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INTERSPECIFIC COMPETITION AND INVASIVE CAPACITY OF *HOLOTHURIA (ROWEOTHURIA) ARGUINENSIS*: DOES ITS DIET REPRESENT A DANGER FOR NATIVE MEDITERRANEAN SPECIES?

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HOLOTHURIA (R.) ARGUINENSIS
INVASIVE SPECIES
DIET
COMPETITION
ALGERIAN WEST COAST
NATIVE MEDITERRANEAN SPECIES
ALGAE
FORAMINIFERA

ABSTRACT. – The aim of this study is to investigate the diet of the invasive species *Holothuria (Roweothuria) arguinensis* Koehler & Vaney, 1906 and its competitive potential in food intake, with native Mediterranean holothurian species in Salamandre province (Algeria). Crustaceans are widely consumed by all native species [21.33 %, 16 %, 10 % and 9.06 %, respectively in *Holothuria (Panningothuria) forskali* Delle Chiaje, 1823, *H. (Platyperona) sanctori* Delle Chiaje, 1823, *H. (Holothuria) tubulosa* Gmelin, 1791 and *H. (Roweothuria) poli* Delle Chiaje, 1824]. Foraminifera are also well appreciated by *H. (R.) poli* and *H. (H.) tubulosa* (respectively with 17.33 % and 29.33 %). *Holothuria (R.) arguinensis* stands out with high consumption of bivalve fragments (24.80 %), sponges fragments (11.6 %) and nematodes (6.80 %). However, cyanophyceae, crustaceans and foraminifera are not consumed by this invasive species. There was a very highly significant difference (Permanova, $p < 0.001$) between *H. (R.) arguinensis* and the four native Mediterranean holothurians. *Holothuria (R.) arguinensis* prefers food resources which are little or not consumed by the other native sea cucumbers; it could therefore be considered as a "specialist" species which shows no tendency to competition with the other holothurians species.

INTRODUCTION

Holothurians, commonly known as sea cucumbers, are marine organisms belonging to the phylum of Echinodermata, which comprises more than 1400 species (Conand 1994, Navarro 2012). Holothuriida are among the most common invertebrates in the benthic compartment of the Mediterranean *Posidonia oceanica* (L.) Delile (1813) ecosystem (Francour 1990, Mezali 2008) and play an important role in the organic matter recycling within the food web of this ecosystem (Zupo & Fresi 1984, MacTavish *et al*. 2012). During their foraging, these deposit-feeders collect selectively the richest organic matter particles (Mezali & Soualili 2013, Belbachir *et al*. 2014), which could favor ecological niche partitioning between species.

Holothuria (Roweothuria) arguinensis is a northeastern Atlantic species (Thandar 1988, Rodrigues 2012), which has recently been spreading into the Mediterranean Sea, where it has been recorded on the Algerian coast (Mezali & Thandar 2014). Due to the colonization of a different area of the Mediterranean Sea, *H. (R.) arguinensis* may compete with native holothurians species and consequently constitute a potential danger for them. Through this work, two questions were considered: (1) what are the food resources consumed by *H. (R.) arguinensis* and the Mediterranean native species *H. (P.) forskali*, *H. (P.) sanctori*, *H. (H.) tubulosa* and *H. (R.) poli*? (2) is there a competition for food resources between native sea cucumbers and *H. (R.) arguinensis*?

MATERIAL AND METHODS

Holothurians were sampled during spring 2018 at the Salamandre site (Mostaganem province, Algeria) (35°54'N; 0°03'E) (Fig. 1) at 3 m depth. This site shows a reduced biodiversity and a degraded *Posidonia oceanica* meadow (Belbachir 2018). Five Holothuriida species are found at the prospected area. *Holothuria (R.) poli* is the most abundant species, it can cover its body

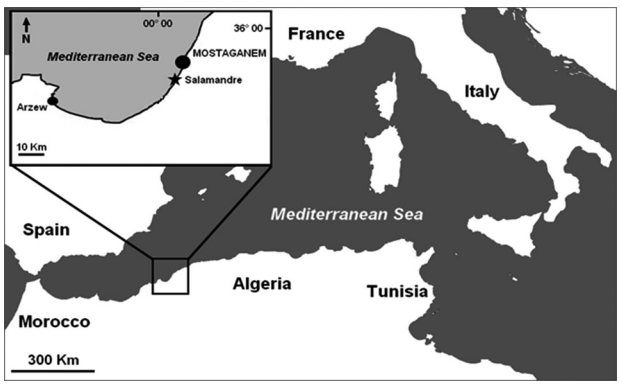

Fig. 1. – Geographical location of the Salamandre site (full star character) where samples of the five holothuroids were collected (from http://www.histgeo.ac-aix-marseille.fr, modified).

with a thin layer of sand (Mezali 2008). This species has a hard body and inhabits the detrital bottoms and the *intermatte* (spaces without living *P. oceanica* leaves within the meadow) (Mezali 2004). *Holothuria (H.) tubulosa* is found much closer to the hard bottom and within the *P. oceanica* meadow (Francour 1990). *Holothuria (P.) forskali* and *H. (P.) sanctori* have a soft body and constitute cryptic species that are found fixed on hard substratum, under rocks and in the eroded vertical edge (thickness of the *matte* that is observed at the level of the *intermattes*) of the *P. oceanica* meadow (Mezali 2008). *Holothuria (R.) arguinensis* is an invasive species recently recorded in Algerian shallow water areas (Mezali & Thandar 2014). At the prospected site, this species is usually found on rocky or sandy substrate.

Ten adult individuals (20 cm average contracted length) were collected for each of the five holothurians species found at the Salamandre site [*Holothuria (P.) forskali*, *H. (P.) sanctori*, *H. (H.) tubulosa*, *H. (R.) poli* and *H. (R.) arguinensis*]. Each individual was dissected and the contents of its digestive tract were carefully collected for microscopic observations. The contact method of Jones (1968), modified by Nedelec (1982), was used for the digestive content analysis (see Belbachir & Mezali 2018). Permutational multivariate analysis of variance (PERMANOVA) (Anderson 2001) was carried out using R v3.4.1 software (R Core Team 2017) to test the dissimilarity of diet items among holothurians digestive tract. Diet composition data were visualized in two-dimensional space through non-metric multidimensional scaling (NMDS) (Clark 1993). The use of the R v3.4.1 software enabled us to introduce confidence ellipses based on the variability existing between the replicates (the confidence level used is 68 %).

RESULTS

Diatoms and algae are relatively well represented in all the analyzed holothurian guts. The highest rate of diatoms is obtained for *Holothuria (P.) forskali* (28.66 %) and the highest percentage of algae is obtained for *H. (P.) sanctori* (31.33 %) (Fig. 2).

Bivalve fragments (24.80 %), sponges (11.6 %) and nematodes (6.80 %) are relatively widely consumed by *H. (R.) arguinensis*. Furthermore, these three food resources are little consumed by the native holothurians species (Fig. 2). *Holothuria (R.) arguinensis* do not consume foraminifera, crustacean and cyanophyceae, unlike most of the native species, which appreciate these food resources (Fig. 2). The leaves (dead and alive) of *P. oceanica* are consumed by all sea cucumbers, but in very small proportions. The highest proportion of dead *P. oceanica* leaves (2.67 %) is obtained in *H. (P.) forskali* gut and the highest percentage of alive *P. oceanica* leaves (3 %) is obtained in *H. (R.) arguinensis* gut (Fig. 2). The PERMANOVA analysis reveals a dietary difference among the five studied holothuroids ($p < 0.001$). According to the non-metric multidimensional scaling (NMDS)

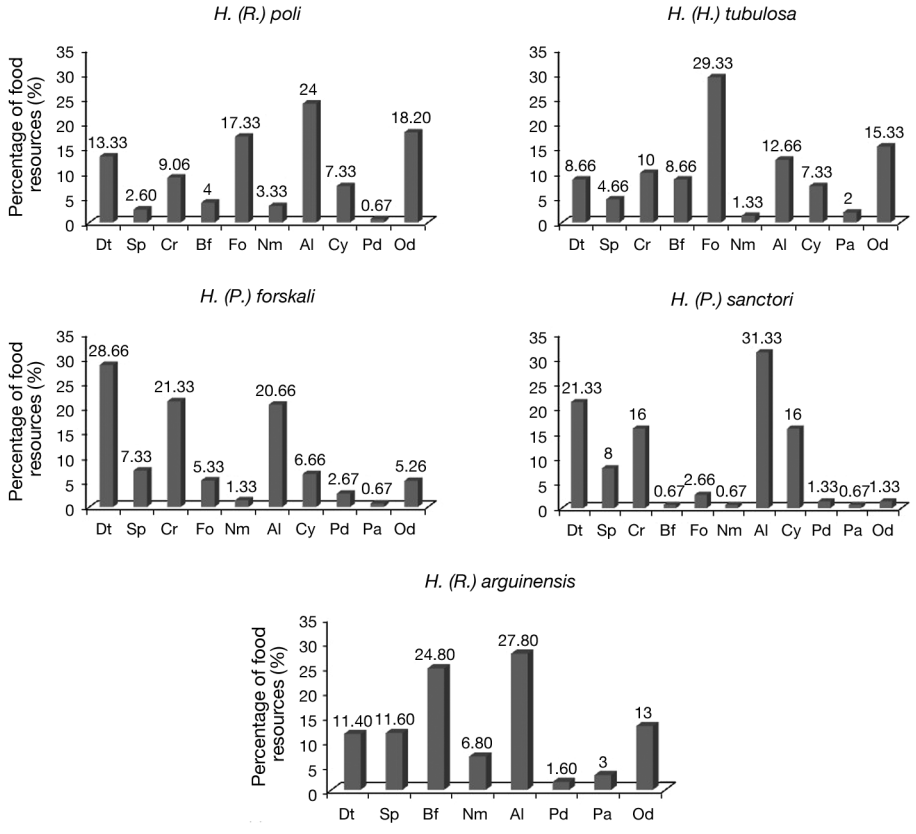

Fig. 2. – Percentage of food resources in the diet of the studied holothurians. Diatoms (Dt), Cyanophyceae (Cy), Macrophytes algae (Al), *Posidonia oceanica* alive leaves (Pa), *Posidonia oceanica* dead leaves (Pd), Foraminifera (Fo), Crustacean (Cr), Sponges (Sp), Nematodes (Nm), Bivalve fragments (Bf), Organic detritus (Od).

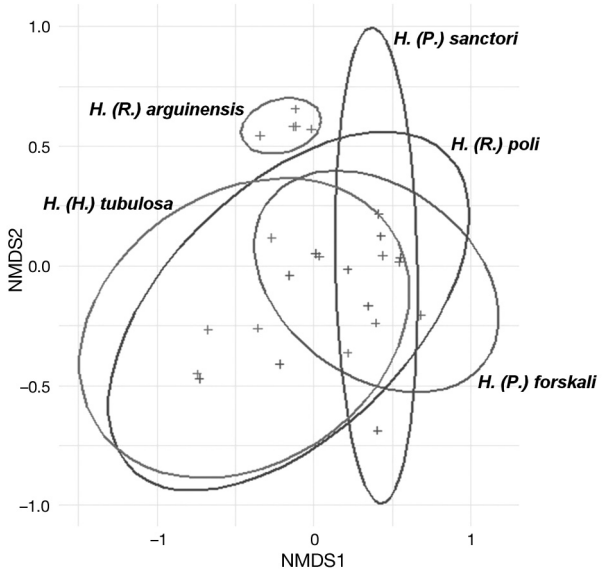

Fig. 3. – Non-metric multidimensional scaling (NMDS) analysis based on Bray-Curtis distances highlighting the relationship between the studied holothurian species at the Salamandre site, according to their diet.

presentation, *H. (R.) arguinensis* ellipse is clearly distinguished from those of the native species (Fig. 3).

DISCUSSION

The food resources of the five studied holothuroids are very diverse. Statistical analysis (PERMANOVA and NMDS) enabled us to distinguish the invasive *Holothuria (R.) arguinensis* from the native holothurian species group [*H. (P.) forskali*, *H. (P.) sanctori*, *H. (H.) tubulosa* and *H. (R.) poli*] in terms of diet. *Holothuria (R.) poli* is much closer to *H. (H.) tubulosa*, since foraminifera are the common food item shared between these two species. *Holothuria (P.) sanctori* and *H. (P.) forskali* are also close to each other in terms of diet; these two holothuroids greatly prefer the vegetal component and crustacean in their diets. Through non-metric multidimensional scaling (NMDS) presentation, we could claim that there is no diet overlap between *H. (R.) arguinensis* and the other native species. The invasive species ellipse is narrower than those of the other species, suggesting that it could be a specialist species. *Holothuria (R.) arguinensis* does not compete with the four studied indigenous Mediterranean sea cucumbers, as long as it consumes some food resources, which are infrequently used by the rest of the sea cucumbers. There are also some food resources consumed by native species, which are not consumed by this invasive species.

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