*Carnets Geol.* 20 (3)

E-ISSN 1634-0744
DOI 10.4267/2042/70719

# A new Cassiduloid (Echinodermata, Echinoidea) in the Albian of the Sergipe-Alagoas basin, Brazil

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**Abstract:** This paper presents a new discovery of the echinoid species *Phyllobrissus humilis* (GAUTHIER, 1875) from the Albian age Riachuelo Formation of the Sergipe-Alagoas Basin. The only specimen obtained in the Maruim 1 outcrop expresses the main species characteristics. Paleoecological notes and a dichotomous key are presented to facilitate the identification of the cassiduloid species from the Cretaceous of Sergipe-Alagoas Basin.

**Key-words:**

- echinoderms;
- *Phyllobrissus humilis* (GAUTHIER);
- Cassiduloida;
- Cretaceous;
- South America

**Citation:** MANSO C.L.C. (2020).- A new Cassiduloid (Echinodermata, Echinoidea) in the Albian of the Sergipe-Alagoas basin, Brazil.- *Carnets Geol.*, Madrid, vol. 20, no. 3, p. 29-35.

**Résumé :** ***Un nouveau cassiduloïde (Echinodermata, Echinoidea) dans l'Albien du bassin de Sergipe-Alagoas, Brésil***.- L'article décrit la découverte de l'espèce d'échinoïde *Phyllobrissus humilis* (GAUTHIER, 1875) dans la Formation Riachuelo d'âge Albien du bassin Sergipe-Alagoas. Le seul spécimen récolté provient dans l'affleurement de Maruim 1 et permet d'observer les principales caractéristiques de l'espèce. Des informations paléoécologiques et une clé dichotomique sont présentées pour faciliter l'identification des espèces de cassiduloïdes du Crétacé du bassin de Sergipe-Alagoas.

**Mots-clefs :**

- échinodermes ;
- *Phyllobrissus humilis* (GAUTHIER) ;
- Cassiduloida ;
- Crétacé ;
- Amérique du Sud

## 1. Introduction

Cassiduloids are irregular echinoids with petaloid ambulacra apically, with phylloid features orally, specific buccal spines (floscelle) and a periproct situated within a groove. These forms reached their acme during the Eocene, dwindling subsequently and leaving a much smaller number of species today (KIER, 1962). To illustrate this observation, there are only three species on record from the Miocene of Brazil, namely *Rhyncholampas oliveirai* (SANTOS, 1958), *Echinolampas paraensis* SANTOS, 1958, and *Rhyncholampas candidoi* FERNANDES & CARREIRA MORAIS, 1994, all from the Pirabas Formation, Bragança-Viseu Basin. In addition, only two recent species of cassiduloid have been described from the Brazilian coast: *Cassidulus mitis* KRAU, 1954, and *C. infidus* MORTENSEN, 1948 (TOMMASI & LIMA VERDE, 1970; MOOI, 1990a; SOUTO *et al.*, 2011).

Cretaceous cassiduloids from Brazil were first recorded from the Sergipe-Alagoas Basin by WHITE (1887). BEURLEN (1964a) reviewed some echinoid species from this basin, while SMITH (in SMITH & BENGTSON, 1991) later reviewed the taxa listed by WHITE (1887). The latter author recorded *Nucleopygus* cf. *similis* (ORBIGNY, 1856) from the Riachuelo Formation, reviewed *Echinobrissus freitasii* (WHITE, 1887) and transferred it to the genus *Phyllobrissus* COTTEAU, 1859, and erected a new genus, *Colliclypeus*, to accommodate *Conoclypus nettoanus* WHITE, 1887. SMITH (in SMITH & BENGTSON, 1991) also described a new taxon, *Acriaster sergipensis*, from the same lithostratigraphical unit. Earlier, BRITO (1981) had reviewed holectypoids and cassiduloids from Brazil, but had not added any new species. In more recent studies MANSO & SOUZA-LIMA (2005) recorded *Pygorhynchus colombianus* (COOKE, 1955) from the Albian Riachuelo Formation, and finally, MANSO &

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*Published online in final form (pdf) on February 22, 2020*
*[Editor: Bruno GRANIER; language editors: Stephen EAGAR and Bruno FERRÉ]*

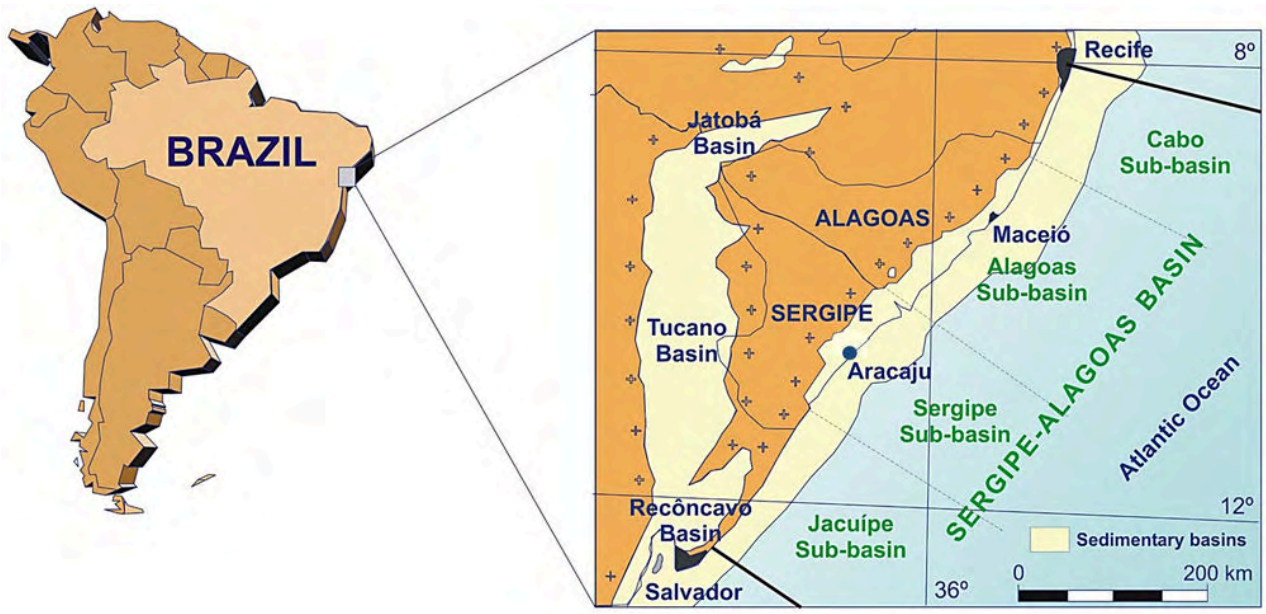


**Figure 1:** Locality map of the Sergipe-Alagoas Basin in northeastern Brazil (adapted from SOUZA-LIMA *et al.*, 2002).

ANDRADE (2008) described *Petalobrissus cubensis* (WEISBORD, 1934) from the Turonian Cotinguiba Formation (Upper Cretaceous) of the Sergipe-Alagoas Basin.

Other cassiduloid species were noted from Cretaceous strata of Brazil, from other sedimentary basins such as those of Potiguar and Araripe. For the former (Turonian-Coniacian intervals), MAURY (1925) described *Parapygus mossoroensis*, followed by *Breynella baixadoleitensis* by MAURY (1934). Later, SANTOS (1960) reassigned *Parapygus mossoroensis* to *Catopygus*, while BEURLEN (1964b) recorded *Phyllobrissus brasiliensis*. SMITH (in SMITH & BENGTSON, 1991) revised taxa described by MAURY (1925), SANTOS (1960) and BEURLEN (1964b) and considered only two species to be valid, *Petalobrissus cubensis* and *P. setifensis* (COQUAND *in* COTTEAU, 1866). OLIVEIRA *et al.* (2013) presented the most recent overview of cassiduloid species from the Potiguar Basin, and finally, ALVES *et al.* (2018) added a new species, *Petalobrissus lehugeurae*, from the Jandaíra Formation. From the Araripe Basin in northeastern Brazil, BEURLEN (1966) listed two new species, *Pygurus* (*Echinopygus) tinocoi* and *Faujasia araripensis*, from the Albian. Later, BRITO (1981) transferred *F. araripensis* to the genus *Pygidiolampas* CLARK, 1923, while MANSO and HESSEL (2007) systematically revised *Pygidiolampas araripensis*, reassigning it to the genus *Bothryopneustes* FOURTAU, 1924.

In the present paper, the find of *Phyllobrissus* cf. *humilis* represents a new record of a cassiduloid from the Albian Riachuelo Formation of the Sergipe-Alagoas Basin.

## 2. Geological setting

The Sergipe-Alagoas Basin is located along the coast of the State of Sergipe, northeast of Brazil (Fig. 1). The Aptian-Albian interval here represents a deposition on a shallow, mixed siliciclastic-carbonate platform (MANSO & SOUZA-LIMA, 2017).

The material studied here comes from levels within the Riachuelo Formation that can be dated as early Albian on the basis of ammonites (*Douvilleiceras* Zone) (SOUZA-LIMA *et al.*, 2002).

## 3. Material and methods

The specimen illustrated here is housed in the fossil echinoderm collections of the Fundação Paleontologica Phoenix (FPH), Aracaju, Sergipe, Brazil, and was systematically positioned according to KROH & SMITH (2010).

For the description of the locality, the present author follows the pattern adopted by BENGTSON (1983, p. 30-33) to the Sergipe-Alagoas Basin (Fig. 1). The co-ordinates were obtained from the Córrego Alegre datum and rounded off to the nearest 50 metres. UTM coordinates are referenced to the central 39º meridian. *Krm* = Cretaceous Riachuelo Formation.

Maruim 1 - UTM 24S 8.813.587N / 710.353E (GPS 10°43'36.0"S 37°04'35.6"W). Topographic map, sheet: SC. 24-Z-B-IV-2 Riachuelo. The outcrop is situated in a roadside section on the southern margin of motorway SE-208, near the junction with motorway BR-101.

Krm - Light-cream bioclastic calcarenite and locally oncolitic/oolitic bioclastic with isolated patch reefs and microbial, yielding echinoids, bivalves and ammonites (MANSO, 2003; MANSO & SOUZA-LIMA, 2012).

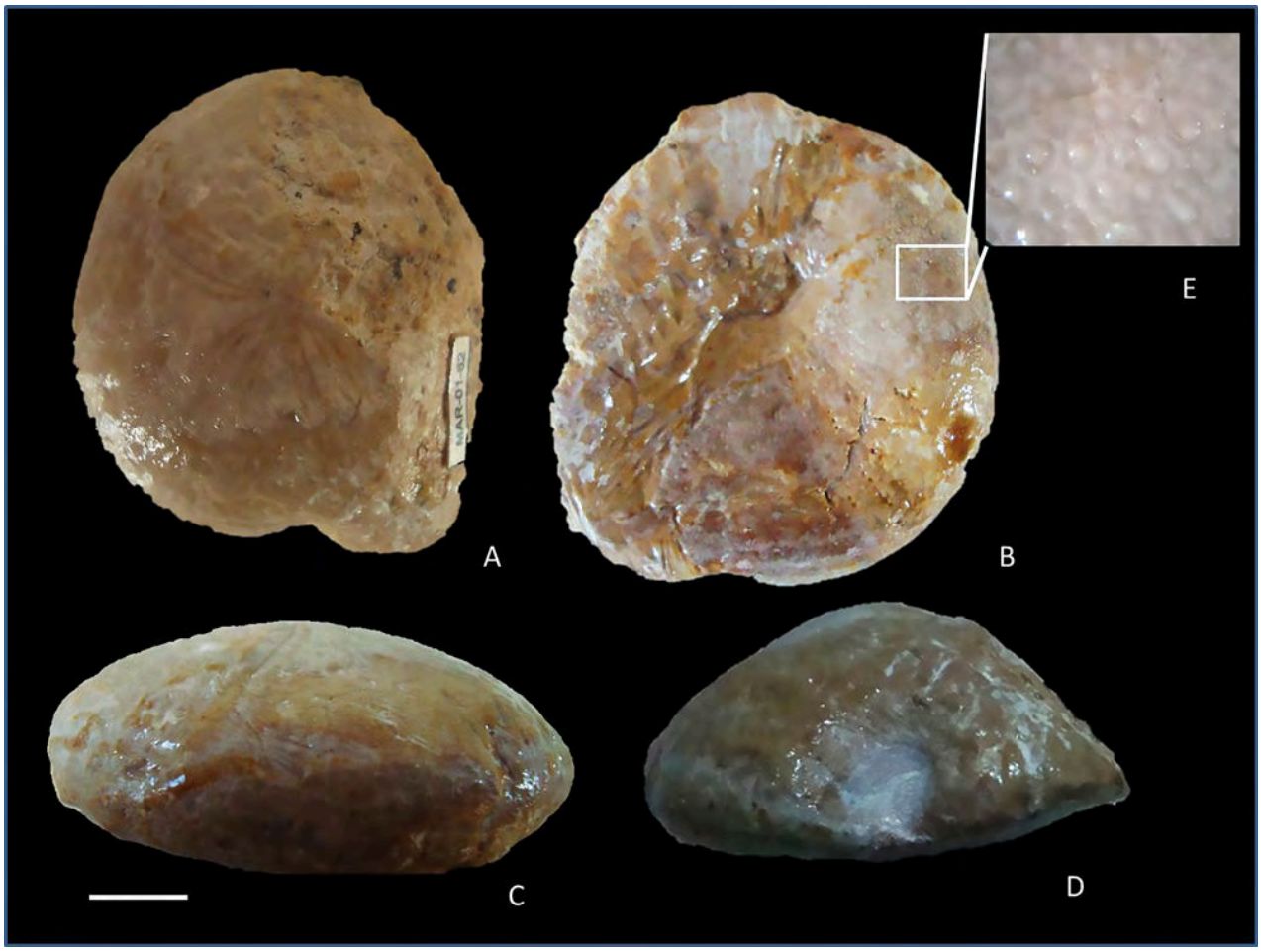


**Figure 2:** *Phyllobrissus* cf. *humilis* (GAUTHIER): A. Dorsal (apical) view; B. Ventral (oral) view; C. Lateral view; D. Posterior View; E. Detail of the tubercles. Scale bar = 10 mm.

## 4. Systematic palaeontology

**Phylum Echinodermata BRUGUIÈRE, 1791**

**Class Echinoidea LESKE, 1778**

**Infraclass Irregularia LATREILLE, 1825**

**Superorder Neognathostomata SMITH, 1981**

**Family Nucleolitidae AGASSIZ & DESOR 1847**

**Genus *Phyllobrissus* COTTEAU, 1870**

***Phyllobrissus* cf. *humilis* (GAUTHIER, 1875)**

Synonymy:

1875 *Echinobrissus humilis* GAUTHIER *in* COTTEAU *et al.*, loc. cit. p. 11, Figs. 74-76.

1884 *Echinobrissus humilis* GAUTHIER *in* COTTEAU *et al.*, p. 79, Pl. 6, figs 5-7.

Type: *Catopygus gresslyi* L. AGASSIZ, 1839, p. 49; by subsequent designation of COTTEAU, 1860, p. 553.

Diagnosis: Test subovate, of small to medium size, ovate with truncate posterior; oral surface slightly sunken towards the peristome. Apical system slightly anterior, tetrabasal, with four gonopores, posterior oculars elongate, no catenal plates. Petals long, parallel, open, extending two-thirds of the way to ambitus, inner pore round, outer pore slightly elongated transversely; all ambulacral plates with double pores. Periproct towards the rear of the aboral surface; supramarginal, bordering on marginal, on an almost vertical face, with a short groove extending from lower edge of periproct to posterior edge of test. Peristome anterior, pentagonal, depressed, wider than high. Bourrelets absent. Phyllode structure unreported. No naked zone in posterior interambulacrum orally (SMITH & KROH, 2011).

Material: FPH-642-I.

Locality and stratigraphical level: Maruim I, Riachuelo Formation, Sergipe-Alagoas Basin, Brazil.

Description: medium-sized test of the circular outline, slightly high, with the oral side slightly concave and swollen (Fig. 2.A-C). Large tubercle with well-marked areoles can be observed on the

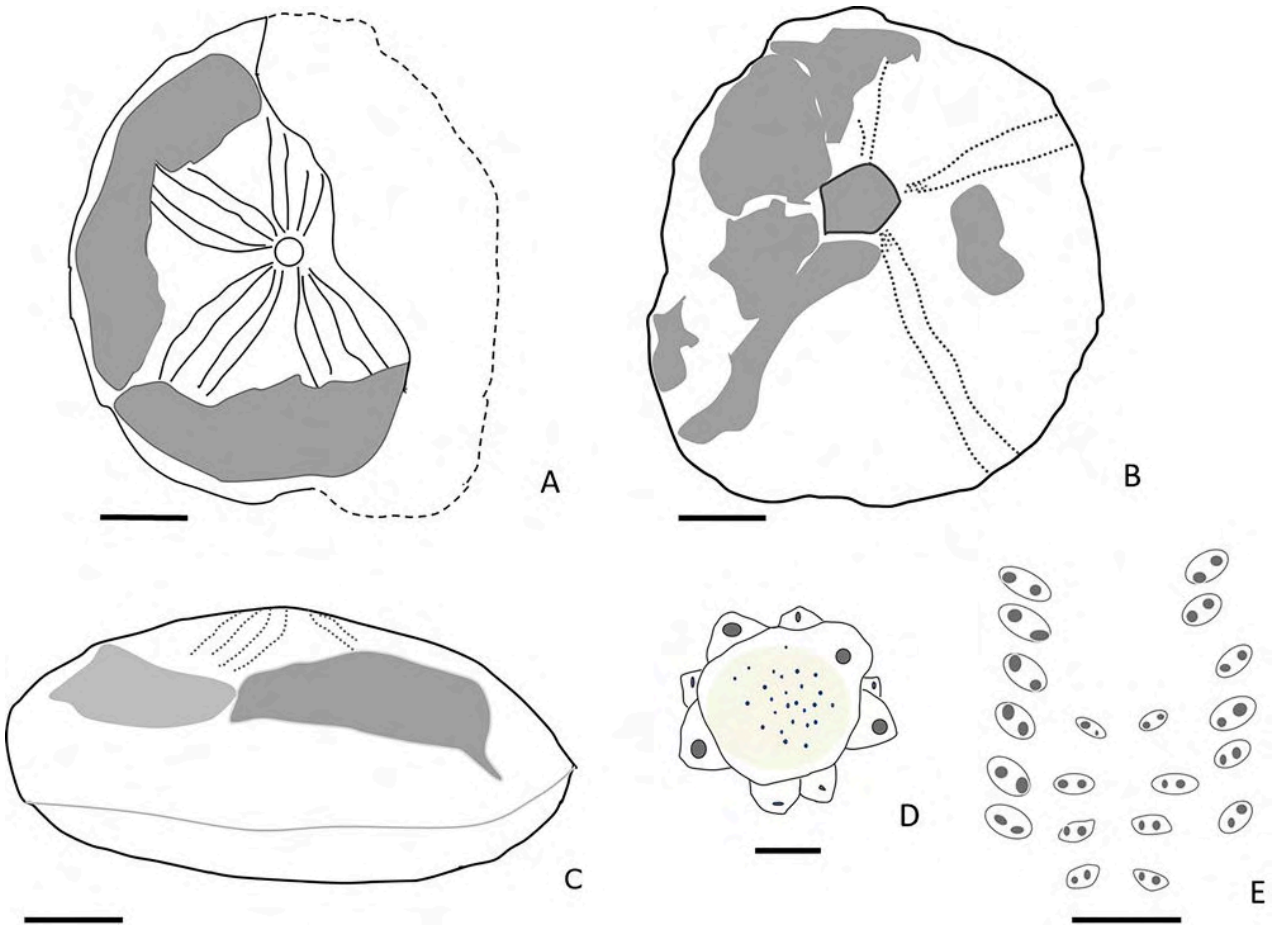


**Figure 3:** *Phyllobrissus* cf. *humilis* (GAUTHIER): A. Dorsal (apical) view; B. Ventral (oral) view; C. Lateral view; D. Apical system; E. Detail of phyllode. Scale bars equal 10 mm (A-C) and 1 mm (D- E). The grey areas correspond the poorly preserved areas.

oral side of the test (Fig. 2.E). The tubercles on the aboral side are poorly preserved.

Apical disc tetrabasal are situated slightly anteriorly, with four genital plates, genital 2 (madreporite) being largest and occupying the entire central region; posterior genital plates separated by two small ocular plates (Fig. 3.D).

The petals are opened and pore pairs are formed of oval pores, mainly in ambulacra III, where the pores of the external rows are little larger than those of the internal rows (Fig. 2.A). All the petals are approximately of the same length and occupying almost 2/3 of the dorsal surface. Internal pores of both paired petals are rounded and external rows are oval to slightly elongate. Pore pairs and found all along the ambulacra. The periproct is positioned in the posterior region, and apparently it is elevated, near the ambitus and it is not visible from the oral side (Fig. 2.D).

Peristome situated anteriorly; pentagonal outline and with well-marked ambulacra (Figs. 2.B, 3.B); rows of phyllode pores double; no differentiated oral pores visible (Fig. 3.E).

Stratigraphical and geographical distribution: Valanginian of Algeria and Albian of Brazil (Lower Cretaceous).

**Table I:** Biometric data for *Phyllobrissus* cf. *humilis* (GAUTHIER, 1875). W - width; H - height; L - length; Adab - apical disc to anterior border; Pab - peristome to anterior border.

| Fossil | Length (mm) | Width (mm) | Hight (mm) | W/L | H/L | Adab (mm) | Pab (mm) |
|---|---|---|---|---|---|---|---|
| FPH-642-I | 52.2 | 47.0 | 21.0 | 0.90 | 0.40 | 24.0 | 17.0 |

Remarks: The specimen identified here matches the main features of the original description of *Phyllobrissus* cf. *humilis* (GAUTHIER, 1875). Although it is larger than the single test recorded by GAUTHIER (1875) (27.0 mm long, 25.0 mm wide and 12 mm tall, with W/L = 0.92 and H/L = 0.44), the present author considers them to be conspecific, representing different ontogenetic stages. *P. humilis* (GAUTHIER) differs from *P. freitasii* (WHITE, 1887), also from the Albian of the Riachuelo Formation as follows: the latter has a test that is mainly relatively flat and subquadrate in outline, with the highest point located posterior of center, closer of the periproct.

From the Sergipe-Alagoas Basin, in addition to *Phyllobrissus* cf. *humilis*, other cassiduloid species have been recorded from Cretaceous levels (Albian-Turonian); these can be differentiated using the following key

**Table II:** Identification Key to the species of the Cassiduloids currently known from the Cretaceous of the Sergipe-Alagoas Basin and their stratigraphical occurrence.

| | | |
|---|---|---|
| **1.** | Phyllode pores single | **7** |
| | Phyllode pores double | **2** |
| **2.** | Test with flat base | **3** |
| | Test without flat base | **4** |
| **3.** | Test with a conical profile and an oval, wider than long periproct | *Colliclypeus nettoanus* (WHITE, 1887) (Clypeidae, Albian, Riachuelo Formation; SMITH & BENGTSON, 1991) |
| | Test without conical shape, periproct oval, longer than wide, shallow and short anal sulcus | *Pygorhynchus colombianus* (COOKE, 1955) (Nucleolitidae, Albian, Riachuelo Formation; *e.g.*, MANSO & SOUZA-LIMA, 2005) |
| **4.** | Apical disc situated well anterior from the test center | **5** |
| | Apical disc next to the test center | **6** |
| **5.** | Periproct opening into a long anal sulcus, short petals | *Nucleopygus similis* (ORBIGNY, 1856) (Nucleolitidae, Albian, Riachuelo Formation; *e.g.*, SMITH & BENGTSON, 1991) |
| | Periproct opening into a short anal sulcus. Conical test in outline, with apical disc at highest point. Anterior petals shortest than posterior petals | *Acriaster sergipensis* SMITH, 1991 (Archiacidae, Albian, Riachuelo Formation; *e.g.*, SMITH & BENGTSON, 1991) |
| **6.** | Flat test, subquadrate with the highest point posterior to apical disc | *Phyllobrissus freitasii* (WHITE, 1887) (Nucleolitidae, Albian, Riachuelo Formation *e.g.*, SMITH & BENGTSON, 1991) |
| | Thick test with and rounded edges | *Phyllobrissus* cf. *humilis* (GAUTHIER, 1875) (Nucleolitidae, Albian, Riachuelo Formation) |
| **7.** | Apical disc towards the anterior test. Periproct opening on the aboral surface, at some distance from the posterior paired petals | *Petalobrissus cubensis* (WEISBORD, 1934) (Faujasiidae, Turonian, Cotinguiba Formation; *e.g.*, MANSO & ANDRADE, 2008) |

## 5. Discussion and conclusions

In his review of cassiduloid echinoids, KIER (1962) found that in general taxa that had been recovered from rocks older than Cenomanian had paired pores in all ambulacral plates outside the petals. In addition, during the Cenomanian one of these pores diminished in size and in even younger material, from the Turonian onwards, tests had only a single pore outside the petals and a new structure could be observed in the peristome, the first buccal pores. According to KIER (1962), in species with two pairs of pores, these would have had a respiratory function, while phyllode pairs near the mouth would have helped to obtain food particles and the pair of tube feet between the phyllodes and petals would have had a sensory function.

On the Sergipe-Basin and Araripe basin (MANSO & HESSEL, 2007), all the cassiduloids species of Albian age have two pores beyond the petals and no differentiated buccal pores, agreeing with KIER's (1962) observations. The only recorded cassiduloid for the Turonian of the Sergipe-Alagoas Basin, *Petalobrissus cubensis* as well the *Petalobrissus* species recorded for the Turonian-Campanian interval of the Potiguar Basin are also in agreement with the observations of KIER (1962) regarding the decrease in the number of pores beyond the petals (MANSO & ANDRADE, 2008; OLIVEIRA *et al.*, 2013; ALVES *et al.*, 2018).

Cassiduloids are generally semi-infaunal forms living on sediments made of gravel or coarse sand with few fine elements (SMITH, 1995). Large periproct and anal sulcus suggest that these fossil species would have had a large fecal discharge (SMITH, 1995).

The locality Maruim 1 where *P. humilis* was collected is part of the Maruim Member. This member consists of calcarenites and oncolitic/oolitic calcirudites, with isolated algal reefs and patch reefs representing high energy coastal environments (SOUZA-LIMA *et al.*, 2002). Therefore, one can assume that *Phyllobrissus* cf. *humilis* would have lived partially buried in a coarse-grained substrate of carbonate sands in a high-energy environment. The species would have ingested large amounts of sediment along with food as evidenced by its large periproct and phyllodes that are not yet specialized. This form of feeding would have been different from that suggested for *Eurhodia relicta* MOOI, 1990b, an extant cassiduloid, but a member of an extinct (Late Eocene) genus. *Eurhodia relicta* ingests organisms that live in or on small sedimentary particles with the aid of their small phyllodes (MOOI, 1990b).

Some species of echinoids may have a wide distribution in the stratigraphic record, as observed with *Phyllobrissus* cf. *humilis*, which was recorded from Albian of Sergipe and from Valanginian of Algeria. Among these species one can also mention *Orthopsis miliaris* (ARCHIAC, 1835) that was recorded from the Albian of the Sergipe-Alagoas Basin (*e.g.*, MANSO & LEMOS, 2008) and from the Maastrichtian layers of the Sinsima Formation north of Oman (*e.g.*, SMITH, 1995; SMITH *et al.*,

1995). *Phyllobrissus* cf. *humilis* has its extended stratigraphic distribution being recorded for the Lower Albian of the Sergipe basin. It is also increased its geographical distribution with the new record to the northeast of Brazil.

## Acknowledgments

The author would like to Dr W. SOUZA-LIMA for assistance in specimen collection and A.C. MANSO by initial correction of the manuscript. Special thanks go to the Dr L. VILLIER and Dr J. JAGT for the valuable contributions to improving the manuscript.

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