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Range extension of *Guyanella clenchi* (Altena, 1968) (Bivalvia, Lucinidae) with new records from Abrolhos Bank, Brazil

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Abstract
Guyanella clenchi (Altena, 1968) is newly reported from Abrolhos Bank, northeastern Brazil. The new records extend the distribution of this species to the Southern Atlantic and reinforce the known overlap between the Caribbean and South American marine faunas. Even though it inhabits well-sampled regions, *G. clenchi* is a poorly known species which is not well represented in collections. The new occurrence of the species in the Southern Atlantic draws attention to the necessity of further improvement in sampling strategies aimed at filling in the distribution gaps of species.

Keywords
Marine faunas, Mollusca, occurrence, overlapping distribution, sampling, Southwestern Atlantic.

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Introduction

Lucinidae is one of the most diverse families of marine bivalves. It contains approximately 380 species divided into nearly 100 globally distributed genera, ranging from intertidal to great depths and inhabiting a vast array of marine habitats (Mikkelsen and Bieler 2007, Taylor et al. 2014, Taylor and Glover 2016, MolluscaBase 2019). About 40 lucinid species are known from the Western Atlantic, most of which show a relatively broad distribution that encompasses the American coast and the Caribbean islands (Taylor and Glover 2016). However, discrete differences in species compositions can be noticed in some regions in the Western Atlantic due to restricted distributions (Taylor and Glover 2016).

Lucinids show a diverse range of shell sizes, with length varying from 1.5 to over 150 mm (Mikkelsen and Bieler 2007, Huber 2015). Their shells are usually round to elliptical, white or cream-coloured externally, and covered by a thin or thick periostracum. External surface sculpture can include several structures from simple growth lines to individualized/mixed radial and concentric ribs, divaricated patterns, or even scales. Internal valve surface is usually white or cream in colour, but some species have pink or yellow shell margins. The muscle scar pattern is dimyarian and anisomyarian, with the anterior adductor muscle commonly differing in length and thickness from the posterior one (Taylor and Glover 2000). The pallial line is continuous and its attachment to the anterior surface of the anterior adductor muscle is dislocated from the muscle's ventral surface (Taylor and Glover 2006). The hinge in lucinids can show various combinations of cardinal and lateral teeth or lack teeth entirely. Anatomically, the family is characterized by 1) an incomplete

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ctenidia with the outer demibranch absent and a pair of thick inner demibranchs present, which carry chemosymbiotic sulfide-oxidizing bacteria; 2) reduced labial palps; 3) the presence of a simple excurrent siphon, and, in some species, the presence of longitudinal mantle folds known as pallial gills that can be used as an extra-surface for gas exchange (Allen 1958, Reid and Brand 1986, Hickman 1994, Taylor and Glover 2000).

The monospecific genus *Guyanella* Taylor & Glover, 2016 was introduced to accommodate *Guyanella clenchi* (Altena, 1968) (Fig. 1A–O) for reflecting recent phylogenetic hypotheses based on molecular data (Taylor and Glover 2016, Taylor et al. 2016). Beyond the type locality in Suriname, *G. clenchi* has been formally recorded in Guadeloupe, Colombia and French Guiana since the original description (Fig. 2) (Altena 1968, Merlano and Hegedus 1994, Taylor and Glover 2016).

Methods

***Guyanella clenchi* types and samples.** Thirty-eight specimens of *Guyanella clenchi* were found in sediment samples collected at Abrolhos Bank, Bahia, Brazil (Fig. 2A, B). Specimens were sampled at 2 locations in the Parcel de Abrolhos, respectively at 18 and 20 m depth, on 25 July 2007 and 27 January 2008. The 38 specimens analyzed are deposited in the Malacological Collection of Museu de Zoologia of University of São Paulo (MZSP), Brazil and of the Museu Nacional of Rio de Janeiro, Brazil. The status of the MNRJ specimens is currently unknown, as they may have been lost to the recent tragic fire of September 2018, which destroyed a significant part of the invertebrate collections. Specimens were photographed and examined under a scanning electron microscope (SEM) at the Museu de Zoologia of the University of São Paulo. For standard deviations in shell measurements only the MZSP lots were used.

Images of the type material of *G. clenchi* were also examined: holotype, RMNH.MOL.55774 (Fig. 1A–D), 2 paired valves, off the coast of Suriname, from a shell of "*Murex brevifrons*" Lamarck, 1822"; paratypes: RMNH.MOL.55778, 1 left valve, from the fifth trip of the Coquette, 29.IV–3.V.1957, NNW of the Marowijne River, ca 30 miles off the coast, down to 36.57 m; RMNH.MOL.55776, 1 right valve, from a tube of the polychaete *Diopatra cuprea* (Bosc), Marian H. Pettibone det., Coquette Sta. 197, 06°22.5′N, 055°10′00″W, 10.VI.1957, 20.11 m; RMNH.MOL.55775, one left valve, from the same locality as the holotype (SM); RMNH. MOL.55777, 1 right valve, from off the coast of Suriname, precise locality and date unknown.

Study area. The Abrolhos Bank (17°20′–18°00′S and 038°30′–039°30′W) (Fig. 2B) is a 200 km thickening of the Eastern Brazilian Continental Shelf that harbours the largest and richest coral reef complex of the Southern Atlantic (Leão 1999, Leão et al. 2003; Nunes et al. 2016). The local reef structures differ from their Caribbean counterparts by their morphology, sediment types, and organisms involved in their construction (Leão 1999, Leão et al. 2003, Zilberberg et al. 2016). The main reef formations in the Abrolhos Bank are known as Chapeirões, giant mushroom-shaped structures reaching up to 5–25 m high and 5–50 m in diameter (Barreira and Margarida 1994, Leão 1999, Leão et al. 2003, Zilberberg et al. 2016). The reefs are usually parallel to the coast and form 2 arcs (Leão 1999, Leão et al. 2003), the coastal arc, located roughly 10–20 km from the coast, and the external arc, located approximately 5 km east of the Abrolhos Archipelago (17°58′S, 038°42′W). Both arcs are separated from the coast by the Sueste Channel and from each other by the Abrolhos Channel (Meyerhöfer and Marone 1996). The Parcel de Abrolhos (17°59′S, 038°39′W) is part of the external arc, located eastwards from the Abrolhos Archipelago. The Parcel extends about 11 km in a north–south direction and 5 km in a east–west direction in waters deeper than 25 m (National Geospatial-Intelligence Agency 2017).

Results

New records. Brazil, south coast of the Bahia state: Abrolhos, Parcel de Abrolhos (17°58′20″S, 038°40′26″W), in calcium carbonate substrate, 20 m depth, Ana Maria Setubal Pires-Vanin and Flávia Maria Pereira Costa leg., 27.i.2008 (5 specimens, MZSP 136469); (17°58′22″S, 038°41′03″W), 18 m, A.M.S. Pires-Vanin and F.M.P. Costa leg., 25.vii.2007 (2 specimens, MNRJ 23172); (17°58′22″S, 038°41′03″W), 18 m, A.M.S. Pires-Vanin and F.M.P. Costa leg., 27.i.2008, (3 specimens, MNRJ 23173); (17°58′22″S, 038°41′03″W), 18 m, A.M.S. Pires-Vanin and F.M.P. Costa leg., 27.i.2008, (2 specimens, MNRJ 23174); (17°58′20″S, 038°40′26″W) 20 m, A.M.S. Pires-Vanin and F.M.P. Costa leg., 27.i.2008, (1 specimen, MNRJ 23175).

Identification. Valves of small size (maximum length of 2.2 ± 0.44 mm, maximum height: 1.85 ± 0.36 mm), elliptical (Fig. 1E, F, J, K), inflated (Fig. 1G), white colour. Umbo narrow and high located at posterior half of shell length (Fig. 1A–F, J, K). Prodissoconch, PI 157 μm, PI + PII: 187 μm, smooth, PII starting in a discreet groove. Lunule and escutcheon (Fig. 1G, J, K, M, N) present. Lunule lanceolate, medium-sized and slightly asymmetrical. Escutcheon long and narrow. External shell sculpture comprising close-spaced concentric lamellae (Fig. 1E, H) microscopically adorned by rows of small denticles projecting from the lamellae margin (Fig. 1H, I). Concentric lamellae may form discreet longitudinal scales at anterior and posterior extremities of shell (Fig. 1A, C). Internal surface white. Muscle scars and pallial line visible (Fig. 1J, K). Anterior and posterior adductor muscle scar present, similarly sized. Anterior adductor muscle scar short. Pallial line entire and connected at ventral edge of anterior adductor muscle scar. Internal ventral shell margin bordered by small nodules, which create a crenulated

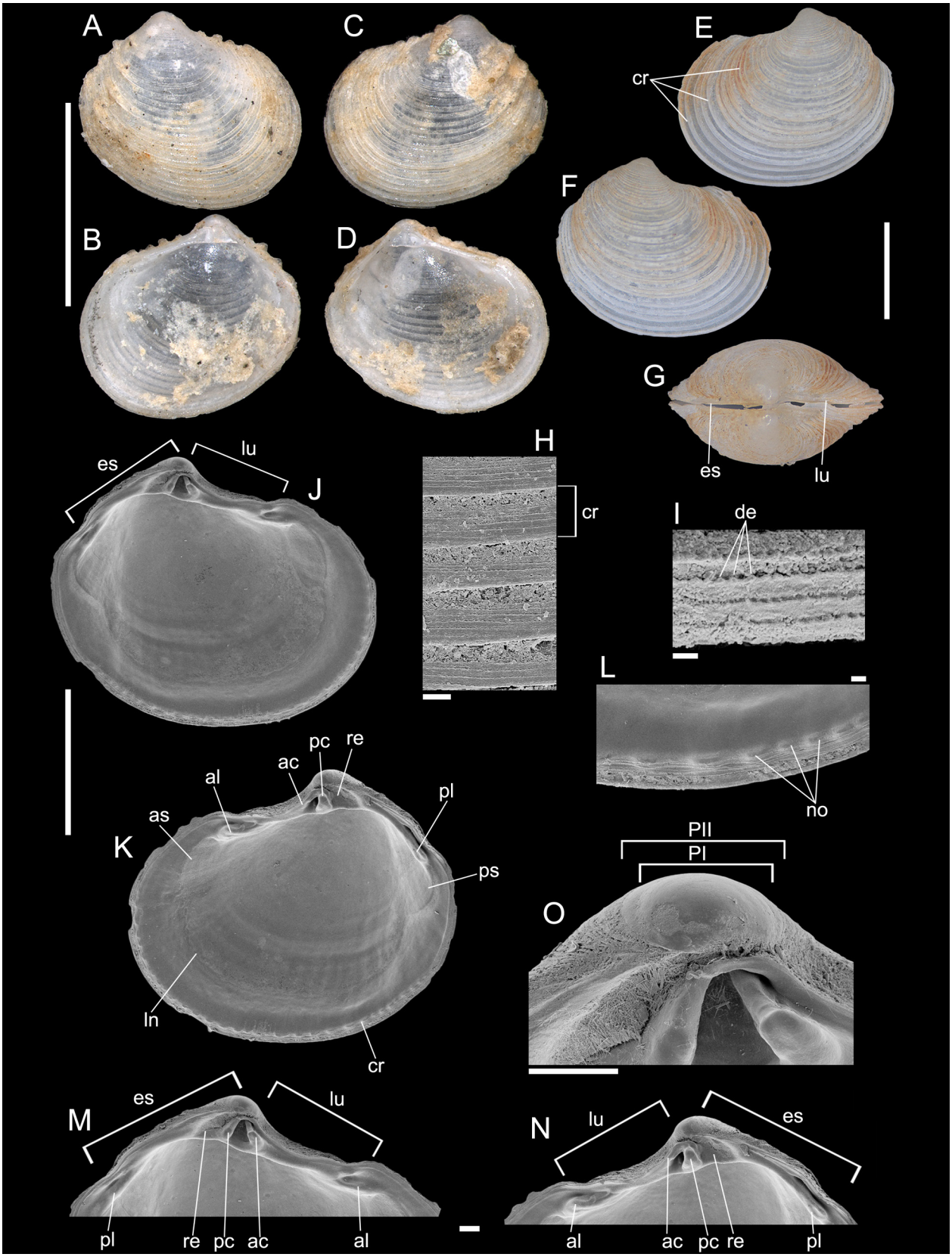

Figure 1. *Guyanella clenchi*. **A–D.** Holotype of *Lucina* (*Parvilucina*) *clenchi* (RMNH.MOL.55774, © Naturalis). **A.** Right valve, external view. **B.** Right valve, internal view. **C.** Left valve, external view. **D.** Left valve, internal view. **E–O.** Specimen of *Guyanella clenchi* from Abrolhos Bank (MZSP 136469, L: 2.2 mm, H: 1.85 mm, W: 1.3 mm). **E**. Left valve, external view. **F.** Right valve, external view. **G.** Dorsal view. **H.** Concentric ribs under SEM, showing the presence of micro sculpture **I.** Concentric rib under SEM showing micro sculpture of micro denticles. **J.** Left valve, internal view under SEM. **K.** Right valve, internal view under SEM. **L.** Internal shell border under SEM, detail in shell border crenulation created by small nodules. **M.** Left hinge detail, SEM. **N.** Right hinge detail, SEM. **O.** Umbo with detail of prodissoconch under SEM, showing Prodissoconch I and Prodissoconch II. Scale bars: **A–G, J, K:** 1 mm; **H:** 10 µm; **I:** 3 µm; **L:** 30 µm; **M–O:** 100 µm. Abbreviations: **ac**: anterior cardinal tooth; **al**: anterior lateral tooth; **as:** anterior adductor muscle scar; **cr**: concentric rib; **de**: denticles; **es**: escutcheon; **ln:** pallial line; **lu**: lunule; **no**: nodule; **pc**: posterior cardinal tooth; **PI**: prodissoconch I; **PII**: prodissoconch II; **pl**: posterior lateral tooth; **ps**: posterior adductor muscle scar; **re**: resilifer.

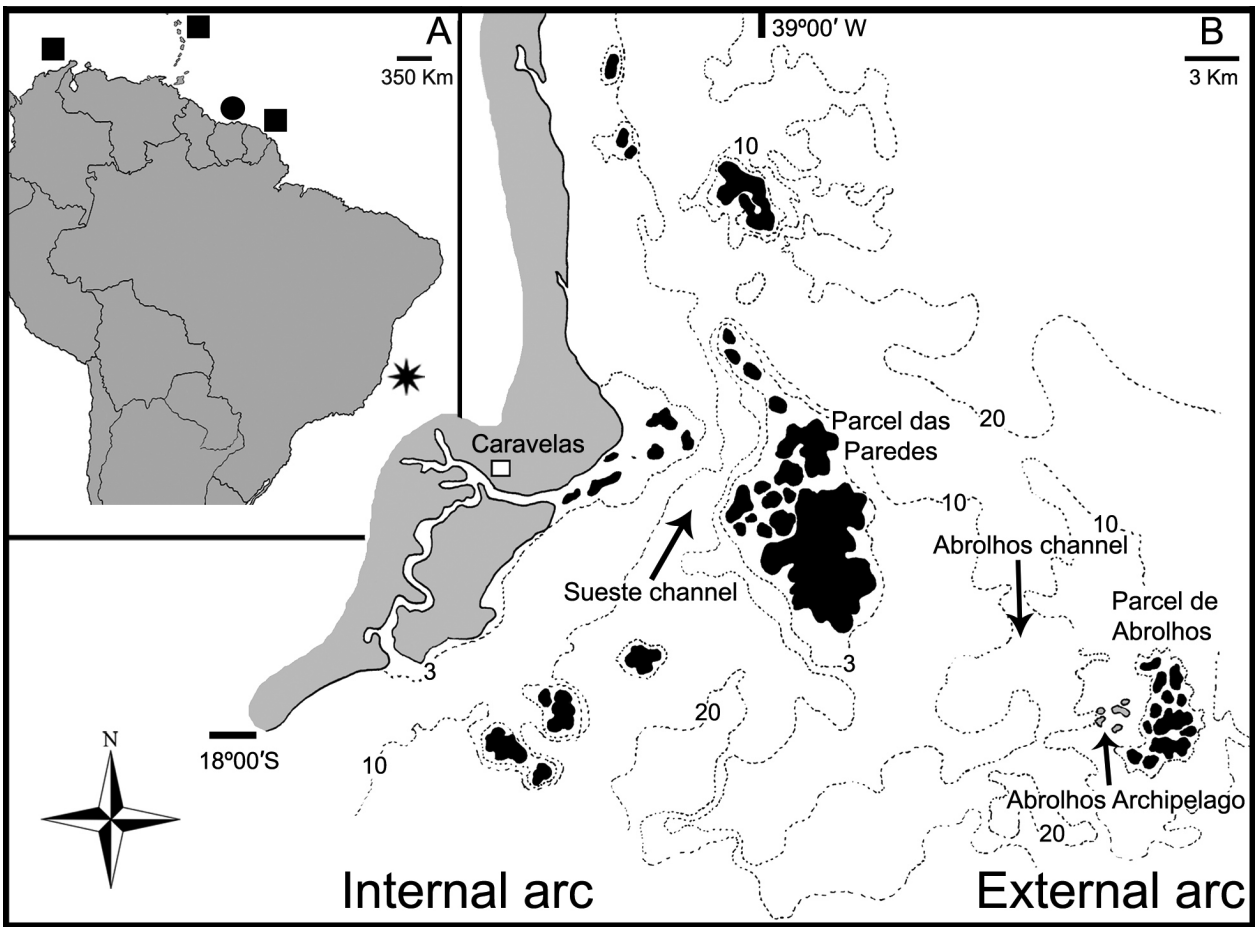

Figure 2. Distribution of *Guyanella clenchi* along the Caribbean and the South American coast, Abrolhos Bank region in detail. **A.** Southern Caribbean and South America map. Circle: Type locality. Square: Subsequent records. Star: New records reported herein. **B.** Abrolhos Bank region. Dark spots represent coral reefs (adapted from Meyerhöfer and Marone 1996, Leão 1999).

aspect (Fig. 1J–L). Hinge composed of anterior and a posterior cardinal teeth and anterior and posterior lateral teeth (Fig. 1M, N). Left valve presenting similarly sized and shaped anterior and posterior cardinal teeth (Fig. 1M). Right valve presenting differingly sized and shaped cardinal teeth; the posterior cardinal tooth wider than the anterior one (Fig. 1N). Ligament short, mostly internal, inserted in a small and deep resilifer located posteriorly to posterior cardinal tooth (Fig. 1J, K, M, N).

Discussion

Range of *Guyanella clenchi*. The specimens were found inhabiting soft sediments mostly composed of calcium carbonate imported from the reef structures present in the Abrolhos area, with contributions from in situ benthic community production (Dutra et al. 2005). The biotope and bathymetrical range of the Abrolhos samples are within the known range of the species, that is, soft sediments at depths of 20–100 m in tropical waters (Merlano and Hegedus 1994, Rosenberg 2009). The new records provide relevant information on the living habits of *G. clenchi* because *G. clenchi* was originally described from disarticulated valves attached to the periostracum of gastropods and tubular structures constructed by polychaetes (Altena 1968).

Overlap of the Caribbean and South American marine faunas. The new geographic data available for *G. clenchi* suggests that this species may have a continuous distribution from the Caribbean to northeastern Brazil. This geographical pattern can be found in many other mollusc species (Mikkelsen and Bieler 2007, Rios 2009, Taylor and Glover 2016) and other marine invertebrates (Barreira and Margarida 1994), despite high endemism of coral species (Leão 1999, Segal and Castro 2000, Leão and Kikuchi 2001, Nunes et al. 2016, Zilberberg et al. 2016) and reef fish (Moura 2000, Dutra et al. 2005, Nunes et al. 2016) occurs at Abrolhos Bank. Moreover, Absalão (2005) suggested that the region may constitute a discreet biogeographical unity, with as much as 12.9% of the mollusc species being endemic, although not other groups, like Crustacea and Polychaeta (Dutra et al. 2005). The Caribbean and Brazilian coast share oceanographic features of tropical waters as high mean temperature and salinity throughout the year. Additionally, although the depth range of the specimens collected in Abrolhos is in accordance with previous records (20–100 m) (Merlano and Hegedus 1994, Rosenberg 2009), these new geographical records extend the distribution of this species far south in the Atlantic.

Knowledge about Western Atlantic Lucinidae. Besides the occurrence records (Altena 1968, Merlano and Hegedus 1994, Taylor and Glover 2016), additional information on *G. clenchi* is very scarce compared with other lucinid species that have a similar distribution, such as *Clathrolucina costata* (d'Orbigny, 1845) (e.g. Abbott 1974, Merlano and Hegedus 1994, Redfern 2001, Mikkelsen and Bieler 2007, Taylor and Glover 2016) and *Divalinga quadrisulcata* (d'Orbigny, 1842) (e.g. Merlano and Hegedus 1994, Redfern 2001, Mikkelsen and Bieler 2007, Rios 2009, Taylor and Glover 2016). Both have been commonly collected in the Caribbean and the coast of Brazil, while *G. clenchi* rarely appears on any accounts. The lack of records mostly likely can be attributed to the small size of the species. However, *Loripes cryptella* (d'Orbigny, 1846) and *Miltha childrenae* (Gray, 1825) are also Western Atlantic lucinid species that are rare in collections and with little information (Taylor and Glover 2016) despite their large sizes (e.g. *M. childrenae* is the third largest species within Lucinidae, reaching over 140 mm in length; Huber 2015). Therefore, the scarcity of information on these species, including *G. clenchi*, is probably a reflection of the lack of sampling, the inadequacy of the sampling methods and in particular sieve size, and the paucity of trained taxonomists able to detect rare species and the morphological differences between juveniles and minute adults.

The present records draw attention to the need to improve sampling methods and strategies in the Western Atlantic, at least for lucinids and other bivalves with miniature adults. Though the Western Atlantic Lucinidae have been studied for more than 150 years (e.g. Dall 1901), the basic biology, distribution, and life history of most species remain virtually unknown. The fact that even in well-sampled areas there are still species we know little about shows that the local sampling carried out until now are insufficient for consistent taxonomic, biological, and biogeographic studies. Additional sampling in the Caribbean and along the Brazilian coast are highly recommended using better sampling equipment and techniques, which might include dredges of several mesh sizes, box corers, and scuba diving, for instance.

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Authors' Contributions

The specimens were provided by FMPC and AMSP-V, and the identification was provided by BLV-R. The specimens were collected by AMSP-V through the Multidisciplinary Research Project PROABROLHOS/BENTOS (process #420219/2005-6). The authors declare that they have no conflict of interest.

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