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An isopod from the Codó Formation (Aptian of the Parnaíba Basin), Northeastern Brazil

Um isópode da Formação Codó (Aptiano da Bacia do Parnaíba), Nordeste do Brasil

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ABSTRACT: The Codó Formation is a lithostratigraphic unit with predominant carbonate sedimentation of the Aptian age situated in the intracratonic Parnaíba Basin. In this formation, the only known crustaceans were conchostracans and ostracods. Systematic collections conducted in the Brejo city, in the Maranhão State, have provided new taxa for the cited lithostratigraphic unit. A new genus and species of isopod is described with the following set of features: cephalon elliptical deeply inserted in the first pereionite; eyes located dorsolaterally; body oblong oval; and isomorphic pereionites and pleonites, which indicate an affinity with the family Archaeoniscidae. The presence of this taxon in the limestone deposits from the Codó Formation reinforces prior inference of a lacustrine/marine paleoenvironments, and indicates a greater diversity of aquatic arthropods during the opening of the South Atlantic in the Early Cretaceous.

KEYWORDS: Archaeoniscidae; Codó Formation; Parnaíba Basin.

RESUMO: *A Formação Codó constitui unidade litoestratigráfica com predomínio de sedimentação carbonática de idade aptiana, e situa-se na bacia intracratônica do Parnaíba. Nessa formação, os crustáceos eram conhecidos apenas por conchostráceos e ostracodes. Coletas sistemáticas realizadas no município de Brejo, Maranhão, proveram novos taxa para a citada unidade litoestratigráfica. Um novo gênero e espécie de isópode é descrito apresentando o conjunto de caracteres: céfalon elíptico, profundamente inserido no primeiro pereionite; olhos localizados dorsolateralmente; corpo oblongo-ovalar; e presença de pereionites e pleonites isomórficos indicando afinidade com a família Archaeoniscidae. A ocorrência deste táxon em depósitos calcários da Formação Codó reforça prévias inferências de paleoambiente lagunar/marinho, e demonstra uma diversidade maior de artrópodes aquáticos durante a abertura do Atlântico Sul no Cretáceo Inferior.*

PALAVRAS-CHAVE: *Archaeoniscidae; Formação Codó; Bacia do Parnaíba.*

INTRODUCTION

The Codó Formation is distributed over an area of approximately 170,000 km^2 (Lima 1982) and is part of the Mesozoic sedimentary sequences in the Parnaíba Basin. This lithostratigraphic unit is composed of bituminous shales, evaporites, limestones, and sandstones formed under low-energy lacustrine environmental conditions with water stratification, which resulted in episodes of anoxia (Reis & Caputo 2007). Faciological and palynostratigraphic studies of this unit indicate an Aptian/Albian age (Lima 1982, Rossetti *et al.* 2001, Antonioli 2001). Fossil occurrences date back to the first half of the 20th century and include fishes, crustaceans, plants, insects, and gastropods (Lisboa 1914, Cardoso 1962, Pinto & Ornellas 1974, Lima & Leite 1978). The ichthyofauna is the most significant of these fossils and can be correlated to the Santana Formation in the Araripe Basin and Riachuelo Formation in the Sergipe/Alagoas Basin (Santos & Carvalho 2009).

Crustaceans in these deposits are rare and poorly studied; until recently, they were only represented by ostracods and conchostracans (Cardoso 1962, Leite *et al.* 1975, Lima & Leite 1978, Krömmelbein & Weber 1985, Silva *et al.* 1985, 1989). In the city of Brejo (Fig. 1), northeastern Maranhão, outcrops attributed to the Codó Formation occur in open pit mines at two locations: Faveirinha Quarry and Perneta Ranch. In these outcrops, the collections have allowed finding new crustaceans such as decapods and a rare appendage print, which might be related to the infraorder Brachyura (Lindoso *et al.* 2011).

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This study aims to describe a new genus and species of isopod for the Codó Formation (Aptian of the Parnaíba Basin), which is the third species from Brazil described for the Cretaceous. Paleoenvironmental inferences are also made from this new fossil.

Geological setting

The new isopod comes from the intracratonic Parnaíba Basin located in a large area of the western portion of Northeast Brazil, covering the states of Maranhão, Piauí and part of Tocantins, Pará, Ceará and Goiás. This basin has a total area of 600,000 km^2, and its sedimentary succession is 3,500 m thick in its depocenter, 500 m of which belong to Mesozoic rocks (Campbell 1949, Mesner & Wooldridge 1964).

The sedimentary and magmatic succession of the Parnaíba Basin is divided into five supersequences: Silurian, Middle-Devonian, Early-Carboniferous, Late-Carboniferous-Early-Triassic, Jurassic, and Cretaceous, and the latter consists of the following formations: Corda, Grajaú, Codó and Itapecuru (Vaz *et al.* 2007). However, according to Carneiro (1974) and Rezende (2002), the Corda, Grajaú and Codó formations are interfingered and chronostratigraphically equivalent. The Corda Formation is composed of reddish-brown, very fine, semi-friable and semi-cohesive sandstones. The Grajaú Formation, in turn, consists of whitish-pale-beige medium/coarse sandstones and conglomeratic levels. In the Codó Formation, there are bituminous shales, siltstones, limestones, evaporites, and sandstones. Superimposed on these deposits is the Itapecuru Formation of the Middle-Albian-Late Cretaceous age, which is composed of fine, friable sandstones and pelites (Vaz *et al*. 2007).

The areas where the Codó Formation occurs are restricted and discontinuous, appearing in river beds that drain the central basin at the confluence of the Tocantins and Araguaia rivers, approaching the Parnaíba River, in the Brejo city and Codó (Santos & Carvalho 2009). The inferred age for these deposits is Aptian/Albian (Lima 1982), and their strata are deposited in an arid to semiarid climate regime (Rossetti *et al*. 2001).

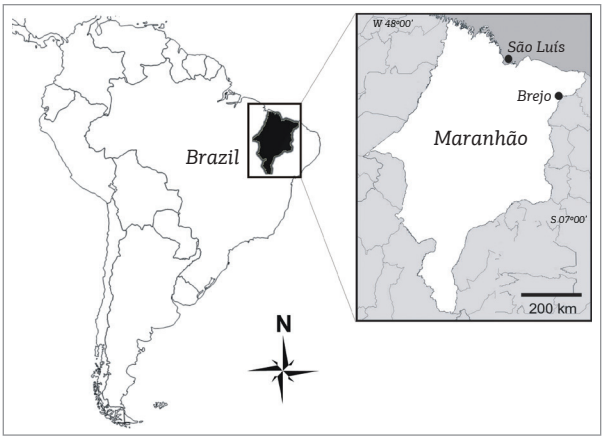

Figure 1. Location of the city of Brejo, Maranhão State.

According to Lima & Leite (1978), paleontological data indicate deposition occurred under marine and brackish lacustrine environments. The stratigraphic and faciological analyses in the region of Codó, Maranhão State, by Rossetti *et al*. (2001) indicated three depositional environments: (1) central lake; (2) transitional lake; and (3) marginal lake. The depositional environments were interpreted in the upper sequence, which corresponds to an upper shoreface, interdistributary lagoon/bay, suspension lobe, and distributary channel (Rossetti *et al*. 2001, Paz & Rossetti 2001). In a palynostratigraphic study, Antonioli (2001) divided the Codó Formation into three lithostratigraphic units: (1) Lower, which had an incipient marine character; (2) Middle, which was essentially evaporitic; and (3) Upper, which had a marine character.

MATERIALS AND METHODS

Nine isopods were collected in the Faveirinha Quarry (42º44'45,4"W and 03º49'20,1"S) and Perneta Ranch (42º44'21,1" W and 03º48'50,0"S), located approximately 20 km from the city of Brejo, northeastern Maranhão. These outcrops have a predominantly carbonatic lithology interbedded with marls; the Faveirinha Quarry is currently abandoned (Fig. 2). The specimen UFRJ DG 170-Cr is bidimensionally preserved in a fragment of massive limestone, which was subjected to mechanical preparation techniques and photographed under a binocular Carl Zeiss Discovery v.12 lens. It is housed in the paleontological collection of the Geology Department of the Federal University of Rio de Janeiro.

PALEONTOLOGICAL SYSTEMATICS

MALACOSTRACA Latreille, 1802
ISOPODA Latreille, 1817
SPHAEROMATIDEA Wägele, 1989
SPHAEROMATOIDEA Latreille, 1825
ARCHAEONISCIDAE Haack, 1918
Codoisopus gen. nov.
(Fig. 3)

Etymology. The generic name refers to the Codó Formation, the lithostratigraphic unit where the specimen comes from.

Diagnosis. The same as for the species. *Codoisopus brejensis* gen. nov. *et* sp. nov.

Etymology. The specific designation, *brejensis* (*latin*), refers to Brejo city.

Holotype. UFRJ DG 170-Cr

Location. Faveirinha Quarry, city of Brejo, Maranhão State.

Stratigraphic Context. Parnaíba Basin, Codó Formation, Lower Cretaceous (Aptian).

Diagnosis. Body oblong-oval measuring 13 mm length and 7 mm width. Cephalon elliptical deeply inserted within the first pereionite. Dorsolateral eyes; somites thoracic and abdominal isomorphic (seven pereionites and five pleonites). Pleotelson small, subtriangular, having half the length of the pereon. Presence of subrectangular exopodites.

DESCRIPTION

Specimen UFRJ-DG 170-Cr measures 13 mm length and 7 mm width. It is dorsoventrally preserved in light-yellow massive limestone. The entire body is preserved in dorsal view. It is possible to identify the cephalon, which has the first somite diamond-shaped and a total of 12 thoracic and abdominal somites, which gives it an oblong-oval shape. Antennules and antennae are not preserved. Exopodites only occur as printings. The pleotelson is subtriangular and twice the length of the pereon.

DISCUSSION

The fossil record for isopods has been limited, partly due to their small size (usually less than 30 mm) and delicate structure (Taylor 1972). Therefore, isopods are rare but important ecological forms, especially in benthic marine habitats (Ruppert *et al*. 2005).

The occurrence of these crustaceans in Brazil is notable as only two species have been described: *Unusuropode castroi* Duarte & Santos (1962), Turonian of the Group Apodi, Açu Sandstone, Ceará, and *Saucrolus silvai* Santos (1971), Aptian of the Areado Formation in the Sanfranciscana Basin. For the carbonate deposits of Brejo, Maranhão, which correspond to the Codó Formation, a new genus and species of isopod, *Codoisopus brejensis* gen. *et* sp. nov., is proposed. This species differs from *U. castroi* for having elliptical cephalon and lateral pleural expansions that are strongly distally arched, although the possibility

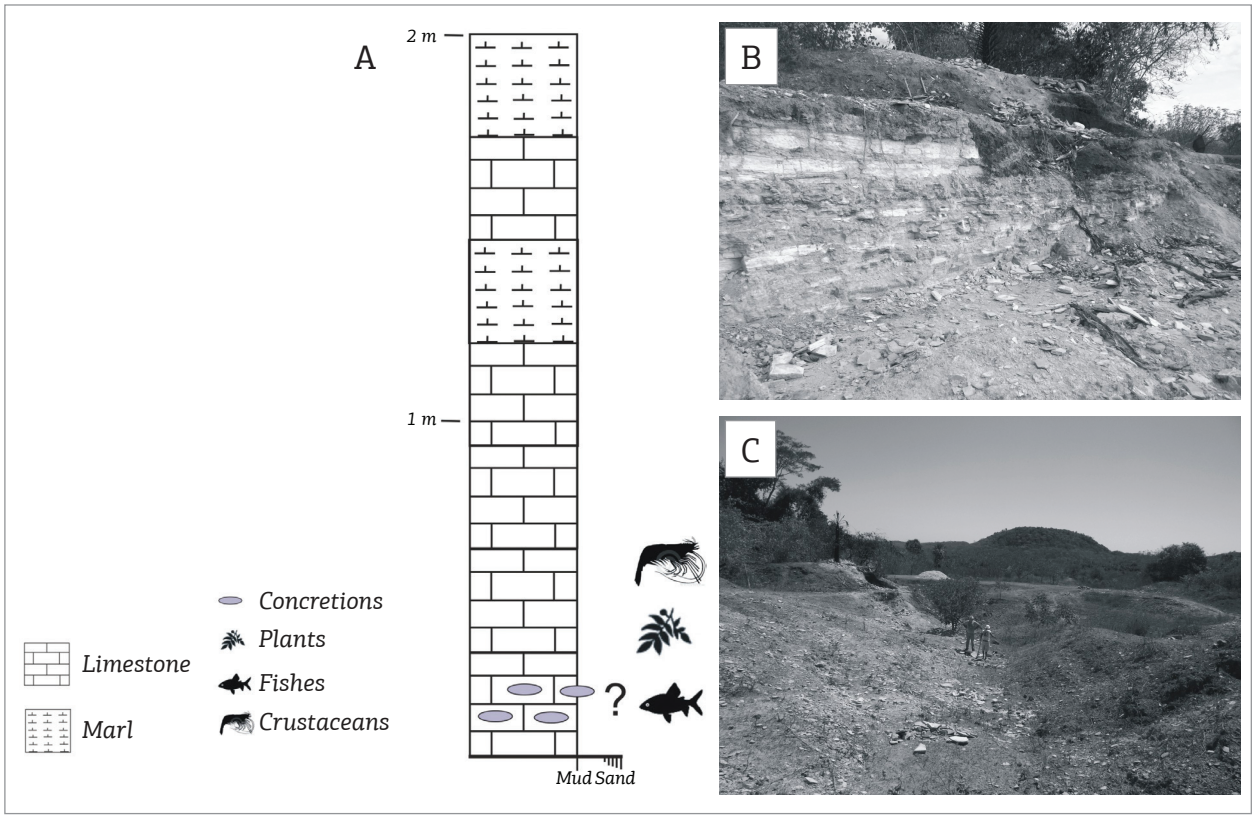

Figure 2. Stratigraphic profile of the Faveirinha Quarry in the city of Brejo, Maranhão (A); Geological cross-section of the same outcrop demonstrating the predominance of carbonate sedimentation (B); Panoramic view of the site where the isopod was found (C).

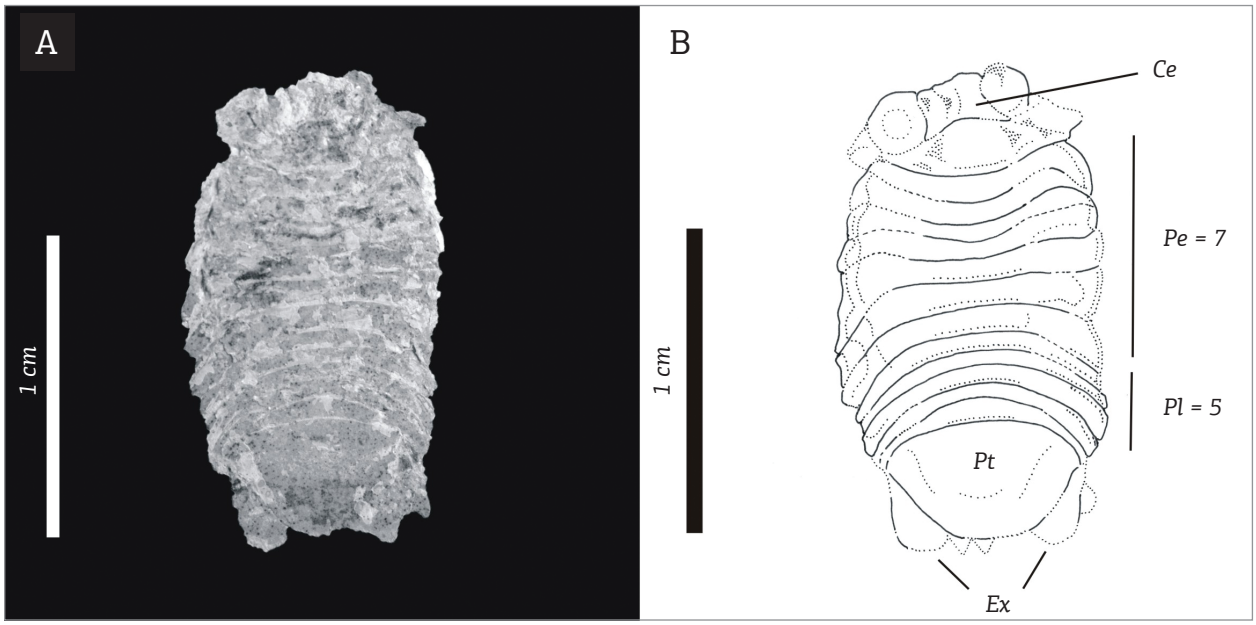

Figure 3. Isopod *Codoisopus brejensis* gen. *et* sp. nov. in dorsal view (A); Reconstitution of *C. brejensis* gen. *et* sp. nov. from identifiable regions (B). Ce: cephalon, Pe: pereon (= 7 pereionites), Pl: pleon (= 5 pleonites), Pt: pleotelson, Ex: exopodites.

that this feature was taphonomically produced has not been ruled out, both 7 pereionites and 5 pleonites, and reduced, subrectangular exopodites. Such distinct features also distance *C. brejensis* gen. *et* sp. nov. from any association with *S. silvai*, which exhibits a sub-hexagonal body with trilobed and subtriangular ophistosoma that distally narrows toward the pleotelson. However, *C. brejensis* gen. *et* sp. nov. exhibits the following features observed for taxa belonging to the family Archaeoniscidae (Haack 1918): a cephalon elliptical deeply inserted in the first pereionite, eyes dorsolaterally located, body oblong-oval, and the presence of seven similar pereionites. According to Vega *et al*. (2005), Archaeoniscidae is a monogeneric extinct family which belongs to the suborder Sphaeromatidea (Wägele 1989), that includes the taxa *Archaeoniscus brodiei* Milne Edwards, 1843, from the Late Jurassic of Europe, which represents the species type, *Archaeoniscus texanus* Wieder & Feldmann 1992 from the Late Cretaceous of Texas, and *Archaeoniscus aranguthyorum* Feldmann, Vega, Applegate and Bishop, 1998 from the Late Albian of Mexico. *C. brejensis* gen. *et* sp. nov. shares only the general body shape and number of pereionites (seven) with *A. brodiei* (Milne Edwards 1843, Feldmann *et al*. 1998). In turn, *C. brejensis* gen. *et* sp. nov. also differs from *A. texanus* because the latter has a markedly oblong body, semicircular pleotelson, and an oval protuberance in the axial region (Wieder & Feldmann 1992). The new Brazilian taxon resembles the taxon *A. aranguthyorum* from the Middle Member of the lithographic limestones of the Tlayúa Formation, in the quarries of Tepexi de Rodríguez, Puebla, Mexico. Prior paleoenvironmental interpretations of a restricted lagoon with episodes of marine ingressions and fluvial influence in these deposits are consistent with the nature of the arthropod fauna (Feldmann *et al*. 1998, Applegate *et al*. 2005, Vega *et al*. 2005).

In addition, members of the family Archaeoniscidae are characterized by a posterior sagittal crest that extends from the central portion of the pleotelson toward the base of the first pereionite, which is a feature apparently absent in *C. brejensis* gen. *et* sp. nov. In fact, Feldmann *et al*. (1998) interpreted this feature as being the dorsal reflection of a ventral structure in females, which is most likely an incubator chamber (sexual dimorphism). Given the set of features outlined above, we propose a new genus and species of isopod for the Cretaceous of Brazil (Codó Formation, Parnaíba Basin) (Fig. 3).

To date, faciological studies have indicated a strictly lacustrine depositional environment for the Codó Formation; therefore, no support for a possible marine invasion existed (Paz & Rossetti 2001). However, when conducting palyno-chronostratigraphic studies in the Codó region, Antonioli (2001) concluded the Codó Formation was deposited in an environment sometimes continental (lacustrine) and sometimes coastal marine, and the presence of dinoflagellates becomes steadier toward the upper strata (Antonioli & Arai 2002).

However, the presence of *C. brejensis* gen. *et* sp. nov. in carbonatic deposits of Brejo and the associated paleobiota reinforce prior inferences of a marine/lacustrine paleoenvironment for the Codó Formation, which was first only supported by palynological evidence. The

paleobiota recorded in Brejo, Maranhão, includes coquina with gastropods, decapods, plants, ichnofossils and euryhaline fishes (Lindoso 2012). Moreover, this finding is in accordance with the hypothesis of a marine transgression via the Parnaíba Basin during the Lower Cretaceous (Maisey 1991, 2000, 2011; Arai 1995, 1999, 2000, 2011).

FINAL CONSIDERATIONS

Until recently, the only known crustaceans from the Codó Formation were conchostracans and ostracods. Recent fieldwork conducted at the Faveirinha Quarry, municipality of Brejo, Maranhão State, identified a new genus and species of isopod for the Cretaceous of Brazil (Codó Formation, Parnaíba Basin). *C. brejensis* gen. *et* sp. nov. shares features with taxa of the family Archaeoniscidae Haack, 1918, which was not yet documented in Brazil.

This finding demonstrates the lack of knowledge about this group of crustacean fossils in Brazilian sedimentary basins. In addition, the occurrence of *C. brejensis* gen. *et* sp. nov. in carbonate deposits of the Codó Formation along with a diverse paleobiota composed of gastropods, decapods, plants, ichnofossils, and fishes reinforces prior inferences of a marine/lacustrine paleoenvironment for the cited lithostratigraphic unit. However, the collection of new specimens with greater anatomical detail is necessary to better understand the biota diversity of aquatic arthropods during the opening of the South Atlantic.

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