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A new Cretaceous Pleurodira Pelomedusoides from the Lower Cretaceous of Parnaíba Basin, Brazil

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ABSTRACT

The new Pleurodira turtle *Itapecuruemys amazonensis* gen. et sp. nov. from the Itapecuru Formation (Parnaíba Basin, Brazil) is described. The new species is represented only by its holotype, which consists of an almost complete carapace and plastron, with an oval-shaped outline. The most peculiar characters of *Itapecuruemys amazonensis* are: neural plates six and seven are separated by costal six, and the seventh neural plate contacts the sixth, seventh and eighth costal plates and a suprapygal. The phylogenetic hypothesis proposed in this paper suggests that *Itapecuruemys amazonensis*, together with *Cearachelys* and *Galianemys* spp., form a monophyletic assemblage and also widen the paleoherpetological diversity of the Itapecuru Formation in the Parnaíba Basin (Brazil).

1. Introduction

In Brazil, as in other parts of the world, several Cretaceous turtles have been described. In all, fourteen testudines fossil species have been found to date within four Cretaceous sedimentary basins (Araripe, Bauru, Sergipe-Alagoas and Potiguar) (Gaffney et al., 2001, 2006; Batista, 2005; Romano et al., 2014; Ferreira et al., 2018; Hermanson et al., 2020). The Brazilian record includes five families: Podocnemididae, Araripemydidae, Protostegidae, Bothremydidae and Euraxemydidae, and a species of uncertain family relationships. Bothremydidae is a large and diverse clade of pelomedusoid turtles of worldwide distribution, extending from the Aptian to the Eocene in North and South America, Europe, Africa and India (Gaffney et al., 2006; De la Fuente et al., 2014).

The material described herein was found in the Aptian strata of the Itapecuru Formation, Parnaíba Basin, Maranhão State, in northeastern Brazil. This region is situated on the eastern limits of Brazil's Legal Amazon (Medeiros and Schultz, 2001). Kischlat and Carvalho (2000) had already reported the presence of shell turtles. After them, Batista and Carvalho (2006) confirmed the record of a specimen of *Araripemys barretoi* Price (1973) in this locality. The purpose of this manuscript is to fully describe this material, diagnose a new taxon, provide a detailed description of its morphology, and explore the relationships of this new taxon.

2. Geological setting

The Cretaceous sedimentary sequence of the Parnaíba Basin (or Grajaú Basin, *sensu* Rossetti et al., 2001) comprises continental and nearshore marine deposits. The oldest unit is the Pastos Bons Formation, consisting mainly of clastic material. It is overlain by conglomerates and red cross-bedded sandstones designated as the Corda Formation. These are commonly interpreted as sediments of fluvial-aeolian environments deposited in a semi-arid climate. During the opening of the Equatorial Atlantic basin, extensive basalt flows (Sardinha Formation) overlaid these units. Later, during the Aptian–Albian, conglomerates, coarse to fine sandstones (Grajaú Formation), shales, and carbonates (Codó Formation) were deposited on top of the basalts. The depositional settings of the latter deposits were fluvial and costal marine environments. The climate at this time was hot and dry (Pedrão et al., 1993a). Fine-grained

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sandstones with interbedded argillaceous and carbonate levels, the Itapecuru Formation, represents the youngest Cretaceous of the Parnaíba Basin. The depositional environment is considered to have been marine in the northern portion, changing to lacustrine and floodplain environments in the southern part of the basin (Carvalho et al., 2003).

The new chelonian specimen comes from Mata locality (Itapecuru-Mirim County, Maranhão State). There are two lithofacies in the Mata sedimentary succession, named L2 and L3 (Figure 1). The L2 lithofacies includes finely laminated reddish siltstones; some levels contain fluidization structures and invertebrate ichnofossils. There are fossils of non-marine molluscs (Bivalvia), turtles, and scales of freshwater fish. The reddish siltstones are interbedded with fine sandstones in which climbing ripples are observed. The layers display lenticular to tabular geometry, and carbonate levels occur in their upper portion. The L3 lithofacies, in which the turtle fossil was found, includes fine-to medium-grained sandstones with channel cross-stratification, climbing ripples and sigmoidal structures. The layers display a lenticular to tabular geometry, with thicknesses varying from 0.5 to 3.0 m, and palaeocurrents trending southwest. In a vertical profile, the muddy facies grade up into sandy deposits in a clear coarsening-upward pattern (Carvalho et al., 2003). This coarsening-upward cycle at Mata is part of a 3 m thick sequence that is interpreted as a fluvial-deltaic progradation in lacustrine conditions during Aptian-Albian times (Gonçalves and Carvalho, 1996). The new species occurs in the L2 lithofacies, which is interpreted as proximal fluvial mouth bar deposits, whereas the subjacent L3 lithofacies represent the distal deposits of these mouth bars (delta front).

The palynological analysis in samples collected along the Itapecuru River, in outcrops located in Guariba (Cantanhede County), Coqueiro, Querru and Igarapé Ipiranga (Itapecuru County) and Rosário city, revealed palynomorphs with the occurrence of Complicatiscus cearensis and Elateropollenites jardinei pollen zone. This association suggests that the depositional paleoenvironment was continental, fluvial, under hot and relatively humid climates (Pedrão et al., 1993b; Pedrão, 1995; Pedrão and Corrêa-Martins, 1999; Ferreira et al., 2016). Theropods were also found next to these chelonian clades such as Carcharodontosauridae and Spinosauridae, which have been recorded based on isolated teeth and vertebrae (Vilas Bôas et al., 1999; Medeiros and Schultz, 2002; Medeiros, 2006; Medeiros et al., 2007).

3. Material and methods

3.1. Material

The specimen described here in were collected in 1995 in the Itapecuru Formation, 2 km south of the type-section of this lithostratigraphic unit at the Mata locality (Itapecuru-Mirim County, Maranhão State, Brazil). The material described herein is deposited at the macrofossil collection of the Geology Department, Institute of Geosciences, Center of Mathematical and Natural Sciences, Federal University of Rio de Janeiro (DGEO-IGEO-UFRJ).

3.2. Institutional abbreviations

UFRJ – DG – Universidade Federal do Rio de Janeiro – Departamento de Geologia.

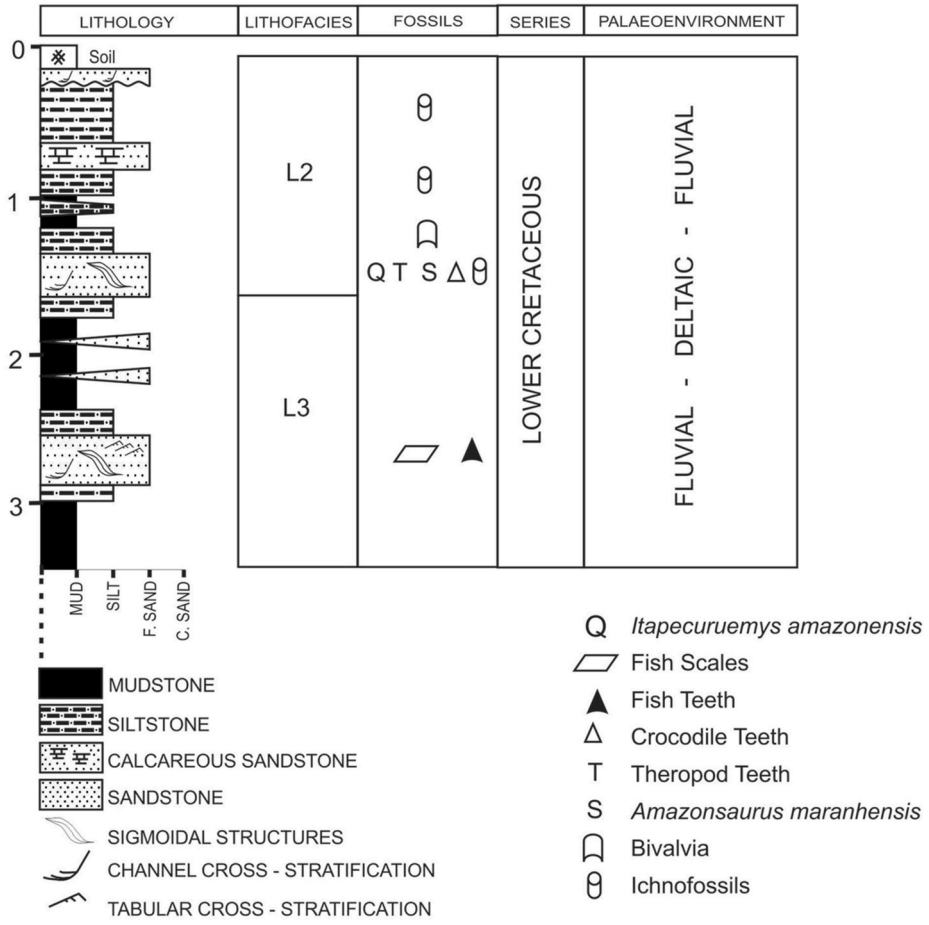

Fig. 1. Lithofacies of Mata locality (Itapecuru-Mirim County, Maranhão State) and the fossiliferous strata where the new taxa was found (Modified from Carvalho et al., 2003).

3.3. Anatomical abbreviations

nuc – nuchal; neu – neural; per – peripheral; cos – costal; spg – suprapygal; hyo – hyoplastron; meso – mesoplastron; hyp – hypoplastron; xiphi – xiphiplastron; hum – humeral; pec – pectoral; abd – abdominal; fem – femoral; an – anal; ple – peural; vert – vertebral.

3.4. Cladistic analysis

A cladistics analysis was conducted to evaluate the phylogenetic relationships of *Itapecuruemys amazonensis*. A dataset of 132 taxa and 285 morphological characters based on the matrix of Hermanson et al. (2020). Cladistics analysis was performed using TNT 1.5 (Goloboff et al., 2008). It was used as a search criterion parsimony ("traditional search" with 1000 replicates, hold 20, random seed 0). Functions implemented in TNT were employed to summarize the most parsimonious trees (MPTs) in strict consensus, as well as to calculate Bremer support, bootstrap (GC, 1000 replicates) and Jacknife (1000 replicates, cut = 1, P = 36). Character list and data matrix are available in supplementary material. Characters states coded to *Itapecuruemys amazonensis* gen. et sp. nov. in data matrix: ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ?????????? ??11021100 02???????0 ?????????? ??0??1?10? ?????? 001? ??1?11110? ?0???0???? ?????????? ?????????? ?????????? ?????????1 1????

4. Systematic paleontology

Testudines Linnaeus, 1758
Pleurodira Cope, 1864
Pelomedusoides Cope, 1868
Itapecuruemys amazonensis, gen. et sp. nov (Figure 2).

Holotype: UFRJ DG 66-R, a partially preserved carapace and plastron.

Etymology- "*Itapecuru*" in allusion to the type-locality in Itapecuru-Mirim County, Maranhão State, Brazil, and "*emys*" from Greek, turtle.; "*amazonensis*" due to the Legal Amazon area, in the northern region of Brazil, where the fossil was discovered.

Type locality and horizon: Mata, Itapecuru-Mirim County, Maranhão State, Brazil.Itapecuru Formation, Early Cretaceous (Aptian).

Diagnosis: *Itapecuruemys amazonensis* can be diagnosed as a pelomedusoids pleurodira by the suturing of the pelvic girdle to the shell, and the presence of rounded and equidimensional meoplastra. *Itapecuruemys amazonensis* can be characterized by a low and broadly rounded carapace outline, with seven neural plates. It differs from other bothremydids by the organization of its neural and costal plates. The sixth pair of costals meets in the midline, between the sixth and seventh neurals. The sixth neural does not have a posterior contact with the seventh neural bone, and this space has a midline contact of the sixth costal bone pair. The seventh neural bone is heptagonal and contacts the sixth, seventh and eighth costals plates and the suprapygal.

5. Description

5.1. Carapace

The carapace of *Itapecuruemys amazonensis* is broadly rounded and low. The lateral margins converge posteriorly, with the widest point at the level of the fourth costal. The carapace is composed of incomplete nuchal and suprapygal plates, seven neural plates, and eight pairs of costals. The right peripheral plates one to nine are the only preserved among the peripheral pair series. There are no costo-peripheral fontanelles. Fragments of the right bridge peripherals are present. The Nuchal plate is preserved only by a fragment of the most anterior portion. The carapace is composed of seven neurals. Between neural plates six and seven there is a gap, which means that these neural plates do not touch each other. The first neural is rectangular, similar to *Kurmademys kallamedensis* Gaffney et al., 2001. In *K. kallamedensis,* the first neural is more elongated than the following neurals and is roughly rectangular in shape (Gaffeny et al., 2006). The second to fifth neural are hexagonal, similar to *Foxemys mechinorun* Tong et al., 1998 and *Polysternon provincial* Matheron, 1869. Much like most Bothremydidae species, the sixth neural in *I. amazonensis* is pentagonal, but the seventh is heptagonal, diverging from other Bothremydidae. The anterior edge of the suprapygal bone is preserved and touches the eighth costal bone, which is common among this family, and the seventh neural bone, which is uncommon.

Costal plates: All the costals plates located on the right side of the carapace are preserved. The first costal is slightly larger anteroposterior than mediolateral. The width of the remaining costal plates is twice to three times wide than long. Between the first and second costals there is a break right at the contact plates. On the left side of the carapace, only the medial portion of the costals are preserved. Although fragmented, the medial contact of the sixth costal is present. This contact also occurs

Fig. 2. UFRJ DG 66R, holotype *Itapecuruemys amazonensis* gen. nov *et* sp. nov corresponding to pleurodiran turtle, from the Lower Cretaceous of Parnaíba Basin, Brazil. A: Plastron. B: Carapace. Scale 5 cm.

in *K. kallamendensis* and *Chedighaii barberi* Schmidt, 1940.

Peripheral plates: The second to sixth right peripherals plates are preserved completely, whereas the first, seventh, eighth and nine right peripherals are only partially preserved. The peripheral plates on the left side were not preserved. The first, second and third peripheral bones are in contact only with the first costal. The fourth peripheral is in contact with the first and second costals. The fifth peripheral is in contact with the second and third costals. The sixth peripheral is in contact with the third and fourth costals. The seventh peripheral is in contact with the fourth and fifth costals. The eighth peripheral is in contact with the fifth and sixth costals. The ninth peripheral is in contact with the sixth and seventh costals.

The scutes are barely recognizable on the carapace of *Itapecuruemys amazonensis* gen. et sp. nov.. The second and third vertebral scutes, and partially the second, third and fourth pleurals are recognized. These vertebral scutes are slightly wider than the pleurals. The second and third vertebral scutes being slightly wider than long and subhexagonal in outline. The second vertebral scute covers the posterior area of the first neural, completely covering the second neural and most of the third neural, a small anterior/posterior portion of the first costal, the medial part of both second costals, and a portion of the anteromedial part of the third costal. The sulcus between the second and third vertebralis its on the third neural and both third costal. in their medial part. The third vertebral overlaps the posterior area of both third costals, the medial part of both fourth costals, the fourth neural, and most of the medial portion of both fifth costals. The sulcus between the third and fourth vertebrals crosses both fifth costals in their medial portion and the posterior part of the fifth neural.

Four pleural scutes on the right side and two on the left side seem to be covered by the carapace in *Itapecuruemys amazonensis*, as is usual in turtles. However, only two scutes (second and third pleural) of the right side can be limited by vertebral and interpleural sulci. The second pleural is wider than it is long and covers the fourth to sixth costals. Third pleural is also wider than it is long and covers the fourth to sixth costals.

5.2. Plastron

Due to the non-preservation of the epiplastra and entoplastron, we cannot be sure of the complete size of the plastron, which in the present circumstance is similar to the carapace. Thus, we are unable to claim that the anterior plastral lobe is broader and shorter than the posterior lobe, as in most Bothremydini (*Foxemys mechinorum*, *Polysternon provinciale*). The bridge is shorter than the posterior lobe. Only the hyoplastron, hypoplastron and xiphiplastron are preserved. The mesoplastra of *Itapecuruemys* are similar in size and shape to those in *Cearachelys*, *Podocnemis*, *Taphrosphys* and *Chedighaii* and are not very large as in *Euraxemys*. The hyoplastron is the largest of all plastral bones. The entoplastron was located between the right and the left hyopolastra. The entoplastron cannot be recognized, but between the right and left hyoplastron it is possible to visualize the geometric shape of the posterior part of the entoplastron where it was once located. The epiplastra are not preserved, probably having been lost in the collecting processes. The posterior lobe is narrower than the anterior lobe, with the lateral margin tapering posteriorly. The hypoplastron is a little smaller than the hyoplastron and is well preserved. In *Itapecuruemys* the right hypoplastron sutures with the left xiphiplastron, as in *Cearachelys,* but is different from *Polysternon*, *Foxemys* and *Kurmademys*. The Hyoplastron and Hypoplastron form a perfect cross, similar to *Kurmademys*, but diverge from most Bothremydidae such as *Cearachelys, Elochelys convenarum* Laurent, Tong and Claude, 2002*, Taphrosphys congolensis* Dollo, 1913 and *Chedighaii barberi* . The xiphiplastron is also well-preserved, but its posterior part was lost.

The plastral scutes of *Itapecuruemys* are not well-preserved. Some sulci are visible in the ventral surface of the plastron. The humero-pectoral sulcus crosses the hyoplastron and likely the unpreserved entoplastron, the pectoral-abdominal and the abdominal-femoral sulci cross the hyo and hypoplastra, respectively, and the femoro-anal sulcus is positioned crossing the xiphiplastron, as is typical in turtles.

In *Itapecuremys*, the humero-pectoral does sulcus not cross the entoplastron, as in *Cearachelys* and *Galianemys* spp. and unlike *Foxemys*, *Polysternon* and *Taphrosphys*. In *Rosasia*, the sulcus is located anterior to the entoplastron. The midline plastral formula in the holotype of *Itapecuremys amazonensis* is Fe > Pe = Ab > An (Figure 3).

6. Results

6.1. Cladistic analysis

The phylogenetic analyses results in 20 trees of 1501 steps (C.I. 0.315; R.I. 0.747). The morphological information of the skull was not excluded for greated data robustness. The unambiguos synapomorphies are listed in the Supplementary material. In the strict consensus, all most parsimonious trees (MPTs) were calculated using Bootstrap and Jacknifing (P = 36) and Bremer support where the results showed similarities. *Itapecuruemys amazonensis*, *Cearachelys placidoi, Galianemys emringeri* and *G. whitei* are nested in a monophyletic group supported by two common synapomorphies (Char. 174 = Neural series completeness and Char. 177 = position of four sided neural) (Figure 4).

7. Discussion

7.1. Taxonomic assignment of Itapecuruemys amazonensis

Characteristics that enable the attribution of *Itapecuruemys amazonensis* gen. nov *et* sp. nov. to the hyperfamily Pelomedusoides (sensu Broin, 2000 and Gaffney et al., 2006) include the presence of rounded and equidimensional mesoplastra and the absence of a cervical scute.

Gaffney et al. (2011) considered the pectoral scales contacting the epiplastra as a characteristic of the Podocnemididae family. Even without epiplastra, the delimitation of the pectoral scales in *Itapecuruemys* is restricted to hyoplastron. Gaffney et al. (2006) considers two caracteristcs in the shell of the Euraxemydidae family: Complete neural series reaching the suprapygal (present in *Itapecuruemys*) and abdominal scale midline length less than anal scale length. Even with the hyoplastron bone with fragmented edges, this characteristic is not identified in *Itapecuruemys*, as the xiphyplastron bone its width preserved and the measurements are opposite when compared with members of the family Euraxemydidae. Gaffney et al. (2006) also considered the neural series incomplete to the suprapygal, whcich is te opposite of the finding in *Itapecuruemys*, as a diagnostic characteristic for the Pelomedusidae family.

According to Antunes and Broin (1988), the Bothremydidae was characterized by seven shell characters. However, *Itapecuruemys amazonensis* does not have sufficient diagnostic characteristics to insert it in this family. Nonetheless, this family was used for its greater equality of forms, to mark the differences and similarities in the description, for exemple: Reduction in the number of neurals to seven or less, which is acknowledged to occur often in pleurodires; apectoral-abdominal sulcus crossing the anterior part of the mesoplastra (parallelism in this character was acknowledged).

An interruption of the neural series between neurals six and seven is a unique feature of this species. However, individual variation in the neural series of the extant pelomedusoid species *Pelusios sinuatus* Smith, 1838 was reported by Broin (1969: 914): not only in the number of neurals (5–7 in this species), but also in the presence of a discontinuity between the fifth and sixth neural bone (with a midline contact of the fifth costal) in three specimens and a discontinuity between the fourth and fifth (fourth costal bone with midline contact) in one specimen among 9 revised specimens of *Pelusios sinuatus*.

Anatomical comparisons were made with the phylogenetically closest species. In *Kurmademys kallamedensis,* from Maastrichtian of

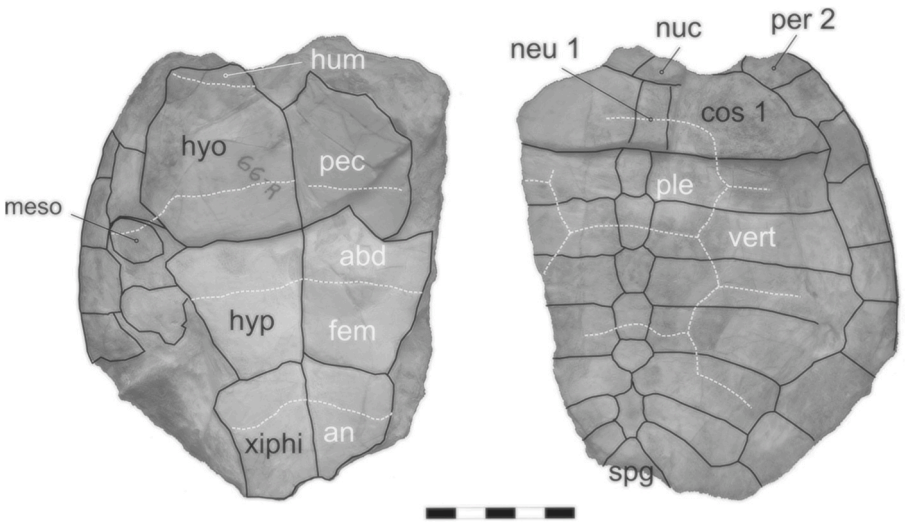

Fig. 3. (UFRJ DG 66R), holotype *Itapecuruemys amazonensis* gen. nov *et* sp. nov corresponding to pleurodiran turtle, from the Lower Cretaceous of Parnaíba Basin, Brazil. A: Plastron. B: Carapace. Scale 5 cm.

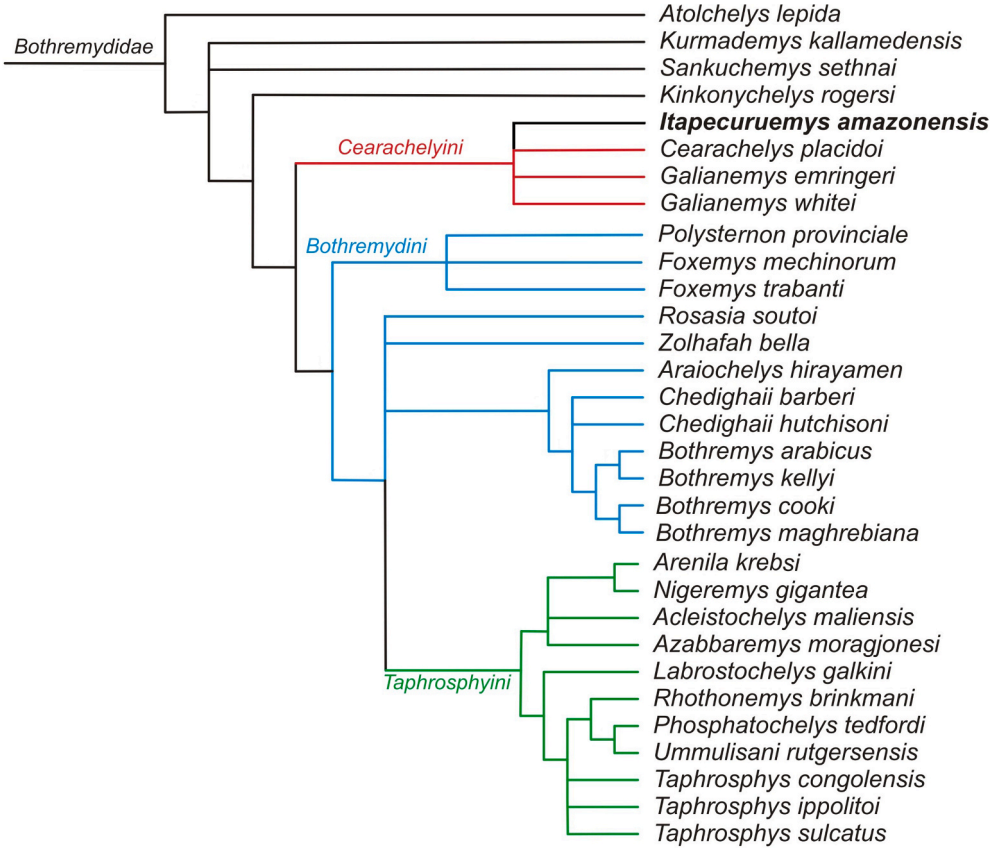

Fig. 4. Simplified cladogram, reduced strict consensus of 10 most parsimonious trees of 1501 steps (CI: 0.315; IR: 0.747); indicating the position of the *Itapecuruemys amazonensis* inside of the family Bothremydidae.

southern India, the second to fifth neurals are all elongated and six-sided with the short anterolateral sides. *I. amazonensis* gen. nov et sp. nov. presents a similar form, six-sided, but the second and fourth neurals are shorter, having almost equal length and width. The pectoral-abdominal sulcus crosses the mesoplastron, while *K. kallamedensis* presents sulcus anterior to the mesoplastron.

Itapecuruemys amazonensis gen. nov et sp. nov. shows similarities to *Cearachelys placidoi* Gaffney et al. (2001) (Santana Formation, Lower Cretaceous, Araripe Basin), as both show a complete neural series contacting the suprapygal. *C. placidoi* has eight neural plates: the first neural is six-sided and has short, paired contacts with the first and second costals, and the sixth neural bone is hexagonal. The new pleurodire has seven neural plates, the first neural being four-sided and touching only the nuchal, first costal and second neural, and the sixth neural bone being pentagonal.

Foxemys mechinorum presents a carapace outline that is an elongated

oval, rather than more rounded, as in *I. amazonensis*. The humero-pectoral and pectoral-abdominal sulcus present in the hyoplastron of the *I. amazonensis* and the sixth neural plate is five-sided, in *F. mechinorum* the humero-pectoral sulcus present in the epiplastron and sixth neural plate is six-sided contacting the seventh neural. Contact of the right hypoplastron with the left hyoplastron occurs in *F. mechinorum*, but not in *I. amazonensis*.

Gaffney et al. (2006) described two possible shells for *Galianemys* spp. from Cenomanian, Kem Kem, Morocco. The specimen AMNH 30551 has eight neural plates, with eigthth costal meeting on the midline, and AMNH 30550 has six neural plates, with costals seven and eight meeting on the midline. *I. amazonensis* has seven neurals with sixth costal meeting on the midline, and costals seven and eigth making no contact. In AMNH 30551, the right hypoplastron does not touch the left xiphoplastron, as presented in *I. amazonensis*, and opposite to AMNH 30550, where the contact is between the left hyoplastron and right xiphoplastron.

In *Polysternon provinciale* and *Rosasia soutoi*, the seventh and eighth pairs of costals meet on the midline, while in *I. amazonensis* only the sixth costal does. The right hypoplastron touches the left xiphiplastron in *I. amazonensis*, while in *P. provincial* the right xiphiplastron touches the left hypoplastron, and in *R. soutoi* no cross-contact is present.

When compared to other chelonians in the Brazilian Cretaceous, we noticed several distinct characteristics. *Apodichelys lucianoi* Price, 1954 is known only by the internal mold of a carapace and plastron, precluding a detailed comparison with *Itapecuruemys amazonensis*.

Itapecuruemys amazonensis presents some differences from *Euraxemys essweini* Gaffney et al., (2006) In *Euraxemys essweini* a complete neural series reaching the suprapygal is present, and the length of the hyo-hypoplastron suture is less than the length of the hypo-xiphoplastron suture; it is the opposite in *Itapecuruemys amazonensis*.

There are several characteristics that separate the *Araripemys barretoi* specie from *Itapecuruemys amazonensis*. A sculptured carapace in which the first costals reach the shell margin between the nuchal and first peripherals, reduced plastron lacking mesoplastra and gular scutes, inverted V-shaped entoplastron, J-shaped epiplastra forming a sharp point anteriorly, three midplastral fontanelles, and absent medial and lateral centralia (Meylan, 1996). All theses characteristics are presents in *Araripemys barretoi* and absent in *Itapecuruemys amazonensis*. *Araripemys barretoi* does not present a tight contact among all bony elements (Meylan, 1996). The peripheral bones and costal bones of the posterior region of the carapace do not have direct contact with one another in this species. *Itapecuruemys amazonensis* differs from this species in the absence of carapacial and plastral fontanelles, the presence of a discontinuous neural series, and in the xiphiplastral shape and robustness.

Itapecuruemys amazonensis differs from the *Brasilemys josai* Broin (2000), in the shape of its neural bones. In *Brasilemys josai,* the first neuralis hexagonal and short-sided posteriorly and the second and third neurals are pentagonal (Broin, 2000), while in *Itapecuruemys amazonensis* the first neural is quadrangular and second and third neurals are hexagonal. In *Brasilemys josai* the seventh neural touches costal bones VI, VII and VII. In *Itapecuruemys amazonensis,* it also touches the suprapygal.

Itapecuruemys amazonensis differs from Podocnemididae, *Cambaremys langertoni* França and Langer, 2005, *Roxochelys wanderleyi* Price, 1953 and *Bauruemys elegans* (Suárez, 1969) Kischlat, 1994, because these taxa display the last neural without contact with the suprapygal. *Itapecuruemys amazonensis* presents contact of the last neural with the suprapygal.

7.2. Phylogenetic comments

All MPTs show *Itapecuruemys amazonensis* nested within Bothremydidae and forming a monophyletic group with *Cearachelys placidoi*, *Galianemys whitei* and *Galianemys emringeri*. These relationships are supported by the aforementioned two synapomorphies. These analyses were carried out to try confirm and position *Itapecuruemys* within the Bothremydidae clade Therefore, more specimens must be found to confirm their phylogenetic position. However, *Itapecuruemys* should be considered a different genus from *Cearachelys* according to the features already mentioned in the discussion.

8. Conclusion

Itapecuruemys amazonensis gen. nov *et* sp. nov. from Parnaiba Basin presents a discontinuous neural series and a seventh neural bone with unusual anatomical morphology. The seventh neural bone does not contact with the sixth neural bone. According to the carapace and plastron morphologies, as the shell is compressed dorso-ventrally, without the presence of fenestras, this induces *Itapecuruemys amazonensis* gen. nov *et* sp. nov. to appear in habitats similar to pleurodiras known to inhabit the southern hemisphere. This new species enhances the chelonian diversity in the Brazilian Cretaceous, first described in the Parnaiba Basin. Regarding the morphological age of the species, we cannot accurately infer whether the specimen is an adult or juvenile. Its plates are well fused, which can lead us to identify such a specimen as an adult, albeit small. It would not be an outlier for an adult chelonian of this size, given that the species *Homopus signatus* is recorded with an average size of 6 cm, but only new findings can corroborate this statement.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jsames.2020.102872.

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