

NON-MARINE OSTRACODA FROM THE ALIANÇA FORMATION IN THE NORTH-CENTRAL PORTION OF THE JATOBÁ BASIN, NORTHEASTERN BRAZIL

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ABSTRACT – This study presents the non-marine ostracode fauna from three localities of the Aliança Formation (upper Jurassic?), in the north-central portion of the Jatobá Basin. Twenty-two samples were collected in the municipality of Ibimirim, Pernambuco, Brazil, distributed in three sections. The ostracode assemblage, characteristic of freshwater bodies, is composed by the following species: *Theriosynoecum pricei* (Pinto & Sanguinetti, 1958), *T. uninodosa* (Pinto & Sanguinetti, 1958), *T. quadrinodosum* Krömmelbein & Weber, 1971, *Reoncavona? jatobaensis* Krömmelbein & Weber, 1971 and *Alicenula?* spp. The occurrence of *Reoncavona? jatobaensis* possibly constitutes the oldest known record of this species. The age of the Dom João local stage, characterized by its endemic ostracode fauna is hitherto a topic of debate in northeastern Brazilian basins studies, and is here briefly discussed as well.

Key words: non-marine ostracodes, Aliança Formation, Dom João local stage, Jatobá Basin, Northeastern Brazil.

RESUMO – Este estudo apresenta os ostracodes não marinhos de três localidades da Formação Aliança (Jurássico superior?), na porção centro-norte da bacia de Jatobá. Vinte e duas amostras foram coletadas no município de Ibimirim, Pernambuco, Brasil, distribuídas em três seções. A associação de ostracodes, característica de corpos de água doce, é composta pelas seguintes espécies: *Theriosynoecum pricei* (Pinto & Sanguinetti, 1958), *T. uninodosa* (Pinto & Sanguinetti, 1958), *T. quadrinodosum* Krömmelbein & Weber, 1971, *Reoncavona? jatobaensis* Krömmelbein & Weber, 1971 and *Alicenula?* spp. A ocorrência de *Reoncavona? jatobaensis* possivelmente constitui o registro mais antigo conhecido desta espécie. A idade do andar local Dom João, caracterizada por uma fauna de ostracodes endêmica, ainda tema de debate nos estudos das bacias do Nordeste do Brasil, é também discutida no presente artigo.

Palavras-chave: ostracodes não marinhos, Formação Aliança, andar local Dom João, bacia de Jatobá, Nordeste do Brasil.

INTRODUCTION

The Campos Village, Ibimirim, Pernambuco corresponds to the north-central portion of the Jatobá Basin. Near Campos Village (Figure 1), the strata succession of reddish claystone and siltstone interbedded with limestone, sandy limestone or calcareous sandstone is defined as the Aliança Formation. Jurassic lacustrine fossils have been reported from this locality (e.g. Silva *et al.*, 2011a). Among vertebrate bones and teeth, and conchostraceans, the ostracodes represent a very important taxon.

The Brazilian Cretaceous non-marine ostracodes have been studied in detail since the 60's, especially due to its application in hydrocarbon exploration (e.g. Krömmelbein, 1962, 1966; Viana 1966a,b; Schaller, 1969; Viana *et al.*, 1971). These studies resulted in detailed zonal schemes used in the biostratigraphic division of the local stages Dom João, Rio da Serra, Aratu, Buracica, Jiquiá, and Alagoas (upper Jurassic?-

lower Cretaceous) within the Recôncavo/Tucano and Sergipe/Alagoas basins in the Northeastern Brazil.

Upper Jurassic?-lower Cretaceous non-marine ostracodes are recognized in marginal and interior northeastern Brazilian basins from Recôncavo and Camamu basins, in the south, until the Patos Shear Zone, in the north, except in the Pernambuco and Paraíba basins. In eastern Brazil and western Africa ostracode biozonation has been assigned along the stratigraphic record of the rifting process that broke up Gondwana, allowing a good correlation between basins of both sides of the present day South Atlantic Ocean (Poropat & Colin, 2012).

The *Bisulcocypis pricei* biozone (recte *Theriosynoecum pricei*) corresponds to the Dom João local stage (upper Jurassic?) (Viana *et al.*, 1971) and is characterized by an association of different ostracode species, including *Theriosynoecum uninodosa*, *T. quadrinodosum*, *Reoncavona? incerta*, *Darwinula* cf. *oblonga* and *D. leguminella*. (e.g.

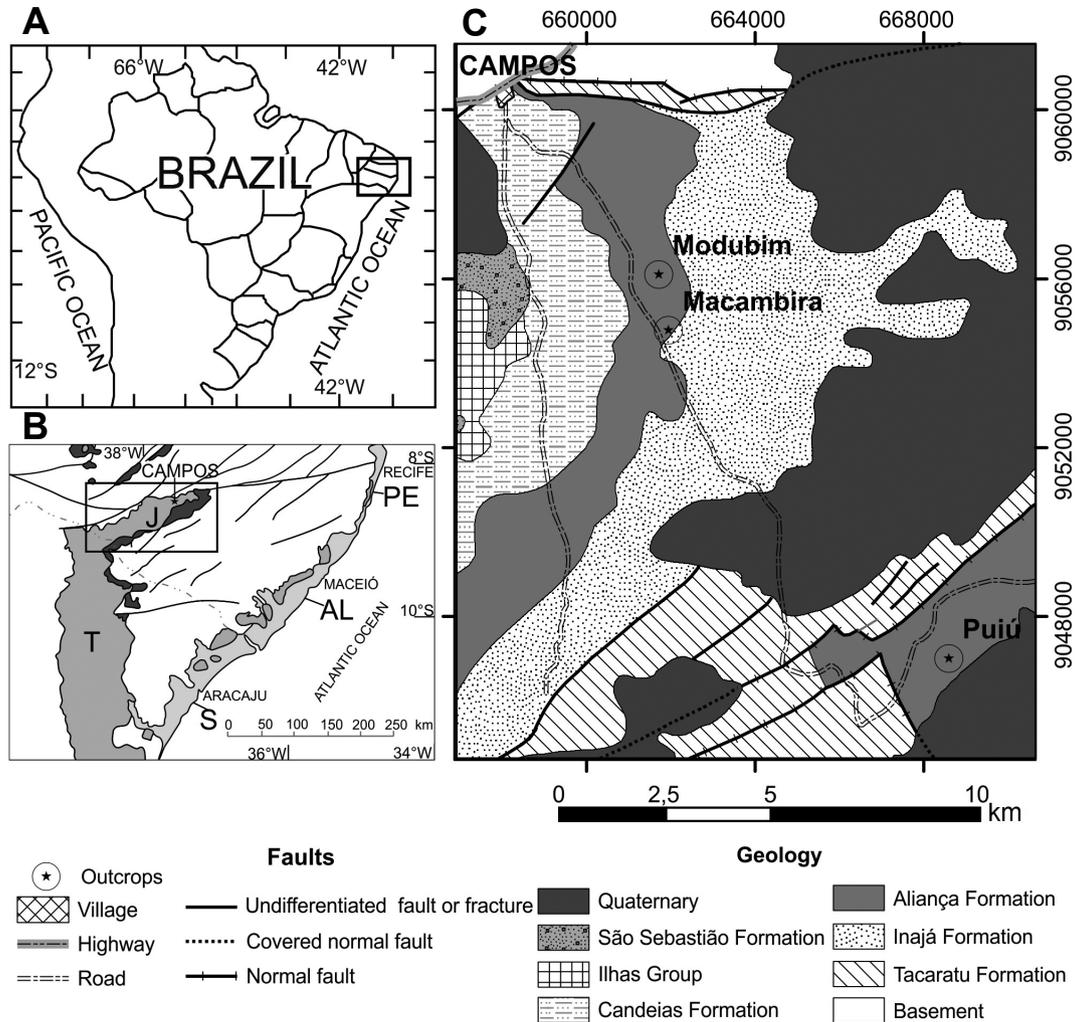


Figure 1. A, Localization of the study area. **B**, Jatobá Basin (J) and Campos Village location; Pernambuco Basin (PE); Alagoas Basin (AL); Sergipe Basin (S); Tucano Basin (T). **C**, lithological map of the region near the localities of Puiú, modubim and Macambira.

Coimbra *et al.*, 2002; Poropat & Colin, 2012). Sedimentary deposits dated as Dom João local stage by their ostracode occurrences have been recognized in Recôncavo-Tucano-Jatobá basins as Aliança Formation (Viana *et al.*, 1971; Caixeta *et al.*, 1994), Sergipe-Alagoas basins as Bananeiras Formation (Schaller, 1969), and Araripe Basin as Brejo Santo Formation (Braun, 1966; Coimbra *et al.*, 2002).

The main aim of this article is to identify the ostracode fauna recovered from carbonate layers of the Aliança Formation near the Campos Village (Ibimirim) area of the Jatobá Basin and to discuss the taxonomic problems between some genera and species. The age of the Dom João local stage is here briefly discussed as well.

STUDY AREA

Geologically, the Jatobá Basin represents the northern end of the Recôncavo-Tucano-Jatobá rift system in Northeastern Brazil. Its sediments recorded the intracontinental evolution of the breakup that divided Gondwana in South America and Africa continents, creating the South Atlantic Ocean. The

sedimentary record of this basin can be divided into three phases of sedimentation: syncline phase, from Silurian to Devonian; rift phase from Tithonian? (Upper Jurassic) to Aptian (Lower Cretaceous); and post-rift phase, from Aptian to lower Albian (Lower Cretaceous) (see revision in Guzmán *et al.*, 2015 and references therein).

The Aliança Formation, studied in the present work, corresponds with the overlaid Sergi Formation to the Brotas Group, dated according to biostratigraphic zones as the Dom João local stage (Upper Jurassic?) (Viana *et al.*, 1971). Three stratigraphic sections were examined from Puiú, Modubim and Macambira localities (Figure 1). These sections are composed mainly for packages of reddish, massive or flat laminated claystone interbedded with either limestone, sandy limestone or calcareous quartzarenite, in minor proportion greenish gray claystone and thin evaporate layers are presented (Figure 2). The limestone and sandy limestone strata correspond to ostracode grainstones (Figure 3) and together with calcareous quartzarenite strata represent the source of the material studied in the present manuscript.

MATERIAL AND METHODS

Several ostracode complete carapaces and disarticulated valves were obtained from 22 samples of ostracode grainstones and ostracode-bearing quartzarenites. In average, 60 g of each rock were broken into small (centimeter sized) pieces and processed using standard laboratory techniques for the study of fossil ostracodes. The samples were disaggregated with hydrogen peroxide (H₂O₂) during 24 h time period, washed through a 62 µm sieve and dried at 50°C. Each sample was sieved again with meshes of 500, 250 and 160 µm. From the material retained on the 250 µm mesh of each sample, 300 ostracodes were picked out under a stereo microscope Zeiss Discovery V8 at the Paleontology Laboratory (PALEOLAB) of the Department of Geology, Federal University of Pernambuco (UFPE), Brazil.

The selected specimens were imaged and measured in scanning electron microscope (SEM) at the Technologic Institute of Micropaleontology (itt Fossil), Vale do Rio dos Sinos University (UNISINOS) and at the Strategic Technologies Center of the Northeastern (CETENE), Brazil.

The illustrated specimens were deposited in the microfossil collection of the Department of Geology at UFPE, under the prefix DGEO-CTG-UFPE and numbers 1390 to 1405. **Abbreviations:** H, height; L, length; W, width; RV, right view; LV, left view; DV, dorsal view.

SYSTEMATIC PALEONTOLOGY

Five ostracode species included in three genera were identified from Aliança Formation near the village of Campos, Ibimirim. A new detailed description of the fauna

had the objective to support the discussion of the taxonomic divergences. It is noteworthy that almost all the material correspond to complete carapaces. The few disarticulated valves do not show internal features. Moreover, the preservation does not seem very good, compared with the figured specimens in Pinto & Sanguinetti (1958, 1962) and Krömmelbein & Weber (1971).

The generic taxonomy adopted in this work follows Sames (2011) for genus *Theriosynoecum*, Smith (2000) for genus *Reconconvona* and Rossetti & Martens (1998) for genus *Alicenula*.

- Class OSTRACODA Latreille, 1802
- Order PODOCOPIDA Müller, 1894
- Suborder PODOCOPINA Sars, 1866
- Superfamily CYTHEROIDEA Baird, 1850
- Family LIMNOCYTHEROIDEA Klie, 1938
- Subfamily TIMIRIASEVIINAE Mandelstam, 1960

Theriosynoecum Branson, 1936

- 1935 *Morrisonia* Branson, p. 521.
- 1958 *Bisulcocypris* Pinto & Sanguinetti, p. 77.
- 1982 *Dryelba* Sohn, p. 313.

Type species. *Morrisonia wyomingense* Branson, 1935.

Remarks. In the original generic diagnosis of *Theriosynoecum* it was assigned the presence of nodes in the carapace; however, according to Do Carmo et al. (1999) this feature may be phenotypic, possibly induced by salinity fluctuations. In this study it was decided to use the generic diagnosis

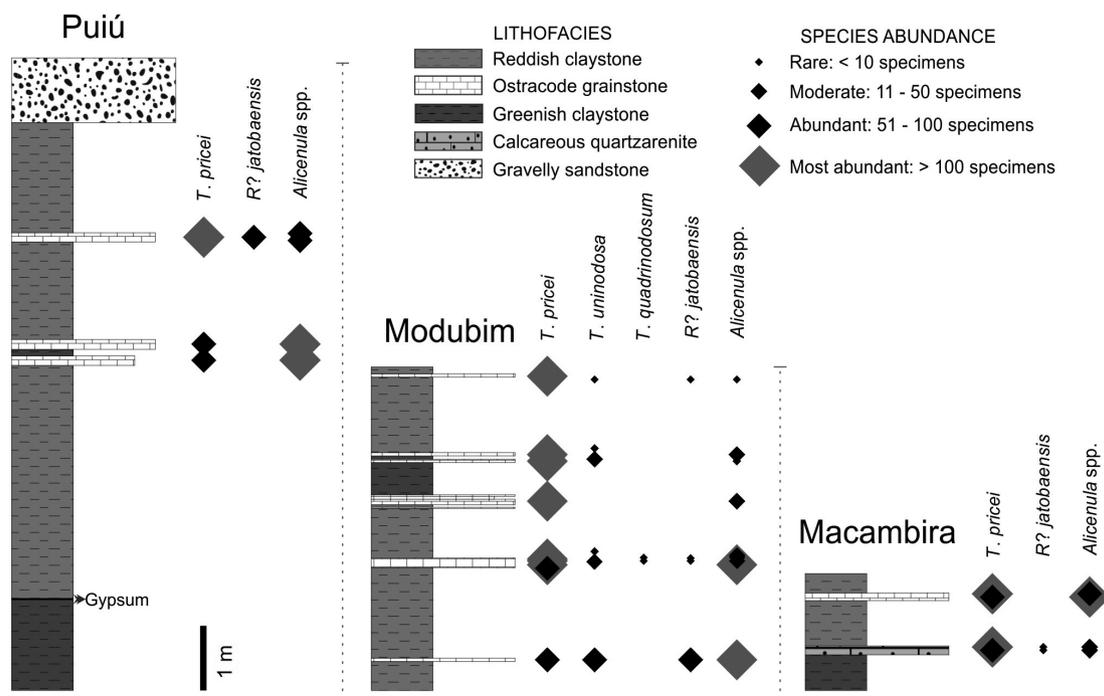


Figure 2. Lithological logs with relative abundance of ostracode fauna from Puiú, Modubim and Macambira localities.

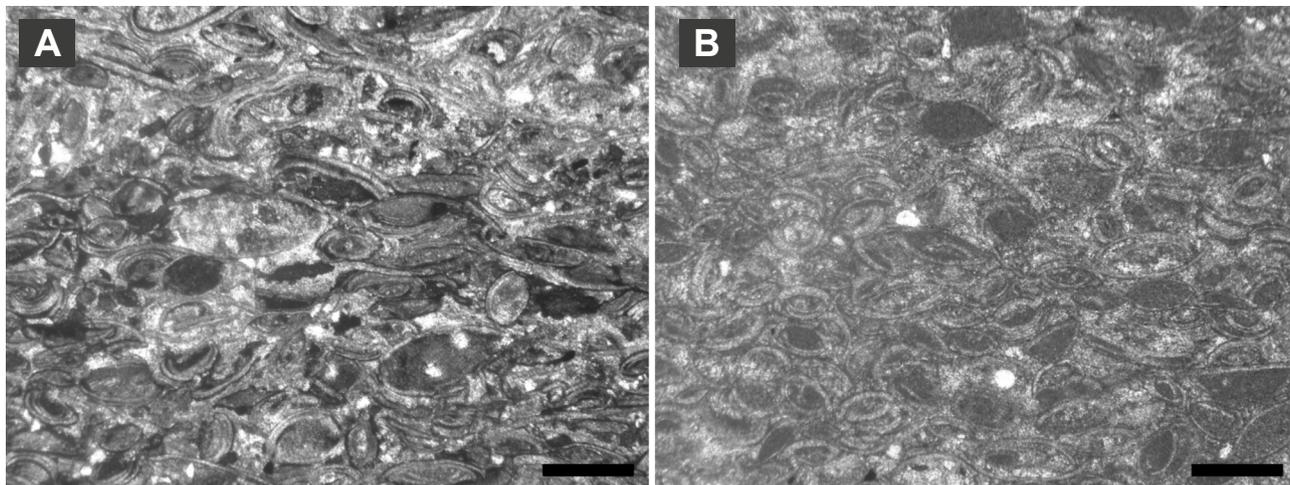


Figure 3. Ostracode grainstone from Modubim (A) and Macambira (B) sections. Scale bars = 0.1 mm.

emended by Sames (2011). The separation of the genera *Bisulcoocypris*, *Dryelba* and *Theriosynoecum* Branson based on either the ornamentation (Pinto & Sanguinetti, 1962) or the bipartite median hinge element, as well as the existence of an accommodation groove (e.g. Pinto & Sanguinetti, 1962; Sohn, 1982; Schudack, 1994) was rejected by Sames (2011) considering these diagnostic characters insufficient to justify the designation of additional genera separated from *Theriosynoecum*. Thereby, *Bisulcoocypris* and *Dryelba* are considered junior synonyms of *Theriosynoecum* (see Do Carmo *et al.*, 2004; Sames, 2011; and references therein).

Stratigraphic range. Middle Jurassic (Upper Bajocian? Bathonian) to Early Cretaceous (middle? Albian), questionably Late Cretaceous (Cenomanian) (Sames, 2011).

Theriosynoecum pricei (Pinto & Sanguinetti, 1958)
(Figures 4A-D)

1958 *Bisulcoocypris pricei* Pinto & Sanguinetti, p. 78.

Figured specimens. DGEO-CTG-UFPE-1390, ♂ DV, L: 0.68 mm, H: 0.33 mm; DGEO-CTG-UFPE-1391, ♀ DV, L: 0.76 mm, H: 0.52 mm; DGEO-CTG-UFPE-1392, ♀ LV, L: 0.77 mm, W: 0.47 mm; DGEO-CTG-UFPE-1393, ♂ RV, L: 0.68 mm, W: 0.39 mm.

Material. About 1150 complete carapaces and disarticulated valves including cup in cup preservation. Mostly adult females and males, but also several juvenile instars.

Description. Carapace oblong, rounded-rhomboid to subquadrate and slightly higher in the posterior quarter, in lateral view. In dorsal view, the carapace is irregularly ovate or piriform; female is larger with the posterior third end forming a pronounced reentrance at the junction of the valves, which is not seen in male. Dorsal and ventral margins are almost parallel. In male, dorsal and ventral margins straight, in female more rounded at the ventral margin ends. Anterior margin is straight below the cardinal angle going downward and forward until almost midlength where it becomes unequally rounded and grades into the ventral margin. Posterior margin

is rounded, grading into the ventral surface. Anterior cardinal angle very obtuse; posterior cardinal angle is less obtuse than the anterior. Just anterior to mid-length, two prominent sulci indent deeply each valve. The posterior one terminates dorsally to before the mid-length. The anterior is shorter and runs more obliquely forward and downward. Carapace surface fine to coarsely reticulated, with the reticula less developed in females; along the ventral region, the reticula are coarser. Strong sexual dimorphism is observed; females are larger and differ from the male in lateral view by having a more rounded anterior end, posterior part higher, dorsal margin slightly concave in the anterior region at the sulci and convex at the posterior quarter. Sulci more deeply impressed in females.

Theriosynoecum uninodosa (Pinto & Sanguinetti, 1958)
(Figures 4E-G)

1958 *Bisulcoocypris uninodosa* Pinto & Sanguinetti, p. 80.

Figured specimens. DGEO-CTG-UFPE-1394, ♂ LV, L: 0.68 mm, H: 0.38 mm; DGEO-CTG-UFPE-1395, ♀ RV, L: 0.65 mm H: 0.38 mm; DGEO-CTG-UFPE-1396, ♀ DV, L: 0.66 mm, W: 0.33 mm.

Material. About 100 complete carapaces of females, males and instars.

Description. Carapace subquadrate, in lateral view; in dorsal view presents an elongate ellipsoidal form, more rounded and larger at posterior third. Dorsal margin almost straight, slightly elevated in the anterior cardinal angle and in third posterior quarter, with two shallow depressions at the sulci; ventral margin slightly convex and continuous rounded to anterior and posterior margins. Similar to the posterior, anterior margin is rounded, slightly flattened and forms an obtuse angle with dorsal margin; in female just after the anterior cardinal angle the anterior margin goes straight downward and forward until the two-thirds of the height where it forms another low obtuse angle and becomes rounded to meet ventral margin. Cardinal angles obtuse, the anterior more than the posterior. Two sulci are present at anterodorsal region; the posterior is slightly

larger than the anterior. In each valve, one node is present at posterocentral region. Surface ornamentation consists of a meshwork of polygonal pits, which become elongate along ventral margin. Sexual dimorphism can be identified, females larger and higher than males at the posterior region of the carapace. Females seem to have less projected nodes and sulci deeper than males.

Theriosynoecum quadrinodosum Krömmelbein & Weber,
1971
(Figures 4H-I)

Figured specimens. DGEO-CTG-UFPE-1397, ♀ RV, L: 0.80 mm, H: 0.49 mm; DGEO-CTG-UFPE-1398, ♂ DV, L: 0.75 mm, W: 0.39 mm.

Material. Ten complete carapaces. Adult females and males are present.

Description. Carapace rounded-rhomboid to subquadrate in lateral view; subovate in dorsal view, with two nodes in each valve posteriorly. Dorsal margin is almost straight with an elevation in the higher part of the carapace at the posterior third. Ventral margin nearly straight to slightly convex, anterior and posterior margins extremities almost rounded. Anterior margin rounded to flattened from ventral margin to anterior cardinal angle; posterior margin broadly curved. The anterior cardinal angle is obtuse but less than the posterior one. Two sulci indent just in front of midlength in each valve; the posterior sulcus is slightly larger and deeper than the anterior one. At posterior region, four elongated and rounded nodes are present in each valve. One node located in posteroventral position, two in posterodorsal position at midlength and below the posterior cardinal angle, and the fourth node is in mid-ventral position. Carapace surface reticulated with irregular fine to medium pits; following ventral margin, the reticula are more elongated and distributed forming three ribs. Sexual dimorphism present: females are higher and larger than males. The position of the nodes in females seems to be different, possible due to the posterior inflation of the carapace.

Superfamily CYPRIDOIDEA Baird, 1845
Family CYPRIDIDAE Baird, 1845
Subfamily CANDONINAE Kaufmann, 1900

Reconcavona Krömmelbein, 1962

Type species. *Candona? striatula* Swain, 1946.

Stratigraphic range. Upper Jurassic? (present authors) to lower Cretaceous (up to Albian) (Smith, 2000).

Reconcavona? jatobaensis Krömmelbein & Weber, 1971
(Figures 4J-K)

Figured specimens. DGEO-CTG-UFPE-1399, DV, L: 0.63 mm, W: 0.3 mm; DGEO-CTG-UFPE-1400, RV, L: 0.83 mm; H: 0.63 mm.

Material. About 150 complete carapaces of adult and juvenile specimens.

Description. Carapace irregularly ellipsoidal in lateral view, higher in anterior part just before the middle; in dorsal view, carapace notably narrow, slightly wider in midlength and asymmetrically biconvex, with right valve straighter than left one. Dorsal margin convex, projecting downward towards posterior margin, and rounded in anterodorsal margin. Ventral margin straight, rounded at the ends. Anterior margin broadly rounded; posterior margin narrow from the cardinal angle until after midlength and rounded in posteroventral margin. Cardinal angles are very obtuse, almost straight. Left valve slightly larger, overlapping left one at anterior and posterior margins and at mid dorsal margin. Carapace surface smooth. Sexual dimorphism not seen.

Remarks. *Reconcavona? jatobaensis* was described by Krömmelbein & Weber, 1971 from the Candeias Formation corresponding to the unique report of this species. The description presented here marks the first report of this species in the Aliança Formation of the Jatobá Basin. All the features are very similar between the present specimens and the holotype figured in Krömmelbein & Weber (1971) (plate 9, figures 40a-c); one difference is in the overlap. In the holotype, the left valve is significantly larger than the left one along the anterior margin; this is probably related to the poor preservation of that specimen.

Superfamily DARWINULOIDEA Brady & Norman, 1889
Family DARWINULIDAE Brady & Norman, 1889

Alicenula Rossetti & Martens, 1998

Type species. *Darwinula serricaudata* Klie, 1935.

Remarks. A taxonomic revision of the Recent and Holocene representatives of the Darwinulidae by Rossetti & Martens (1998), including carapace characters, resulted in the description of three new genera, including *Alicenula*. As *Darwinula*, the genus *Alicenula* presents an elongated external form, the difference between these genera is recognized through the size and internal characters, such as absence of teeth in left valve of *Darwinula* and presence of these in left valve of *Alicenula* (Rossetti & Martens, 1998). However, the taxonomy of fossil Darwinulidae remains problematic for various reasons and no review has been made. Nevertheless, some progress has been made on allocating informally fossil darwinulids previously assigned to *Darwinula* s.l. to different genera. In Brazilian basins the fauna reported as *Darwinula oblonga* Roemer, 1839 and *Darwinula leguminella* Forbes, 1855 from the Dom João local stage for the Afro-Brazilian Depression (e.g. Da Rosa & Garcia, 2002), and from the Araripe Basin (Coimbra *et al.* (2002), present not only an elongated carapace but the left valve larger than the right. These characteristics together indicate that these species should not belong to the genus *Darwinula* and should be reallocated to another genus of the Family Darwinulidae. *D. leguminella* from the Lulworth Formation of The Purbeck

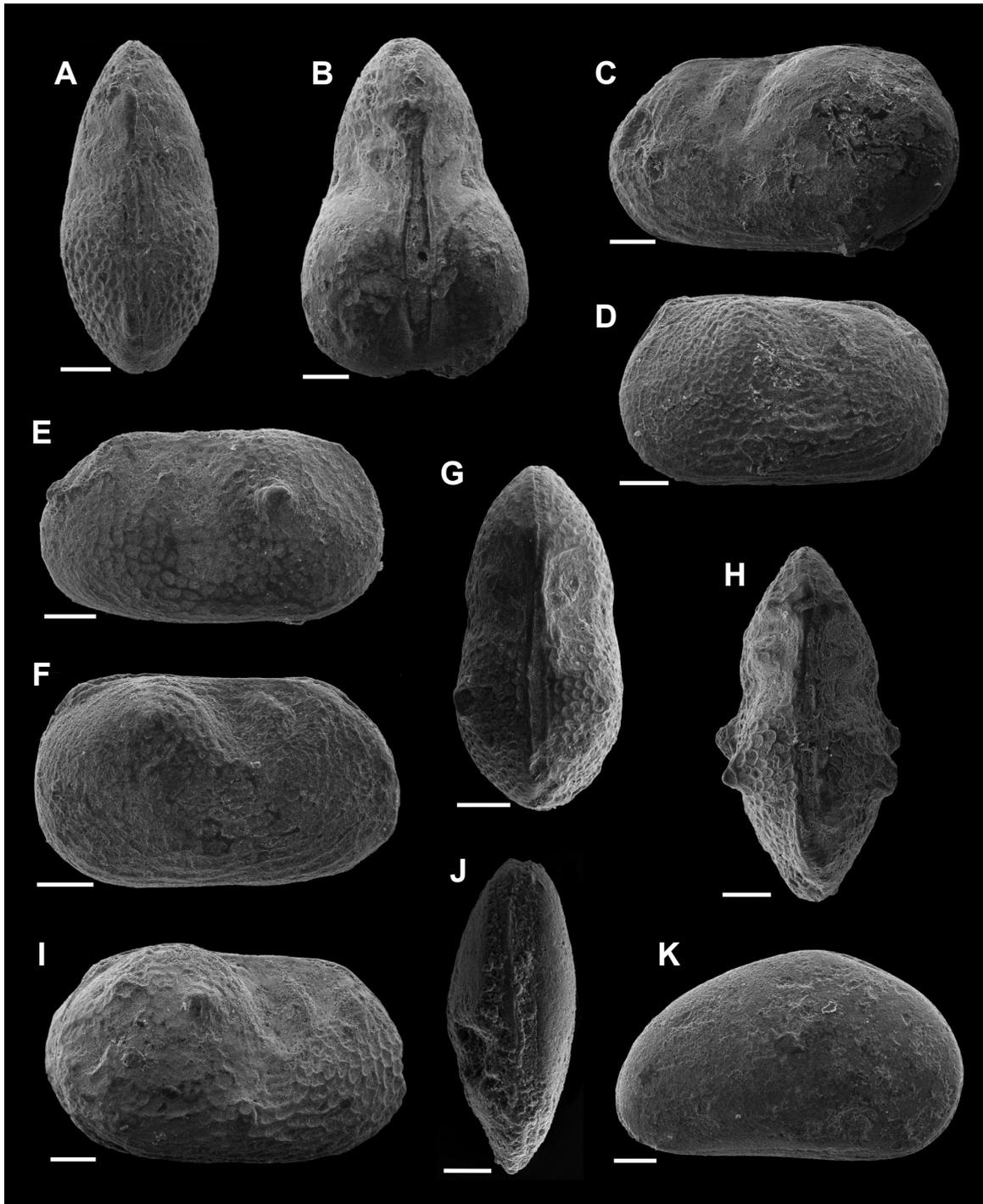


Figure 4. A-D, *Theriosynoecum pricei*. A, ♂ dorsal view, DGEO-CTG-UFPE-1390; B, ♀ dorsal view, DGEO-CTG-UFPE-1391; C, ♀ left view, DGEO-CTG-UFPE-1392; D, ♂ right view, DGEO-CTG-UFPE-1393. E-G, *Theriosynoecum uninodosa*. E, ♂ left view DGEO-CTG-UFPE-1394; F, ♀ right view, DGEO-CTG-UFPE-1395; G, ♀ dorsal view, DGEO-CTG-UFPE-1396. H-I, *Theriosynoecum quadrinodosum*. H, ♂ dorsal view, DGEO-CTG-UFPE-1398; I, ♀ right view, DGEO-CTG-UFPE-1397; . J-K, *Reconcavona? jatobaensis*. J, dorsal view, DGEO-CTG-UFPE-1399; K, right view, DGEO-CTG-UFPE-1400. Scale bars = 0.1 mm.

Limestone Group (latest Jurassic?, England, UK), has been referred to the genus *Alicenula* based on external and internal characters like elongated valves with left valve overlapping the right valve, absence of a keel in the right valve and the presence of an anteroventral and a posterior internal teeth in the left valve (Martens *et al.*, 2003). However, the internal

features of *D. oblonga* have yet not been taxonomically revised in detail.

Stratigraphic range. Late Jurassic to present.

Alicenula? spp.
(Figures 5A-E)

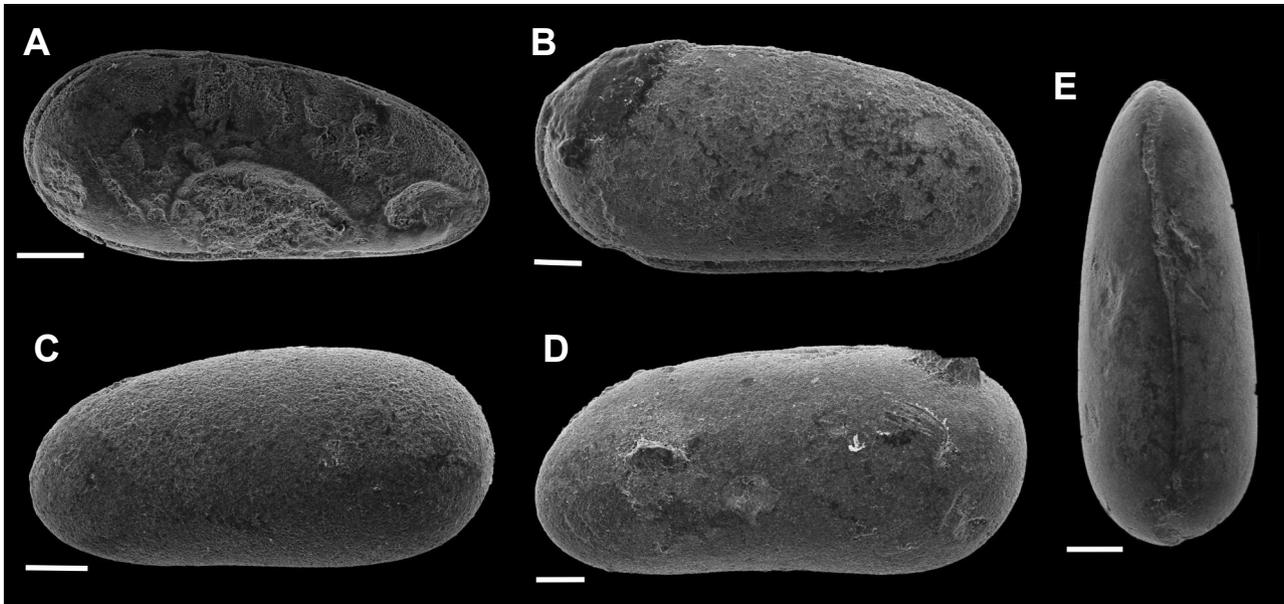


Figure 5. *Alicenula?* spp. specimens showing size and shape variability. Right view: **A**, L: 0.710 mm, H: 0.320 mm, L/H: 2.21, DGEO-CTG-UFPE-1401; **B**, L: 1.041 mm, H: 0.495 mm, L/H: 2.1, DGEO-CTG-UFPE-1402. Left view: **C**, L: 0.767 mm, H: 0.364 mm, L/H: 2.1, DGEO-CTG-UFPE-1403; **D**, L: 1.046 mm, H: 0.490 mm, L/H: 2.13, DGEO-CTG-UFPE-1404. Dorsal view: **E**, L: 0.851 mm, W: 0.454 mm, DGEO-CTG-UFPE-1405. Scale bars = 0.1 mm.

Figured specimens. DGEO-CTG-UFPE-1401, RV, L: 0.71 mm, H: 0.32 mm; DGEO-CTG-UFPE-1402, RV, L: 1.04 mm, H: 0.49 mm; DGEO-CTG-UFPE-1403, LV, L: 0.77 mm, H: 0.36 mm; DGEO-CTG-UFPE-1404, LV, L: 1.046 mm, H: 0.490 mm; DGEO-CTG-UFPE-1405, DV, L: 0.85 mm, W: 0.45 mm.

Material. About 550 complete carapaces and few single valves including cup in cup preservation.

Description. Carapace club-shaped in lateral view, wider towards posterior region. Dorsal view ovate, widening posteriorly. Dorsal margin slightly convex, ventral margin straight with slight concavity at midlength of several larger carapaces ($L > 0.9$ mm). Anterior margin narrowly rounded, slightly infracurvate, posterior margin broadly rounded and equicurvate. Anterior cardinal angle inconspicuous, posterior cardinal angle unrecognizable. Greatest height at posterior region. Left valve larger than right, overlapping it along entire margin except hinge. Carapace surface smooth.

Remarks. L/H ratios of 26 carapaces were measured to find differences that can separate *Alicenula?* spp. in two species reported for Brazilian basins in literature and attributed to *Darwinula leguminella* and *D. oblonga*. The results in Figure 6 show a relatively wide range ($L = \text{ca. } 0.65\text{--}1.05$ mm; $H = \text{ca. } 0.29\text{--}0.51$ mm; $L/H = 1.99\text{--}2.34$) without distinctive clusters. Minimum and maximum L/H values correspond both to greatest length values (1 and 1.01 mm), which demonstrate that with these measurements cannot be differentiated between larger carapaces with broad anterior region and slightly concavity in the mid ventral margin, and smaller carapaces with narrow anterior region and straight ventral margin. Thus, the relatively wide size and shape variability of the specimens plotted in Figure 6 seems to be an ontogenetic series and insufficient to differentiate as *D. oblonga* and/

or *D. leguminella*. Darwinulids are ancient asexual animals (Martens *et al.*, 2003); on this basis and due to the lack of clusters in Figure 6 sexual dimorphism cannot be considered within the analyzed material.

Due to the combined effects of poor preservation of the few single valves present in the material, many internal features like marginal structures or muscle scars were not analyzed; for these reason we prefer to maintain this taxon in open nomenclature. In addition, general problems with the often unclear morphological descriptions of *Darwinula oblonga* and *D. leguminella* species (see below) keep in unrevised diagnosis of these species. The original description of Roemer (1839, p. 52) for *D. oblonga*, included by him in the genus *Cypris* is: "Valves oblong, somewhat curved and the upper margin and smooth all over". For *D. leguminella* a better description is found in Jones (1885) who put the *Cypris leguminella* of Forbes (1855) into *Darwinula*: "Valves small, smooth, shining, elongate, with rounded ends, one (anterior) narrower, more elliptically curved and more compressed than the other, the left valve the largest; carapace subcylindrical, tapering anteriorly, blunter behind" (Forbes, 1855, p. 294). The differences between these forms are based in external features. Schudack (1994) reports for the first time internal characters and observed that the central muscle scars field of *D. leguminella* has seven arranged scars while *D. oblonga* has 13. This feature would have to be further examined in order to know to what extent one of these types should be included or excluded. Rossetti & Martens (1998) noted that *?Penthesilenula repoa* (Chapman, 1963) has rather atypical kidney-shaped valves, which resemble the Cretaceous species *D. oblonga*; thereby, detailed taxonomic studies should be made to discriminate if *D. oblonga* belongs to genus *Darwinula*, *Alicenula* or *?Penthesilenula*.

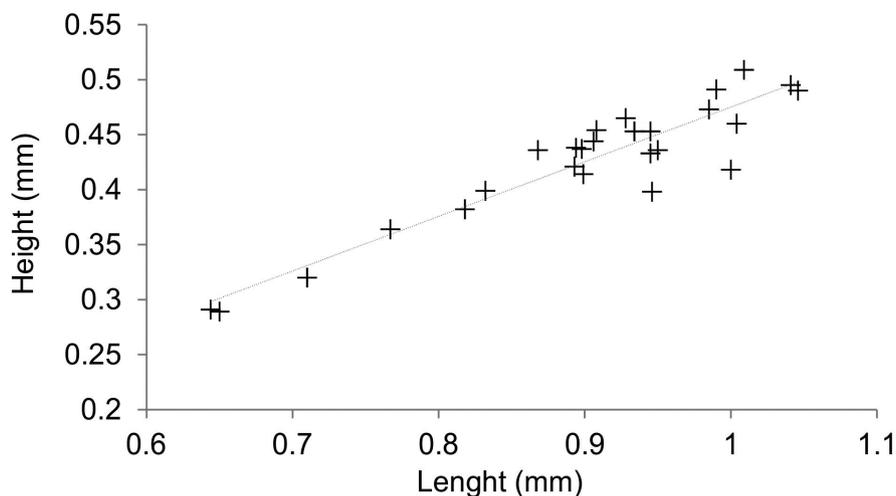


Figure 6. Scatter plot of the length and height measurements of 26 carapaces of *Alicenula?* spp.

FAUNAL DISCUSSION

According to Horne (2002) by comparison with modern faunas, representatives of the families Limnocytheridae, Cyprididae and Darwinulidae, as the genera identified from the Aliança Formation of the Jatobá Basin, can be recognized as non-marine ostracodes; bearing in mind that continental environments include saline as well as freshwater lakes, temporary as well as permanent water bodies, and other habitats such as rivers and groundwater. *Theriosynoecum* and *Alicenula* genera (Limnocytheridae and Darwinulidae, respectively), very abundant within the studied material, with reproductive strategies that involved the brooding of the eggs and young juveniles by the adult females, do not have desiccation resistant eggs records and are confined to permanent water bodies (Horne, 2002). The genus *Reconcovona* (Cyprididae) is subordinated in the studied material, probably had swimming capability as indicated by Whatley (1990) for the cypridoids. This may be the reason to be less abundant in the studied material; probably the representatives of *Reconcovona* came sporadically to the sheltered and shallow littoral, where the benthic *Theriosynoecum* and *Alicenula* dominated.

As stated in the discussion of *Alicenula?* spp., respect to the impossibility to do a specific determination, another aspect is discussed as follows. Fossil assemblages almost never represent a single population and generation, a bed few centimeters thick is more likely to contain a time-averaged assemblage of valves and carapaces accumulated over hundreds of generations, depending on factors such as sedimentation rate and degree of bioturbation (Griffiths & Evans, 1992). Thus, fossil assemblages could comprise valves of ostracodes that developed in different environmental conditions, which can lead to significant size differences between adults (Martens *et al.*, 2003). It is well known that, for example, temperature and salinity can significantly influence size and shape of ostracode valves (Martens, 1985). However,

the outline and the overlapping of the left valve over the right valve, makes the assignment of these specimens to this genus very possible.

AGE DISCUSSION

The age of the Dom João local stage based on the non-marine ostracode fauna of the *Theriosynoecum pricei* biozone as upper Jurassic? was firstly proposed by Viana *et al.* (1971). However, Arai *et al.* (1989) postulated that there is no dating element to attest a Neojurassic age for the Dom João Stage and that equivalent units in the Gabon Basin in Western Africa were dated as Middle Jurassic by palynological data. Based on ostracodes and palynological dating of the Santo Amaro Group, Caixeta *et al.* (1994) presented a stratigraphic chart of the Recôncavo, South/Central Tucano and North Tucano/Jatobá basins restricting the Dom João local stage to the Tithonian international stage, the accepted age in the following stratigraphic revisions of Petrobras (*e.g.* Assine, 2007; Costa *et al.*, 2007; Da Silva *et al.*, 2007). The palynological association of the Missão Velha Formation of Araripe Basin (correlated with Sergi Formation of Jatobá Basin), described by Arai *et al.* (2001) and Coimbra *et al.* (2002) in the middle part of the formation is suggestive of Jurassic age (Arai, 2006). Assuming Sr isotope homogenization during sediment deposition, Rb-Sr radiometric dating of siliciclastic material from the Aliança Formation and the correlated Bananeiras Formation of Sergipe-Alagoas Basin resulted in isochron ages of 226 ± 6 and 227.2 ± 2.2 Ma, respectively. These geochronological results indicate that the sedimentation of the Dom João units began during the Neotriassic and possibly continuing until the Jurassic (Silva *et al.*, 2006; Silva *et al.*, 2011b). Thus, there is an ongoing debate concerning the age of the Aliança Formation and its correlated units in northeastern Brazilian basins.

Other fossils have been found in the Aliança Formation and they can contribute in the interpretation of these deposits.

Cardoso (1966) described the conchostracean *Cyzicus brauni* and Silva *et al.* (2011a) reported the presence of many bone fragments of coelacanth and of the fish genus *Lepidotes* Agassiz (1832), in addition to *Lepidotes* isolated teeth and scales, dorsal fin spines and isolated teeth of hybodontid sharks as well as a lungfish dental plate. Hybodontid sharks teeth attributed to the genus *Planohybodus* Rees & Underwood, 2008 have been reported in Malhada Vermelha and Missão Velha formations (correlated with Sergi Formation and included as a Dom João unit), of Lima Campos Basin and Araripe Basin, respectively (Cupello *et al.*, 2012; Pinheiro *et al.*, 2011). However, those specimens were allocated into the new described species *Planohybodus marki* by Pinheiro *et al.* (2013). During the collection of the ostracode fauna studied herein, one shark tooth was recovered from Macambira outcrop; it resembles the species *P. marki*. Thus, in future research the broadly discussed age of the Dom João local stage could be better dated base on the above mentioned teeth, which belong to the genus *Planohybodus* with a very well dated stratigraphical distribution from the Bathonian to the Barremian (Rees & Underwood, 2008).

CONCLUSIONS

The material analyzed and discussed in this work allows an explanation of why species belonging to the genera *Bisulcocypris* and *Darwinula*, and referred to the Dom João local stage by many authors, should be re-allocated in *Theriosynoecum* and *Alicenula*, respectively. With the taxonomic revisions of the *Theriosynoecum* and *Alicenula* (Sames, 2011; Rossetti & Martens, 1998; respectively), *Bisulcocypris* as a synonym of *Theriosynoecum* is an invalid taxon, and the externally features seen in darwinulids of the material herein studied resemble the description of *Alicenula* and not the description of *Darwinula*. *Reconcavona? jatobaensis* is for first time reported in the Aliança Formation, thereby the stratigraphic range of this species can now be considered from upper Jurassic? to lower Cretaceous (Berriasian).

The ostracode fauna association from the Aliança Formation of the Jatobá Basin in the Campos Village area is characterized by *Theriosynoecum pricei*, *T. uninodosa*, *T. quadrinodosum*, *Reconcavona? jatobaensis* and *Alicenula? spp.*, all these could be referred to freshwater genera that inhabited permanent water bodies.

It is worth noting that the continuity of taxonomic studies is fundamental, especially in the species here referred as *Darwinula cf. oblonga* and *Darwinula leguminella* (recte *Alicenula leguminella*), given that the distinction between them has been often based on the size since externally they share all characters.

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