# Gut content analysis of *Parastichopus regalis* (Cuvier, 1817) from the west Algerian coast

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## Abstract

*Parastichopus regalis* (Cuvier, 1817) is the only sea cucumber species in the family Stichopodidae that is present in the Mediterranean Sea. It is found in the upper part of the sublittoral zone of Sidi-Medjdoub (Mostaganem, Algeria). An analysis of its digestive content revealed that it is a species with a preference for very fine sediment particles that have a high organic matter content. The remaining part of its diet is composed of a faunal fraction (foraminifera, annelids, fragments of mollusc shells, sponge and echinoderm ossicles, and undetermined fauna) and a floral fraction (diatoms and cyanobacteria).

**Keywords:** *Parastichopus regalis*, feeding behaviour, digestive contents, Mostaganem, Algeria

## Introduction

Currently, the sea cucumber family *Stichopodidae* has 9 genera and 32 species that are distributed mainly in the Indo-Pacific region (Levin 1999; Byrne et al. 2010). *Parastichopus regalis* is the only species of this family that is present in the Mediterranean (Byrne et al. 2010). It is a benthic species that is found in a wide range of depths (5–800 m, Tortonese 1965), and which can be very abundant between 150 and 200 m depth where the sea temperature is quite constant (13°C) throughout the year (Ramon et al. 2010). It is a commercially important species for human consumption in a large area of the northwestern Mediterranean (Catalonia, Balearic Islands and Valencia), making it the only holothurian species consumed in Europe (Ramon et al. 2010). In the western Mediterranean basin, the trophic activity of *P. regalis* has been studied by Ramon et al. (2019). In Algeria, there are no data on its diet, as it was only recently reported by Benzait et al. (2020). The present work describes some qualitative aspects of its feeding behaviour.

## Methodology

### *Study site*

During May 2020, nine individuals of *Parastichopus regalis* were collected as bycatch during a fishing trip on a professional trawler in the Sidi-Medjdoub area (Mostaganem, Algeria) at a depth of 53 m (N36°0.032, E0°1.456, Fig.1).

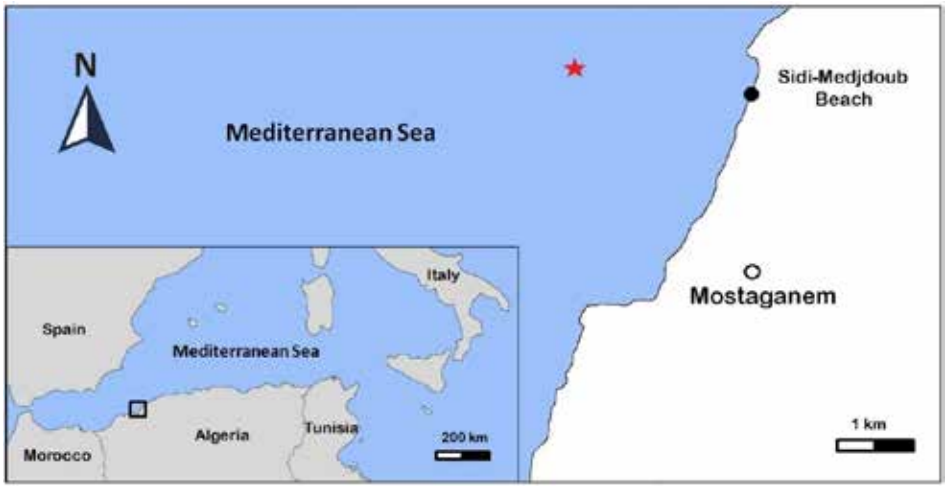


**Figure 1.** Location of the sampling site in the Mostaganem area (red star).

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### *Digestive content analysis*

To prevent evisceration (due to stress), collected individuals were dissected immediately on the trawler. Among the nine collected individuals (15-cm long on average, contracted length), only four did not expel their internal organs. The gut of each individual was opened by a longitudinal incision and the digestive contents were carefully collected and placed separately in a small plastic bag containing 10% formalin-seawater, then transported quickly to the Protection, Valorization of Coastal Marine Resources and Molecular Systematic Laboratory in Algeria. The method developed by Jones (1968), and later modified by Nédélec (1982), was used to analyse the digestive content of the individuals (see Belbachir and Mezali 2018). The average contribution of each constituent (digestive contents) was calculated for all individuals.

## Results

The analysis of the digestive content of *Parastichopus regalis* individuals from the Sidi-Medjdoub region shows that these sea cucumbers generally ingest the same constituents (Table 1). The digestive tract content of this species is mainly composed of a mixture of very fine particles (mud), fine particles (sand) and a small amount of large particles (gravel), all in different proportions (Table 1). An important diversity in the faunal fraction is observed, with mainly nematodes, sponge spicules, echinoderm ossicles, mollusc shell fragments, foraminifera, and an undetermined faunistic fraction. The floristic fraction is mainly represented by diatoms and cyanobacteria (Table 1).

Nearly two-thirds of the digestive contents of the four individuals of *P. regalis* consisted of very fine sedimentary fraction (61.38%) (Table 1, Fig. 2). In contrast, the rest of the sedimentary fraction was composed of fine sand particles (5.88%) and coarse sand particles (1.05%) (Table 1; Fig. 2). The latter are only observed in the digestive contents of individuals 3 and 4 (Table 1). The faunal fraction is also an important presence in the digestive content of *P. regalis*, representing a proportion of approximately 25.21% (Table 1). The presence of foraminifera in the gut was also found (7.54%), and the highest proportion is represented by undetermined foraminifera species (3.58%) (Table 1, Fig. 2). Indeed, the foraminifera of this group, in particular *Globigerina* sp. and *Textularia* sp., were observed in the guts of all individuals (Table 1). In addition, undetermined fauna (5.06%) were well represented, followed by sponge ossicles (4.98%), nematodes (3.35%), mollusc shell fragments (2.22%) and echinoderm ossicles (2.06%) (Table 1, Fig. 2). Diatoms were observed in the digestive contents of all individuals, with an average proportion of 4.04% (Table 1, Fig. 2). Finally, the cyanobacteria group is the least represented (at 2.45%) in the gut contents of *P. regalis* (Table 1, Fig. 2).

**Table 1.** Variation of the average contribution (in percentage) of items of the digestive contents of *Parastichopus regalis* in the region of Sidi-Medjdoub (Mostaganem).

| Items | Specimen 1 | Specimen 2 | Specimen 3 | Specimen 4 | Average |
|---|---|---|---|---|---|
| Very fines particles | 66.00 | 63.00 | 56.75 | 59.75 | 61.38 |
| Fines particles | 3.75 | 8.25 | 4.17 | 7.35 | 5.88 |
| Large particles | 0.00 | 0.00 | 1.45 | 2.75 | 1.05 |
| Nematodes | 4.75 | 2.75 | 4.15 | 1.75 | 3.35 |
| Sponge ossicles | 3.25 | 3.24 | 5.18 | 8.25 | 4.98 |
| Echinoderm ossicles | 1.50 | 0.75 | 2.75 | 3.25 | 2.06 |
| Mollusc shells fragments | 3.25 | 4.11 | 1.25 | 0.25 | 2.22 |
| Undetermined fauna | 4.25 | 6.50 | 6.25 | 3.25 | 5.06 |
| *Globorotalia menardii* | 0.25 | 0.00 | 0.55 | 0.00 | 0.20 |
| *Globigerina* sp. | 1.00 | 0.60 | 0.65 | 0.75 | 0.75 |
| *Bolivina* sp. | 0.25 | 0.50 | 0.00 | 0.60 | 0.34 |
| *Leptohalysis scottii* | 3.25 | 1.25 | 2.45 | 0.00 | 1.74 |
| *Textularia* sp. | 0.50 | 0.25 | 1.75 | 1.25 | 0.94 |
| Undetermined foraminifa | 1.25 | 4.15 | 3.75 | 5.15 | 3.58 |
| **Total foraminifera** | **6.50** | **6.75** | **9.15** | **7.75** | **7.54** |
| **Total fauna** | **23.50** | **24.10** | **28.73** | **24.50** | **25.21** |
| *Pleurosigma* sp. | 0.00 | 1.25 | 0.00 | 0.25 | 0.38 |
| *Nitzschia* sp. | 2.00 | 0.40 | 0.60 | 0.75 | 0.94 |
| Centric diatoms | 0.25 | 0.00 | 0.00 | 0.00 | 0.06 |
| Undetermined diatoms | 3.25 | 2.75 | 3.15 | 1.50 | 2.66 |
| **Total diatoms** | **5.50** | **4.40** | **3.75** | **2.50** | **4.04** |
| **Cyanobacteria** | **1.25** | **0.25** | **5.15** | **3.15** | **2.45** |

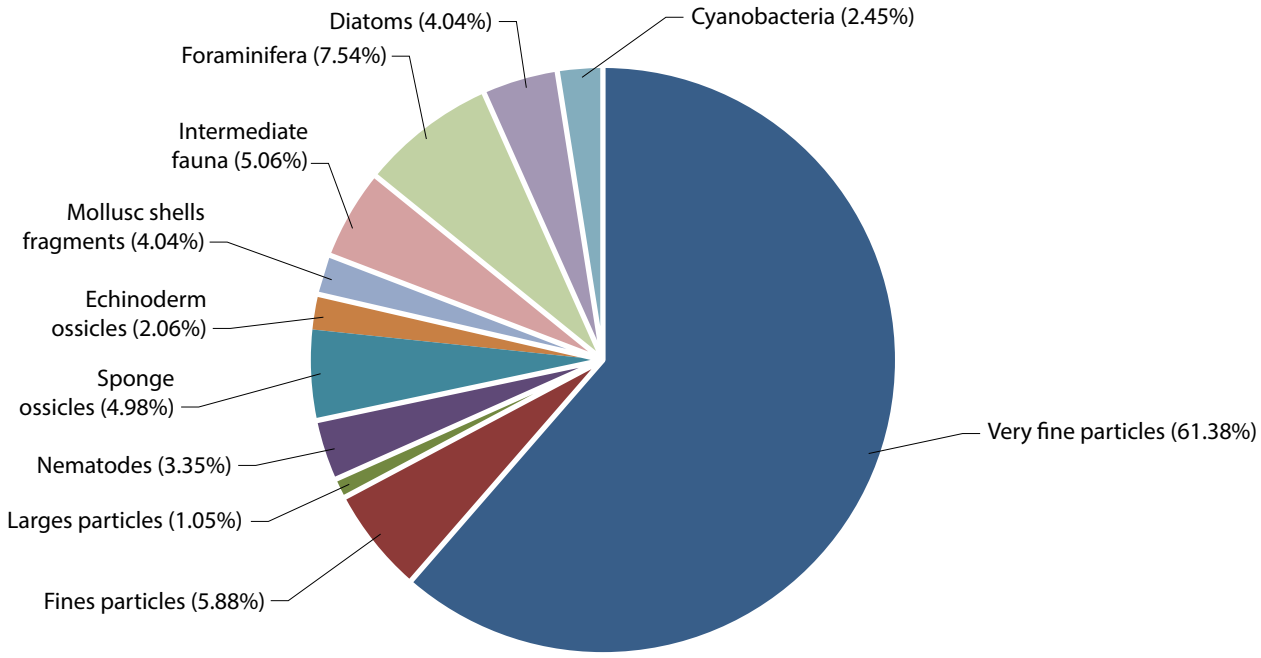


**Figure 2.** Main digestive tract content in *Parastichopus regalis* from the Sidi-Medjdoub area (average contributions expressed as a percentage).

## Discussion

The digestive contents of *Parastichopus regalis* is divided into three components: sediments, fauna and flora – with proportions of 68.31%, 25.46% and 6.49%, respectively. The proportion of very fine particles is high at more than 61%. The presence of this fine sediment fraction in the digestive tract of *P. regalis*is due to the biotope in which this species lives. According to Ramon et al. (2019), *P. regalis* ingests these fine sand particles (between 0.103µm and 1 mm in size), which are generally high in organic matter (Hudson et al. 2005; Holmer et al. 2009). According to Belbachir et al. (2014), marine deposit feeders adapt choose foods that are easily assimilated (rapid transit in gut) and for which the release of particles requires less effort. Holothurians feed selectively and are able to discriminate between nutritionally rich and poor particles, and select the rich ones using their gustatory receivers located on their tentacles (Mezali and Soualili 2013). The shape of the tentacles is generally adapted to the size of the particles to be ingested: detritus feeders that live on fine sediment have shorter tentacles, often peltate, contractile, and have an adhesive substance on their surfaces. Species of the *Stichopodidae* family, of which *P. regalis* is a part, are mainly found on sandy and muddy bottoms (Byrne and O'Hara 2017). According to our results, low percentages of large particles were found in the digestive contents of *P. regalis*, and this could be due to their low organic matter content. Moreover, according to Dar and Ahmad (2006), the presence of large particles in the digestive system of holothurians is necessary for carrying out essential functions such as digestion. The animal (fauna) fraction occupies an important place in the digestive content of *P. regalis*, with foraminifera constituting the greatest proportion. In fact, according to Bakus (1973), foraminifera are one of the main food sources for holothurians. The low percentage of diatoms found in the digestive tract of *P. regalis* confirms that this species uses microalgae as a food source as reported by several authors (Khripounoff and Sibuet 1980; Sonnenholzner 2003; Yokoyama 2013; Xie et al. 2017). Moreover, this food source is considered to be an essential part of the diet of holothurians, especially during their early stages of development (Shi et al. 2013, 2015).

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