



Evaluation of an unreported and unregulated sea cucumber fishery in eastern Brazil

Isabela de Abreu Rodrigues Ponte*, Caroline Vieira Feitosa

Instituto de Ciências do Mar, Universidade Federal do Ceará, Brazil



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ABSTRACT

Holothuria grisea is abundant in Brazil, however there is only one study on this species. This study aimed to characterize the sea cucumber fishery in the State of Ceará, Brazil, through the evaluation of the capture, length classes most susceptible to catch, fishing effort as well as the processing, stakeholders characterization, income and marketing of the final product. The study was carried out in two fishing communities (Xavier and Camocim) from August 2015 to July 2016. Processing is performed in four stages: evisceration, cooking, draining and drying. The fishing cycle occurs in spring tides. The annual catch was 12,341 kg, which was totally commercialized. The *t*-test shows that there was no significant difference for capture per unit effort (CPUE) and fishing effort between communities. The processed individuals showed an average loss of 79% weight and 49% length. 66% of the captured organisms were below the size at first maturity. This activity plays an important role as complementary income. However, this is an unreported and unregulated activity and an intense fishing pressure can lead to overexploitation of this resource. This study is essential to not only the knowledge of the dynamics of this activity, but also as an attempt to contribute to a future fishery management.

1. Introduction

Invertebrates represent one of the most important economic resource for the coastal fishery (Anderson et al., 2011b). In Brazil, sea cucumber fisheries is practiced by coastal communities (Leite-Castro et al., 2016), however, is an unregulated activity, therefore, it is not supervised by the state or federal government. The sea cucumber fishing in Brazil could play an important role in economy, as a new source of seafood (Lima et al., 2001). However, nothing is known about the impact of this activity, number of animals collected, the economic importance and the market route.

Although the highest diversity of sea cucumber is recorded in tropical shallow waters (Hadel et al., 1999), in Brazil, only 32 species of holothuroides were recorded (Tiago and Ditadi, 2001). Along the Brazilian coast, *Holothuria grisea* Selenka, 1867 is the most abundant species from the Northeast region (2°S 41°W) to the South of Santa Catarina (29°S 49°W), found in intertidal zones, associated with rocks and in contact with the sandy substrate (Tommasi, 1969; Mendes et al., 2006; Rocha, 2006).

A survey carried out in Brazil Northeast indicates Ceará as the state with the highest densities of *H. grisea* in intertidal and in shallow submerged areas (Souza Junior et al., 2017), which favors the sea cucumber traditional fishery with captures through manual collection or

snorkelling (Choo, 2008a, 2008b).

Sea cucumber fisheries can provide extra income for fishermen of coastal communities in Brazil (Leite-Castro et al., 2016) and characterizes the species as a new Brazilian fishery resource for the sea cucumber market in the world (Souza Junior et al., 2017). However, reviews about sea cucumber at a global level (Toral-Granda, 2008; Anderson et al., 2011b; Purcell et al., 2013) do not provide fisheries information and the conservation status of sea cucumbers in Brazil.

Therefore, aiming to minimize the gap in information about the topic, the present study characterized the sea cucumber fishery (*Holothuria grisea*) in the extreme west of the State of Ceará, Brazil, through the evaluation of the capture, identification of length classes most susceptible to capture, estimation of the fishing effort employed, as well as the resource processing, stakeholder characterization, income and marketing of the final product.

2. Material and methods

2.1. Study site

The study was carried out in the State of Ceará, Northeastern Brazil, where *Holothuria grisea* is the only species captured in this sea cucumber fishery and is practiced by the Xavier and Camocim communities in six

* Corresponding author.

E-mail address: iarp.bio@gmail.com (I.d.A.R. Ponte).

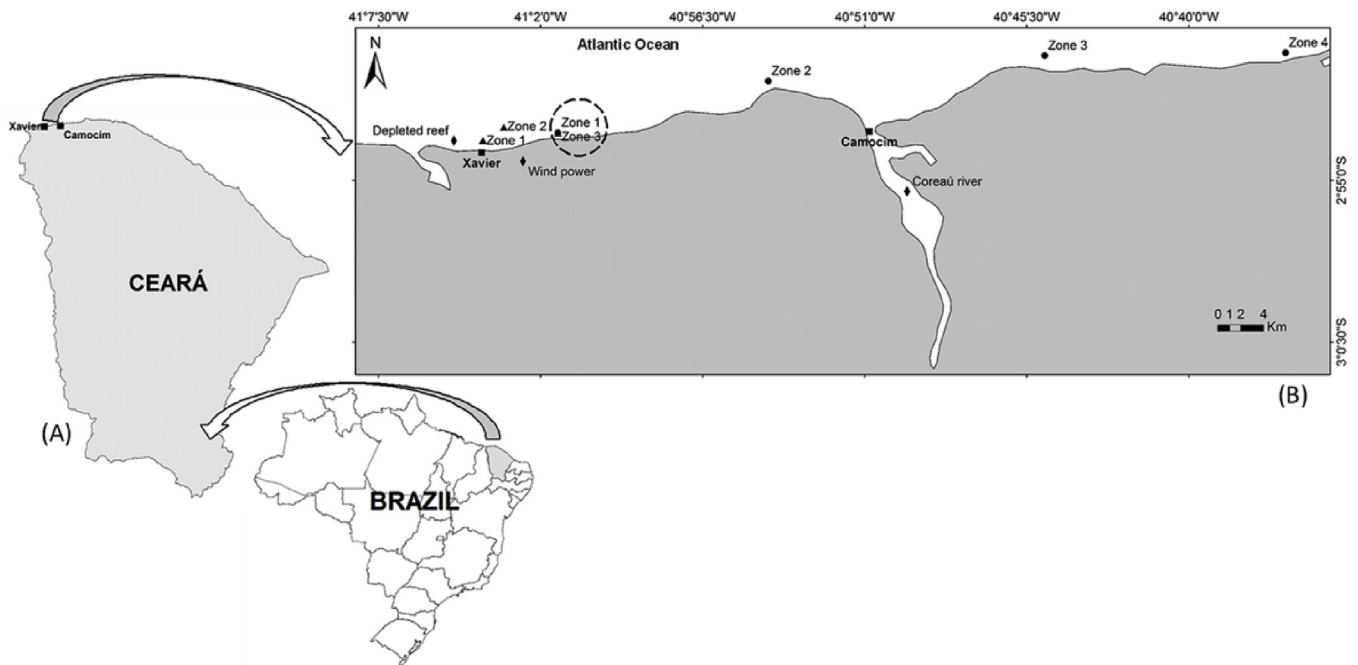


Fig. 1. Map of Ceará-BR state with emphasis on fishing zones of sea cucumbers. Legend: ▲ = fishing zones exploited by fishers from Xavier, Zone 1 (Xavier 1), Zone 2 (Xavier 2), Zone 3 (Xavier 3: Conflict Zone); ● = fishing zones exploited by fishers from Camocim, Zone 1 (Conflict Zone), Zone 2 (Caraúbas), Zone 3 (Imburanas) e Zone 4 (Tatajuba); ○ = fishing zones exploited by both communities making the region into a conflict zone.

Table 1

Information about sea cucumber fishery per fishing zone.

| Fishing Zone (FZ) | Fishermen origin | Characterization of FZ | Manual capture Method | Access to FZ |
|-------------------|------------------|----------------------------------|------------------------------------|--|
| Xavier 1 | Xavier | Submerged sandstone reef | Collection through snorkelling | In the surroundings of the village |
| Xavier 2 | Xavier | Partially submerged coastal reef | Collection by hand and snorkelling | 15-min motor-powered canoe trip |
| Conflict Zone | Xavier e Camocim | Intertidal reef on beach zone | Collection by hand and snorkelling | Near the village of Xavier and 35 min far from Camocim |
| Caraúbas | Camocim | Intertidal reef on beach zone | Collection by hand and snorkelling | 20-min rented transportation travel |
| Imburanas | Camocim | Intertidal reef on beach zone | Collection by hand and snorkelling | 30-min rented transportation travel |
| Tatajuba | Camocim | Intertidal reef on beach zone | Collection by hand and snorkelling | 40-min rented transportation travel |

fishing zones (Fig. 1). Other neighbouring communities practice this fishing activity, but the study was concentrated in these two localities because this activity was already well established. The fishing zones consist of regions characterized by the presence of intertidal sandstone reefs as well as a zone with submerged coastal reefs (Table 1).

2.2. Studied species

Holothuria grisea occurs in West Africa, the United States (Florida), the Gulf of Mexico, Puerto Rico, Panama, the Antilles, Colombia, Jamaica, Venezuela and Brazil (Pawson et al., 2010). Along the Brazilian coast, this species can be found in abundance from the North-eastern region (2°S 41°W) to the south of the State of Santa Catarina (29°S 49°W), in the intertidal zones, under rocks and in direct contact with the sandy substrate (Tommasi, 1969; Mendes et al., 2006; Rocha, 2006). In the State of Ceará, there are records of *H. grisea* in the municipalities of Fortaleza, Caucaia, Camocim, Itapipoca, Icapuí and Barroquinha, where it was found in large numbers (0.54 ± 0.14 ind/ m^2) (Lima-Verde, 1969; Souza Junior et al., 2017).

Holothurians have a gregarious habit (Pawson, 1966) with a strong relationship with rock roughness. *H. grisea* is usually found in the cracks of rocky outcrops where it finds shelter and sediment with organic matter important to its detritivorous feeding habit (Mendes et al., 2006; Mezali and Soualili, 2013).

For tropical holothurians, the spawning period occurs during spring or summer, that is, during the hottest seasons of the year (Chao et al.,

1995). In the State of Ceará, the gametogenic maturity peak of *H. grisea* occurs between December and February along with the spawning activity. Despite the smaller weight and size of the adult compared to many other tropical sea cucumbers, the minimum size of sexual maturity is similar to that of other Aspidochirotida, for example, 13–20 cm (Leite-Castro et al., 2016).

2.3. Survey methodology and data collection

Data collection was performed during the period from August 2015 to July 2016, with the observation of an entire fishery cycle (period when fishery occurs). The observation includes the types of vessels used, the use of fishing gears or materials that help in the capture of sea cucumber; duration of fishing activity, quantity of the total captured, identification of specific fishing areas and digital image collection. For the study of final yield (loss in biomass after artisanal processing) (Arias et al., 2017) and the identification of length classes most susceptible to capture, a total of 120 sea cucumbers were measured for length and weight (biometry). These individuals were, chosen at random, derived from the exploited biomass in five out of the six fishing zones. One of the zones could not be sampled due to logistical issues. The individual weight and length were measured from eviscerated sea cucumber from fresh and processed (dried) samples. A minimum waiting time of 20 min was determined, aiming to reduce variations in measurements, due to the capacity of contraction and relaxation of these animals (Hearn et al., 2005).

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