Volunteer programme assesses the *Holothuria arguinensis* populations in Ria Formosa (southern Portugal)

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Abstract

The population status of *Holothuria arguinensis* in Ria Formosa (southern Portugal) was assessed using a visual census conducted by a volunteer programme, the CUMFISH project. We found high densities of this species (267 ± 152 ind. ha^{-1}) in Praia de Faro, but the values oscillated, depending on transect and habitat. *H. arguinensis* seems to prefer a bottom covered with seagrass, mainly *Cymodocea nodosa* and *Zostera marina*. Its size-frequency distribution was multimodal, showing lengths ranging from 7 to 33 cm. During the sampling last March (data not included), we found a high percentage of juveniles smaller than 6 cm, which indicates good recruitment inside the Ria.

Introduction

Holothuria genus is the only Holothuriidae present in the Mediterranean Sea and north-eastern Atlantic. It is found in various marine habitats in shallow coastal waters. They are found in high density, providing important ecosystem services and enhancing nutrient cycling and local productivity in oligotrophic carbonate sediments through their bioturbation and deposit-feeding activities (Byrne et al. 2010).

Holothuria (*Roweothuria*) *arguinensis* (Koehler and Vaney, 1906) belongs to this genus and, in the last few years, has been considered a target species in the growing sea cucumber fishery (Aydin 2008; Sicuro and Levine 2011). This species had been considered a north-eastern Atlantic species, distributed from Portugal to Morocco and Mauritania, including the Canary Islands (Thandar 1988). It has not been found in other Macaronesian Islands such as Açores, Selvagens or Madeira, nor in the Cape Verde Archipelago (Borerro-Pérez et al. 2010; Micael et al. 2012). However, its geographical distribution is changing, including its colonisation of the Mediterranean Sea, where it was registered in the Alicante coast in southern Spain (González-Wangüemert and Borrero-Pérez 2012), and its extension to the northern Portugal coast in the Berlengas Islands (Rodrigues 2012). However, information about this species is scarce (density, abundance, habitat and reproduction) in spite of its high potential as a fishery target and its very restricted geographic distribution. Under the CUMFISH project (PTDC/MAR/119363/2010, http://www.ccmar.ualg.pt/cumfish/), we are carrying out a volunteer programme to assess the *H. arguinensis* populations inhabiting the Ria Formosa (southern Portugal) using a visual census that will continue for two more years. This study will provide useful information concerning density patterns, habitat preferences, distribution of size classes and some observations *in situ* about its recruitment inside Ria Formosa.

Materials and methods

Ria Formosa is a large tidal lagoon extending for 55 km along the south coast of Portugal with a total area of 170 km^2. A strongly branched system of creeks and channels is connected to the ocean by six outlets. The system has semi-diurnal tides, with 50–75% of the water volume exchanged during each tide. The lagoon shows a salinity around 35.5–36.9 PSU and water temperatures range from 12–28°C.

The visual census was carried out in Praia de Faro (36° 59' 0'' N, 7° 55' 0'' W) on both sides of the main bridge (Fig. 1). The census was conducted during low tide at least twice a month. The results described here were obtained between November 2012 and February 2013.

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Figure 1. Sampling sites in Praia de Faro (Ria Formosa, southern Portugal). A: East side of the bridge; B: West side of the bridge.

Figure 2. Transect outside water during low tide with two individuals of *Holothuria arguinensis*.

To carry out the visual census, we used two transects of 100 x 2 m with three replicates for each one (Dissanayake and Stefansson 2010) on two different scales, considering the level of maximum low tide (Transect 1: outside water, transect 2: inside water) (Fig. 2).

We established the sampling date, considering the best low tides, from local tide tables (http://www.hidrografico.pt/previsao-mares.php). For each transect, we obtained information about the identity of the sea cucumber species, the total length, external marks, bottom and habitat types (sand, clay, pebbles, rocks, seaweeds, seagrass), and position in the transect. Some photos were taken during samplings.

Results and discussion

H. arguinensis was observed in all of the sampling sites, with an average density of 267 ± 152 ind. ha^{-1}, although the density ranged from 140 to 480 ind. ha^{-1}, depending on the transect and habitat. During the samplings, we registered the presence of another sea cucumber species, *H. mammata*, but its density was very low. In general, *H. arguinensis* densities were higher on the west side of the bridge and along transect 2 (inside water) (Fig. 3).

These results are logical, considering the presence of dense and continuous *Zostera marina* and *Cymodocea nodosa* seagrass on the west side, while on the east side there is a heterogeneous habitat of small patches of seagrass, sand and mud. *Holothuria arguinensis* seems to prefer a bottom covered with seagrass. The data showing higher densities in transect 2 (inside water) are also understandable because sea cucumbers minimise the

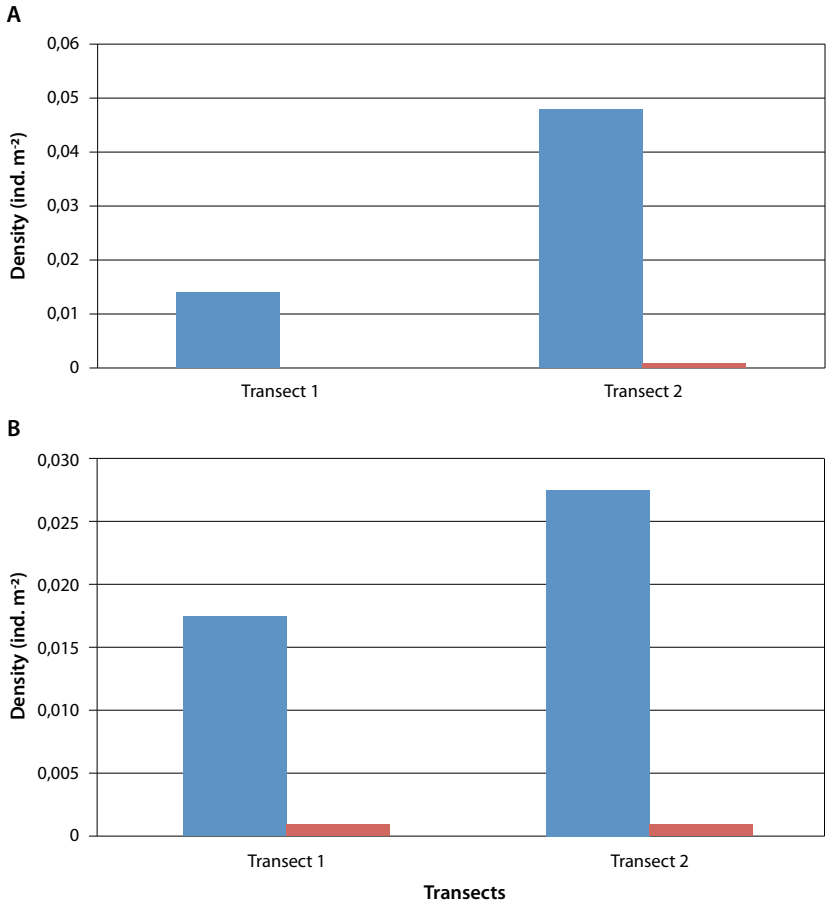

Figure 3. Density (in ind. m^{-2}) of *Holothuria arguinensis* (in blue) and *Holothuria mammata* (in red) over a period of four months in Praia de Faro for the different transects (transect 1: outside water; transect 2: inside water). A: Densities on the west side of the bridge; B: Densities on the east side.

Figure 4. *Holothuria arguinensis* damaged by exposure.

risk of phototoxicity by maintaining themselves under water or covered with leaves of seagrass. In fact, some of the sea cucumbers that were not covered with water during low tide on days of high radiance (ultraviolet light) showed a sickly and mucilaginous aspect (Fig. 4).

H. arguinensis individuals from Praia de Faro ranged in length from 7 cm to 33 cm and showed a multimodal size-frequency distribution, with the higher abundances 19–20 cm in length (Fig. 5). It is important to note that during the last samplings we found many juveniles, mainly on the west side in the seagrass (Fig. 6).

During the next two years, we will continue to carry out the visual census in Praia de Faro and three other localities inside Ria Formosa (Tavira, Fuseta and

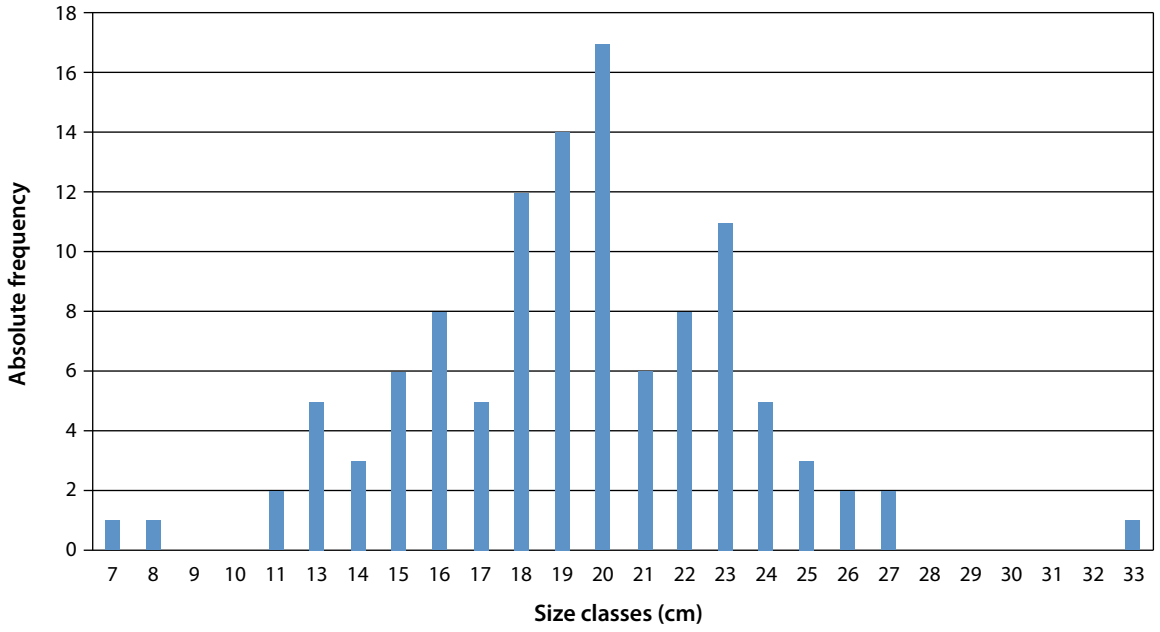

Figure 5. Length-frequency distribution of target species (*Holothuria arguinensis*) over a period of four months from Ria Formosa.

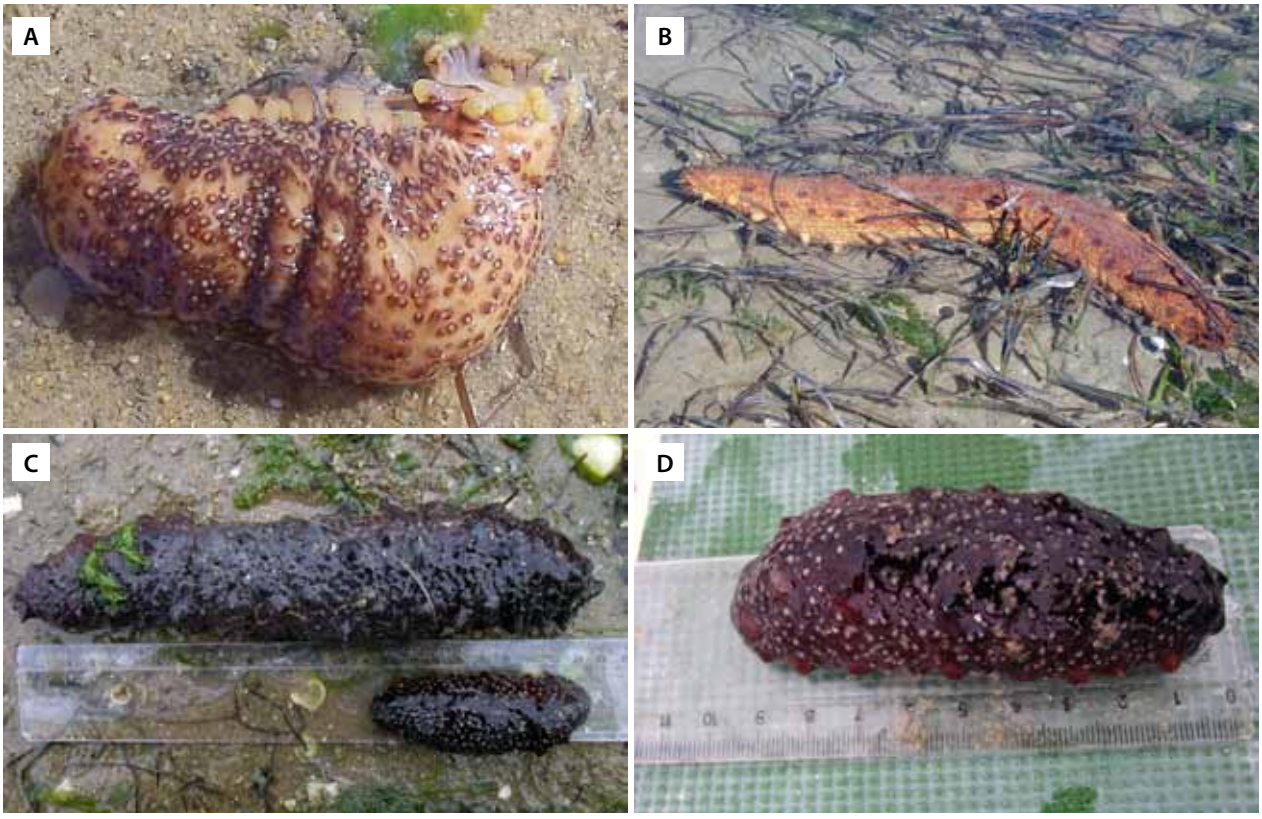

Figure 6. Different specimens of *Holothuria arguinensis* sampled in Ria Formosa.
A: *H. arguinensis* juvenile found inside seagrass (5 cm); B: Adult of *H. arguinensis* sampled on a patch with *Cymodocea nodosa* and *Ulva* sp; C: Juvenile and adult of *H. arguinensis*; D: *H. arguinensis* juvenile with 9 cm of length.

Culatra), recording the same parameters and supplementary ones, such as seagrass covering, irradiance, water and air temperature and granulometry of sediment. This information, obtained through the volunteer programme, together with the studies of the genetic diversity, ethology, reproduction and nutritional profile, which are accomplished at the same time by MSc students, will allow us to have a better picture of *H. arguinensis* populations in Ria Formosa for future fishery management.

Acknowledgements

This research was supported by the CUMFISH project (PTDC/MAR/119363/2010; http://www.ccmar.ualg.pt/cumfish/index.html) funded by Fundacão para Ciência e Tecnologia (FCT, Portugal). M. González-Wangüemert was supported by an FCT postdoctoral fellowship (SFRH/BPD/70689/2010). Special thanks to the volunteers – Divna Djokic, Ewelina Heil, Siel Wellens and Nadia Morado – for their help during samplings.

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