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CONSERVATION OF ENDEMIC SPECIES OF SCLERAACTINOUS CORALS IN BRAZIL THROUGH THE EFFECTIVENESS OF CONSERVATION UNITS

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ABSTRACT

Coral reefs stand out as the marine ecosystem that holds the greatest biodiversity on the planet, approximately more than 50% of marine species depend directly or indirectly on reefs. In addition, in the economic context, its importance is based not only on the subsistence of coastal communities in tropical regions, but also on the growing tourist activity in these areas. The reef areas studied comprise the Parcel de Manuel Luís, Atol das Rocas, Arquipélago de Fernando de Noronha, Maracajaú, Tamandaré, Maragogi and the coast of Bahia. The areas that do not constitute reefs per se, but that have records of occurrences of endemic species, are: Trindade Island, Rio de Janeiro, Espírito Santo, São Paulo and Santa Catarina. The choice to describe only the species of scleraactinous corals is due to the role performed by these corals in the construction of the reefs. Thus, this work described the endemic species of reef-building corals, reporting the main threats to the life of these species and the degree of threat they are, in order to generate knowledge to carry out actions aimed at their protection. In addition, through a literature review, the effectiveness of conservation units in the protection of the coral environment is discussed, reporting the challenges in the management of coastal and marine Conservation Units.

Keywords: Coral reefs. Endemic corals. Coral conservation.

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INTRODUCTION

True corals or scleractines are cnidarians belonging to the class Anthozoa, mainly responsible for the formation of coral reefs. This is because these organisms have the ability to absorb the calcium carbonate present in the sea and accumulate it in calcareous depositions, forming coral reefs (HISSA et al, 2009).

According to the Ministry of the Environment, the reef formations in Brazil are the only ones in the South Atlantic, extending for 3 thousand kilometers of the coast from Maranhão to the south of Bahia, with the Parcel de Abrolhos being the richest region of the Western South Atlantic (MMA, 2015). In Brazil, corals are still found from Espírito Santo to Santa Catarina, although they do not form reefs. Brazilian reefs have a low diversity compared to the fauna of the reefs of the North Atlantic, Pacific and Indian Oceans, however, they have a high degree of endemism. (CASTRO and ZILBERBERG, 2016).

One in four marine species lives on coral reefs, including 65% of fish, so they are considered the most diverse marine habitat in the world (MMA, 2018).

However, in the last century, the average temperature of the ocean's surface has increased by about 1°C and the ocean's absorption of CO2 is making its waters more acidic. Allied to this, heat stress is responsible for breaking the symbiosis with the microalgae (zooxanthellae) that are responsible for coloring and providing food to them (CASTRO and ZILBERG, 2016).

In the national context, it can be stated that, despite the ecological importance, marine conservation in Brazil is numerically inferior to terrestrial conservation, because while 1,928 Conservation Units (CUs) protect 17.2% of the 8,516,000 km² of the Brazilian territory, only 157 CUs protect 1.5% of 8.5 thousand kilometers of the national maritime coast (MMA, 2015).

With environmental degradation and the loss of species in Brazil and in the world, several researches have been carried out in order to seek protection measures for this important coastal ecosystem - coral reefs. In addition, the main measures to prevent coral degradation are monitoring and protection through conservation units (GODOY et al., 2020).

DEVELOPMENT

The present work has the general objective of determining, through a literature review, the main strategies defined for the conservation of endemic species of scleractinian

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corals in Brazil. In view of the conservation strategies, the specific objectives of the research are:

I. Describe the endemic species of scleractinian corals that occur in Brazil;

II. Indicate the degree of threat of Brazilian endemic scleractineal corals;

V. To discuss preliminarily the effectiveness of conservation units in preserving the coral reef ecosystem and endemic reef-building species in Brazil.

The data used to prepare this work were collected from books, magazines and specialized websites, such as: Google Scholar, SciELO (Scientific Electronic Library), ICMBIO (Chico Mendes Institute for Biodiversity Conservation), MMA (Ministry of the Environment) and IUCN (International Union for Conservation of Nature), whose contents were published between 1996 and 2020. The following descriptors were used: Coral reefs, Endemic corals, Coral conservation, as well as their English versions: Coral reefs, Endemic corals and Conservation of corals. The selection of articles initially occurred by reading the titles and abstracts, followed by reading only the selected articles in full, where the most relevant information was highlighted.

THE ENDEMISM OF SCLERACTINIAN CORALS IN BRAZIL

Endemism can be defined as the phenomenon in which a species occurs exclusively in a certain geographic region (HOUAISS, 2001). Endemic species are at greater risk of extinction, as modifications in their habitat can eliminate all individuals of the species, reducing biodiversity (MMA, 2015).

The main characteristic of Brazilian coral reefs is the high degree of endemic coral species, despite the low diversity compared to other reefs in the world. Another characteristic of Brazilian coral species is that they occur in waters with a high degree of turbidity when compared to reefs in other regions of the planet (CASTRO and ZILBERG, 2016). On the Brazilian coast, scleractinian corals are known from the Parcel de Manoel Luís (Maranhão) to the reefs of Viçosa (Bahia) (FERREIRA & MAIDA, 2006), and the Parcel de Abrolhos is the richest region in endemic species of the Southwestern Atlantic (KIKUCHI et al, 2010). Coral species are also found on the Brazilian coast, although they do not form reef structures, from Espírito Santo to Santa Catarina (CASTRO and ZILBERBERG, 2016).

Of the 43 coral species recorded, 25 are endemic. Therefore, 58.1% of the coral species recorded in Brazil are endemic, among these species 18 are scleractinian coral

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species registered in Brazil, of which 10 are endemic, which confirms that the contribution of endemic scleractinian corals is 55.6%. (LEÃO et al, 2015).

A first analysis of the endemism of corals of the order Scleractinia on the Brazilian coast revealed that the Parcel de Manuel Luís (Maranhão) and the coastal region of the state of Bahia are the places that are most relevant as endemic areas (MMA, 2018).

DESCRIPTION OF ENDEMIC SCLERACTINE CORALS OF THE BRAZILIAN COAST

Favia leptophylla Verrill, 1868

Favia leptophylla is an endemic species of the Brazilian coral fauna. Its record is limited to the coast of the State of Bahia. It occurs in abundance in the Abrolhos area, in waters with depths between 3 and 15 m; it is rare on the reef of the island of Itaparica, being observed only at depths around 4 m. The color of the living colony varies from light beige to greenish (LEO; KIKUCHI; ENGELBERG, 2014). According to the Red List of the International Union for Conservation of Nature and Natural Resources (IUCN), this species is classified as DD, that is, there is no adequate information for a direct or indirect assessment of its risk of extinction (IUCN, 2020).

Favia gravida Verrill, 1868

The species is endemic to Brazil and is very resistant to environmental variations, especially temperature, salinity and turbidity (LEÃO; KIKUCHI; ENGELBERG, 2014). Its records range from the reefs of the coast of the state of Ceará, Rocas Atoll and Fernando de Noronha Archipelago to the coast of the state of Espírito Santo. It is abundant in the shallow parts of the reefs of Abrolhos, the island of Itaparica and on the north coast of Bahia, and is also recorded on the island of Trindade. According to the IUCN, it is categorized as NE, that is, not evaluated and not yet submitted to the risk assessment criteria (IUCN, 2020).

Mussismilia braziliensis Verrill, 1868

The species *Mussismilia braziliensis,* known as brain coral, is a species of stony coral, occurs only in Bahia and Espírito Santo and plays an important role as the main builder of coral reefs in Abrolhos, Bahia (ICMBIO, 2018); in Abrolhos, it occurs between March and mid-May. It has high fecundity when compared to the reproductive effort of other massive corals with similar morphology and size of female gametes (LEÃO; KIKUCHI;

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ENGELBERG, 2014). This species is classified as vulnerable (VU), according to the Red Book of Endangered Brazilian Fauna (ICMBIO, 2018).

Mussismilia harttii Verrill, 1868

This is an endemic Brazilian species, occurring from the coast of the state of Rio Grande do Norte, on the islands of Fernando de Noronha, to the coast of the State of Espírito Santo. Studies reveal that this species apparently competes for space with M. braziliensis, as it is rare where the latter is abundant. It was observed in the Abrolhos area that M. harttii is an important primary constructor where M. braziliensis is absent. It occurs in shallow waters (2 to 3 m), resisting well to moderate turbidity, and is also recorded in deeper waters (15 to 30 m and, occasionally, at 80 m). According to the red book of the Brazilian Fauna Threatened with Extinction is classified as endangered (EN) (ICMBIO, 2018).

Mussismilia hispida Verril, 1902

Considering the two species Mussismilia tenuisecta and Mussismilia hispida, this coral and the species Madracis decactis have the largest geographical distribution on the Brazilian coast, specifically located on the coast of the islands of the Fernando de Noronha Archipelago and Rocas Atoll and on the reefs of the coast of the State of Rio Grande do Norte, Paraíba, Pernambuco, Alagoas and Sergipe. and Mussismilia hispida sp, are found on the coast of the states of Bahia and Rio de Janeiro, and in Ubatuba and São Sebastião, in the State of São Paulo. It is an endemic species of Brazil, its colony of this species has a low hemispherical shape, with a maximum diameter of approximately 40 cm. The colors of the animal vary between light gray, green and blue. (LEO; KIKUCHI; ENGELBERG, 2014). This species is also considered as DD according to the IUCN (IUCN, 2020)

Siderastrea stellata Verril 1868

Endemic species in Brazil, widely distributed in Abrolhos and coastal areas of Bahia, especially in coral reefs along the northern coast of Salvador. In Abrolhos, because it competes for space with the Brazilian species Mussismilia braziliensis, it plays a secondary role in the construction of the reef structure. North of the São Francisco River, this coral is very abundant, forming a single reef structure on the coast of Rio Grande do Norte. It occurs on the coasts of Fernando de Noronha and Atol das Rocas, whose

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northern border is the state of Piauí. In the southern part of Abrolhos, where the water is colder, the species becomes rarer. Colonies of this species tend to get smaller and disappear completely in the vicinity of the municipality of Cabo Frio, on the coast of Rio de Janeiro. Colonies of this species also occupy several square meters on Tartaruga beach, in Búzios (RJ) (LEÃO; KIKUCHI; ENGELBERG, 2014) This species is also categorized as DD, according to the IUCN (IUCN, 2020).

Meandrina braziliensis Milne Edwards and Haime, 1848

It is a species that has colonies with approximately low hemispherical or elongated elliptical shapes (Figure 11). In addition, it has two morphological variations that characterize this species: one free, living on the mobile bottom, in very shallow waters, from 2 to 4 m, or at greater depths (30 to 60 m), and the other, fixed in the reef substrate. The free-water form of deep water has the dimensions of the larger axis and much more pronounced than those of the minor axis, and has more delicate septa than shallow-water forms. According to the coral guide made available by UFBA, this species lives in shallow and sheltered waters off the coast of the state of Bahia and in deep waters (30 to 60 m), from Ceará to the height of Cabo Frio (RJ). It is important to note that the records of the occurrence of this species indicate that the organisms of this species are susceptible to rough waters (LEÃO; KIKUCHI; ENGELBERG, 2014). As exposed by the IUCN, it is a species classified with DD (IUCN, 2020).

Astrangia braziliensis Vaughan, 1906

This animal is a small species, has separate calyxes and maximum dimensions of 7 mm in diameter and 5 mm in height. When alive, the colony is brownish-orange and can occur by embedding shells and skeletal fragments. The species is endemic to Brazil, but has affinities with the Caribbean fauna. It is recorded on the coast of the State of Pernambuco, in the Bay of All Saints, and in the area of the Abrolhos reefs, in waters that have moderate turbidity, often protected inside burrows. (LEO; KIKUCHI; ENGELBERG, 2014). By the end of this research, no official information had been published on the current conservation status of this species.

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Phyllangia americana Milne Edwards and Haime, 1849

This coral is small, with calyxes measuring, on average, 6 to 7 mm in diameter, and reaching 10 mm, and 3 to 4 mm in height. Reddish brown is the color of living coral. The species Phyllangia americana is endemic to Brazil, but has affinities with the Caribbean fauna. It occurs on the coast of the states of Ceará, Pernambuco and Rio de Janeiro, in shaded places (LEÃO; KIKUCHI; ENGELBERG, 2014). According to IUCN data, this species is classified as NE (IUCN, 2020)

Scolymia wellsi Laborel, 1967

This species does not form colonies, so it is made up of a simple polyp that inhabits a deep calyx, circular or elliptical in shape, and sometimes a little deformed. Its dimensions can reach up to 7cm in diameter for circular shapes, and 6 x 4 cm for elliptical shapes. The first three cycles reach the columella and the next three are curved and weld to the first. The living forms have a strong green, gray, or dark violet coloration. It is a common species in the shaded parts of the reefs off the coast of the State of Pernambuco and the Abrolhos area, and has affinities with the Caribbean coral fauna. It lives in calm and clear waters, with the company of the species Agaricia fragilis and the fixed form of Meandrina braziliensis. It is recorded at depths between 50 and 80 m, off the coast of the State of Pernambuco and in the Coral Bank of Vitória, off the coast of the State of Espírito Santo. (LEO; KIKUCHI; ENGELBERG, 2014). Species classified as DD, according to IUCN (IUCN, 2020)

ON THE EFFECTIVENESS OF CUS IN PROTECTING THE ENDEMISM OF CORAL REEF-BUILDING SPECIES

According to item I of article 2 of Law No. 9,985, of July 18. 2000, a Conservation Unit can be defined as a "territorial space and its environmental resources, including jurisdictional waters, with relevant natural characteristics, legally established by the Government, with conservation objectives and defined limits, under a special administration regime, to which adequate protection guarantees apply" (BRASIL, 2000).

In Brazil, only 1.57% of the marine territory is protected by conservation units, most of which (1.43%) are sustainable use (MMA, 2015). The most critical situation identified, however, refers to coral reef ecosystems, unique to the South Atlantic and under a strong

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impact of anthropic action, requiring to be the object of new conservation units and specific research and monitoring programs (MMA, 2015).

According to environmental laws, the protection of Brazilian marine biodiversity still leaves something to be desired in several aspects, with an insufficient number of protected UCs and territories. In some cases, management plans have not been developed or implemented, or the infrastructure to implement them does not meet local needs. The management of fishing activities remains unstable and the participation of the communities involved is low (HAUEISEN, et al, 2019).

There is still a terrestrial focus on the implementation and management of marine and coastal conservation units, where the peculiarities of the ecosystems present are not considered. In addition, the lack of personnel, adequate equipment and the inaccessibility of the areas hinder the protection of the areas. The lack of a coast guard that could assist enforcement actions is also another point to be considered. The lack of research aimed at estimating the carrying capacity of conservation units is also another difficulty present in the implementation. (PEREIRA, 1999 and 2000).

Conservation units are essential for the management and management of coralline species, as they protect areas of undamaged reefs that will be sources of larvae, and thus fundamental to contribute to their recovery. Another purpose is the conservation of areas that have a low vulnerability because they guarantee the protection of areas that are free of anthropogenic impact and that have an appropriate substrate for the establishment of coral with new growth, ensuring that the reefs continue to sustain the needs of local communities, which depend on them indirectly (WESTMACOTT et al, 2000).

The endemic species of scleractinian corals are also favored with the creation of marine CUs that enable the control of access and activities within the CU, in this way, corals are able to grow in a healthier way compared to other areas that suffer from low water quality caused by pollution, the destruction of habitats and the intensive presence of people (VILA-NOVA and FERREIRA, 2016).

Another benefit is the growth of corals with the fauna of fish and herbivorous invertebrates – such as urchins – which, by feeding on the algae, clean the space on the reef so that corals and other slow-growing organisms are not harmed when competing with macroalgae, which have rapid growth. This is evident when visiting reefs close to the Brazilian coast, reefs without adequate protection and already at critical levels of overfishing, which become reefs dominated by algae. In these places, the presence of

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corals is greatly reduced and is composed of species that are more resistant to these impacts (VILA-NOVA and FERREIRA, 2016).

According to Westmacott et al. (2000), the main management actions of reef conservation units with the presence of endemic species should be linked to the identification of the areas of the reef with the least degree of damage, the revision of zonation schemes and boundaries. (WESTMACOTT et al, 2000).

According to the Ministry of the Environment (2015), in Brazil, the conservation units of reef areas include the Parcel do Manuel Luis Marine State Park (MA), the Rocas Atoll Biological Reserve (RN), the Fernando de Noronha National Marine Park (PE), the Fernando de Noronha Environmental Protection Area - Rocas- São Pedro and São Paulo, the Coral Reefs State Environmental Protection Area, the Areia Vermelha Marine State Park, the Costa dos Corais Environmental Protection Area (PE/AL), the North Coast Environmental Protection Area (BA), the All Saints Bay Environmental Protection Area (BA), the Recifes de Pinaúnas Municipal Environmental Protection Area (BA), the Tinharé - Boipeba Environmental Protection Area (BA), the Camamu Bay Environmental Protection Area (BA), the Coroa Alta Marine Municipal Park (BA), the Recife de Fora Marine Municipal Park (BA), the Corumbau Marine Extractive Reserve (BA), the Recife de Areia Marine Municipal Park (BA), the Abrolhos Marine National Park (BA) and the Ponta da Baleia/Abrolhos Environmental Protection Area. In addition, there are conservation units that protect corals that do not form reefs, but form colonies along the Brazilian coast, which are the Arraial do Cabo Marine Extractive Reserve (RJ), the Pau Brasil State Environmental Protection Area (RJ), the Armação dos Búzios Municipal Marine Environmental Protection Area (RJ), the Municipal Natural Park of Corais - Armação dos Búzios (RJ), the Natural Monument of the Cagarras Islands Archipelago (RJ), the Tamoios Ecological Station (RJ), the Aventureiro Marine State Park (RJ), the Paraty, Paraty-Mirim and Saco do Mamanguá Bay Environmental Protection Area (RJ), the Tupinambás Ecological Station (SP), the Laje de Santos Marine State Park (SP), the Central Coast State Environmental Protection Area (SP) and the Arvoredo Marine Biological Reserve (SC) (CASTRO and ZILBERG, 2016).

CONCLUSION

It can be concluded that Brazilian coral reefs exert great influence in the South Atlantic, with Abrolhos being the region with the highest endemicity of scleractinian corals.

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Among the endemic species, the following species stand out: Favia leptophylla, Favia gravida, Mussismilia braziliensis, Mussismilia harttii, Mussismilia hispida, Siderastrea stellata, Meandrina braziliensis, Astrangia braziliensis, Phyllangia americana and Scolymia welsii.

Although they exert great importance in the formation of Brazilian reefs, the degree of conservation of these species is low. This is because, among the species described in this work, 54% of the species are classified as DD, that is, they do not have data to classify the species, 15% are classified as NE, because it has not yet been submitted to evaluation criteria, 15% are classified as VU, that is, vulnerable, 8% as endangered and 8% there was no data regarding their degree of threat. This shows that little is known about the state of preservation of these species that are essential in the construction of the only coral reefs in the South Atlantic. The lack of research and conservation measures is also noteworthy, since the extinction of these species would cause irreparable genetic loss and put the lives of several marine species at risk.

Since conservation units are the most efficient form of protection for endemic species, in Brazil there are 18 conservation units of reef areas and 14 conservation units that cover coral colonies. Therefore, it is evident that marine conservation units in Brazil still have gaps to be filled to be fully sufficient for the protection of endemic species due to the effects of natural phenomena and anthropogenic threats. Despite this, integral conservation units are currently the most effective form of protection for coral reefs.

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