0 ????? ??10? ?

Allognathosuchus wartheni ("Wilwood alligatorid")
????1 ?0??? ????? ????0 ?0000 ?1111 ??100 0?11? ??1?? ?1111
0010? 100?0 11110 00001 ?101? ???00 010?0 00010 10200 00100
00010 001?0 ?0000 00?01 11001 ?1111 11111 10??1 10200 ?0112
00102 10100 00?1? 1?001 00110 01?00 10??? ????0 ????? ???0? ?

Navajosuchus mooki

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????? ?0?1? ????? 0???0 ?00?? ?1111 ??1?? 0?111 111?? ?1111
0010? ????0 1?11? ?00?? 110?? ???00 010?0 00210 10200 001??
?0?10 00??0 ???00 ?00?1 1100? 01110 11111 100?? ?020? ?0112
?0102 10100 0???? 1??01 0??10 01000 10110 0?000 000?1 00100 0
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Wannaganosuchus brachymanus

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????1 ?0??? 1?00? 0???0 10000 ?1111 00100 0?11? ??1?? ?1111
00?0? ????0 ??100 ?00?1 ??0?? ???00 110?0 0001? 10200 ??100
???10 00??0 ?1000 00??? 1??0? ?1111 1?111 100?? ????? ?0?12
001?? 10100 0???? ????1 0011? 01000 10110 01000 00??1 ?0100 0
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Procaimanoidea kayi

```
????1 10?1? ????? 0???0 10?00 ?1111 ??10? 0?112 121?? ???01
0?1?? 100?0 1?110 00001 110?? ???10 ????? 0???0 10?00 001??
?0?10 00??0 ?0000 00001 11001 011?1 11111 1000? ?0200 ?0112
00102 10102 0???? ???01 00110 01000 10?1? ??00? 00011 ?0?0? 0
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Procaimanoidea utahensis

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????? ????? ????? ????? ????? ????? ????? ????? ????? ?1101
00?00 ??010 11110 ??001 1101? ???10 110?0 100?0 1020? 00100
??010 00??? ?0000 000?1 11001 01111 1?111 100?1 ?0200 ?0112
0010? 10100 0???? ???01 00110 01000 10??? 00000 0??11 ?0000 0
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Arambourgia gaudryi

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????? ????? ????? ????? ????? ????? ????? ????? ????? ?1111
0??0? ????0 1?100 ?0??1 ?10?? ???00 01??0 00??0 10200 001?0
?0?10 00100 0?000 0???? 11001 ?1011 1?111 100?1 102?0 10?12
?0?02 10100 ????? ????0 0011? 01000 1011? ?00?? 00?11 00000 0
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Necrosuchus ionensis

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????? ?0??? ????? ????0 ???01 ?111? ??130 0?11? ??1?? ?1100
0??2? ????? ??1?? ?0??? ??0?? ???00 ????? ????? ????? ?????
????? ????? ????? ????? ????? ????? ????? ????? ????? ?????
????? ????? 0???? ????? ?0??? ?1?0? 1???? ????? ?0??? 00?0? ?
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Tsoabichi greenriverensis

```
????? ????? ????? ????0 1???? ????? ????? ??10? ?20?? ?1100
???2? ????? ??1?? ????1 1???0 1??00 010?1 0???? 10??0 001??
????? ?0??? ????? ????? ????? ??000 1?111 1?0?1 ?0??? ?0??2
11??? 101?3 ????? ????? ????? ?100? ?0??? ?10?0 0???? ???00 0
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Purussaurus mirandai

```
????? ????? ????? ????? 1?110 01??? ??11? 0?1?? ????? ?1100
?0?2? ?1?11 ?1201 100?1 1?01? ???0? 112?0 0021? 10000 11100
???10 00??? ?0000 00011 11?1? 11021 0?111 110?1 10200 10112
000?? 10104 ????? ????? 0011? 2?00? 10??0 01000 00??1 00?10 0
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Purussaurus brasiliensis

```
????? ????? ????? ????? ????? ????? ????? ????? ????? ?1100
1??2? ????1 11??? ????1 10??? ???00 112?0 00211 10000 111?0
???10 00??? ?0?00 00011 1???? ?1021 0?111 110?1 1???? 101?2
101?? 101?4 ????? ????1 ?0?1? ?1000 10110 010?0 00??1 00010 0
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Purussaurus neivensis

```
101?1 00?1? 00001 0?0?? 1???? 011?? ????? 0?11? ??1?? ?1100
??1?1 010?1 11201 10001 1001? ???00 110?0 00020 10000 01110
?0010 001?0 ?0000 00011 11011 11021 01111 110?1 10201 ?0112
001?2 10104 00010 1??01 0??10 21000 10?10 01000 00?01 00010 0
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Mourasuchus atopus

```
10??1 00?1? 00?01 0?00? 1?10? 011?? ??130 0?11? ??1?? ?1102
?112? ????0 1110? 10001 1000? ???00 120?1 00001 10500 01100
?0010 011?? ?0000 00011 11011 ?1021 0?111 112?1 10?00 10??2
111?? 12104 0???? 1???1 00110 ?1000 10110 210?0 00??? ?0?10 0
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Mourasuchus amazonensis

```
????? ????? ????? ????? ????? ????? ????? ????? ????? ?????
????? ????? ????? ????? ????? ????? 120?1 0???1 ???0? 01???
0???? ?1??? ????? ????? ????? ??221 ??111 ?12?1 102?0 ?0??2
111?? 1?1?4 ????? ????? ???1? ????? ?0??? 210?0 0???? ????0 0
```

Mourasuchus arendsi

```
????? ????? ????? 1?00? ?1100 11??? ??01? ????? ????? ?11?2
???2? ????? ????? ????? 1?0?? ????? 12??1 ?0?01 ??50? 01?00
????0 ?1??? ??000 0???? ????1 ?1?21 ????1 ?12?1 ????1 ?????
????? 1?104 ????? ????? ????0 ????? ?0??? 210?0 0???? ????0 0
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Mourasuchus nativus

```
????? ????? ????? ????? ????? ????? ????? ????? ????? ?11?2
?112? ????0 1110? 10?01 1000? ????? ??0?? ????1 ??5?? ?????
????? ?0??0 ?1?0? ?0011 1?01? ?1?2? ????? ?1??1 102?0 100?2
11112 12104 ?0010 1000? 00?10 01??? 1011? 210?0 0???? ???10 0
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Eocaiman cavernensis

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????? ????? ????? ????? ????? ????? ????? ????? ????? ?1110
0??2? ????0 1?1?? ????? ????? ???00 ????0 ????? ?0??? ??1??
???10 0???0 ?1??0 000?? ????? 0???? ??1?1 1?0?? ???0? ?????
????? ??1?4 ????? ????? 0??1? 2???? ?0??? 0?00? ????? ??00? 0
```

Caiman yacare

```
10111 1001? 10001 00000 10101 11111 00110 00111 22111 01100
11121 01011 10101 10201 10010 11100 11000 00020 11200 00100
00010 00110 01000 00011 11011 11120 11111 11001 10201 10112
01112 10104 00010 11001 00110 21000 10110 01000 00011 00000 0
```

Caiman crocodilus
10111 1001? 10001 00000 10101 11111 00110 00111 22111 01100
11121 01011 10101 10201 10010 11100 11000 00020 11200 00100
00010 00110 01000 00011 11011 11110 11111 11001 10201 10112
01112 10104 00010 11001 00110 21000 10110 01000 00011 00000 0

Caiman latirostris
10111 0001? 10001 00000 1010? 11111 00110 00111 22121 01100
11121 01011 1?101 10201 100?? ?1100 11000 00020 10200 10100
00010 00110 01000 00011 11011 11110 11111 11001 10201 10112
11112 10104 00010 11001 00110 21000 10110 01000 00011 00000 0

La Venta *Caiman* (UCMP. 39978, formerly *Caiman* cf. *lutescens*)
????? ????? ????? ????? ????? ????? ????? ????? ????? ?????
????? ????? ????? ????? ????? ???00 110?0 00010 10200 10100
?0010 00??? ?1000 00011 11111 111?0 ????1 ??0?? ???0? ?????
????? ????? ????? ????? ????? ?1000 10??0 0?00? ????? ????? 0

Melanosuchus fisheri
????? ?0??? ????? 0???? ????? ????? ????? ????? ????? ????0
1???? ????1 ?1101 1???? 10?1? ???00 1?0?0 0002? 10200 10110
???10 00??0 ?1?0? ???11 ????1 ?112? ??111 110?? ????? ?0???
?11?? 1010? ????? ???01 0??1? 2?000 101?0 01??? 0???? ????0 0

Melanosuchus niger
10111 1001? 1?001 00000 10101 11111 00110 00111 22121 01100
11121 01011 11101 10201 1001? ?1100 11000 00020 10200 10110
00010 00110 01000 00011 11011 11110 11111 11001 10201 10112
11112 10104 00010 11001 00110 21000 10110 01000 00011 00000 0

Paleosuchus trigonatus
10011 1111? 01001 01000 10001 11111 21130 00111 32112 01100
11222 11111 11101 10201 10010 11110 11000 01010 10200 00100
00010 00110 00100 01111 11011 11000 11111 11011 10201 10112
121?2 10103 00010 11001 00110 21000 10110 01000 00011 00000 0

Paleosuchus palpebrosus
10011 1111? 01001 01010 10001 11111 21130 00111 32112 01100
11222 111?1 11101 10201 100?0 11110 11000 01010 10200 00100
00010 00110 00100 01111 11011 11000 11111 11011 10201 10112
121?2 10103 00010 11001 00110 21000 10110 01000 00?11 00000 0

Caiman brevirostris
????? ????? ????? ????? ????? ????? ????? ????? ????? ?1110
???2? ????1 ??1?? ?0201 ????? ???00 110?0 00??1 10200 1010?
????? ????? ????0 000?? ??0?? ??110 ????1 110?? ????? ?01?2
011?? 101?? ????? ???0? ????? 210?? 10??? 0?0?0 0???? 00?00 0

Culebrasuchus mesoamericanus
```
????? ????? ????? ????? ????? ????? ????? ????? ????? ?1100
???2? ????0 ??20? ????? ????? ???10 ????0 ????? ?000? 0?1??
????? ????0 ?0??? ????? ????? ????? ??1?1 ?00?? ????? ????2
10?0? ??1?4 ????? ????1 ???1? 0???? ?0??? ????0 00??? 00000 0
```

Centenariosuchus gilmorei
```
????? ????? ????? ????? ????? ????? ????? ????? ????? ?1100
1??2? ????? ????? ????? ????? ???00 1?0?0 0002? ?020? 1?10?
???1? ????? ?0??0 0???? ????? ????? 1?1?? 11??? ????? 10?12
?1?1? 1?1?4 ????? ????1 ???1? 2???? ?0110 01??0 00??? 00?0? 0
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Globidentosuchus brachyrostris
```
????? ????? ????? ????0 1???? ????? ????? ????? ????? ?1110
0??0? 1???0 ?1101 10311 1001? ???00 1???0 00??0 1?200 00???
?1?10 ?0??? ?1?0? ??0?1 1???? ?1020 0?1?1 100?? ????0 ?0??2
011?? 101?4 ????? ????1 ???1? ????0 ?0?1? 010?0 00??? 00200 0
```

Mecistops cataphractus
```
10?00 1001? 00001 00000 11100 11111 20120 00111 10110 11110
31010 10001 00100 01110 201?1 00100 12000 00010 02100 00100
01000 00110 10000 10110 10001 01000 00111 11000 01011 00012
00100 10100 01110 10111 10010 00000 30110 01110 00011 00000 0
```

Crocodylus niloticus
```
10100 0001? 10101 00010 11100 11111 20120 00111 20110 11100
11010 10001 01100 01110 20111 00100 11000 00010 02100 00100
11000 00110 10010 00110 10010 01000 00111 11000 01011 00012
00100 10100 01110 10111 10011 00000 30110 01000 00011 00000 0
```

Crocodylus porosus
```
11100 0001? 00101 01010 11100 01111 20120 00111 20110 11100
11010 10001 01100 01110 20111 00100 11000 00010 02100 01100
11000 00110 10010 00110 10000 01000 00111 11000 01011 00012
00100 10100 01110 10111 10011 00000 30110 01000 00011 00000 0
```

Crocodylus acutus
```
00100 0001? 10101 10010 11100 11111 20120 00110 20110 11100
11010 10001 01100 01110 20111 00100 11000 00010 02101 00100
11000 00110 10010 00110 10000 01100 00111 11000 01011 00012
00100 10100 01110 10111 10011 00000 30110 01000 00011 00000 0
```

Osteolaemus tetraspis
```
??1?0 0001? 00101 01000 11100 11111 20111 00111 11110 11100
11010 10001 01100 00110 20111 00110 10000 01010 02100 01100
01000 00110 11001 01110 10100 01000 10111 11010 01010 10012
11100 10110 01110 10111 10110 00000 30110 01000 00011 00000 0
```

Australosuchus clarkae

```
????? ?0??? ????1 ??0?? 1???? ?11?? ????? 0?10? ??1?? ?1110
?101? ????0 01100 00110 ?011? ???00 110?0 00011 02100 00100
01000 001?0 ?0000 00??? ????0 01000 ?0111 110?0 02011 ?0112
00100 10100 011?? 1??11 ?0010 00?00 10?10 010?0 0?0?1 ????0 0
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Kambara implexidens

```
????? ?0??? ????? ????0 1???? ?11?? ??110 0?10? ??1?? ?1110
1101? ????0 01100 00110 ?011? ???00 110?0 00011 02100 00100
01000 001?0 10000 00100 10000 01000 00111 110?0 02011 ?0012
00100 10100 01110 1?111 10010 00000 10?10 01000 00??1 00??0 ?
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Thecachampsa americana

```
????? ????? ????1 ????0 1?000 ?1111 ??110 0?00? ??1?? ?1122
???4? ????0 0010? 0031? ?010? ???00 120?0 00011 02100 00100
?1000 00??? ?0000 10000 10000 ??100 0?111 110?0 00?10 01012
00100 10102 ???0? ???11 10010 0?200 301?0 01000 00??? 00000 0
```

Tomistoma schlegelii

```
02100 0001? 00101 00010 11000 11111 10110 00101 30110 11122
?1040 00001 00100 00000 20100 00100 12000 00011 02100 00101
01000 00110 10001 00000 10000 01100 00111 11000 00110 00012
10100 10100 01100 10111 10010 00000 30110 01000 00011 00000 0
```

Kentisuchus spenceri

```
????? ?0??? ????? ????? 1???? ????? ????? ????? ????? ??1?0
???4? ????0 ??100 0?110 ??11? ???00 110?0 000?1 02100 00100
???00 00??0 ?0100 10100 100?0 01100 0?111 110?? ????0 ?0??2
0010? 10100 ????? ??111 ?0?10 0?0?0 30?10 0?0?0 00??1 00??0 0
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Crocodylus acer

```
????? ????? ????? ????? ????? ????? ????? ????? ????? ?????
????? ????? ????? ????? ????? ???00 110?0 000?1 02100 00100
??000 001?? ?0001 00?10 10000 01000 10111 100?0 02?01 ?00?2
00100 10100 01??0 ??111 00010 00000 30?10 01000 00?11 00??0 0
```

Crocodylus affinis

```
00100 1001? 10001 00001 11000 01111 00110 0?10? ??1?? ?1110
11010 10000 01100 00000 20110 0??00 110?0 00010 01100 00100
?0100 00??0 ?0001 00110 10000 01000 00111 100?0 ?010? ?0012
00100 10100 01??0 ???11 00010 00000 30?10 01000 000?1 00??0 0
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Asiatosuchus germanicus

```
001?0 ?0?1? 00101 0?010 1?000 ?1111 ??1?? 0???? ??1?? ?1110
1000? ????0 01100 00??0 101?0 0??00 010?0 000?0 00100 0010?
??100 00??0 ?0001 0???0 10000 01000 0?111 100?? ?0100 ?0011
10100 10100 0???? ???11 00?10 00000 30?10 010?0 0?001 ????0 0
```

Gnatusuchus pebasensis

```
????? ????? ????? ????? ????? ????? ????? ????? ????? ?2020
?1200 0?011 11101 00001 1001? ???02 110?0 10010 10000 001??
?0010 ?0??? ?1??? ??11? 10011 01?1? 1???1 100?? ?0?0? 1?012
0111? 10104 ????? 1??01 00110 21001 10110 01000 00011 00401 0
```

Kuttanacaiman iquitosensis

```
????? ????? ????? ????? ????? ????? ????? ????? ????? ?1110
11120 0?010 1110? 10201 1001? ???10 110?0 00010 10200 001?0
?0010 00??? ?1000 01011 1101? 11020 01??1 100?? ?020? 10?12
11112 10104 ????? 1??01 00?10 21000 10110 01000 00011 00200 0
```

Caiman wannlangstoni

```
????? ????? ????? ????? ????? ????? ????? ????? ????? ?1110
1112? ????1 ??10? ????? ????? ???00 010?0 0???0 10200 1010?
?0?10 001?0 ?1?0? ??011 111?? 11120 ??111 110?1 10?01 10112
011?? 10104 ????? 1??01 0??10 21000 10110 01000 00??1 00200 0
```

***Paleosuchus* sp. (Pebas *Paleosuchus*)**

```
????? ????? ????? ????? ????? ????? ????? ????? ????? ?1100
???2? ????? ????? ????? ????? ???10 1?0?0 01??0 1020? 0?1??
??010 0???? ?0100 0???? ????? ????? ????? ??0?? ????? ?????
????? ????? ????? ????? ????? ????? ?0??0 0??0? ????? ???0? 0
```

Pebas gavialoid

```
????? ????? ????? ????? ????? ????? ????? ????? ????? ?1132
20?4? ????0 0011? ?0?00 211?? ???00 130?0 01101 02500 00100
?0000 00??? ?0000 10100 1000? 01100 00001 111?0 00001 01?01
?010? 00101 ????? 0???1 ?101? 10000 01000 20111 21000 11001 1
```

Fig. S7 – Life reconstruction of the head of *Gnatusuchus pebasensis*. Natural-sized model by Kevin Montalbán-Rivera.

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