

New species of Xestoleberididae (Crustacea, Ostracoda) from Archipelago of São Pedro and São Paulo, Equatorial Atlantic

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ABSTRACT. Two new species of Xestoleberididae: *Xestoleberis brasilinsularis* sp. nov. and *Xestoleberis machadoae* sp. nov., both endemic to Archipelago of São Pedro and São Paulo, are described. The record of these shallow marine waters species from Brazilian oceanic islands represents an important contribution to the knowledge of the evolutionary history of the species inhabit areas.

KEYWORDS. *Xestoleberis*, taxonomy, morphology, Atlantic Ocean.

RESUMO. Novas espécies de Xestoleberididae (Crustacea, Ostracoda) do Arquipélago de São Pedro e São Paulo, Atlântico Equatorial. Duas novas espécies de Xestoleberididae: *Xestoleberis brasilinsularis* sp. nov. e *Xestoleberis machadoae* sp. nov., ambas endêmicas do Arquipélago São Pedro e São Paulo, são descritas. O registro dessas espécies marinhas de águas rasas em ilhas oceânicas brasileiras representa uma importante contribuição para o conhecimento da história evolutiva das espécies que habitam estas áreas.

PALAVRAS-CHAVE. *Xestoleberis*, taxonomia, morfologia, Oceano Atlântico.

The oceanic islands are of great scientific interest, mainly their origins and their very special terrestrial and marine ecosystems. The island environments have been used as a model for many scientific fields, such as biogeography, ecology, evolution and conservation. In recent decades, the study of the Brazilian oceanic islands and their flora and fauna has grown significantly with the financial support of the governmental program known as PROARQUIPÉLAGO. This program is also responsible by the logistical support to the researches performed in the Archipelago of São Pedro and São Paulo, that is a group of very small rocky islets in the Equatorial Atlantic Ocean (CAMPOS *et al.*, 2003; COIMBRA *et al.*, 2009, 2013; ANTONIETTO *et al.*, 2012; COIMBRA & CARREÑO, 2012).

COIMBRA *et al.* (2013) is an important contribution to the knowledge of the ostracod fauna from the Archipelago of São Pedro and São Paulo. The authors identified and illustrated 14 species, described one new genus and species and leaving the two species of the genus *Xestoleberis* Sars, 1866, herein described, in open nomenclature.

Xestoleberis, a cosmopolitan marine ostracod genus, is the most specious Xestoleberididae and possesses a rich fossil record, being known since the Cretaceous (MORKHOVEN, 1962). This genus prefers shallow marine waters, but some of its species have been recovered from deep sea (DANIELOPOL *et al.*, 1996) and marine marginal environments (DIAS-BRITO *et al.*, 1988). The present paper describes and illustrates two new species of *Xestoleberis*, both recovered from the cove of the Archipelago of São Pedro and São Paulo, and very likely endemic to this oceanic area.

MATERIAL AND METHODS

The Archipelago of São Pedro and São Paulo (00°55'10"N/29°20'33"W) is the top of a submarine

morphological elevation whose base is at ~3,800 m water depth. Few rocky islets compose it, being the four largest (Cabral, São Pedro, São Paulo and Belmonte) arranged in a semicircle forming a shallow cove with maximum depth of ~15 m (Fig. 1). The Calcanhar Cape, in the State of Rio Grande do Norte, is the nearest Brazilian continental area of the Archipelago of São Pedro and São Paulo (ASPSP), whose distance is 510 nautical miles (~1,100 km). On the other hand, the archipelago is around 985 nautical miles (~1,824 km) from the coast of Guinea-Bissau, in Africa (ALMEIDA, 2006).

The ASPSP and the Brazilian coast are separated by deep ocean whose depth can reach up to 4,000 m, and in its nearest surroundings the top of some seamounts are located only 100 m below the surface (MORAES & MURICY, 2007). According to STRAMMA & ENGLAND (1999), this archipelago is inserted into the system of equatorial currents, suffering direct influence of the South Equatorial Current, which flows superficially from east to the west, and of the South Equatorial Undercurrent, that flows in the opposite direction, at a depth ranging between 60 and 100 m. The combined action of these two currents results in a pattern of high hydrological complexity and with great influence on the island ecosystem, causing nutrient enrichment of waters due to upwelling resulting from the interaction between ocean currents and submarine topography (CAMPOS *et al.*, 2009).

The study material is composed by 22 samples (seven barren for Xestoleberididae) (Tab. I), hand collected in three different areas in the cove of the ASPSP by free diving at depths ranging from 2 and 11 m (Fig. 2). All material examined was collected by Cláudia Pinto Machado, Fernando Erthal and Sandro Monticelli Petró, with the help of the Brazilian Navy crew, during 15 days in July/August 2010. COIMBRA *et al.* (2013) present more details of field and laboratorial procedures.

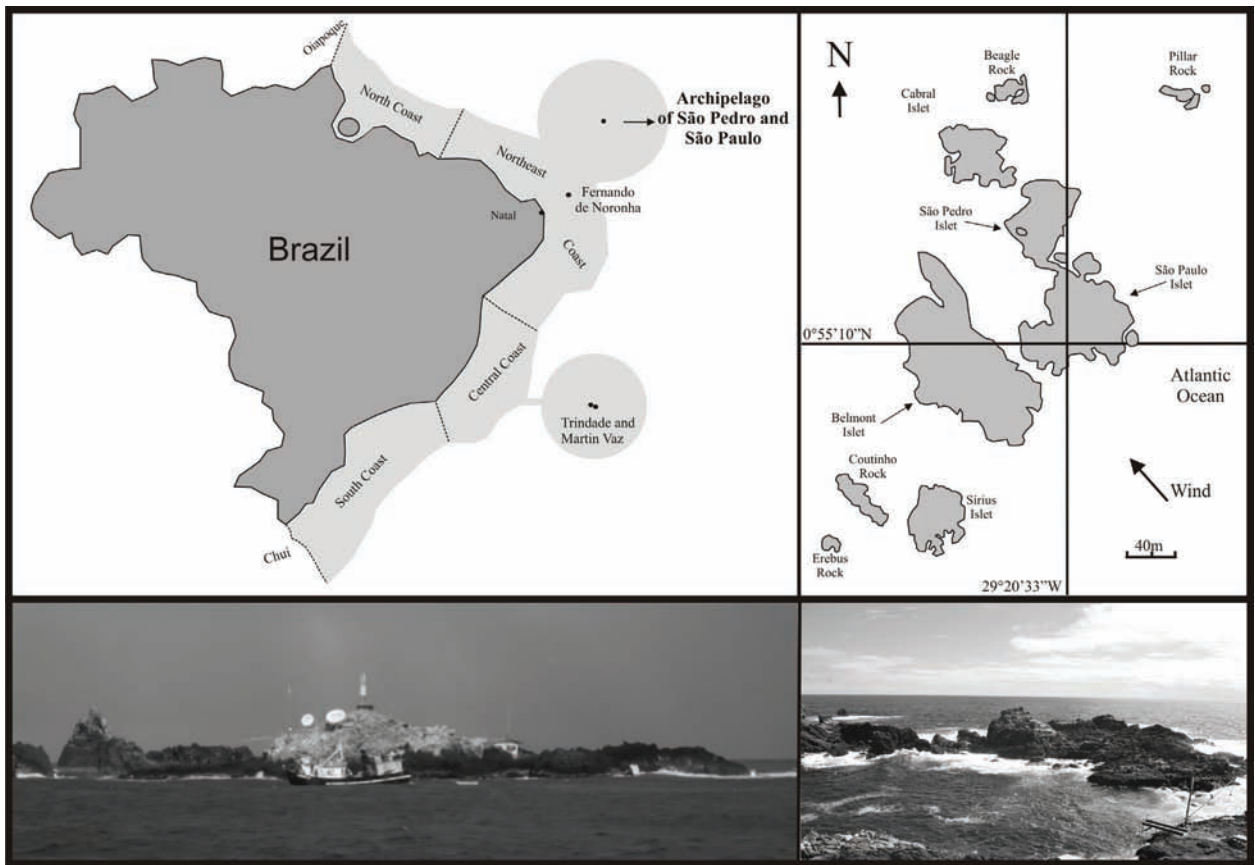


Fig. 1. Location map of Archipelago of São Pedro and São Paulo (modified from SOARES *et al.*, 2009; MACEDO *et al.*, 2009).

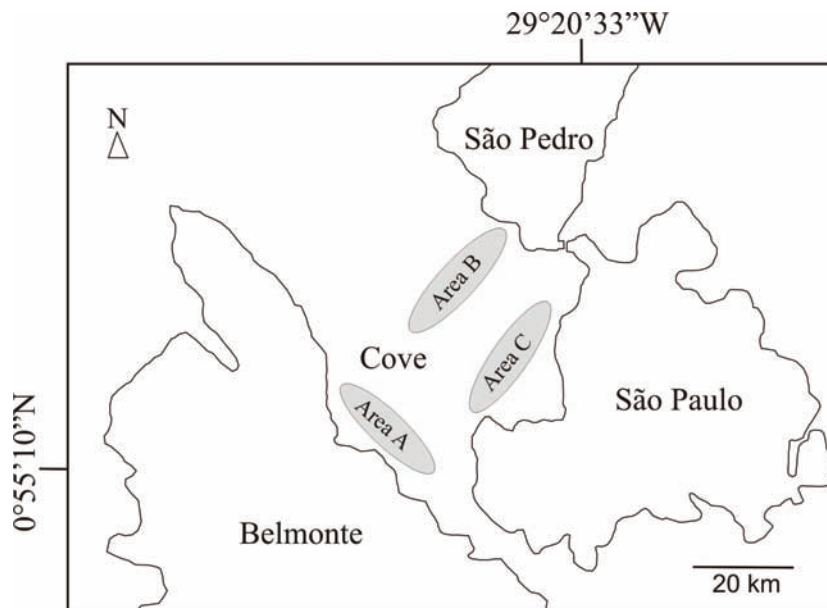


Fig. 2. Cove of the Archipelago of São Pedro and São Paulo (modified from COIMBRA *et al.*, 2013).

The ostracodes herein examined are held in the collections of the ‘Museu de Paleontologia’, Universidade Federal do Rio Grande do Sul (UFRGS), Section of Ostracoda. The figured material is identified by the prefix MP-O. All scanning electronic microscopy (= SEM) photographs were taken at the ‘Centro de Microscopia

Eletrônica’ at UFRGS. Unfortunately, the LV number MP-O-2466 was broken after SEM analysis. However, only this adult specimen rendered a good photo of the central muscle scars.

Morphological abbreviations: LV, left valve; RV, right valve; c, carapace; v, valve.

Tab. I. Number, location, substrate and depth of the 15 fertile samples for Xestoleberididae, cove of the Archipelago of São Pedro and São Paulo, Equatorial Atlantic.

Sample number	Area of collection in the cove	Substrate (Algae/Sediment)	Depth (~m)
M 1001-N	Area A	Algae (<i>Caulerpa racemosa</i>)	2
M 1002-N	Area A	Algae sp. 1	2
M 1003-N	Area A	Sediment	5
M 1004-N	Area A	Sediment	5
M 1005-N	Area A	Sediment	5
M 1010-N	Area A	Sediment	10
M 1012-N	Area B	Sediment	11
M 1014-N	Area B	Sediment	11
M 1017-N	Area A	Algae sp. 1	2
M 1023-N	Area C	Algae (<i>Caulerpa racemosa</i>)	4
M 1025-N	Area C	Algae (<i>Caulerpa racemosa</i>)	4
M 1030-N	Area C	Algae sp. 2	5
M 1031-N	Area C	Algae (<i>Caulerpa racemosa</i>)	5
M 1032-N	Area C	Algae (<i>Caulerpa racemosa</i>)	5
M 1036-N	Area C	Algae sp. 2	5

***Xestoleberis brasilinsularis* sp. nov.**

(Figs 3-13)

Xestoleberis toni? ANTONIETTO *et al.*, 2012:40-41, Figs 6:9-12; Tab. 8 (non *Xestoleberis toni* WOUTERS, 2003:152, Pl. 9, Figs 1-8; Pl. 13, Figs 5a-c).

Xestoleberis sp. 1 COIMBRA *et al.*, 2013:297, Figs 58-61; Tab. 4.

Type material. Holotype, MP-O-2474, ♀, RV, length: 0.42 mm; height: 0.22 mm. Paratypes. MP-O-2475, ♀, LV, length: 0.41 mm; height: 0.22 mm; MP-O-2476, ♀, carapace, width: 0.19 mm; length: 0.40 mm. MP-O-2477, ♂, RV, length: 0.44 mm; height: 0.21 mm.

Etymology. From Brasil and the Latin origin, *insularis* = of an island, because of its record being restricted to an archipelago.

Type locality. Archipelago of São Pedro and São Paulo, Equatorial Atlantic.

Occurrence. See Table II.

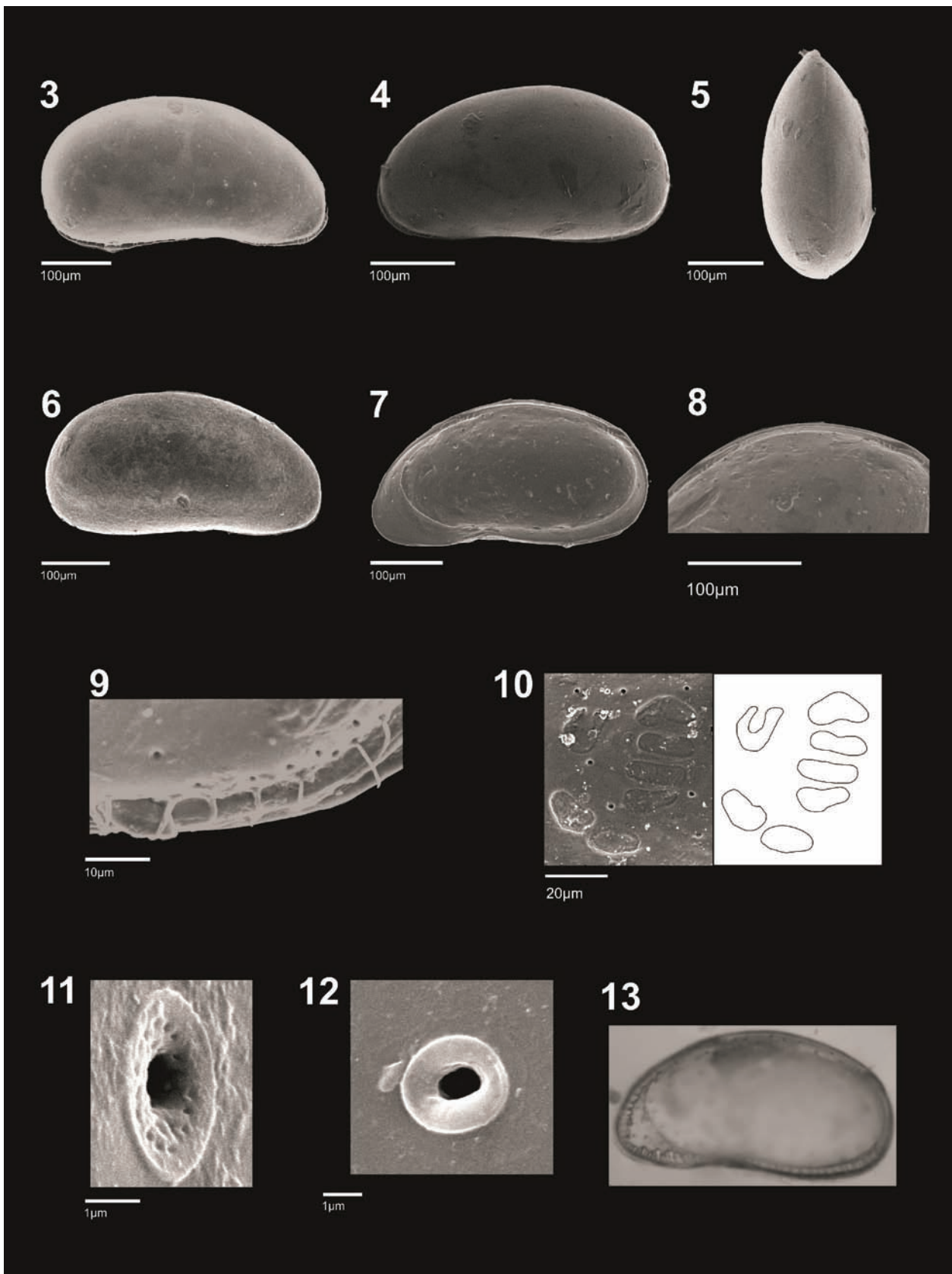
Diagnosis. Small-sized and relatively thin carapace. Subovate elongate to subrectangular in lateral view; ovate-elongate in dorsal view. Greatest length just below mid-height. Greatest height just posterior mid-length. Anterior margin obliquely rounded, with apex in the lower third.

Posterior margin subtruncated. Surface typically smooth with two types of normal pore canals: sieve-type and lip-type. A very delicate flange, more developed in RV, runs along the anterior and ventral margins.

Description. A relatively thin-shelled and small-sized species of *Xestoleberis*. Subovate elongate to subrectangular in lateral view. In dorsal view, ovate-elongate. In ventral view, flattened. LV overlapping RV mainly anteriorly and posteroventrally. Maximum length just below mid-height. Maximum height just posterior mid-length. Maximum width posteriorly. Anterior margin obliquely rounded, with apex in the lower third. Posterior margin subtruncated. Dorsal margin moderately arched. Ventral margin sinuous near the middle, more conspicuously in RV. Surface typically smooth with two types of normal pore canals (*sensu* SATO & KAMIYA, 2007): sieve-type and lip-type. A very delicate flange, more developed in RV, runs along the anterior and ventral margins. In living specimens, some very short marginal bristles overlaps the flange forming a false delicate reticulum when photographed by SEM (see Figs 3, 9). *Xestoleberis*-spot small and almost invisible; around it there is a milky patch. Inner lamella wide at anterior, narrow ventrally and posteriorly. Line of concrescence

Tab. II. Occurrence and abundance of living and dead *Xestoleberis brasilinsularis* sp. nov. recovered at the Archipelago of São Pedro and São Paulo, Equatorial Atlantic.

Sample number	Substrate (Algae/Sediment)	Depth (m)	Adults	Juveniles
M 1003-N	Sediment	5	6c, 4v	3c, 5v
M 1004-N	Sediment	5	-	6v
M 1005-N	Sediment	5	1c	1v
M 1010-N	Sediment	10	1c, 2v	2v
M 1012-N	Sediment	11	1c, 3v	1v
M 1014-N	Sediment	11	1c, 1v	1v
M 1023-N	Algae (<i>Caulerpa racemosa</i>)	4	1v	1v
M 1025-N	Algae (<i>Caulerpa racemosa</i>)	4	1v	9v
M 1030-N	Algae sp. 2	5	1v	3v
M 1031-N	Algae (<i>Caulerpa racemosa</i>)	5	1v	4v
M 1036-N	Algae sp. 2	5	-	1v



Figs 3-13, *Xestoleberis brasilsularis* sp. nov.: 3, MP-O-2474, ♀, RV; 4, MP-O-2475, ♀, LV; 5, MP-O-2476, ♀, c, dorsal view; 6, MP-O-2477, ♂, RV; 7, MP-O-2477, ♂, RV, internal view; 8, MP-O-2474, ♀, RV, hinge; 9, MP-O-2476, ♀, c, flange; 10, MP-O-2477, ♂, RV, central muscle scars; 11, MP-O-2474, ♀, c, sieve-type pore; 12, MP-O-2476, ♀, c, lip-type pore; 13, MP-O-2474, ♀, RV, internal view, not in scale.

and inner lamella widely separated anteriorly, forming a large vestibulum. Posterior vestibulum very small, visible only in large magnification. Selvage subperipheral in both valves, bending outwards in the oral region. Marginal pore canals numerous and short, mostly simple and straight, as typical for the genus. Hinge hemimerodont, with well-developed crenulate terminal teeth in RV; median element smooth. Central muscle scars constituted by four adductors vertically aligned and a frontal U-shaped. Two mandibular scars below in front. Sexual dimorphism: females more inflated posteriorly, somewhat more height and with a more marked oral concavity. Males more rounded posteriorly.

Remarks. *Xestoleberis brasilinsularis* sp. nov. was identified by ANTONIETTO *et al.* (2012) as *Xestoleberis toni*? Wouters, 2003. However, as already briefly discussed by COIMBRA *et al.* (2013), these two taxa are not conspecific. In fact, they have not only different outlines, but also different central muscle scars pattern and *Xestoleberis* spot, that is larger in the species described by WOUTERS (2003) for Cape Verde Islands. The new species does not fit well in any *Xestoleberis* morphological group proposed by BONADUCE & DANIELOPOL (1988) neither by SATO & KAMIYA (2007).

***Xestoleberis machadoae* sp. nov.**

(Figs 14-24)

Xestoleberis sp. 1 ANTONIETTO *et al.*, 2012:40-41, Figs. 6:13-20; Tab. 9.
Xestoleberis sp. 2 COIMBRA *et al.*, 2013:297, Fig. 62-66; Tab. 4.

Type material. Holotype, MP-O-2478, ♀, RV, length: 0.34 mm; height: 0.19 mm. Paratypes. MP-O-2466, ♂, RV, length: 0.28 mm; height: 0.13 mm; MP-O-2479, ♀, LV, length: 0.33 mm; height: 0.16 mm; MP-O-2480, ♀, carapace, width: 0.21 mm; length: 0.32 mm; MP-O-2481, ♂, RV, length: 0.33 mm; height: 0.16 mm; MP-O-2482, ♂, LV, length: 0.34 mm; height: 0.16 mm; MP-O-2483, ♂, carapace, width: 0.19 mm; length: 0.33 mm.

Etymology. This species was named in honor of Cláudia Pinto Machado (Universidade de Caxias do Sul), a friend of the authors, in recognition of her contribution to the study of Recent Brazilian shallow water marine ostracodes, and for her tireless willingness to collect ostracodes in inhospitable Brazilian oceanic islands.

Type locality. Archipelago of São Pedro and São Paulo, Equatorial Atlantic.

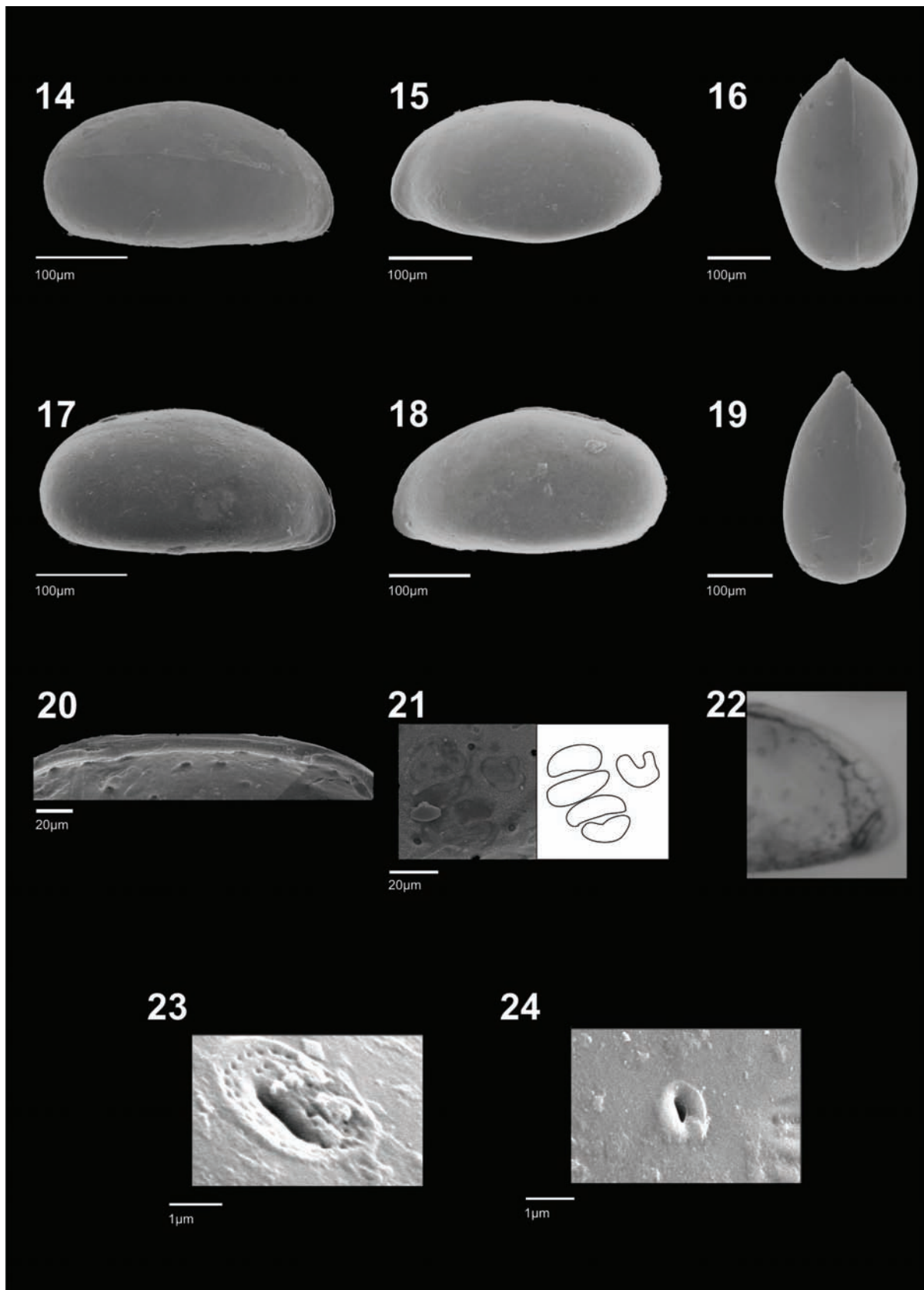
Occurrence. See Table III.

Diagnosis. Carapace very small and relatively thin. Subrectangular elongate in lateral view; in dorsal view, oval in females and subpiriform in males. In ventral view, strongly flattened. Anterior margin obliquely rounded, projected ventrally, with an adjacent small sunken area. Posterior margin almost evenly rounded in RV, more narrowly rounded in LV. Surface predominantly smooth, with three different normal pore canals: sieve-type, simple-type and lip-type. In SEM, there are one very delicate anteroventral submarginal rib and two minor ribs behind it.

Description. A very small and relatively thin-shelled species of *Xestoleberis*. Subrectangular elongate in lateral view. In dorsal view, strongly inflated and ovate. In ventral view, strongly flattened. LV overlapping RV mainly anteriorly and posterodorsally. Maximum length almost ventrally. Maximum height medially. Maximum width near the middle. Anterior margin obliquely rounded, projected ventrally, with a depressed region adjacent to it forming a well-defined small sunken area. Posterior margin almost evenly rounded in RV, more narrowly rounded in LV. Dorsal margin moderately convex. Ventral margin almost straight, hidden by a lateral inflation more developed in LV. Surface predominantly smooth, with three patterns of normal pore canals (*sensu* SATO & KAMIYA, 2007): sieve-type, simple-type and lip-type. In SEM, there are one very delicate anteroventral submarginal rib and two minor ribs behind it. *Xestoleberis*-spot small and almost invisible. A large vestibulum is present anteriorly. Selvage subperipheral in both valves, bending outwards in the oral region. Marginal

Tab. III. Occurrence and abundance of living and dead *Xestoleberis machadoae* sp. nov. recovered at the Archipelago of São Pedro and São Paulo, Equatorial Atlantic.

Sample number	Substrate (Algae/Sediment)	Depth (~m)	Adults	Juveniles
M 1001-N	Algae (<i>Caulerpa racemosa</i>)	2	-	1c
M 1002-N	Algae sp. 1	2	1c	1c
M 1003-N	Sediment	5	15c, 32v	3c, 15v
M 1004-N	Sediment	5	20c, 7v	2c, 1v
M 1005-N	Sediment	5	17c, 11v	3v
M 1010-N	Sediment	10	1c, 1v	1v
M 1012-N	Sediment	11	2c	7c
M 1014-N	Sediment	11	3v	-
M 1017-N	Algae sp. 1	2	-	3v
M 1023-N	Algae (<i>Caulerpa racemosa</i>)	4	-	1c, 1v
M 1025-N	Algae (<i>Caulerpa racemosa</i>)	4	1v	1c, 1v
M 1030-N	Algae sp.2	5	2v	-
M 1032-N	Algae (<i>Caulerpa racemosa</i>)	5	1v	-



Figs 14-24, *Xestoleberis machadoae* sp. nov.: 14, MP-O-2478, ♀, RV; 15, MP-O-2479, ♀, LV; 16, MP-O-2480, ♀, c, dorsal view; 17, MP-O-2481, ♂, RV; 18, MP-O-2482, ♂, LV; 19, MP-O-2483, ♂, c, dorsal view; 20, MP-O-2481, ♂, RV hinge; 21, MP-O-2466, ♂, RV, central muscle scars; 22, MP-O-2481, ♂, anterior margin, not in scale; 23, MP-O-2478, ♀, RV, sieve-type pore; 24, MP-O-2478, ♀, RV, lip-type pore.

pore canals not numerous, simple and straight. Hinge hemimerodont, with delicately crenulate terminal teeth in RV; median element smooth. Central muscle scars constituted by four adductors vertically aligned and a frontal U-shaped. Mandibular scars not visible. Sexual dimorphism present. Males with a more arched dorsal margin and less developed lateral inflation in LV. In dorsal view, subpiriform. Maximum width posteriorly.

Remarks. *Xestoleberis machadoae* sp. nov. has less than 0.4 mm in length, exhibits elongate and dorsally gently convex valves in lateral view, hinge hemimerodont with slightly crenulate terminal teeth in RV and smooth hinge-bar in LV, and *Xestoleberis*-spot poor-developed, features typical of the *Xestoleberis arcturi* Triebel group of BONADUCE & DANIELOPOL (1988). Conversely, this new species does not fit well in any group proposed by SATO & KAMIYA (2007) for Japanese species.

DISCUSSION

The study of Recent and Quaternary ostracodes of the family Xestoleberididae in Brazil showed that the species of the genus *Xestoleberis* already identified are mainly under open nomenclature. COIMBRA *et al.* (1992), analyzing the relationship of ostracodes, biofacies of foraminifers and lithofacies in the coralline Bay of Tamandaré (NE Brazil), identified *Xestoleberis* spp. only in the carbonate lithofacies. COIMBRA *et al.* (1999) recorded *Xestoleberis* sp. 1 along the entire equatorial shelf, while *Xestoleberis* sp. 2 was identified only in the most western portion of that region. MACHADO *et al.* (2005), studying very shallow water ostracodes off Cabo Frio town (~22°S), in the state of Rio de Janeiro, identified *Xestoleberis umbonata* Whatley *et al.*, 1998, one of the dominant ostracod species in their material. BERGUE & COIMBRA (2008), in a study of littoral benthic meiofauna of the State of São Paulo, recorded only five specimens of a species of this genus that remained in open nomenclature. COIMBRA *et al.* (2009) and COIMBRA & CARREÑO (2012), in a preliminary study of ostracodes from the Trindade Island (20°30'S, 29°18'W) and Rocas Atoll (03°52'S, 33°09'W), two oceanic Brazilian islands, recorded *Xestoleberis* sp. in Trindade and *Xestoleberis* spp. in Rocas. COIMBRA *et al.* (2013), as already briefly presented in the introduction of this paper, also discussed preliminarily the two taxa herein formally described. In that paper, the authors outlined a first comparison among the ostracod fauna of three Brazilian oceanic islands (ASPSP, Trindade and Rocas) and discussed the dispersal and potential of colonization of isolated oceanic islands by benthic ostracodes. Finally, the first author, examining 377 samples recovered from the north and northeastern Brazilian shelf, found four unidentified species of *Xestoleberis* that will be studied in an ongoing project.

A comparison of all species of *Xestoleberis* above discussed with the two new species of this genus described for the ASPSP, revealed no similarity among X.

brasilinsularis sp. nov., *X. machadoae* sp. nov. and any of those taxa.

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