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Taxonomic remarks on Brazilian Cretaceous Decapoda from Araripe Basin, Brazil, and ecological inferences

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ABSTRACT
Beurlenia araripensis Martins-Neto and Mezzalira, 1991 (Decapoda: Caridea) and *Paleomattea deliciosa* Maisey and Carvalho, 1995 (Decapoda: Penaeoidea) are reviser baseated upon new and better preserved samples. The new specimens were found in the Santana Formation, Araripe Basin, Northeast Brazil, respectively in the Crato and Romualdo members. *B. araripensis* is represented by a well preserved specimen, where is possible to see a cephalothorax with antennal and branchiostegal spines, rostrum with 14 dorsal spines, and telson with posterior spines. This material permits a better characterization of the species' morphology and its placement in Palaemonidae. The Dendrobranchiata material of *P. deliciosa*, found in the bituminous shale of Romualdo Member, is for the first time recorded in clusters of fragmentary parts that suggest mass mortality and morphologies that point to a planktonic lifestyle, as occurs with extant forms of sergestids.

Key words: Crustacea, Palaemonidae, Sergestoidea, Lower Cretaceous, Santana Formation, Brazil.

RESUMO
OBSERVAÇÕES TAXONÔMICAS SOBRE OS DECÁPODOS FÓSSEIS DO CRETÁCEO DA CHAPADA DO ARARIPE, BRASIL, E INFERÊNCIAS ECOLÓGICAS. Restos fósseis de camarões da Formação Santana, Chapada do Araripe, Cretáceo Inferior, referentes à *Beurlenia araripensis* Martins-Neto e Mezzalira, 1991 (Decapoda: Caridea) e *Paleomattea deliciosa* Maisey e Carvalho, 1995 (Decapoda: Penaeoidea) são revisados e novos materiais referidos. O primeiro deles se refere a um exemplar bem preservado de *B. araripensis*, proveniente dos calcáreos laminados do Membro Crato e que, pela presença de um cefalotórax com espinhos antenais e branquiostegais, rostro com 14 espinhos dorsais, e télson com espinhos posteriores, permite sua melhor caracterização e a proposta de sua inclusão na família Palaemonidae. O material adicional refere-se a um grande número de espécimes de sergestídeos (Penaeoidea) registrados nas camadas de xisto betuminoso no Membro Romualdo e referentes à *Paleomattea deliciosa* (Dendrobranchiata). Os agrupamentos, além de sugerirem mortalidade em massa, exibem morfologias que caracterizam um hábito de vida planctônico, similar aos sergestídeos modernos.

Palavras-chave: Crustacea, Palaemonidae, Sergestoidea, Cretáceo Inferior, Formação Santana, Brasil.

INTRODUCTION

The Santana Formation, in the northeast of Brazil, is a source of abundant and well preserved Lower Cretaceous fossil assemblages, including vertebrates, invertebrates and plants (Maisey, 1991, 1993). Among the arthropod fossil fauna, decapods have been reported both in the Crato and Romualdo members (Beurlen, 1963; Martins-Neto and Mezzalira, 1991; Maisey and Carvalho, 1995). While in the Romualdo Member exists evidence of periodic marine ingressions inferred from the remains of ostracods and dinoflagellates (Arai and Coimbra, 1990), the Crato Member has yielded a rich fauna, in laminated limestone strata, that includes species of insects, spiders, scorpions, fishes, frogs, reptiles, algae, and terrestrial plants (Maisey, 1993; Martins-Neto, 2002, 2005; Martins-Neto and Rodrigues, 2009).

The Decapoda constitutes one of the major divisions of the Eumalacostraca, and it has been the subject of more published papers than have all other crustacean groups combined (Martin and Davis, 2001). Almost all the major higher taxa have at least some representation in the fossil record that begins in the late Devonian (Schram *et al.*, 1978, 2000).

Fossils of decapod crustaceans have been known from Brazil for a reasonable time, but there is a sparse literature on them (Beurlen, 1950). Among the crustacean fossil fauna, freshwater decapods are exceedingly rare, especially in the Mesozoic (Feldmann and Pole, 1994). To date,

only three taxa have been recognized in the Santana Formation. The first description of a decapod fossil species in that region was the Portunoidea *Araripecarcinus ferreirai* Martins-Neto, 1987. However, Beurlen (1963) mentioned some decades before the occurrence of some decapod fossils in the Araripe Basin. Following the single crab description of the Santana Formation, two shrimp-like fossils were collected and described, the Caridea *Beurlenia araripensis* Martins-Neto and Mezzalira, 1991 and the Penaeoidea *Paleomattea deliciosa* Maisey and Carvalho, 1995.

New morphologic data on the two shrimp-like fossils species, *B. araripensis* and *P. deliciosa* (Crustacea, Decapoda), obtained from the Crato and Romualdo Members of the Santana Formation, Araripe Basin, Brazil, are provided here. The material allowed us to describe some morphological observations, identify new shrimp structures and present some ecological interpretations and taxonomic inferences.

MATERIAL AND METHODS

The new fossils of decapods were obtained from the levels of Santana Formation, Araripe Basin (Figure 1). The original species descriptions of *B. araripensis* and *P. deliciosa*, respectively by Martins-Neto and Mezzalira (1991) and Maisey and Carvalho (1995) were used to identify the present material. Additionally, in the case of *B. araripensis*, we utilized Holthuis (1951) and Holthuis (1952) for family level classification.

The specimens were prepared mechanically, catalogued and deposited in the Santana do Cariri Paleontological Museum (SCPM - MPSC) and at URCA Laboratory of Paleontology (LPU). All specimens were drawn under a microscope stereoscope with camera lucida, and measured under a microscope stereoscope with photo-camera and a distance measurement system.

SYSTEMATIC PALEONTOLOGY

Subphylum CRUSTACEA Brünnich, 1772
Order DECAPODA Latreille, 1802
Suborder PLEOCYEMATA Burkenroad, 1963
Infraorder CARIDEA Dana, 1852
Family PALAEMONIDAE Rafinesque, 1815
Genus *Beulernia* Martins-Neto and Mezzalira, 1991

Beurlenia araripensis Martins-Neto and Mezzalira, 1991
(Figure 2)

Material. SCPM -MPSC/C/2108, deposited in the collection of the Santana do Cariri Paleontological Museum
Stratotype. laminated limestone of Crato Member, Santana Formation
Description. Medium-sized caridean with well preserved exoskeleton, preserved in laminated lacustrine limestone. The antennae and antennules are long, but total length is unknown because of the fragmentary nature of the specimen; laminar scaphocerite is present. Carapace sub-rectangular in lateral view, with 11.53 mm overall length; ocular incision is narrow; antennal and branchiostegal spines are clearly visible as well as depressions in the superior region of the carapace. The medium-sized rostrum exhibits 14 supra-rostral spines, small and close together with serrate appearance; three sub-rostral spines are less obvious. The first two pereiopods are represented by chelipeds, the second higher than all others (4.32 mm), without terminal brush of hairs; the three subsequent pereiopods are typical ambulatory legs, lack chelae, represented by thin articles with terminal and elongate dactyl. Smooth abdomen without spines; the pleura of the first and third somite is somewhat rounded, while the second somite is strongly rounded, overlapping the first and third; the fourth and fifth somites are with a strongly acute pleura. The pleopods are visible, multisegmented. The telson with at least one pair of articulated spines on distal extremity, and the uropod is slightly longer than the telson.
Discussion. The well preserved specimen here described improves the information previously published by Martins-Neto and Mezzalira (1991) and Maisey and Carvalho (1995) who described in some detail the morphology

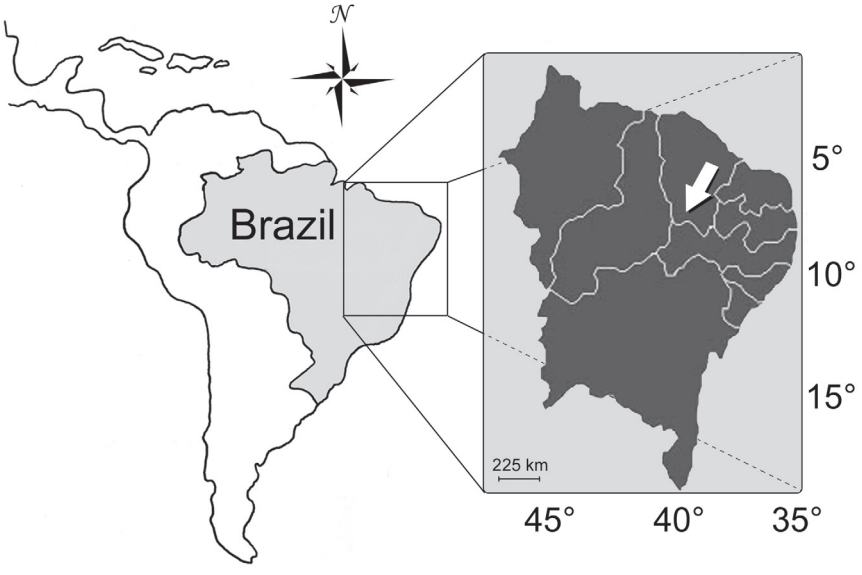

Figure 1. Location of the Araripe Basin, Northeast Brazil.
Figura 1. Localização da Chapada do Araripe no nordeste do Brasil.

of the *B. araripensis*. Caridean shrimps are very rare in the fossil record and their morphological features are not easily recognized because of their frequent poor state of preservation (Garassino and Bravi, 2003). For this reason, Martins-Neto and Mezzalira (1991) did not describe properly the number of rostrum spines and Maisey and Carvalho (1995) recognized the presence of 12 small supra-rostral spines in only one analyzed specimen, while 14 supra-rostral spines can be seen in the specimen described here. These number of rostrum spines are essential for caridean species identification (Holthuis, 1951), and this variation can indicate a probable morphologic plasticity of this species as occurs for extant *Macrobrachium* Bate, 1868 species (Gomes-Correa, 1977; Melo, 2003). The carapace described before as smooth presents two evident spines that are common in the Palaemonidae. Combining this with the articulated spines found in the posterior extremity of telson, its inclusion in the Palaemonidae is confirmed here, as suggested by Martins-Neto and Mezzalira (1991) in the former species description.

Another observation particularity of this *B. araripensis* specimen is the apparent female condition, documented by one depression in the superior region of the carapace, which presumably corresponds to the female gonad region. This information is reported here for the first time in a shrimp-like fossil. In the extant carideans, the ovaries are restricted to the cephalothorax and can occupy almost all the available space just before spawning (Bauer, 2004).

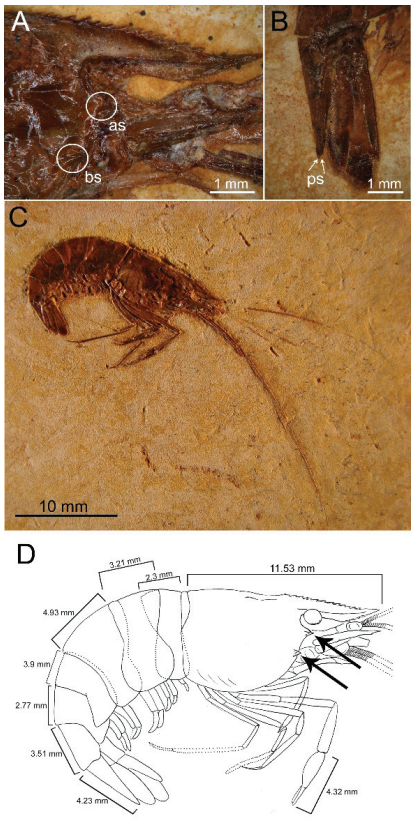

Figure 2. *Beurlenia araripensis* from the Crato Member, Santana Formation (MPSC/C/2108). **A.** Detail of the rostrum and carapace spines, as = antennal spine, bs = branchiostegal spine; **B.** Detail of the telson, ps = posterior spines; **C.** Overview of the specimen; **D.** Detailed reconstruction, with measurements of distinct sections of the body (black arrows indicate the spines position).
Figura 2. *Beurlenia araripensis* proveniente do Membro Crato, Formação Santana (MPSC/C/2108). **A.** Detalhe do rostro e dos espinhos da carapaça, as = espinho antenal, bs = espinho branquiostegal; **B.** Detalhe do télson, ps = espinhos posteriores; **C.** Vista geral do espécime; **D.** Reconstrução detalhada, com as medidas das diferentes seções do corpo (setas pretas indicam a posição dos espinhos).

Suborder DENDROBRANCHIATA Bate, 1888
Superfamily SERGESTOIDEA Dana, 1852
Family SERGESTIDAE Dana, 1852
Genus *Paleomattea* Maisey and Carvalho, 1995

Paleomattea deliciosa Maisey and Carvalho, 1995
(Figure 3)

Material. LPU/C/001 and LPU/001, obtained near the Missão Velha municipality and deposited in the collection of the URCA Laboratory of Paleontology.

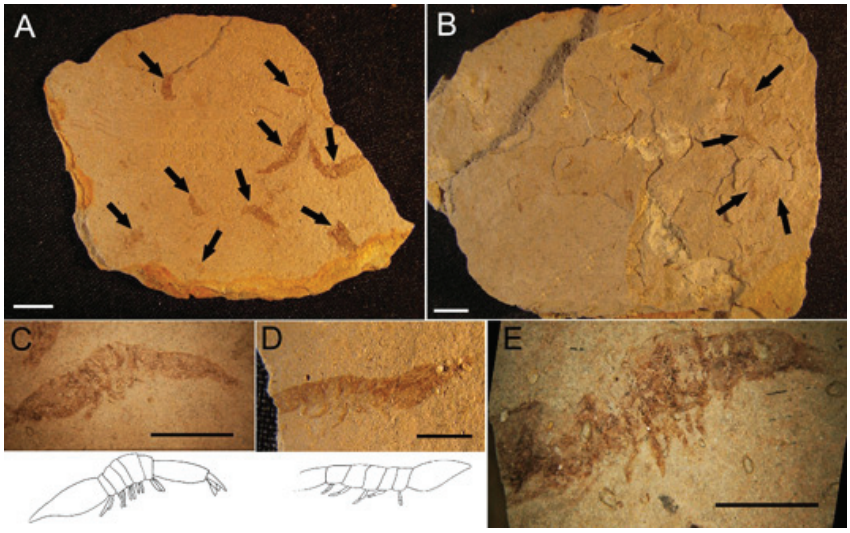

Figure 3. *Paleomattea deliciosa* from the Romualdo Member, Santana Formation. **A-B.** General view, respectively from LPU/C/001 and LPU/001, and the distinct specimens (arrows); **C-D.** Detail of two specimens (LPU/C/001) and its reconstructions; **E.** Detail of one specimen from the slab LPU/001. Scale bars = 5 mm.
Figura 3. *Paleomattea deliciosa*, proveniente do Membro Romualdo, Formação Santana. **A-B.** Vista geral, respectivamente, das amostras LPU/C/001 e LPU/001, evidenciando os distintos espécimes (setas); **C-D.** Detalhe de dois espécimes (LPU/C/001) e sua reconstituição; **E.** Detalhe de um espécime da amostra LPU/001. Escala = 5 mm.

Stratotype. bituminous shale from the Romualdo Member, Santana Formation.
Description. Two slabs with many small sergestideans, obtained in bituminous shale: one slab with at least five specimens and one with eight specimens. All specimens with laterally compressed bodies, apparently smooth, with poorly preserved exoskeletons; rostra cannot be observed in these samples. Eyes, cephalic, and thoracic appendages cannot be observed. The first five somites are approximately of equal size, while the sixth is more elongate, three times longer than the others; the second pleuron did not overlap the first and the third; midlateral locking hinge joints between the pleura can not be observed. The pleopods are segmented and well developed. The uropodal exopod overlaps the endopod; both rami are longer than the telson.
Discussion. Very little can be said about the anatomy of *P. deliciosa* from this available material, but one morphologic feature requires attention. The pleopod shape, visible in some specimens, has not been detailed in descriptions in the previous papers. The elongated and well developed pleopod may be a good indication of a planktonic lifestyle, because these individuals spent much of their life in the water column, and use pleopods to swim (Vereshchaka, 2000). The slabs with many specimens registered here for the first time, undoubtedly indicate severe mortality in this brackish environment. However, it can provide important information regarding the planktonic aggregating behavior of this species. This fact can be supported by an analysis of the extant group related to *P. deliciosa* (see Maisey and Carvalho, 1995), the recent genus *Acetes H. Milne Edwards*, *1830*. The living species *Acetes sibogae* Hansen, 1919, for example, is highly aggregated in the water column and exhibits tidal and nocturnal vertical movements, acting to facilitate its population maintenance in estuarine/coastal waters (Xiao and Greenwood, 1992). Furthermore, we can infer that *P. deliciosa* represented an important role in the trophic network in Albian time. According to Omori (1974), the dense decapod pelagic groups are very important as a food source for coastal marine vertebrates. In a study on predator-prey relationships of the same region and period, these shrimp were reported as common items in the diet of fish species (Maisey, 1994).

CONCLUSION

The knowledge about fossil decapod crustaceans is still sparse, and information presented on new fossil specimens can be valuable to the understanding of their classification and life history. The new specimen of *B. araripensis* here described show features that could indicate its female condition and its inclusion on Palaemonidae family by its excellent state of preservation. In the case of *P. deliciosa*, some ecological inferences suggesting a planktonic habit can be made based on its pleopod morphology. Samples exhibiting many specimens of these last species were registered here for the first time and can indicate a probably planktonic aggregating behavior.

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