Selective feeding behaviour in some aspidochirotid holothurians (Echinodermata: Holothuroidea) at Stidia, Mostaganem Province, Algeria

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Abstract

A study of the feeding behaviour of some aspidochirotid holothurian species inhabiting the *Posidonia oceanica* meadows near Stidia in Mostaganem Province, Algeria, was carried out in order to assess their ability to selectively feed. This study is an assessment of the level of organic matter in sediments of the gut contents of these species, their faeces, and the sediment of their biotope. A granulometric analysis of the ingested particles by *Holothuria* (*Roweothuria*) *poli* and sediment particles of its biotope was also conducted as part of this study in order to estimate this species' degree of feeding selectivity. The holothurians studied showed a selectivity for organic matter: *H.* (*Platyperona*) *sanctori* is the most selective species, followed by *H.* (*Panningothuria*) *forskali*, *H.* (*R.*) *poli* and *H.* (*Holothuria*) *tubulosa*. This difference in selectivity may be related to their micro-distribution in the different habitats of the *Posidonia* meadows ("herbier sur matte", "inter-matte", "tombants de matte"). The fine and very fine fractions of the sediment are selected by *H.* (*R.*) *poli*, thereby confirming the "optimal foraging theory".

Introduction

The aspidochirotid holothurians are the major representatives of the benthic component of the *Posidonia oceanica* ecosystem of the Mediterranean Sea; they actively contribute to the recycling of organic matter and play an important role in the "detritus food web" of this ecosystem (Zupo and Fresi 1984). Selective feeding behaviour in sea cucumbers has been studied in many works; set apart from the obvious benefit of getting food with high nutritional value, the selection of nutrients by sea cucumbers could be a way to explain the niche partitioning between different species that live in the same habitat (Roberts 1979). Recently, Mezali and Soualili (2013) analysed the digestive contents of Algerian shallow water holothurians species and showed that some holothurians ingest both coarse and fine sediments — *Holothuria* (*Holothuria*) *tubulosa*, *H.* (*Roweothuria*) *poli* and *H.* (*H.*) *stellati* — while others select fine and very fine sediments — *H.* (*Panningothuria*) *forskali* and *H.* (*Platyperona*) *sanctori*. The aim of the present work was to study the selective feeding behaviour of the aspidochirotid holothurians of the coastal fringe of Mostaganem Province in Algeria.

Materials and methods

Sampling was conducted at Stidia (Fig. 1) at an average depth of less than 3 m. For the organic matter (OM) rate analysis, batches of samples of 10 individuals were collected for each species: *H.* (*H.*) *tubulosa*, *H.* (*R.*) *poli*; *H.* (*P.*) *sanctori* and *H.* (*P.*) *forskali*.

Figure 1. Location of the study area.

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The first few millimetres of the biota sediment (BS) and faeces (F) ejected by holothurians were collected. The digestive contents (DC) of each individual were carefully collected. The rate of organic matter in DC, BS and F was determined according to the protocol recommended by Massin (1980); the sediments were oven dried and weighed (dry weight: DW), then incinerated in a muffle furnace and then re-weighed (ashes weight: AW). The following formula was used: $OM (\%) = (1 - AW/DW) \times 100$. A one-way ANOVA was performed. For the granulometric analysis, 20 individuals of *Holothuria* (*R.*) *poli* were collected, together with the first millimetres of their BS. The digestive tracts of each individual and their contents were collected. In order to have a sufficient quantity of dry sediment (≥ 150 g), the sediment of the gut contents of the 20 individuals were pooled (following Roberts' [1979] protocol). The sediment was then oven dried, then weighed to obtain the initial weight. The fine fraction is obtained after wet sieving (40-µm mesh sieve). The remaining part was again oven dried, weighed (final weight) then mechanically sieved on an AFNOR sieve series. Each sieve residue was weighed and expressed as a percentage of the initial weight. The percentage of the different fractions: very coarse (> 2,000 µm); coarse (600–2,000 µm); medium (200–600 µm); fine (60–200 µm) and very fine (40–60 µm) are thus determined (Berthois 1975). This protocol is also used for BS. The selectivity of *H.* (*R.*) *poli* in the choice of the grain sediment has been studied through the calculation of the electivity index: $E' = (ri - pi) / (ri + pi)$ (ri: % of retained sediment; pi: % of ambient sediment; $E' = 0$ indicates no selectivity; $-1 < E' < 0$ indicates avoidance; $0 < E' < 1$, indicates preference) (Ivlev 1961 in Stamhuis et al. 1998).

Results

The rate of OM found in the DC sediment of the four holothurians species was high compared with that found in the sediment of their biotope (Fig. 2). The rate of OM in the DC varies from one species to another ($P < 0.01$) (Fig. 2), these results allow us to classify species according to their selectivity to the OM: *H.* (*P.*) *sanctori* is the most selective species followed by *H.* (*P.*) *forskali*, *H.* (*R.*) *poli* and *H.* (*H.*) *tubulosa*. The rate of OM in the DC sediment of *H.* (*R.*) *poli* is very high (7.45%) compared with that obtained for *H.* (*H.*) *tubulosa* (2.99%) (Fig. 2), a high rate of OM was found in the faeces of *H.* (*P.*) *sanctori* and *H.* (*R.*) *poli* compared with the sediment of their biota ($P < 0.01$) (Fig. 2). However, the OM rate from the faeces of *H.* (*H.*) *tubulosa* and *H.* (*P.*) *forskali* is practically equal to that of the BS (Fig. 2).

Stidia sediments are dominated by medium sand fraction (200–600 µm) (Fig. 3). All proportions of size fractions originating from the DC sediment of *H.* (*R.*) *poli* are greater than those of BS, except for the medium fraction (Fig. 3).

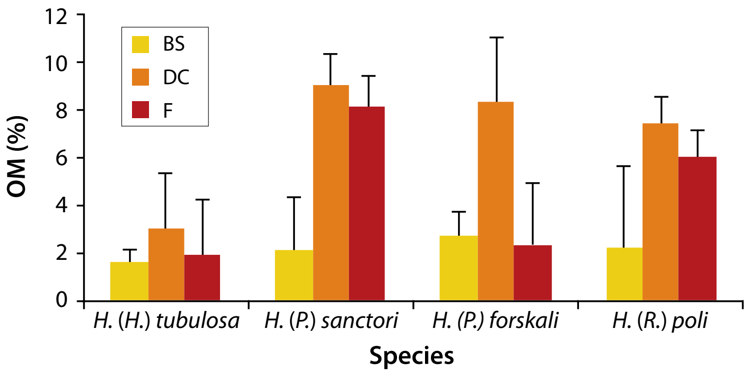

Figure 2. Percentage of organic matter in the biota sediment (BS), the digestive content (DC) and faeces (F) of the aspidochirotid holothurians at Stidia, Mostaganem Province, Algeria.

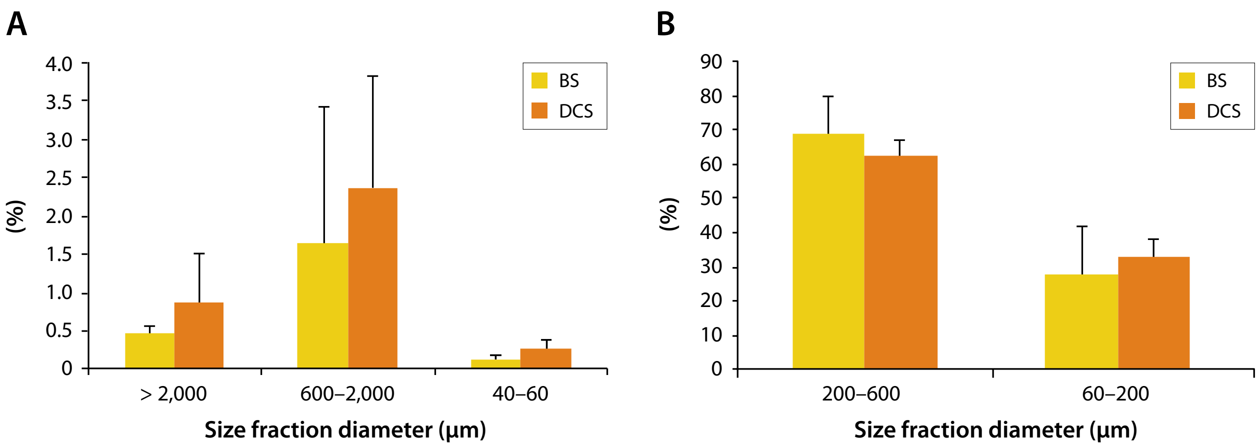

Figure 3. Percentage of size fractions of the biota sediment (BS), and the digestive content sediment (DCS) of *H.* (*R.*) *poli* at Stidia. (A): very coarse fraction (> 2,000 µm), coarse fraction (600–2,000 µm) and very fine fraction (40–60 µm); (B): medium fraction (200–600 µm) and fine fraction (60–200 µm) (According to Berthois [1975] classification).

Holothuria (*R.*) *poli* tends to select a large amount and preferably the fine fraction (Fig. 3). However, it is the very fine fraction that is preferred as long as it has the highest E′ (Fig. 4). *Holothuria* (*R.*) *poli* presents an almost equal selectivity degree for fine and coarse sand (Fig. 4).

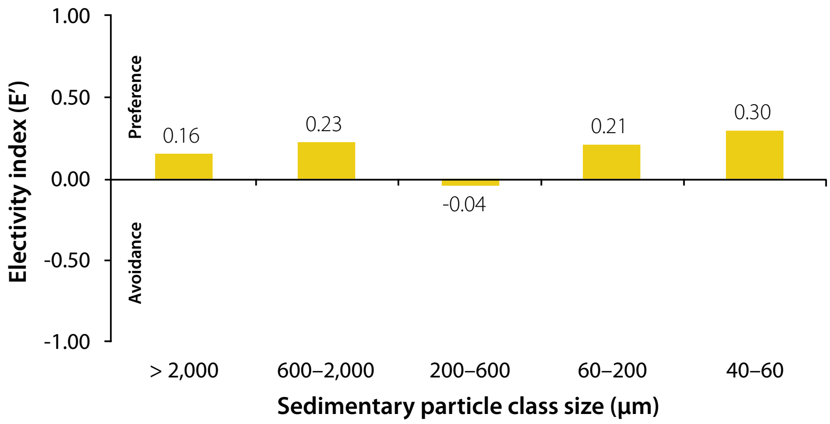

Figure 4. Electivity index (E') with sizes class of sediment particles, indicating preference (positive values) or avoidance (negative values) of a size class of sediment during the selection of the sediment particles by *Holothuria* (*R.*) *poli*.

Discussion

Organic matter rate analysis

The high rate of OM found in the DC compared with the BS, may be the result of the action of selectivity by these holothurians species to OM (Moriarty 1982; Mezali and Soualili 2013). The difference between the OM concentrations in the DC of these species could be explained by the fact that each species frequents a specific biota within the *Posidonia* meadow: *H.* (*H.*) *tubulosa* occurs in the inter-matte (Mezali 2004), which is heavily influenced by the hydrodynamic environment and, therefore, tends to disperse the food; *Holothuria* (*P.*) *sanctori* and *H.* (*P.*) *forskali* often occur between the rhizomes of *Posidonia* at the tombant de matte (Mezali 2008) biota where a large amount of biodetritic material accumulates (Boudouresque and Jeudy De Grissac 1983). The high rate of OM obtained in the DC of *H.* (*R.*) *poli* compared with that obtained in *H.* (*H.*) *tubulosa* does not corroborate the results obtained by Mezali and Soualili (2013) in Tamentefoust, where 8.70% of OM was found in the DC of *H.* (*H.*) *tubulosa* and 6.67% of OM was found in the DC of *H.* (*R.*) *poli*; therefore, it is considered to be a surprising result because these two species frequent the same biota (inter-matte). In addition, the rate of OM obtained for the DC of *H.* (*R.*) *poli* at Stidia (exposed area) is almost similar to that obtained by Mezali and Soualili (2013) at the protected site of Tamentefoust (6.67%), and is higher than the rate of OM obtained by the same authors in the exposed site of Sidi-Fredj (2.49%); normally, hydrodynamism, which is common in the exposed site, disperses biodetrical materials rich in OM. We noticed in our samples that the majority of individual *H.* (*R.*) *poli* were confined within a *Caulerpa prolifera* meadow, which preceded the *Posidonia* seagrass bed. This biota preference was also reported by Tortonese (1965). According to Holmer et al. (2009), *Caulerpa prolifera* promotes the enrichment of sediment in OM through its ability to retain and trap organic particles, and it is for this reason that *H.* (*R.*) *poli* was able to accumulate high rates of OM in its DC. Thus, *H.* (*R.*) *poli* might have the ability to select habitats rich in OM, and leave its favourite biotope, the inter-matte. According to Pyke et al. (1977), it is sometimes better for a species to move from one biota to another that is richer in nutrients. The high OM rate found in *H.* (*P.*) *sanctori* and *H.* (*R.*) *poli* faeces, shows that faecal matter contains a high rate of nutritive compounds. These results confirm those of Mezali (2008), at least for *H.* (*P.*) *sanctori*, *H.* (*H.*) *tubulosa* and *H.* (*P.*) *forskali*.

Granulometric analysis

The high proportion of medium sand fraction at the study site demonstrates an active hydrodynamism in the area (Jeudy De Grissac and Le Fur 1983). As noted by Mezali and Soualili (2013), *H.* (*R.*) *poli* has a preference for fine sediments. The increase in OM rate in fine fractions was demonstrated by Berthois et al. (1968). Effectively, as the surface to volume ratio increases with fine fractions, the surface to which the organic matter can adhere to is increased as well. Holothurians, therefore, have the ability to identify and generally select particles rich in OM (Massin and Jangoux 1976). The tendency to select coarse sediments was also observed by Mezali et al. (2003); some authors estimate that the presence of coarse particles in the digestive tract of holothurians can help them perform essential functions such as digestion (Dar and Ahmad 2006). It is assumed that the results obtained in this study are consistent with the model of feeding behaviour of marine deposit feeders proposed by Taghon and colleagues (1978). This model assumes that these animals tend to select smaller particles with high OM rates in order to maximise their energy gains. According to the authors, the model provides a relationship between particle size selection, food assimilation efficiency, gut transit time and the cost of rejecting particles. Marine deposit feeders adjust their food intake by selecting food that is efficiently assimilated with a short gut transit time, and with little cost of rejecting particles. This provides animals with the maximum amount of energy with a minimum loss of time (and minimum loss of energy), which is consistent with the "Optimal Foraging Theory", which assumes that animals recognise and select the food that provides them with the maximum amount of energy in a minimum amount of time (Taghon 1982; Pyke 1984).

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