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Rock pool malacofauna from a Marine Protected Area in Rio de Janeiro (Brazil)

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ABSTRACT

A survey of mollusks was carried out in a rock pool on Redonda Island at the Monumento Natural das Ilhas Cagarras, a new marine protected area in Rio de Janeiro state, Brazil. A total of twenty-four species (thirteen gastropods, nine bivalves, one chiton and one cephalopod) with different feeding modes were recorded in the rock pool. Many mollusks species were found in a small and shallow area, a very fragile habitat that can suffer from human disturbances, deserving urgent management planning.

Keywords: Conservation, mollusks, Monumento Natural das Ilhas Cagarras.

INTRODUCTION

Rock pools are uneven habitats with specific environmental conditions, differing from intertidal habitat for organisms are not exposed to the air during low tide. The physical conditions vary much less than those on the emergent rock (Little *et al*. 2009), as they are not subject to the tidal cycles of submersion and air exposure (Bertocci *et al*. 2012). On the other hand, rock pools have greater fluctuations of water temperature, salinity and pH, when compared to habitats in the subtidal zone (Bertocci *et al*. 2012).

Rock pools provide excellent conditions for the study of the factors governing the structure of ecological communities, mainly because they are very small and structurally simple habitats (Ranta 1982). Biotic communities of rocky pools are less studied than those of the emergent substrate (Metaxas & Scheibling 1993). Moreover, most of the attention in tropical regions is given to the macroalgae assemblages in the rock pools (Araújo *et al*. 2006; Hayes 2007; Martins 2007) rather than to other components of these communities.

Considering the lack of knowledge on rock pool habitats, the aim of the present study is to report the malacofauna in the unique rock pool in the Monumento Natural das Ilhas Cagarras (Rio de

Janeiro, Brazil), also discussing some potential trophic relationships. The potential impact sources for this single rock pool are also discussed, looking for a synergic monitoring and protective approach.

MATERIAL AND METHODS

Study Area

The Monumento Natural das Ilhas Cagarras (MoNa Cagarras) was established on April 13, 2010, and is the first integral marine protected area (MPA) situated on the coast of Rio de Janeiro city, in southeast Brazil. This MPA comprises four inner islands (Cagarra, Filhote da Cagarra, Palmas and Comprida Islands), forming the Cagarras Archipelago, and two outer islands (Redonda and Filhote da Redonda Islands) (Fig. 1).

The proximity of this insular system to a large urban center makes the access easy to visitors, such as amateur fishermen and sportsmen. The Ipanema submarine outfall (about 2 km from Cagarras Archipelago) discharges into the sea about 6.5 m^3/s of raw sewage. The eutrophic waters from Guanabara Bay usually reach the islands (VAN WEERELT *et al*. 2013).

The present work was conducted in a single rock pool on the north face of Redonda Island (23º05'S 43º12''W), about 9 km south from Ipanema beach (Fig. 1). The rock pool forms a sheltered habitat of about 7 x 4 m by 1.5 m of maximum depth, connected with the surrounding sea in high tides (maximum tide in the region is 1.6 m) or under strong swell (Fig. 1).

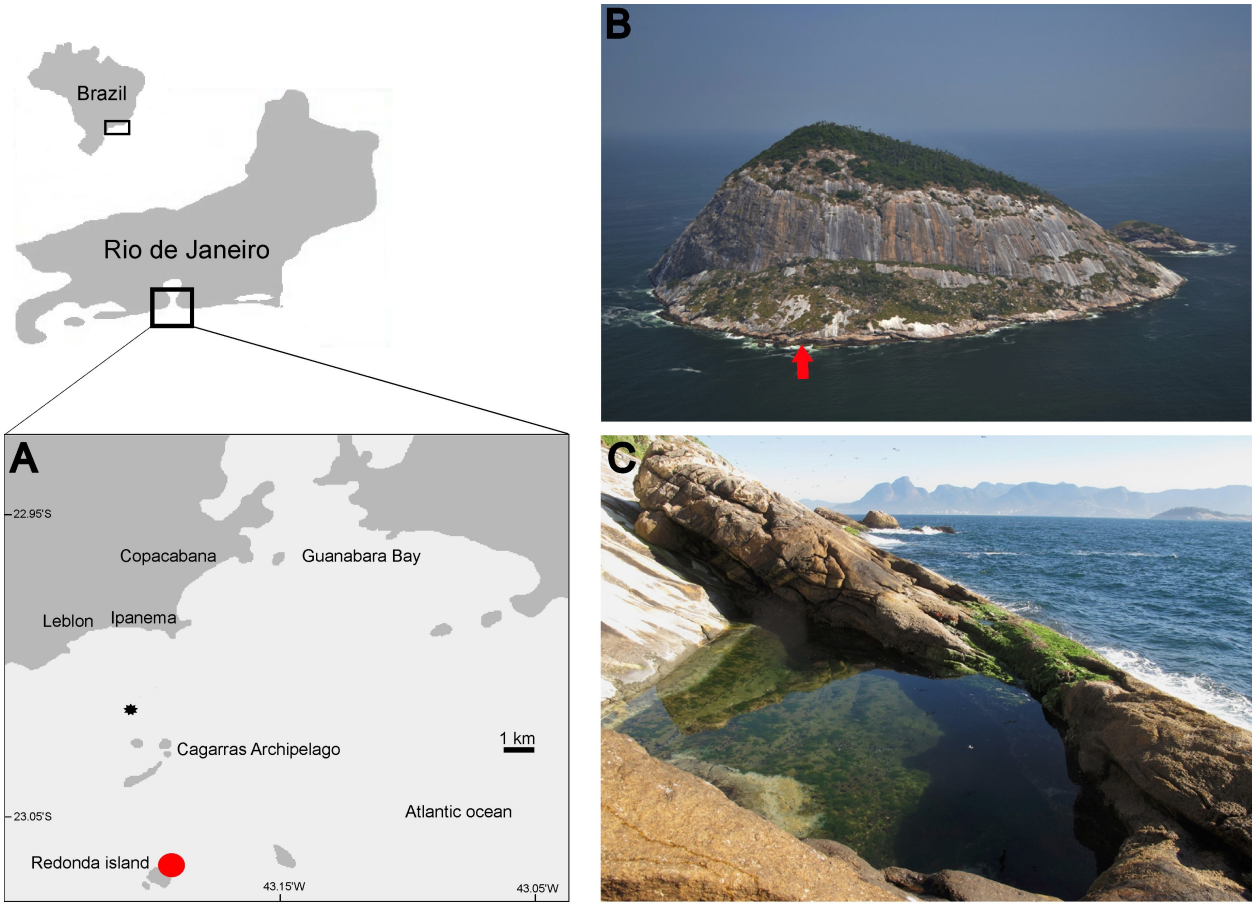

Fig. 1. Monumento Natural das Ilhas Cagarras. **A.** Map of Cagarras Archipelago and the study site on Redonda Island (red dot). **B.** Aerial view of the north face of Redonda Island indicating the location of the study site (red arrow). **C.** Detail of the rock pool. *Ipanema Submarine Sewage Outfall. Photos by A. Breves and F. Moraes.

Field Work and Laboratory

A survey of mollusks inside and on the border of the rock pool was carried out during three expeditions between July and October of 2012. One specimen of each sessile and sedentary species was collected (except the cephalopod) by snorkeling (Fig. 2), stored in labeled plastic bags, fixed and preserved in 70% ethanol.

Mollusks were identified, photographed and housed in the Mollusks Collection at the Museu Nacional/UFRJ (MNRJ), Rio de Janeiro, Brazil (lots 26001–26022 and 26058). Modes of feeding were surveyed to better characterize the mollusks recorded in the rock pool.

Fig. 2. Some mollusk species from the rock pool on Redonda Island. **A.** *Cymatium parthenopeum*. **B.** *Petaloconchus varians*. **C.** *Stramonita haemastoma*. **D.** *Pinctada imbricata*. **E.** *Isognomon bicolor*. **F.** *Octopus vulgaris*. Photos by A. Bertoncini and F. Moraes.

RESULTS

Twenty-four mollusk species were recorded in the rock pool of MoNa Cagarras. From this total, there are thirteen gastropods (in twelve families), nine bivalves (six families), one chiton and one cephalopod (Table 1).

Considering the species collected in the rock pool and comparing them with results of Batista *et al*. (2013), five species were found only on Redonda Island and eight species were also found in other islands. The new records for MoNa Cagarras are: *Bostrycapulus odites* Collin, 2005 (Calyptraeidae); *Costoanachis sertulariarum* (d'Orbigny, 1839) (Columbellidae); *Lottia subrugosa* d'Orbigny, 1839 (Lottiidae); *Urosalpinx haneti* (Petit, 1856) (Trochidae); *Onchidella indolens* (Couthouy *in* Gould 1852) (Onchidiidae); *Fossarus orbignyi* (Fischer, 1864) (Planaxidae); *Tegula viridula* (Gmelin, 1791) (Tegulidae); *Trachypollia nodulosa* (C.B. Adams, 1845) (Muricidae); *Chama congregata* Conrad, 1833 and *Pseudochama radians* Lamarck, 1819 (Chamidae); *Lasaea adansoni* (Gmelin, 1791) (Lasaeidae).

The bivalves *Isognomon bicolor* (C.B. Adams, 1845) (Isognomonidae), *Myoforceps aristatus* (Dillwyn, 1817) (Mytilidae) and *Perna perna* (Linnaeus, 1758) (Mytilidae) are exotics (Domaneschi & Martins 2004; Simone & Gonçalves 2006; Fernandes *et al*. 2008), but most of the other species collected are native to Brazil (Rios 2009). Clusters of the vermetid *Petaloconchus varians* (d'Orbigny,

1839) were observed in the rock pool, as well as a paleo-reef with vermetid shells in a transition gradient from underwater to about 2 m above the current sea level.

The feeding modes differ among the classes of mollusks: the bivalves are filter-feeders, the gastropods have diverse feeding modes (carnivores, mucus-feeder, herbivores and grazers), the chiton is a grazer and the cephalopod a carnivore (Table 1).

Table 1. Mollusks in the rock pool on Redonda Island, Monumento Natural das Ilhas Cagarras (Rio de Janeiro state, Brazil). Abbreviations: **FM,** feeding mode; **C,** carnivore; **F,** filter-feeder; **G,** grazer; **H,** herbivore; **M,** mucus-feeder. [1]New record for MoNa Cagarras. [2]Exotic species.

CLASS	FAMILY	SPECIES	FM	REFERENCE
Gastropoda	Calyptraeidae	*Bostrycapulus odites* R. Collin, 2005[1]	H	Souza *et al*. 2010
	Columbellidae	*Costoanachis sertulariarum* (d'Orbigny, 1839)[1]	C	Morgado & Tanaca, 2001
	Fissurellidae	*Fissurela clenchi* Farfante, 1943	H	Calil *et al*. 2009
	Littorinidae	*Echinollitorina ziczac* (Gmelin, 1791)	H	Calil *et al*. 2009
	Lottiidae	*Lottia subrugosa* d'Orbigny, 1841[1]	H	Calil *et al*. 2009
	Trochidae	*Urosalpinx haneti* (Petit, 1856)[1]	C	Lorenzo & Verde 2004
	Onchidiidae	*Onchidella indolens* (Couthouy, 1852)[1]	G	Marcus & Marcus 1954
	Planaxidae	*Fossarus orbignyi* (Fischer, 1864)[1]	G	Bandel 2006
	Ranellidae	*Cymatium parthenopeum* (von Salis, 1793)	C	Souza *et al*. 2010
	Tegulidae	*Tegula viridula* (Gmelin, 1791)[1]	H	Calil *et al*. 2009
	Muricidae	*Stramonita haemastoma* (Linnaeus, 1767)	C	López *et al*. 2010
		Trachypollia nodulosa (C. B. Adams, 1845)[1]	C	López *et al*. 2010
	Vermetidae	*Petaloconchus varians* (d'Orbigny, 1841)	M/F	Morton 1965
Bivalvia	Chamidae	*Chama congregata* Conrad, 1833[1]	F	Zurel *et al*. 2011
		Pseudochama radians Lamarck, 1819[1]	F	Zurel *et al*. 2011
	Isognomonidae	*Isognomon bicolor* (C. B. Adams, 1845)[2]	F	Ignacio *et al*. 2012
	Lasaeidae	*Lasaea adansoni* (Gmelin, 1791)[1]	F	Neves *et al*. 2012
	Mytilidae	*Brachidontes solisianus* (d'Orbigny, 1842)	F	Ignacio *et al*. 2012
		Perna perna (Linnaeus, 1758)[2]	F	Ignacio *et al*. 2012
		Myoforceps aristatus (Dillwyn, 1817)[2]	F	Ignacio *et al*. 2012
	Ostreidae	*Ostrea puelchana* d'Orbigny, 1842	F	Doldan *et al*. 2012
	Pteriidae	*Pinctada imbricata* Roding, 1798	F	Souza *et al*. 2010
Polyplacophora	Ischinochitonidae	*Ischinochiton striolatus* (Gray, 1928)	G	Steneck & Watling 1982
Cephalopoda	Octopodidae	*Octopus vulgaris* Cuvier, 1797	C	Ambrose & Bobette 1983

DISCUSSION

The mollusks from MoNa Cagarras are currently under study and are representative invertebrates in intertidal and subtidal rocky shores on different islands (Batista *et al*. 2013). The present work focused mainly on reporting the malacofauna in this single rocky pool of MoNa Cagarras.

Our results show 11 new records for MoNa Cagarras, increasing from 36 to 47 the total of mollusk species known to date in this MPA. The rock pool species richness (24 spp.) encompasses 51% of all malacofauna recorded in the whole protected area. Although many are new records, none of these species is considered rare on the coast of Rio de Janeiro (Rios 2009). Despite this, the diversity in the rock pool on Redonda Island may be considered very high (the study area is a small and shallow pool), greater than the few other surveys on the Brazilian coast, as the rock pools of São Pedro and São Paulo Archipelago, ranging from fourteen (Spotorno-Oliveira *et al*. 2003) to eighteen

species (Spotorno-Oliveira *et al*. 2009). Moreover, none of the species registered in the present work was recorded on this oceanic archipelago.

The present work also describes the feeding modes of mollusks from the rock pool of MoNa Cagarras. The knowledge of the organism functional groups is informative to explore some potential trophic relationships in the rock pool, although many other ecological studies are yet necessary. Mollusks have an important role in the structure of the community of the rock pool in MoNa Cagarras, mainly as predator-prey relationships. Here we present only some examples as the top predator cephalopod *Octopus vulgaris* Cuvier, 1797 (Octopodidae) that hunts preferentially bivalves, but also crabs and fishes (Ambrose & Bobette 1983). We suppose that, because of the food availability in the rock pool and because the surrounding area adjacent to the pool is a rich ground for *Octopus* fishing (Moraes *et al*. 2013), some octopuses would occasionally move into the pool. All the bivalves herein recorded are epibenthic byssates, which is probably related with the water flow in the rock pool and their feeding modes. The invasive bivalves *Isognomon bicolor*, *Myoforceps aristatus* and *Perna perna* were recorded in the rock pool. *Isognomon bicolor* and *M. aristatus* are natives from the Central West Atlantic (Tunell Jr. *et al*. 2010) and were recently introduced in the Brazilian coast (Domaneschi & Martins 2002; Simone & Gonçalves 2006), while *P. perna* is native from the East Atlantic on the African coast and has a long invasion history in Brazil (Fernandes *et al*. 2008). These species are currently found living on intertidal rocky shores on the coast of Rio de Janeiro and, according to López *et al*. (2010), *I. bicolor* and *P. perna* are commonly predated by the gastropods *Trachypollia nodulosa* and *Stramonita haemastoma* (Linnaeus, 1767) (Muricidae). Field experiments showed however that predation intensity by native predators was higher on *Perna perna* than *Isognomon bicolor* (López *et al*., 2010). Moreover, *I. bicolor* likely settles preferentially on crevices to use it as shelter from predators and extreme physical factors (Moysés *et al*. 2007; Zamprogno *et al*. 2010).

Biological invasions are also a real threat in this protected area, since it is close to Rio de Janeiro's harbor, which is an anchoring ground for heavy load ships, and it is also on the main route in and out of the Guanabara Bay. The invasive bivalve *I. bicolor* is highly competitive on intertidal rocky shores (Breves-Ramos *et al*. 2010a) while *M. aristatus* bore the shells of other mollusks (Simone & Gonçalves 2006; Breves-Ramos *et al*. 2010b). Both species are considered with a high invasiveness potential and it may be dangerous to the local biodiversity. The exotic bivalve *P. perna* is extracted and farmed inside the Guanabara Bay and also collected on the rocks of the islands along the coast, sustaining an economically and socially very important market (Lage & Jablonski 2008).

Beside mollusks, species of sponges, crustaceans, briozoans, polychaetes, echinoids, fishes and algae were also observed living in the rock pool, but they were not collected and catalogued in the present study. The top predator fish *Epinephelus marginatus* (Lowe, 1834) (Serranidae) was observed in a cave in the pool and, although it was not seen feeding, small mollusks and cephalopods are known to be some of its main preys (Begossi & Silvano 2008).This single habitat is exposed to several human disturbances, including misuse by fishermen (who discharge mussels' shells after cooking them *in situ*) and occasional swimmers. Apart from the impact of fisheries and predatory tourism, the Ipanema submarine outfall discharge and waters from Guanabara Bay are also potential organic pollution fonts to MoNa Cagarras (van Weerelt *et al*. 2013).

Cagarras Archipelago is considered one of the priority areas for conservation in Brazil (MMA 2002). The recent creation of an integral protection area (MoNa Cagarras) facilitates the conservation of its marine life. Its management plan is currently under development and should determine a monitoring and protection program for this unique rock pool.

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