
Convergent Evolution of a Eusuchian-Type Secondary Palate within Shartegosuchidae

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CHARACTERS IN CHARACTER CODING

The data matrix was taken from Clark (2011) analyses of *Fruitachampsia*. Clark (2011) developed upon character's taken mostly from Pol and Gasparini (2009) work. Pol and Gasparini (2009) matrix was composed of characters developed from other authors, e.g., Clark (1994). Furthermore, Clark (2011) expanded on Pol and Gasparini (2009) matrix with four additional characters (258–262). This study further expands on this matrix with the addition of 1 character (char. 263) describing the position of the choana relative to the suborbital fenestra, and the connection between choana and palatal fenestra. Also, characters 258 and 200 were amended to include more specific information concerning the palatines contact with other elements, size and sculpturing. Characters 1, 3, 6, 23, 32, 37, 43, 45, 49, 65, 67, 69, 73, 77, 79, 86, 90, 91, 96, 97, 104, 105, 106, 108, 126, 142, 143, 149, 167, 182, 197, 226 were ordered (marked with a "+").

AMENDMENT TO CHARACTER CODING

Characters coding to *Shartegosuchus asperopalatum* were changed from features observed in IGM 200/50.

Character 10: ? to 1
Character 14: ? to 0
Character 15: ? to 1
Character 37: 2 to ?
Character 43: 0 to 2
Character 80: ? to 1
Character 103: ? to 0
Character 108: ? to 0
Character 125: ? to 1

Character 129: 0 to 1
 Character 134: ? to 1
 Character 140: ? to 1
 Character 146: ? to 0
 Character 155: ? to 1
 Character 161: ? to 0
 Character 162: ? to 0
 Character 164: ? to 0
 Character 172: 1 to ?
 Character 176: ? to 0
 Character 185: ? to 0
 Character 190: ? to 0
 Character 193: ? to 0
 Character 194: ? to 0
 Character 195: ? to 0
 Character 200: ? to 1
 Character 213: ? to 0
 Character 246: ? to 0

CHARACTERS

- Character 1 (Clark, 1994: char. 1; modified by Clark, 2011): + External surface of dorsal cranial bones: smooth (0), slightly grooved (1) and heavily ornamented with deep pits and grooves (2).
 Character 2 (Clark, 1994: char. 2; modified by Clark, 2011): Skull expansion at orbits: gradual (0), or abrupt (1).
 Character 3 (Clark, 1994: char. 3; modified by Clark 2011): + Rostrum proportions: narrow oreinrostral (0), broad oreinrostral (1), nearly tubular (2), or platyrostral (3).
 Character 4 (Clark, 1994: char. 4): Premaxilla participation in internarial bar: forming at least the ventral half (0), or with little participation (1).
 Character 5 (Clark, 1994: char. 5): Premaxilla anterior to nares: narrow (0), or broad (1).
 Character 6 (Clark, 1994: char. 6; modified by Clark, 2011): + External nares facing anterolaterally or anteriorly (0), dorsally not separated by premaxillary bar from anterior edge of rostrum (1), or dorsally separated by premaxillary bar (2).
 Character 7 (Clark, 1994: char. 7): Palatal parts of premaxillae: do not meet posterior to incisive foramen (0), or meet posteriorly along contact with maxillae (1).
 Character 8 (Clark, 1994: char. 8): Premaxilla-maxilla contact: premaxilla loosely overlies maxilla (0), or sutured together along a butt joint (1).
 Character 9 (Clark, 1994: char. 9; modified by Clark, 2011): Ventrally opened notch on ventral edge of rostrum at premaxilla-maxilla contact: absent (0), present as a notch (1), or present as a large fenestra (2).
 Character 10 (Clark, 1994: char. 10): Posterior ends of palatal branches of maxillae anterior to palatines: do not meet (0), or meet (1).
 Character 11 (Clark, 1994: char. 11): Nasal contacts lacrimal (0), or do not contact (1).
 Character 12 (Clark, 1994: char. 12): Lacrimal contacts nasal along medial edge only (0), or medial and anterior edges (1).

- Character 13 (Clark, 1994: char. 13): Nasal contribution to narial border: yes (0), or no (1).
- Character 14 (Clark, 1994: char. 14): Nasal-premaxilla contact: present (0), or absent (1).
- Character 15 (Clark, 1994: char. 15; modified by Clark, 2011): Descending process of prefrontal: does not contact palate (0), or contacts palate (1).
- Character 16 (Clark, 1994: char. 16): Postorbital-jugal contact: postorbital anterior to jugal (0), or postorbital medial to jugal (1), or postorbital lateral to jugal (2).
- Character 17 (Clark, 1994: char. 17): Anterior part of the jugal with respect to posterior part: as broad (0), or twice as broad (1).
- Character 18 (Clark, 1994: char. 18): Jugal bar beneath infratemporal fenestra: flattened (0), or rod-shaped (1).
- Character 19 (Clark, 1994: char. 19): Quadratojugal dorsal process: narrow, contacting only a small part of postorbital (0), or broad, extensively contacting the postorbital (1).
- Character 20 (Clark, 1994: char. 20): Frontal width between orbits: narrow, as broad as nasals (0), or broad, twice as broad as nasals (1).
- Character 21 (Clark, 1994: char. 21): Frontals: paired (0), unpaired (1).
- Character 22 (Clark, 1994: char. 22): Dorsal surface of frontal and parietal: flat (0), or with midline ridge (1).
- Character 23 (Clark, 1994: char. 23 modified by Buckley and Brochu, 1999: char. 81 and Clark, 2011): + Parieto-postorbital suture: absent from dorsal surface of skull roof and supratemporal fossa (0), absent from dorsal surface of skull roof but broadly present within supratemporal fossa (1), or present within supratemporal fossa and on dorsal surface of skull roof (2).
- Character 24 (Clark, 1994: char. 24): Supratemporal roof dorsal surface: complex (0), or dorsally flat 'skull table' developed, with postorbital and squamosal with flat shelves extending laterally beyond quadrate contact (1).
- Character 25 (Clark, 1994: char. 25; modified by Clark, 2011: char. 25) Postorbital bar: sculpted (if skull sculpted) (0), or unsculpted (1).
- Character 26 (Clark, 1994: char. 26; modified by Clark, 2011: char. 26): Postorbital bar: transversely flattened (0), or cylindrical (1).
- Character 27 (Clark, 1994: char. 27): Vascular opening in dorsal surface of postorbital bar: absent (0), or present (1).
- Character 28 (Clark, 1994: char. 28; modified by Clark, 2011: char. 28): Postorbital anterolateral process: absent or poorly developed (0), or well developed, long, and acute (1).
- Character 29 (Clark, 1994: char. 29): Dorsal part of the postorbital: with anterior and lateral edges only (0), or with anterolaterally facing edge (1).
- Character 30 (Clark, 1994: char. 30): Dorsal end of the postorbital bar broadens dorsally, continuous with dorsal part of postorbital (0), or dorsal part of the postorbital bar constricted, distinct from the dorsal part of the postorbital (1).
- Character 31 (Clark, 1994: char. 31): Bar between orbit and supratemporal fossa broad and solid, with broadly sculpted dorsal surface if sculpture present (0), or bar narrow, sculpting restricted to anterior surface (1).
- Character 32 (Clark, 1994: char. 32; modified by Clark, 2011: char. 32): + Parietal: with broad occipital portion (0), or with narrow occipital portion that is broader than the thickness of the parietal immediately anterior to the occiput (1), or very narrow on occiput, no broader than thickness of parietal immediately anterior to occiput (2).
- Character 33 (Clark, 1994: char. 33) Parietal: with broad sculpted region separating fossae (0), or with sagittal crest between supratemporal fossae (1).

- Character 34 (Clark, 1994: char. 34): Postparietal (dermosupraoccipital): a distinct element (0), or not distinct (fused with parietal?) (1).
- Character 35 (Clark, 1994: char. 35): Posterodorsal corner of the squamosal: squared off, lacking extra 'lobe' (0), or with unsculpted 'lobe' (1).
- Character 36 (Clark, 1994: char. 36; modified by Clark, 2011: char. 36): Posterolateral process of squamosal: poorly developed and projected horizontally at the same level of the skull (0), elongated, thin, and posteriorly directed, not ventrally deflected (1), or elongated, posterolaterally directed, and ventrally deflected (2).
- Character 37 (Clark, 1994: char. 37): + Palatines: do not meet on palate below the narial passage (0), form palatal shelves that do not meet (1), or meet ventrally to the narial passage, forming part of secondary palate (2).
- Character 38 (Clark, 1994: char. 38): Pterygoid: restricted to palate and suspensorium, joints with quadrate and basisphenoid overlapping (0), or pterygoid extends dorsally to contact laterosphenoid and form ventrolateral edge of the trigeminal foramen, strongly sutured to quadrate and laterosphenoid (1).
- Character 39 (Clark, 1994: char. 39; modified by Clark, 2011: char. 39): Choanal opening: continuous with pterygoid ventral surface except for anterior and anterolateral borders (0), or opens into palate through a deep midline depression (choanal groove) (1).
- Character 40 (Clark, 1994: char. 40): Palatal surface of pterygoids: smooth (0), or sculpted (1).
- Character 41 (Clark, 1994: char. 41): Pterygoids posterior to choanae: separated (0), or fused (1).
- Character 42 (Clark, 1994: char. 42; modified by Ortega et al., 2000: char. 139): Depression on primary pterygoidean palate posterior to choana: absent or moderate in size being narrower than palatine bar (0), or wider than palatine bar (1).
- Character 43 (Clark, 1994: char. 43): + Pterygoids: form posterior half of the choanal opening (0), or form posterior, lateral and part of the anterior margin of the choana (1), or completely enclose choana (2).
- Character 44 (Clark, 1994: char. 44; modified by Clark, 2011: char. 44): Anterior edge of choana situated near posterior edge of suborbital fenestra (or anteriorly) (0), or near posterior edge of pterygoid flanges (1).
- Character 45 (Clark, 1994: char. 45): + Quadrate: without fenestrae (0), with single fenestrae (1), or with three or more fenestrae on dorsal and posteromedial surfaces (2).
- Character 46 (Clark, 1994: char. 46): Posterior edge of quadrate: broad medial to tympanum, gently concave (0), or posterior edge narrow dorsal to otoccipital contact, strongly concave (1).
- Character 47 (Clark, 1994: char. 47): Dorsal, primary head of quadrate articulates with: squamosal, otoccipital, and prootic (0), or with prootic and laterosphenoid (1).
- Character 48 (Clark, 1994: char. 48): Ventrolateral contact of otoccipital with quadrate: very narrow (0), or broad (1).
- Character 49 (Clark, 1994: char. 49): + Quadrate, squamosal, and otoccipital: do not meet to enclose cranioquadrate passage (0), enclose passage near lateral edge of skull (1), or meet broadly lateral to the passage (2).
- Character 50 (Clark, 1994: char. 50): Pterygoid ramus of quadrate: with flat ventral edge (0), or with deep groove along ventral edge (1).
- Character 51 (Clark, 1994: char. 51): Ventromedial part of quadrate: does not contact otoccipital (0), or contacts otoccipital to enclose carotid artery and form passage for cranial nerves IX--XI (1).
- Character 52 (Clark, 1994: char. 52): Eustachian tubes: not enclosed between basioccipital and basisphenoid (0), or entirely enclosed (1).

- Character 53 (Clark, 1994: char. 53): Basisphenoid rostrum (cultriform process): slender (0), or dorsoventrally expanded (1).
- Character 54 (Clark, 1994: char. 54): Basispterygoid process: prominent, forming movable joint with pterygoid (0), or basispterygoid process small or absent, with basisphenoid joint suturally closed (1).
- Character 55 (modified from Clark, 1994: char. 55 by Ortega et al. 2000: char. 68): Basisphenoid ventral surface: shorter than the basioccipital (0), or wide and similar to, or longer in length than basioccipital (1).
- Character 56 (Clark, 1994: char. 56): Basisphenoid: exposed on ventral surface of braincase (0), or virtually excluded from ventral surface by pterygoid and basioccipital (1).
- Character 57 (Clark, 1994: char. 57): Basisoccipital: without well-developed biltaeral tuberosities (0), or with large pendulous tubera (1).
- Character 58 (Clark, 1994: char. 58): Otoccipital: without laterally concave descending flange ventral to subcapsular process (0), or with flange (1).
- Character 59 (Clark, 1994: char. 59): Cranial nerves IX--XI: pass through common large foramen vagi in otoccipital (0), or cranial nerve IX passes medial to nerves X and XI in separate passage (1).
- Character 60 (Clark, 1994: char. 60): Otoccipital: without large ventrolateral part ventral to paroccipital process (0), or with large ventrolateral part (1).
- Character 61 (Clark, 1994: char. 61): Crista interfenestralis between fenestrae pseudorotunda and ovalis nearly vertical (0), or horizontal (1).
- Character 62 (Clark, 1994: char. 62): Supraoccipital: forms dorsal edge of the foramen magnum (0), or otoccipitals broadly meet dorsal to the foramen magnum, separating supraoccipital from foramen (1).
- Character 63 (Clark, 1994: char. 63): Mastoid antrum: does not extend into supraoccipital (0), or extends through transverse canal in supraoccipital to connect middle ear regions (1).
- Character 64 (Clark, 1994: char. 64): Posterior surface of supraoccipital: nearly flat (0), or with bilateral posterior prominences (1).
- Character 65 (Clark, 1994: char. 65; modified by Clark, 2011: char. 65): + Palpebrals: absent (0), or one small palpebral present in orbit (1), or one large palpebral (2), or two large palpebrals (3).
- Character 66 (Clark, 1994: char. 66): External nares: divided by a septum (0), or confluent (1).
- Character 67 (Clark, 1994: char. 67): + Antorbital fenestra: as large as orbit (0), about half the diameter of the orbit (1), much smaller than the orbit (2), or absent (3).
- Character 68 (Clark, 1994: char. 68; modified by Ortega et al. 2000: char. 41): Supratemporal fenestrae extension: relatively large, covering most of surface of skull roof (0), or relatively short, fenestrae surrounded by a flat and extended skull roof (1).
- Character 69 (Clark, 1994: char. 69; modified by Clark, 2011: char. 69): + Choanal groove: undivided (0), partially septated (1), or completely septated (2).
- Character 70 (Clark, 1994: char. 70): Dentary: extends posteriorly beneath mandibular fenestra (0), or does not extend beneath fenestra (1).
- Character 71 (Clark, 1994: char. 71; modified by Clark, 2011: char. 71): Retroarticular process: absent or extremely reduced (0), very short, broad, and robust (1), with an extensive rounded, wide, and flat (or slightly concave) surface projected posteroventrally and facing dorsomedially (2), posteriorly elongated, triangular-shaped and facing dorsally (3), or posteroventrally projecting and paddle-shaped (4).
- Character 72 (Clark, 1994: char. 72): Prearticular: present (0), or absent (1).
- Character 73 (Clark, 1994: char. 73; modified by Clark, 2011: char. 73): + Articular without medial process (0), with short process not contacting braincase (1), or with process articulating with otoccipital and basisphenoid (2).

- Character 74 (Clark, 1994: char. 74): Dorsal edge of surangular: flat (0), or arched dorsally (1).
- Character 75 (Clark, 1994: char. 75): Mandibular fenestra: present (0), or absent (1).
- Character 76 (Clark, 1994: char. 76): Insertion area for *M. pterygoideus* posterior: does not extend onto lateral surface of angular (0), or extends onto lateral surface of angular (1).
- Character 77 (Clark, 1994: char. 77; modified by Clark, 2011: char. 77): + Splenial involvement in symphysis in ventral view: not involved (0), involved slightly in symphysis (1), or extensively involved (2).
- Character 78 (Clark, 1994: char. 78): Posterior premaxillary teeth: similar in size to anterior teeth (0), or much longer (1).
- Character 79 (Clark, 1994: char. 79; modified by Clark, 2011: char. 79): + Maxillary teeth waves: absent, no tooth size variation (0), one wave of teeth enlarged (1), or enlarged maxillary teeth curved in two waves (festooned) (2).
- Character 80 (Clark, 1994: char. 80): Anterior dentary teeth opposite premaxilla-maxilla contact: no more than twice the length of other dentary teeth (0), or more than twice the length (1). Character 81 (Clark, 1994: char. 81; modified by Clark, 2011: char. 81): Dentary teeth posterior to tooth opposite premaxilla-maxilla contact: equal in size (0), or enlarged dentary teeth opposite to smaller teeth in maxillary tooththrow (1).
- Character 82 (Clark, 1994: char. 82; modified by Ortega et al. 2000: char. 120): Anterior and posterior scapular edges: symmetrical in lateral view (0), anterior edge more strongly concave than posterior edge (1), or dorsally narrow with straight edges (2).
- Character 83 (Clark, 1994: char. 83; modified by Ortega et al. 2000: char. 121): Coracoid length: up to two-thirds of the scapular length (0), or subequal in length to scapula (1).
- Character 84 (Clark, 1994: char. 84): Anterior process of ilium: similar in length to posterior process (0), or one-quarter or less of the length of the posterior process (1).
- Character 85 (Clark, 1994: char. 85): Pubis: rodlike without expanded distal end (0), or with expanded distal end (1).
- Character 86 (Clark, 1994: char. 86): + Pubis: forms anterior half of ventral edge of acetabulum (0), or pubis contacting the ilium but partially excluded from the acetabulum by the anterior process of the ischium (1), or pubis completely excluded from the acetabulum by the anterior process of the ischium (2).
- Character 87 (Clark, 1994: char. 87): Distal end of femur: with large lateral facet for the fibula (0), or with very small facet (1).
- Character 88 (Clark, 1994: char. 88): Fifth pedal digit: with phalanges (0), or without phalanges (1).
- Character 89 (Clark, 1994: char. 89): Atlas intercentrum: broader than long (0), or as long as broad (1).
- Character 90 (Clark, 1994: char. 90; modified by Clark, 2011: char. 90): + Cervical neural spines: all anteroposteriorly large (0), only posterior ones rod-like (1), or all spines rod-like (2).
- Character 91 (Clark, 1994: char. 91; modified by Buscalioni and Sanz, 1988: char. 37, and by Brochu, 1997 : char. 7): + Hypapophyses in cervicodorsal vertebrae: absent (0), present only in cervical vertebrae (1), present in cervical and the first two dorsal vertebrae (2), present up to the third dorsal vertebra (3), or up to the fourth dorsal vertebrae (4).
- Character 92 (Clark, 1994: char. 92): Cervical vertebrae: amphicoelous or amphiplatian (0), or procoelous (1).
- Character 93 (Clark, 1994: char. 93): Trunk vertebrae: amphicoelous or amphiplatian (0), or procoelous (1).
- Character 94 (Clark, 1994: char. 94): All caudal vertebrae: amphicoelous or amphiplatian (0), first caudal biconvex with other procoelous (1), or procoelous (2).

- Character 95 (Clark, 1994: char. 95): Dorsal osteoderms: rounded or ovate (0), or rectangular, broader than long (1), or square (2).
- Character 96 (Clark, 1994: char. 96, modified by Brochu, 1997: char. 40 and Clark, 2011: char. 96): + Dorsal osteoderms: without articular anterior process (0), with a discrete convexity on anterior margin (1), or with a well-developed process located anterolaterally in dorsal parasagittal osteoderms (2).
- Character 97 (Clark, 1994: char. 97; modified by Clark, 2011: char. 97, and by Ortega et al. 2000: chars. 107 and 108): + Rows of dorsal osteoderms: two parallel rows (0), more than two (1), or more than four with accessory ranges of osteoderms (*sensu* Frey, 1988) (2).
- Character 98 (Clark, 1994: char. 98): Osteoderms: some or all imbricated (0), or sutured to one another (1).
- Character 99 (Clark, 1994: char. 99): Tail osteoderms: dorsal only (0), or completely surrounded by osteoderms (1).
- Character 100 (Clark, 1994: char. 100): Trunk osteoderms: absent from ventral part of the trunk (0), or present (1).
- Character 101 (Clark, 1994: char. 101): Osteoderms: with longitudinal keels on dorsal surfaces (0), or without longitudinal keels (1).
- Character 102 (Wu and Sues, 1996: char. 14): Jugal: participating in margin of antorbital fossa (0), or separated from it (1).
- Character 103 (Wu and Sues, 1996: char. 17; modified by Clark, 2011: char. 103): Mandibular symphysis in lateral view: shallow and tapering anteriorly (0), deep and tapering anteriorly (1), deep and anteriorly convex (2), or shallow and anteriorly convex (3).
- Character 104 (Wu and Sues, 1996: char. 23; modified by Clark, 2011: char. 104): + Articular facet for quadrate condyle: equal in length to the quadrate condyles (0), slightly longer (1), or close to three times the length of the quadrate condyles (2).
- Character 105 (Wu and Sues, 1996: char. 24, and Wu et al. 1997: char. 124; modified by Clark, 2011: char. 105): + Jaw joint: placed at level with basioccipital condyle (0), below basioccipital condyle about above level of lower toothrow (1), or below level of toothrow (2).
- Character 106 (Wu and Sues, 1996: char. 27, and Ortega et al. 2000: char. 133; modified by Clark, 2011: char. 106): + Premaxillary teeth: five (0), four (1), three (2), or two (3).
- Character 107 (Wu and Sues, 1996: char. 29; modified by Clark, 2011: char. 107): Unsculptured region along alveolar margin on lateral surface of maxilla: absent (0), or present (1).
- Character 108 (Wu and Sues, 1996: char. 30): + Maxilla: with eight or more teeth (0), seven (1), six (2), five (3), or four teeth (1).
- Character 109 (Wu and Sues, 1996: char. 33): Coracoid: without posteromedial or ventromedial process (0), with elongate posteromedial process (1), or distally expanded ventromedial process (2).
- Character 110 (Wu and Sues, 1996: char. 40): Radiale and ulnare: short and massive (0), or elongate (1).
- Character 111 (Gomani, 1997: char. 4; modified by Clark, 2011: char. 111): Prefrontals anterior to orbits: elongated, oriented parallel to anteroposterior axis of the skull (0), or short and broad, oriented posteromedially-anterolaterally (1).
- Character 112 (Gomani, 1997: char. 32; modified by Clark, 2011: char. 112): Basioccipital and ventral part of otoccipital: facing posteriorly (0), or posteroventrally (1).
- Character 113 (Buscalioni and Sanz, 1988: char. 35): Vertebral centra: cylindrical (0), or spool shaped (1).
- Character 114 (Buscalioni and Sanz, 1988: char. 39; modified by Clark, 2011: char. 114): Transverse process of posterior dorsal vertebrae dorsoventrally low and laminar (0), or dorsoventrally high (1).

- Character 115 (Buscalioni and Sanz, 1988: char. 44): Number of sacral vertebrae: two (0), or more than two (1).
- Character 116 (Buscalioni and Sanz, 1988: char. 49): Supra-acetabular crest: present (0), or absent (1).
- Character 117 (Buscalioni and Sanz, 1988: char. 54): Proximal end of radiale expanded symmetrically, similarly to the distal end (0), or more expanded proximomedially than proximolaterally (1).
- Character 118 (Ortega et al., 1996: char. 5): Lateral surface of the anterior region of surangular and posterior region of dentary: without a longitudinal depression (0), or with a longitudinal depression (1).
- Character 119 (Ortega et al., 1996: char. 9): Ventral exposure of splenials: absent (0), or present (1).
- Character 120 (Ortega et al., 1996: char. 11, 2000: char. 100): Tooth margins: with denticulate carinae (0), or without carinae or with smooth or crenulated carinae (1).
- Character 121 (Pol, 1999a: char. 133, and Ortega et al., 2000: char. 145; modified by Clark, 2011: char. 121): Lateral surface of anterior process of jugal: flat or convex (0), or with broad shelf below the orbit with triangular depression underneath it (1).
- Character 122 (Pol, 1999a: char. 134): Jugal: does not exceed the anterior margin of orbit (0), or exceeds margin (1).
- Character 123 (Pol, 1999a: char. 135): Notch in premaxilla on lateral edge of external nares: absent (0), or present on the dorsal half of the external nares lateral margin (1).
- Character 124 (Pol, 1999a: char. 136): Dorsal border of external nares: formed mostly by the nasals (0), or by both the nasals and premaxilla (1).
- Character 125 (Pol, 1999a: char. 138): Posterodorsal process of premaxilla: absent (0), or present extending posteriorly wedging between maxilla and nasals (1).
- Character 126 (Pol, 1999a: char. 139, and Ortega et al., 2000: char. 9): + Premaxilla-maxilla suture in palatal view, medial to alveolar region: anteromedially directed (0), sinusoidal, posteromedially directed on its lateral half and anteromedially directed along its medial region (1), or posteromedially directed (2).
- Character 127 (Pol, 1999a: char. 140): Nasal lateral border posterior to external nares: laterally concave (0), or straight (1).
- Character 128 (Pol, 1999a: char. 141): Nasal lateral edges: nearly parallel (0), oblique to each other converging anteriorly (1), or oblique to each other diverging anteriorly (2).
- Character 129 (Pol, 1999a: char. 143): Palatine anteromedial margin: exceeding the anterior margin of the palatal fenestrae extending anteriorly between the maxillae (0), or not exceeding the anterior margin of palatal fenestrae (1).
- Character 130 (Pol, 1999a: char. 144): Dorsoventral height of jugal antorbital region respect to infraorbital region: equal or lower (0), or antorbital region more expanded than infraorbital region of jugal (1).
- Character 131 (Pol, 1999a: char. 145): Maxilla-lacrimal contact: partially included in antorbital fossa (0), or completely included (1).
- Character 132 (Pol, 1999a: char. 146): Lateral eustachian tube openings: located posteriorly to the medial opening (0), or aligned anteroposteriorly and dorsoventrally (1).
- Character 133 (Pol, 1999a: char. 147): Anterior process of ectopterygoid: developed (0), or reduced-absent (1).
- Character 134 (Pol, 1999a: char. 148): Posterior process of ectopterygoid: developed (0), or reduced-absent (1).
- Character 135 (Pol, 1999a: char. 149, and Ortega et al., 2000: char. 13): Small foramen located in the premaxillo-maxillary suture in lateral surface (not for big mandibular teeth): absent (0), or present (1).

- Character 136 (Pol, 1999a: char. 150): Jugal posterior process: exceeding posteriorly the infratemporal fenestrae (0), or not (1).
- Character 137 (Pol, 1999a: char. 151): Compressed crown of maxillary teeth: oriented parallel to the longitudinal axis of skull (0), or obliquely disposed (1).
- Character 138 (Pol, 1999a: char. 152): Large and aligned neurovascular foramina on lateral maxillary surface: absent (0), or present (1).
- Character 139 (Pol, 1999a: char. 153; modified by Clark, 2011: char. 139): External surface of maxilla and premaxilla: with a single plane facing laterally (0), or with ventral region facing laterally and dorsal region facing dorsolaterally (1).
- Character 140 (Pol, 1999a: char. 154, and Ortega et al., 2000: char. 104): Maxillary teeth: not compressed laterally (0), or compressed laterally (1).
- Character 141 (Pol, 1999a: char. 155): Posteroventral corner of quadratojugal: reaching the quadrate condyles (0), or not reaching the quadrate condyles (1).
- Character 142 (Pol, 1999a: char. 156; modified by Clark, 2011: char. 142): + Base of postorbital process of jugal: directed posterodorsally (0), or dorsally (1), or anterodorsally (2).
- Character 143 (Pol, 1999a: char. 157): + Postorbital process of jugal: anteriorly placed (0), in the middle (1), or posteriorly positioned (2).
- Character 144 (Pol, 1999a: char. 158, and Ortega et al., 2000: char. 36): Postorbital-ectopterygoid contact: present (0), or absent (1).
- Character 145 (Pol, 1999a: char. 161): Quadratojugal: not ornamented (0), or ornamented in the base (1).
- Character 146 (Pol, 1999a: char. 162): Prefrontal-maxillary contact in the inner anteromedial region of orbit: absent (0), or present (1).
- Character 147 (Pol, 1999a: char. 163): Basisphenoid: without lateral exposure (0), or with lateral exposure on the braincase (1).
- Character 148 (Pol, 1999a: char. 165): Quadrate process of pterygoids: well developed (0), or poorly developed (1).
- Character 149 (Pol, 1999a: char. 166, modified by Clark, 2011: char. 149, and by Ortega et al., 2000: char. 44): + Quadrate major axis directed: posteroventrally (0), ventrally (1), or anteroventrally (2).
- Character 150 (Pol, 1999a: char. 167): + Quadrate distal end: with only one plane facing posteriorly (0), or with two distinct faces in posterior view, a posterior one and a medial one bearing the foramen aereum (1).
- Character 151 (Pol, 1999a: char. 168): Anteroposterior development of neural spine in axis: well developed covering all the neural arch length (0), or poorly developed, located over the posterior half of the neural arch (1).
- Character 152 (Pol, 1999a: char. 169): Prezygapophyses of axis: not exceeding anterior edge of neural arch (0), or exceeding the anterior margin of neural arch (1).
- Character 153 (Pol, 1999a: char. 170): Postzygapophyses of axis: well developed, curved laterally (0), or poorly developed (1).
- Character 154 (Pol, 1999b: char. 212): Shape of dentary symphysis in ventral view: tapering anteriorly forming an angle (0), U-shaped, smoothly curving anteriorly (1), or lateral edges longitudinally oriented, convex anterolateral corner, and extensive transversely oriented anterior edge (2).
- Character 155 (Pol, 1999b: char. 213): Unsculpted region in the dentary below the tooth row: absent (0), or present (1).
- Character 156 (Buckley and Brochu, 1999: char. 102): Surangular forms only the lateral wall of glenoid fossa (0) or forms approximately one-third of the glenoid fossa (1).

- Character 157 (Buckley and Brochu, 1999: char. 102): Anterior margin of femur linear (0), or bears flange for coccygeofemoralis musculature (1).
- Character 158 (Buckley and Brochu, 1999: char. 105): Dentary smooth lateral to seventh alveolous (0), or with lateral concavity for the reception of the enlarged maxillary tooth (1).
- Character 159 (Ortega et al., 1996: char. 1, modified by and Buckley and Brochu, 1999: char. 107, and Clark, 2011: char. 159): Dorsal edge of dentary slightly concave or straight and subparallel to the longitudinal axis of skull (0), straight with an abrupt dorsal expansion, being straight posteriorly (1), with a single dorsal expansion and concave posterior to this (2), or sinusoidal, with two concave waves (3).
- Character 160 (Ortega et al., 1996: char. 2; modified by and Buckley and Brochu, 1999: char. 108, and Clark, 2011: char. 160): Dentary compression and lateroventral surface anterior to mandibular fenestra: compressed and vertical (0), or not compressed and convex (1).
- Character 161 (Ortega et al., 1996: char. 7, and Buckley and Brochu, 1999: char. 110): Splenial: thin posterior to symphysis (0), or splenial robust dorsally posterior to symphysis (1).
- Character 162 (Ortega et al., 1996: char. 13, and Buckley et al., 2000: char. 117): Cheek teeth: not constricted at base of crown (0), or constricted (1).
- Character 163 (Ortega et al., 2000: char. 10): Ventral edge of premaxilla located: at the same height as ventral edge of maxilla (0), or located deeper, with the dorsal contour of anterior part of dentary strongly concave (1).
- Character 164 (Ortega et al., 2000: char. 19; modified by Clark, 2011: char. 164): Maxillary dental implantation: teeth in isolated alveoli (0), or located on a dental groove (1).
- Character 165 (Ortega et al., 2000: char. 24): Caudal tip of nasals: converge at sagittal plane (0), or caudally separated by anterior sagittal projection of frontals (1).
- Character 166 (Ortega et al., 2000: char. 33): Relative length between squamosal and postorbital: squamosal is longer (0), or postorbital is longer (1).
- Character 167 (Ortega et al., 2000: char. 34; modified by Clark, 2011: char. 167): Jugal portion of postorbital bar: flush with lateral surface of jugal (0), anteriorly continuous but posteriorly inset (1), or medially displaced and a ridge separates postorbital bar from lateral surface of jugal (2).
- Character 168 (Ortega et al., 2000: char. 42): Outer surface of squamosal laterodorsally oriented: extensive (0), or reduced and sculpted (1), or reduced and unsculpted (2).
- Character 169 (Ortega et al., 2000: char. 47): Quadratojugal spine at caudal margin of infratemporal fenestra: absent (0), or present (1).
- Character 170 (Ortega et al., 2000: char. 53; modified by Clark, 2011: char. 170): Quadrate condyles with poorly developed intercondylar groove (0), or medial condyle expands ventrally, being separated from the lateral condyle by a deep intercondylar groove (1).
- Character 171 (Ortega et al., 2000: char. 62): Exposure of supraoccipital in skull roof: absent (0), or present (1).
- Character 172 (Ortega et al., 2000: char. 70): Nasal participation in antorbital fenestra: yes (0), or no (1).
- Character 173 (Ortega et al., 2000: char. 75): Anterior opening of temporo-orbital foramen in dorsal view exposed (0), or hidden in dorsal view and overlapped by squamosal rim of supratemporal fossa (1).
- Character 174 (Ortega et al., 2000: char. 90): Foramen intramandibularis oralis: small or absent (0), or big and slot-like (1).
- Character 175 (Ortega et al., 2000: char. 98; modified by Clark, 2011: char. 175): Coronoid size: short and located below the dorsal edge of the mandibular ramus (0), or anteriorly extended with posterior region elevated at the dorsal margin of the mandibular ramus (1).

- Character 176 (Ortega et al., 2000: char. 101): Width of root of teeth with respect to crown: narrower or equal (0), or wider (1).
- Character 177 (Ortega et al., 2000: char. 109): Gap in cervico-thoracic dorsal armor: absent (0) or present (1).
- Character 178 (Ortega et al., 2000: char. 130): Lateral contour of snout in dorsal view: straight (0) or sinusoidal (1).
- Character 179 (Ortega et al., 2000: char. 138): Pterygoidean flanges: laminar and expanded (0) or bar-like and elongated (1), or bar-like and poorly developed.
- Character 180 (Ortega et al., 2000: char. 146): Ectopterygoid medial process: single (0), or forked (1).
- Character 181 (Ortega et al., 2000: char. 157; modified by Clark, 2011: char. 181): Skull roof: rectangular shaped in dorsal view (0), or trapezoidal shape (1).
- Character 182 (Ortega et al., 2000: char. 30): + Prefrontal pillars when integrated in palate: pillars transversely expanded (0), transversely expanded in their dorsal part and columnar ventrally (1), or longitudinally expanded in their dorsal part and columnar ventrally (2).
- Character 183 (Ortega et al., 2000: char. 21): Ventral edge of maxilla in lateral view: straight or convex (0), or sinusoidal (1).
- Character 184 (Ortega et al., 2000: char. 156; modified by Clark, 2011: char. 184): Position of first enlarged maxillary teeth: second or third alveoli (0), or fourth or fifth (1).
- Character 185 (Pol and Apesteguia, 2005: char. 180): Splenial-dentary suture at symphysis on ventral surface: v-shaped (0), or transverse (1).
- Character 186 (Pol and Apesteguia, 2005: char. 181): Posterior peg at symphysis: absent (0), or present (1).
- Character 187 (Pol and Apesteguia, 2005: char. 182): Posterior ridge on glenoid fossa of articular: present (0), or absent (1).
- Character 188 (Gomani, 1997: char. 46; modified by Buckley et al., 2000: char. 113, and Clark, 2011: char. 188): Cusps of teeth: unique cusp (0), one main cusp with smaller cusps arranged in one row (1), one main cusp with smaller cusps arranged in more than one row (2), several cusps of equal size arranged in more than one row (3), or multiple small cusps along edges of occlusal surface (4).
- Character 189 (Pol and Apesteguia, 2005: char. 184): Dorsal surface of mandibular symphysis: flat or slightly concave (0), or strongly concave and narrow, trough shaped (1).
- Character 190 (Pol and Apesteguia, 2005: char. 185): Medial surface of splenials posterior to symphysis: flat or slightly convex (0), or markedly concave (1).
- Character 191 (Pol and Apesteguia, 2005: char. 186): Choanal septum shape: narrow vertical bony sheet (0), or T-shaped bar expanded ventrally (1).
- Character 192 (Pol and Norell, 2004a: char. 164): Cross section of distal end of quadrate: mediolaterally wide and anteroposteriorly thin (0), or subquadrangular (1).
- Character 193 (Pol and Apesteguia, 2005: char. 188): Lateral surface of dentaries below alveolar margin, at mid to posterior region of tooth row: vertically oriented, continuous with rest of lateral surface of the dentaries (0), or flat surface exposed laterodorsally, divided by a ridge from rest of the lateral surface of the dentaries (1).
- Character 194 (Pol and Norell, 2004a: char. 165): Palatine-pterygoid contact on palate: palatines overlie pterygoids (0), or palatines firmly sutured to pterygoids (1).
- Character 195 (Pol et al., 2004: char. 164): Ectopterygoid main axis oriented: laterally or slightly anterolaterally (0), or anteriorly, subparallel to the skull longitudinal axis (1).
- Character 196 (Wu et al., 1997: char. 103): Squamosal descending process: absent (0), or present (1).

- Character 197 (Wu et al., 1997: char. 105; modified by Clark, 2011: char. 197): + Development of distal quadrate body ventral to otoccipital-quadrate contact: distinct (0), incipiently distinct (1), or indistinct (2).
- Character 198 (Wu et al., 1997: char. 106): Pterygoid flanges: thin and laminar (0), or dorsoventrally thick, with pneumatic spaces (1).
- Character 199 (Wu et al., 1997: char. 108): Postorbital participation in infratemporal fenestra: almost or entirely excluded (0), or bordering infratemporal fenestra (1).
- Character 200 (Wu et al., 1997: char. 109; modified by Dollman et al., 2018: char. 200): Palatines: form margin of suborbital fenestra (0), or are small and excluded from the margin of the suborbital fenestra by the pterygoids and maxillae (1)
- Character 201 (Wu et al., 1997: char. 110): Angular posterior to mandibular fenestra: widely exposed on lateral surface of mandible (0), or shifted to the ventral surface of mandible (1).
- Character 202 (Wu et al., 1997: char. 112): Posteroventral edge of mandibular ramus: straight or convex (0), or markedly deflected (1).
- Character 203 (Wu et al., 1997: char. 119; modified by Clark, 2011: char. 203): Quadrate ramus of pterygoid in ventral view: narrow (0), or broad (1).
- Character 204 (Wu et al., 1997: char. 121): Pterygoids: not in contact anterior to basisphenoid on palate (0), or pterygoids in contact (1).
- Character 205 (Wu et al., 1997: char. 122): Olecranon: well developed (0), or absent (1).
- Character 206 (Wu et al., 1997: char. 123): Cranial table width respect to ventral portion of skull: as wide as ventral portion (0), or narrower than ventral portion of skull (1).
- Character 207 (Wu et al., 1997: char. 127): Depression on posterolateral surface of maxilla: absent (0), or present (1).
- Character 208 (Wu et al., 1997: char. 128): Anterior palatal fenestra: absent (0), or present (1).
- Character 209 (Pol and Norell, 2004a: char. 179): Paired ridges located medially on ventral surface of basisphenoid: absent (0), or present (1).
- Character 210 (Pol et al., 2004a: char. 179): Ventral margin of infratemporal bar of jugal: straight (0), or dorsally arched (1).
- Character 211 (Pol and Norell, 2004a: char. 180): Posterolateral end of quadratojugal: acute or rounded, tightly overlapping the quadrate (0), or with sinusoidal ventral edge and wide and rounded posterior edge slightly overhanging the lateral surface of the quadrate (1).
- Character 212 (Pol and Norell, 2004a: char. 181): Orientation of quadrate body distal to otoccipital-quadrate contact in posterior view: ventrally (0), or ventrolaterally (1).
- Character 213 (Gasparini et al., 1993: char. 3): Wedge-like process of the maxilla in lateral surface of premaxilla-maxilla suture: absent (0), or present (1).
- Character 214 (Pol and Norell, 2004b: char. 181) Palpebrals: separated from the lateral edge of the frontals (0), or extensively sutured to each other and to the lateral margin of the frontals (1).
- Character 215 (Pol and Norell, 2004b: char. 182) External surface of ascending process of jugal: exposed laterally (0), or exposed posterolaterally (1).
- Character 216 (Pol and Norell, 2004b: char. 183) Longitudinal ridge on lateral surface of jugal below infratemporal fenestra: absent (0), or present (1).
- Character 217 (Pol and Norell, 2004b: char. 184) Dorsal surface of posterolateral region of squamosal: without ridges (0), or with three curved ridges oriented longitudinally (1).
- Character 218 (Pol and Norell, 2004b: char. 185) Ridge along dorsal section of quadrate-quadratojugal contact: absent (0), or present (1).

- Character 219 (Pol and Norell, 2004b: char. 186) Sharp ridge along the ventral surface of angular: absent (0), or present (1).
- Character 220 (Pol and Norell, 2004b: char. 187) Longitudinal ridge along the dorsolateral surface of surangular: absent (0), or present (1).
- Character 221 (Pol and Norell, 2004b: char. 188) Dorsal surface of osteoderms ornamented with antero-laterally and anteromedially directed ridges (fleur de lys pattern of Osmólska et al., 1997): absent (0), or present (1).
- Character 222 (Pol and Norell, 2004b: char. 189) Cervical region surrounded by lateral and ventral osteoderms sutured to the dorsal elements: absent (0), or present (1).
- Character 223 (Pol and Norell, 2004b: char. 190) Appendicular osteoderms: absent (0), or present (1).
- Character 224 (Ortega et al., 2000: char. 72): Supratemporal fenestra: present (0), or absent (1).
- Character 225 (Pol and Apesteguia, 2005: char. 220): Flat ventral surface of internal narial septum: anteriorly broad (0), or tapering anteriorly (1).
- Character 226 (Pol and Apesteguia, 2005: char. 221): + Perinarial fossa: restricted extension (0), extensive, with a distinctly concave surface facing anteriorly (1), or large concave surface facing anteriorly, projecting anteroventrally from the external nares opening toward the alveolar margin (2).
- Character 227 (Serenó et al. 2001: char. 67; modified by Clark, 2011: char. 227): Premaxillary palate circular paramedian depressions: absent (0), present located anteriorly on the premaxilla (1), or present located at the premaxilla-maxilla suture (2).
- Character 228 (Pol and Apesteguia, 2005: char. 223): Posterolateral region of nasals: flat surface facing dorsally (0), or lateral region deflected ventrally, forming part of the lateral surface of the snout (1).
- Character 229 (Zaher et al., 2006: char. 193): Ventral half of the lacrimal: extending ventroposteriorly widely contacting the jugal (0), or tapering ventroposteriorly, does not contact or contacts the jugal only slightly (1).
- Character 230 (Zaher et al., 2006: char. 194): Large foramen on the lateral surface of jugal, near its anterior margin: absent (0), or present (1).
- Character 231 (Zaher et al. 2006: char. 195; modified by Clark, 2011: char. 231): Procumbent premaxillary alveoli absent (0) or present (1).
- Character 232 (Martinelli, 2003: char. 36; modified by Zaher et al. 2006: char. 196): Palatine bar: absent (0), or present (1).
- Character 233 (Zaher et al., 2006: char. 197): Participation of ectopterygoid in palatine bar: no (0), or yes (1).
- Character 234 (Pol and Norell, 2004a: char. 183): Choanal opening: opened posteriorly and continuous with pterygoid surface (0), or closed posteriorly by an elevated wall formed by the pterygoids (1).
- Character 235 (Zaher et al., 2006: char. 198): Ectopterygoid projecting medially on ventral surface of pterygoid flanges: barely extended (0), or widely extended covering approximately the lateral half of the ventral surface of the pterygoid flanges (1).
- Character 236 (Gasparini et al, 2006): Evaginated maxillary alveolar edges: absent (0), or present as a continuous sheet (1), or present as discrete evaginations at each alveoli (2).
- New Character 237 (Gasparini et al, 2006): Foramen in perinarial depression of premaxilla: absent (0), or present (1).
- Character 238 (Serenó et al. 2001: char. 27): Frontal anterior ramus with respect to anterior tip of prefrontal: ending posteriorly (0), or ending anteriorly (1).
- Character 239 (Serenó et al. 2001: char. 68): Premaxillary anterior alveolar margin and teeth orientation: vertical (0), or inturned (1).

- Character 240 (Serenio et al. 2001: char. 69): Premaxillary tooth row orientation: arched posteriorly from midline (0), or angled posterolaterally, at 120 degree angle (1).
- Character 241 (Serenio et al. 2001: char. 70): Last premaxillary tooth position relative to tooth row: anterior (0), or anterolateral (1).
- Character 242: Posterior teeth with rings of undulated enamel: absent (0), or present (1).
- Character 243 (Brochu, 1999: char. 108; modified by Clark, 2011: char. 243): Maxilla-palatine suture: palatine anteriorly rounded (0), or palatine anteriorly pointed (1), or palatine invaginated (2).
- Character 244 (Gasparini et al., 2006): Lateral surface of postorbital bar: formed by postorbital and jugal (0), or only by postorbital (1).
- Character 245 (Gasparini et al., 2006): Enlarged foramen at anterior end of surangular groove: absent (0), or present (1).
- Character 246 (Gasparini et al., 2006): Shape of antorbital fossa: subcircular or subtriangular (0), or elongated, low, and oriented obliquely (1).
- Character 247 (Gasparini et al., 2006): Prefrontal lateral development: reduced (0), or enlarged, extending laterally over the orbit (1).
- Character 248 (Gasparini et al., 2006): Foramen for the internal carotid artery: reduced, similar in size to the openings for cranial nerves IX-XI (0), or extremely enlarged (1).
- Character 249 (Gasparini et al., 2006): Squamosal posterolateral region, lateral to paroccipital process: narrow (0), or bearing a subrounded flat surface (1).
- Character 250 (Gasparini et al., 2006): Posteromedial branch of squamosal oriented: transversely (0), or posterolaterally (1).
- Character 251 (Gasparini et al., 2006): Dorsal margin of squamosal occipital flange: straight (0), or dorsally concave (1).
- Character 252 (Gasparini et al., 2006): Sculpture in external surface of rostrum: absent (0), or present (1).
- Character 253 (Gasparini et al., 2006): Longitudinal depressions on palatal surface of maxillae and palatines: absent (0), or present (1).
- Character 254 (Gasparini et al., 2006): Angle between medial and anterior margins of supratemporal fossa: approximately 90° (0), or approximately 45° (1).
- Character 255 (Gasparini et al., 2006): Transverse process of sacral vertebrae directed: laterally (0), or markedly deflected ventrally (1).
- Character 256 (Gasparini et al., 2006): Prefrontal and lacrimal around orbits: forming flat rims (0), or evaginated, forming elevated rims (1).
- Character 257 (Gasparini et al., 2006): Nasal bones: paired (0), or partially or completely fused (1).
- Character 258 (Clark, 2011: char. 258; modified by Dollman et al., 2018: char. 258): Sculpturing on palate is (0) absent, (1) small pitting on the palatines or (1) heavy pitting on the palatines and pterygoids.
- Character 259 (Clark, 2011: char. 259): Lower teeth: present to anterior end of dentary (0), or absent anterior to lower caniniforms (1).
- Character 260 (Clark, 2011: char. 260): Anterior teeth in dentary: project dorsally (0), or anterior two teeth horizontal (1).
- Character 261 (Clark, 2011: char. 261): Ventrolateral edge of palatine medial to suborbital fenestra: sharp, palatine does not curve dorsally (0), or smooth, palatine curves dorsally (1).

Orthosuchus

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Edentosuchus

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Zaraasuchus

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Gobiosuchus

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Sichuanosuchus

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Shantungosuchus

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Zosuchus

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Fruitachampsia

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Shartegosuchus

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Adzhosuchus

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Nominosuchus

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Notosuchus

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Comahuesuchus

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Mariliasuchus

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Uruguaysuchus

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Iberosuchus

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Libycosuchus

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Araripesuchus gomesii

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Araripesuchus patagonicus

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Araripesuchus buitreiraensis

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Araripesuchus wegneri

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Lomasuchus

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Peirosaurus

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Theriosuchus

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Alligatorium

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Goniopholis

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Eutretauranosuchus

203?????1?10010111000100111?00?0101001110?000?1112011?1010??0?1?0?1312
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Bernissartia

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Hylaeochampsia

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Borealosuchus

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Gavialis

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00111000001?00000000000?000?00?100010000[1 2]00?0000010001000010?

Crocodylus

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31003100010020121112110131112021100?3000002100100100?101??121100?0000
000100110101?00001?0000310?001022101?100011000211??000000010100100001
11000001000000000000?0000000?1000?0000?00?0000010000000010?

Alligator

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Hsisosuchus

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Pelagosaurus

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Steneosaurus bollensis

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Metriorhynchus superciliosus

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Metriorhynchus casamiquelai

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Geosaurus araucaniensis

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Geosaurus suevicus

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Dakosaurus maximus

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Dakosaurus andiniensis

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Rhabdognathus

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Sokotosuchus

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Dyrosaurus

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Hyposaurus

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Pholidosaurus

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Sarcosuchus

203?12?10100101?100010011001010101012?10101[01]01?12?1??10100?0?100?1
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?121100??00000010010?1??00???110?0[02]11010[01]022[01]00?0000?000000
?000000?00?01001000?1?100?0010?00000000?0?0100000?100011110100?0?0001
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Terminonaris robusta

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12]10?????0?0000?0?0000?0001?0?00?0?0?11100?00?0??00??00?0?0100?00?1
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