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A NEW HOLOCENE NERITIC SPECIES OF *AUSTRALOECIA* MCKENZIE (OSTRACODA, PONTOCYPRIDIDAE) FROM THE BRAZILIAN SHELF

LISANDRA APARECIDA ALVES SARTORI
Programa de Pós-Graduação em Geociências, IGeo, UFRGS, Cx.P. 15001, 91501-970, Porto Alegre, RS, Brasil.
lisartori03@gmail.com

JOÃO CARLOS COIMBRA
Departamento de Paleontologia e Estratigrafia, IGeo, UFRGS, Cx.P. 15001, 91501-970, Porto Alegre, RS, Brasil.
joao.coimbra@ufgrs.br

ABSTRACT – This study is based on 923 samples of dry sediments collected along all the Brazilian shelf by the REMAC Project and the GEOMAR I, II and III, and 11 more samples collected by the Researcher Vessel "El Austral" in the southernmost Brazil. The majority of the samples were recovered from the neritic zone, while 60 samples were collected in deeper waters (maximum 560 m, many of them in the northern region). The cosmopolitan ostracode *Australoecia* presents a good fossil record since the Cretaceous, although not all species are thick-shelled and well preserved. The diversity of this genus is greater in infraneritic and bathyal regions; however, it may exceptionally reach up to 4,000 m depth. In the Quaternary of Brazil just two species are known, *A. atlantica* Maddocks and *A. neritica* sp. nov., the last one herein described. The geographic and stratigraphic distributions of *Australoecia* are also briefly discussed.

Key words: *Australoecia*, Ostracoda, Brazilian continental shelf, geographic distribution, stratigraphic distribution, systematic.

RESUMO – Foram analisadas 923 amostras de sedimentos secos coletados ao longo de toda a costa brasileira pelos Projetos REMAC e GEOMAR I, II e III, e mais 11 amostras coletadas pelo NOc."El Austral" no extremo sul do país. A maioria das amostras provém da zona nerítica; apenas 60 foram obtidas em regiões batiais (profundidade máxima de 560 m, a maior parte na região norte). O ostracode cosmopolita *Australoecia* possui bom registro fóssil desde o Cretáceo, embora nem todas as suas espécies apresentem carapaças robustas e bem preservadas. A diversidade deste gênero é maior em regiões infraneríticas e batiais, podendo, excepcionalmente, ocorrer até 4.000 m de profundidade. No Quaternário do Brasil são conhecidas apenas duas espécies, *A. atlantica* Maddocks e *A. neritica* sp. nov., esta última descrita no presente trabalho. As distribuições espacial e temporal de *Australoecia* são também brevemente discutidas.

Palavras-chave: *Australoecia*, Ostracoda, plataforma continental brasileira, distribuição geográfica, distribuição estratigráfica, sistemática.

INTRODUCTION

In the 1960s the genus *Australoecia* was proposed by McKenzie (1967) based on Recent dry material recovered from sediments of Phillip Bay, Australia, with *A. victoriensis* as the type-species. Ten years later, an emended diagnosis was proposed by Maddocks (1977), including the description of soft parts of some extant species. Since then 19 species have been described for *Australoecia*, many of them fossil (Table 1). Nowadays, it is well known that this genus has a good fossil record since the Cretaceous.

Bold (1974) included three deep water Tertiary species from the Caribbean in the new genus *Abyssocypris*: *A. pykna*, *A. tipica* and *A.* sp.. According to Maddocks (1977) this genus should be a junior synonym of *Australoecia*, and in her opinion *A. pykna* is an instar of another species of *Australoecia*. In the present paper, we agree that *A. tipica*, *A. pykna* and *A.* sp. could belong to the genus *Australoecia*, but there is no enough data to assume that the type material of *A. pykna* is composed just by juveniles. However, a more conclusive discussion of this subject is beyond the scope of this study.

According to McKenzie (1981), the new genus *Maddocksella* differs from *Australoecia* on the carapace inflation, robustness and the overlap pattern. The adductor scars, however, are typically *Australoecia*-like. McKenzie *et al.* (1991) refer the species *A. osbcura* Whatley & Downing, 1983, *A. argilloeciaformis* Whatley & Downing, 1983 and *A. tumefacta* (Chapman, 1914) McKenzie, 1974 to the genus *Maddocksella*. In the Table 1 of the present paper these three species are assigned to *Australoecia* since we believe that a more detailed discussion on the validity of

Maddocksella is necessary to solve this problem. However, this is also beyond the scope of this study.

Along the Brazilian margin are known just two species of *Australoecia*, *A. atlantica* Maddocks, 1977 and *A. neritica* sp. nov., the last one herein described. *A. atlantica* as recorded by Bergue & Coimbra (2008) for the Late Pleistocene of the Santos Basin is typically bathyal. On the other hand, *A. neritica* sp. nov. has been recovered only for shallow water sediments along the eastern, northeastern and northern shelves (Figure 1). Although taxonomy is the main subject of this paper, the geographic and stratigraphic distributions of the genus *Australoecia* are also briefly discussed.

STUDY AREA

The Brazilian continental margin is around 8.000 km long and is divided in five regions (according Martins & Coutinho, 1981 modified by Machado, 2008): northern (Cape Orange to Cape São Roque), northeastern (Cape São Roque to Belmonte town), eastern (Belmonte town to Cape Frio), southeastern (Cape Frio to Cape Santa Marta) and southern (Cape Santa Marta to Chuí) (Figure 1).

The Brazilian northern shelf presents maximum width of 330-350 km at the Amazon and Pará rivers mouths with mainly terrigenous sediments on the inner shelf and relict biodetritic sediments along the infraneritic region. Carbonate sediments are restricted to the outer shelf and isolated spots on the epineritic region (Martins & Coutinho, 1981; Coutinho, 1993).

In the northeastern region the shelf extends from the coast out to 40-70 km with maximum deep of 60 m. Off Salvador it is just 8 km wide. From Belmonte to Cape Frio (eastern region) it reaches up to 246 km off Caravelas (BA), and decreases its width near Regência (ES) where it has only 48 km. In the southeastern and southern regions the width ranges from 80 up to 230 km off Santos city (SP) (Zembruscki, 1979). Facies carbonate with high $CaCO_3$ concentrations and biodetritic sands dominates in both northeastern and eastern regions, while in the southeastern and southern regions have predominately terrigenous sediments, with small carbonate areas on the outer shelf (Martins & Coutinho, 1981; Coutinho, 1993).

The northern, northeastern and eastern regions (*sensu* Machado, 2008) are under the influence of the warm Guyanas (northern) and Brazil currents. The Guyanas Current (= North Brazil Current) flows northwards along the equatorial margin while the Brazil Current flows southwards in the northeastern and eastern margins. The Brazil Current is a southern branch of the Equatorial South Atlantic Current with an average temperature of ~26ºC and high salinity (> 36.2‰) (Martins, 1984; Stevenson *et al.*, 1998).

On the other hand, the southeastern and southern shelves are affected by the cold waters of the Malvinas (= Falkland) Current. The Malvinas Current originates in subantarctic waters with bottom temperatures of ~4ºC near the Malvinas (= Falklands) Islands. About 35ºS, the Malvinas Current stops flowing northwards at the surface water, and its waters descend under the Brazil Current, flowing along the bottom (Martins, 1984). Near Cabo Frio town (23ºS), Rio de Janeiro State, upwelling the last remains of the Malvinas Current (Coimbra *et al.*, 1995). Along the Brazilian margin, waters of Malvinas Current have a temperature up to 20ºC and its salinity ranges between 33.5‰ to 34.7‰ (Martins, 1984).

MATERIAL AND METHODS

This study is based on 923 samples of dry sediments collected along all the Brazilian shelf by the REMAC Project (coordinated by Petróleo Brasileiro S.A.) and the GEOMAR I, II, III (coordinated by the Brazilian Navy), and more 11 samples collected by the Researcher Vessel "El Austral" in the southernmost Brazil. The majority of the samples were recovered from the neritic zone, while 60 samples were collected in deeper waters (maximum 560 m, many of them in the northern region). The material was provided as dried sediment samples and each one sieved into three size fractions: 0.250, 0.177 and 0.074 mm. Only the first two size fractions were picked totally for Ostracoda, while the last one was too fine and frequently barren. The specimens illustrated herein were photographed using SEM. Additional photos by optical microscopy were taken for accurate description of internal view.

This paper follows the classification of Ostracoda by Liebau (2005). The type material is held in the collections of the Museu de Paleontologia of the Universidade Federal do Rio Grande do Sul, section of Ostracoda (MP-O). **Morphological abbreviations. RV**, right valve; **LV**, left valve; **C**, carapace; **l**, length; **h**, height, **w**, width.

SYSTEMATIC DESCRIPTION

Order PODOCOPIDA Sars, 1866
Suborder CYPRIDOCOPINA Jones, 1901
Superfamily PONTOCYPRIDOIDEA Müller, 1894
Family PONTOCYPRIDIDAE Müller, 1894
Genus *Australoecia* McKenzie, 1967

Type species. *Australoecia victoriensis* McKenzie, 1967.

Diagnosis. A pontocyprid ostracode genus with very stout, smooth, egg-shaped carapace, usually quite large and asymmetrical, with either right or left valve overlap. Adults with very broad duplicature, irregular line of concrescence, narrow anterior vestibule, fine radial pore-canals; rather large pontocyprid muscle-scar pattern situated centrally, consisting of five wedge-shaped scars close-packed in rosette; hinge robust, adont (Maddocks, 1977; only carapace).
Remarks. Although the emended diagnosis proposed by Maddocks (1977) is more appropriate to the present knowledge of this genus, it is quite important to note that some species are not typically egg-shaped in lateral view, such as *Australoecia neritica* sp. nov. herein described. Even the type-species is clearly elongate in lateral view as described and figured by McKenzie (1967). According to Mark

Figure 1. Map of the Brazilian continental shelf indicating location of the 44 samples with *Australoecia neritica* sp. nov..

Warne (per. comm., 2010) the material studied by McKenzie (1967) are also not particularly robust, similar to the new species herein described.

Australoecia neritica sp. nov.
(Figures 2A-I)

1995 *Australoecia whatleyi* (*nom. nudum*) Coimbra, p. 36-38, pl. 1, figs. 8-10.

1999 *Australoecia* sp. Coimbra, Pinto, Würding & Carmo, p. 372, tab. 1.

2005 *Australoecia*? sp. Machado, Coimbra & Carreño, p. 240, pl. 1, fig. 7.

2008 *Australoecia whatleyi* (*nom. nudum*) Machado, p. 46-48, text-fig. 16, pl. 1, fig. 14.

Etymology. With reference to its bathymetric distribution.
Holotype. MP-O-2145, RV, l: 0.55 mm, h: 0.22 mm.

Paratypes. MP-O-2146, LV, l: 0.52 mm, h: 0.21 mm, Geomar II, sample 101; MP-O-2147, juvenile, RV, l: 0.47 mm, h: 0.19 mm, Geomar II, sample 108; MP-O-2148, C, l: 0.55 mm, w: 0.24 mm, Remac Leg 7, sample 3961; MP-O-2149, C, l: 0.54 mm, w: 0.25 mm, Remac Leg 7, sample 3847; MP-O-2150, LV, l: 0.52 mm, h: 0.20 mm, Remac Leg 7, sample 3819; MP-O-2151, LV, l: 0.53 mm, h: 0.21 mm, Geomar III, sample 192; MP-O-2152, LV, l: 0.55 mm, h: 0.25 mm, Remac Leg 7, sample 3780; MP-O-2153, RV, l: 0.53 mm, h: 0.25 mm, Remac Leg 7, sample 3846.

Material. Nine carapaces and 74 valves of adults and juveniles.

Type locality. Geomar II, sample 108, 03º03´N/49º02´W.

Age. Holocene.

Distribution. Brazilian continental shelf (between 04º58'N/51º07'W and 22º42'S/41º51'W).

Occurrence. See Table 2.

Diagnosis. Carapace small, delicate, subrectangular elongate in lateral view. LV larger than and overlapping RV. Dorsal and ventral margins subrectilinear; posterior rounded; anterior obliquely rounded. In dorsal view subelliptical. Anterior vestibule large; posterior vestibule small and subparallel to the margin.

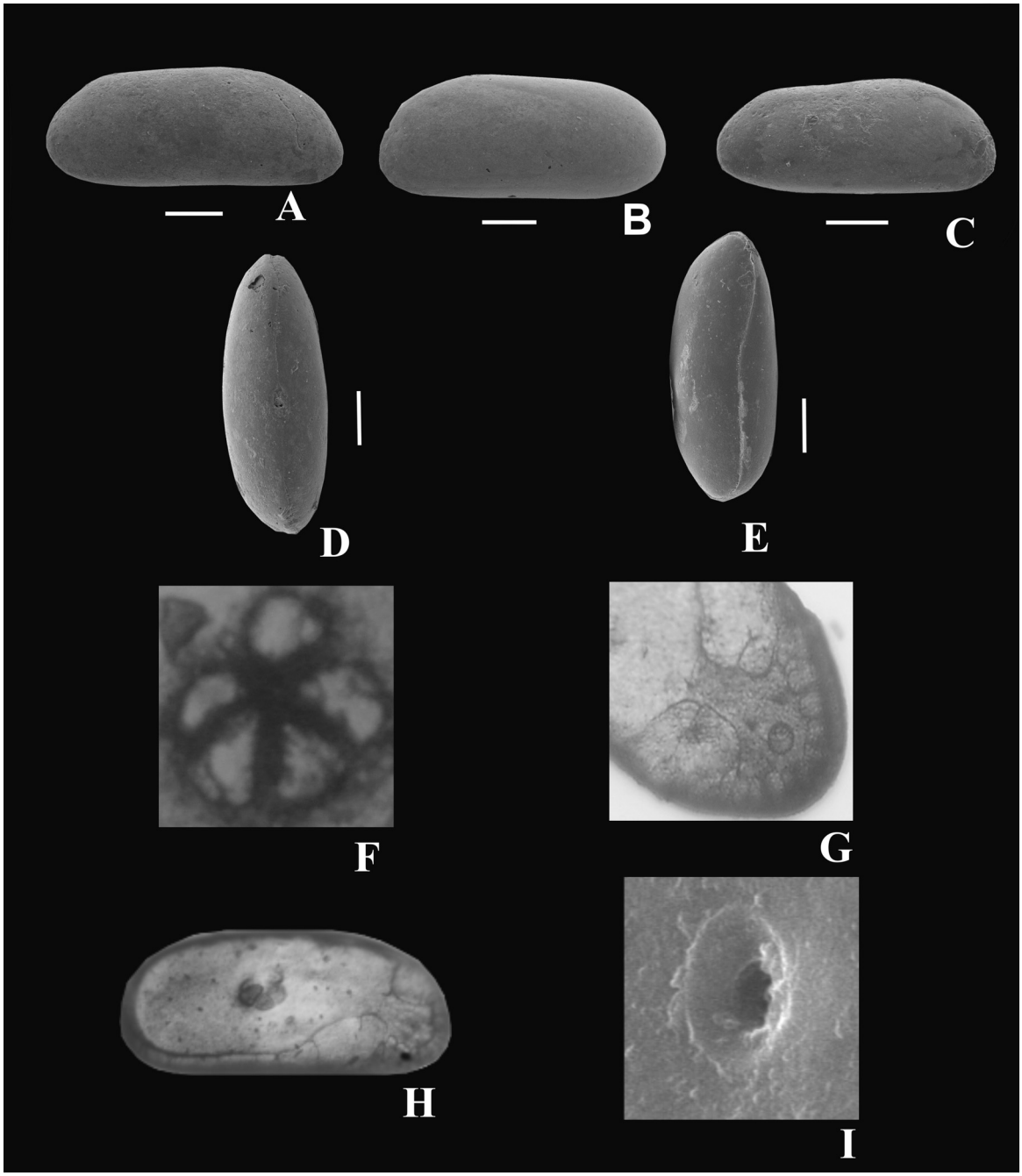

Figure 2. A-I, *Australoecia neritica* sp. nov.: **A**, holotype, RV, MP-O-2145; **B**, paratype, LV, MP-O-2146; **C**, paratype, juvenile, RV, MP-O-2147; **D**, paratype, dorsal view, C, MP-O-2148; **E**, paratype, ventral view, C, MP-O-2149; **F**, paratype, detail of central muscle scars, LV, MP-O-2151; **G**, paratype, detail of anterior vestibule, LV, MP-O-2152; **H**, paratype, internal view, LV, MP-O-2150; **I**, paratype, detail of a rimmed normal pore canal, RV, MP-O-2153. F-I not in scale. Scale bars = 100 µm.

Description. Small. Shell of medium thickness, somewhat fragile and subrectangular elongate in lateral view. Greatest height approximately anterior. LV overlapping RV along the free margin especially ventrally. Dorsal and ventral margins subrectilinear; posterior rounded; anterior obliquely rounded. Surface smooth. Normal pore canals rimmed and scattered. In dorsal view subelliptical; greatest width at mid-length; ends subacuminate. Internal features typical of the genus. Inner lamellae broad with a large and deep vestibule anteriorly; posterior vestibule small and subparallel to the margin. Marginal pore canals branched, more developed anteriorly. Hinge adont. Central muscle scars large, five in number, arranged in a characteristic radial pattern. Sexual dimorphism not observed.

Remarks. This species is somewhat similar to *Australoecia argilloeciaformis* Whatley & Downing, 1983 from the Miocene of Vitoria, Australia, but differs mainly by the small size, anterior vestibule more developed, and central muscle scars grouped somewhat more loosely.

ECOLOGICAL AND PALEOECOLOGICAL COMMENTS

Although many fossil and living species of this genus are bathyal dwellers, the new species herein described is part of a smaller group of shallow water species of *Australoecia* (Figure 3). The 44 samples with specimens of *Australoecia neritica* sp. nov. were collected between 23 and 114 m depth (Table 2). Most of the samples were recovered from biodetritic sands (Figures 4). *Australoecia neritica* sp. nov. is typically a warm water infraneritic ostracode whose distribution along the Brazilian margin ranges from the northern continental shelf to the eastern one (between 04º58'N/51º07'W and 22º42'S/41º51'W) (Figure 1).

As has been discussed since Maddocks (1977), *Australoecia* includes two morphological groups discriminated by outline. The first one has elongate-oblong lateral outline with rounded ends. The second group possesses ovate-subtrapezoidal lateral outline and somewhat pointed posterior end. According to Maddocks (1977) and Nikolaeva (1981) the first group is neritic while the ovate-subtrapezoidal species are typically bathyal ostracodes. The carapace of *Australoecia neritica* sp. nov. is subrectangular elongate with both ends rounded and agrees with the ecological conclusions of Maddocks (1977) and Nikolaeva (1981). Thus, although it is important to be cautious when using this genus as a palaeobathymetrical tool, it is worthy highlighting that it is very likely that these two morphological groups characterize two distinct palaeoenvironments.

Table 1. Published records of *Australoecia* with ages and geographic occurrences. The number refers the authors (ordered by date) that registered the species. [1]Bold (1960); [2]Mckenzie (1967); [3]Maddocks (1969); [4]Bold (1974); [5]McKenzie (1974); [6]Bonaduce *et. al*. (1975); [7]Maddocks (1977); [8]Pokorný (1979); [9]Dingle (1980); [10]Steineck (1981); [11]Nikolaeva (1981); [12]Whatley & Downing (1983); [13]Coles & Whatley (1989); [14]Mckenzie *et. al*. (1991); [15]Dingle (1993); [16]Boomer (1999); [17]Coimbra *et. al.* (1999); [18]Barra & Bonaduce (2001); [19]Ciampo (2004); [20]Machado *et. al*. (2005); [21]Bergue & Coimbra (2008); [22]in this paper. **Geological time abbreviations: E**, Eocene; **H**, Holocene; **K**, Cretaceous; **M**, Miocene; **O**, Oligocene; **P**, Pliocene; **Q**, Quaternary; **R**, Recent; **T**, Tertiary. **Geographical abbreviations: A.S.**, Adriatic Sea; **Aus.**, Australia; **Carib.**, Caribbean Sea; **I.O.**, Indian Ocean; **M.C.**, Mozambique Channel; **M.S.**, Mediterranean Sea; **NE A.**, Northeasthern Atlantic Ocean; **Russ.**, Russia; **P.O.**, Pacif Ocean; **SE A.**, Southeastern Altantic Ocean; **SW A.**, Southwesthern Atlantic Ocean. For a more detailed discussion of species with doubtful generic position, read the Introduction.

Species	Locality										
	A.S.	Aus.	Carib.	I.O.	M.C.	M.S.	NE A.	Russ.	P.O.	SE A.	SW A.
A. abyssophilia					R[3]						
A.? argilloeciaformis		E-O[14]-M[12]									
A. atlantica										R[7]	Q[21]
A. cf. *A. micra*									O[16]		
A. fulleri										Q[15]	
A. mckenziei		R[3]									
A. micra	Q[6,19]										
A. neritica sp. nov.											H[17,20,22]
A.? obscura		O[14]-M[12]									
A. palavensis								O[8]			
A. polita								E[11]			
A. posteroacuta							E-O[13]				
A. posterocurva						M[18]					
A. richardbayensis				K[9]							
A. sp. 1									R[3]		
A.? tumefacta	O[14]-T[5]										
A. victoriensis		R[2]									
A.? pikna			M[1]								
A.? sp.			T[4]								
A.? tipica			M[4,10]-P[4]								

Table 2. Occurrence of *Australoecia neritica* sp. nov. along the Brazilian margin.

Project	Samples	Coordinates	Depth (m)	Sedimentology
Geomar I	08	02°04'S/42°43'W	67	Biodetritic sand
Geomar II	97	02°24'N/48°38'W	77	Muddy sand
	99	01°22'N/48°38'W	76	Muddy sand
	101	02°56'N/49°12'W	70	Quartz sand
	103	03°13'N/49°28'W	77	Muddy sand
	105	03°29'N/49°28'W	76	Biodetritic sand
	106	03°19'N/49°19'W	82	Muddy sand
	108	03°03'N/49°02'W	97	Quartz sand
	111	02°40'N/48°43'W	83	Biodetritic sand
	118	02°45'N/49°08'W	83	Biodetritic sand
Geomar III	166	02°15'N/48°15'W	68	Biodetritic sand
	169	02°27'N/47°45'W	114	Biodetritic sand
	180	04°51'N/50°51'W	81	Quartz sand
	182	04°40'N/50°46'W	80	Quartz sand
	184	04°26'N/50°25'W	79	Biodetritic sand
	185	04°20'N/50°18'W	86	Quartz sand
	187	04°04'N/50°06'W	90	Biodetritic sand
	188	03°47'N/50°01'W	88	Biodetritic sand
	189	03°50'N/49°55'W	69	Biodetritic sand
	190	03°42'N/49°49'W	86	Biodetritic sand
	192	03°24'N/49°51'W	70	Sandy mud
	199	03°47'N/49°42'W	91	Biodetritic sand
	202	04°28'N/50°46'W	70	Biodetritic sand
	203	04°39'N/50°53'W	71	Biodetritic sand
	204	04°47'N/50°59'W	70	Quartz sand
	2500	04°58'N/51°07'W	67	Quartz sand
	2522	02°44'N/48°47'W	84	Biodetritic sand
Remac Leg 6	3608	00°14'N/44°56'W	66	Biodetritic sand
	3616	00°49'S/44°00'W	40	Biodetritic sand
	2672	02°09'S/42°15'W	60	Biodetritic sand
	3699	02°21'S/39°56'W	35	Biodetritic sand
	3711	02°33'S/39°47'W	23	Biodetritic sand
Remac Leg 7	3780	10°32'S/36°11'W	24	Biodetritic sand
	3819	16°23'S/38°35'W	46	Biodetritic sand
	3820	16°24,5'S/38°30'W	51	Biodetritic sand
	3846	16°38'S/38°45'W	40	Biodetritic sand
	3847	16°46'S/38°44'W	42	Biodetritic sand
	3860	19°03'S/38°59'W	51	Terrigenous and biodetritic sand
	3892	17°59'S/38°01'W	49	Terrigenous and biodetritic sand
	3899	18°27,5'S/37°52'W	71	Biodetritic sand
	3902	18°24'S/38°24'W	48	Biodetritic sand
	3921	20°46'S/40°19'W	27	Biodetritic sand
	3943	22°31'S/40°38'W	91	Terrigenous and biodetritic sand
	3961	22°42'S/41°51'W	37	Terrigenous and biodetritic sand

Species	Bathymetrical distribution					
	Epineritic (< 40 m)	Infraneritic (40 - 200 m)	Upper bathyal (201 - 500 m)	Middle bathyal (501 -1000 m)	Lower bathyal (1001 - 2000 m)	Bathyabyssal (> 2001 m)
A. abyssophilia Maddocks, 1969				▨	▨	▨
A. altantica Maddocks, 1977				▨	▨	▨
A. fulleri Dingle, 1993		▨	▨			
A. mckenziei Maddocks, 1969	▨					
A. micra (Bonaduce, Ciampo & Masoli, 1975)		▨	▨			
A. neritica sp. nov. (in this paper)	▨	▨				
A. sp. 1 Maddocks, 1969						▨
A. victoriensis McKenzie, 1967	▨					

Figure 3. Bathymetrical distribution of Recent species of *Australoecia* McKenzie, 1967.

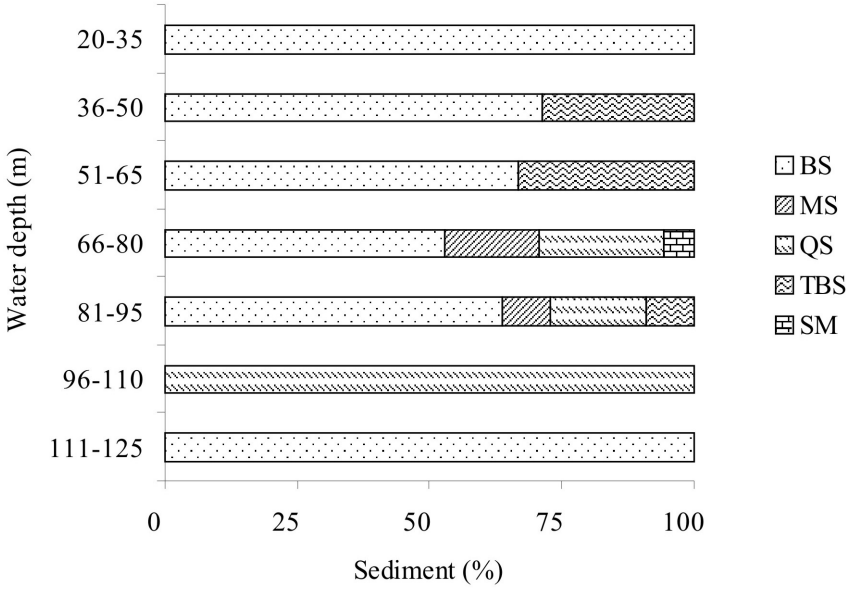

Figure 4. Proportion of sediment type by depth in the 44 samples containing *Australoecia neritica* sp. nov.. **Abbreviations: BS**, biodetritic sand; **MS**, muddy sand; **QS**, quartzose sand; **TBS**; terrigenous biodetritic sand; **SM**, sandy mud.

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