

## Feeding response of the polychaete *Sabellaria alveolata* (Sabellariidae) to changes in seston concentration

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### ARTICLE INFO

#### Article history:

Received 24 October 2008

Received in revised form 18 June 2009

Accepted 22 June 2009

#### Keywords:

Feeding activity

Reefs

Suspension-feeders

Trophic capacity

Tubicolous polychaete

Bay of Mont-Saint-Michel

### ABSTRACT

*Sabellaria alveolata* is a tube-building gregarious polychaete that constructs large biogenic reefs. In macrotidal shellfish ecosystems, this species competes for food with cultivated suspension-feeders. The suspension-feeding activity and clearance rate of *S. alveolata* were investigated in response to changes in seston concentration. A flow-through system was designed to study 225 cm<sup>2</sup> reef blocks with more than 500 individuals. The experimental conditions were characterized by increasing concentrations of suspended particulate matter ranging from 6.5 to 153.8 mg L<sup>-1</sup>, while the organic content of the diet (microalgae *Skeletonema costatum*) decreased inversely from 49 to 9%, to mimic the dilution of organic matter by inorganic particles, characteristic of tidal resuspension. We showed that the clearance rate exponentially decreased in relation to an increase in SPM concentration. Clearance rate was estimated at 5.3 10<sup>-3</sup> L h<sup>-1</sup> or 0.93 L h<sup>-1</sup> g<sup>-1</sup> (dry weight) for the lowest seston concentration (SPM = 6.5 mg L<sup>-1</sup>) and reached the asymptote at CR = 1.97 10<sup>-3</sup> L h<sup>-1</sup> or 0.35 L h<sup>-1</sup> g<sup>-1</sup> (dry weight) when SPM exceeded 45 mg L<sup>-1</sup>. Using picture analyses of polychaete movements, we showed that, paradoxically, an increase in SPM concentration did not adversely affect the feeding activity of *S. alveolata* since the number of filtering individuals remained stable from SPM = 6.5 to 55.5 mg L<sup>-1</sup>. These values were applied at the scale of the bay of Mont-Saint-Michel (France) to demonstrate that the filtration pressure of large populations of wild suspension-feeders should not be underestimated when the carrying capacity has to be assessed in the context of increasing bivalve cultures.

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### 1. Introduction

*Sabellaria alveolata* is a tube-building suspension-feeding polychaete, widely distributed on European coasts from the Bristol Channel to the Portuguese coast (Dubois et al., 2002, 2006a). In fact, it builds the largest biogenic formations on the European coast (Holt et al., 1998). Bioconstructions of *S. alveolata* are colonies typically found as veneers adhering to rocky shores at the mid-level of the intertidal zone. However, the largest structures are found in rare locations where these reefs can cover extensive areas on sandflats in the lower intertidal zone. In the bay of Mont-Saint-Michel, *S. alveolata* reefs create irregularly-shaped, patchy banks that cover approximately 100 ha and are considered the largest reef in Europe (Gruet and Bodeur, 1997). These biogenic reefs are known to host highly diverse and unique species assemblages, composed of species originating from both subtidal and intertidal areas, muddy and sandy bottoms (Dubois et al., 2002, 2006a). Besides providing shelter, other ecological functions of these biogenic reefs are poorly understood, including their role in the trophic web of the ecosystem they

inhabit. In the particular case of the bay of Mont-Saint-Michel, where the cultivation of oysters *Crassostrea gigas* and *Ostrea edulis* and mussels *Mytilus edulis* is the main economic activity (Le Mao et al., 2004), the question of the carrying capacity is of primary importance in a system largely dominated by benthic suspension-feeders (Cloern, 1982). In this bay, the large biogenic reefs (i.e. over 100 ha and up to 60,000 ind m<sup>-2</sup>) might be seen as a significant biological filter. In that context, measurement of the feeding activity of *S. alveolata* is a necessary step to assess the effects of biogenic reefs at the bay scale, compared with that of other cultivated and wild suspension-feeders.

In intertidal areas, filter-feeding organisms are greatly exposed to rapid changes in the availability and nutritional value of suspended particulate matter (hereafter SPM or seston). Because of the local action of wind- or tide-induced currents, the resuspension of sedimentary material, causing short-term variations in inorganic particles, may considerably modify the relative organic concentration of seston available to suspension-feeders. Understanding the effects of seston variations on feeding activity and filtration rates is an important goal in order to evaluate accurately the filtration of suspension-feeders in turbid macrotidal ecosystems. Suspension-feeder responses to changes in seston concentration have revealed a complex set of physiological (Barillé et al., 1997; Navarro and Widdows, 1997), morphological (Barillé et al., 2000; Dutertre et al., 2007) and behavioral adaptations (Iglesias

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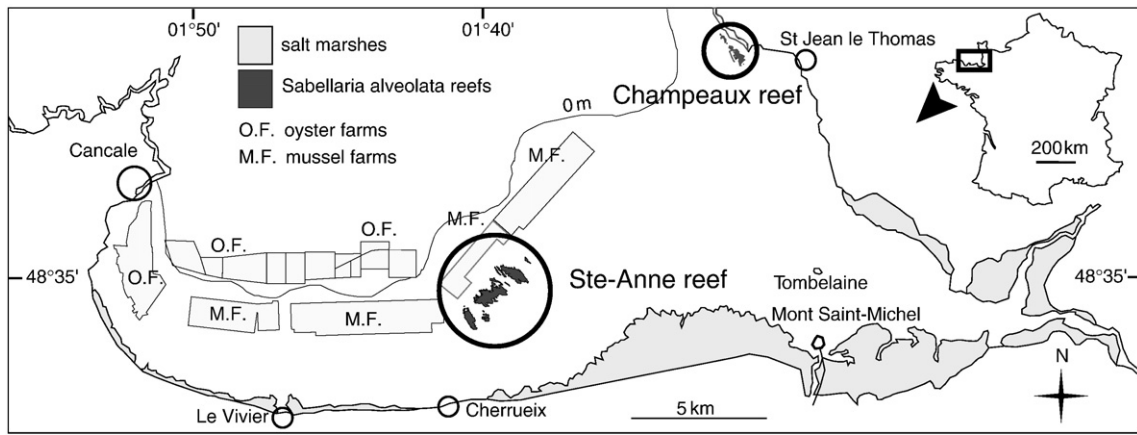


Fig. 1. Location of *Sabellaria alveolata* reefs within the bay of Mont-Saint-Michel (black circles). Note the spread of the cultivated oyster and mussel beds.

et al., 1996; Newell et al., 2001; Riisgård et al., 2003). While bivalves and gastropods have been widely studied (see references above), much less is known about other taxonomic groups such as polychaetes (but see Jordana et al., 2001; Riisgård et al., 2002; Hentschel and Larson, 2005), yet these are the most abundant and diverse group in estuarine and marine environments. Although Dubois et al. (2005) have studied the mechanisms of particle capture and processing in polychaetes *S. alveolata*, the effects of seston variations on filtration and feeding activity have not been investigated.

Because of its wide variety of depositional sedimentary environments and its macrotidal-related hydrological features, the bay of Mont-Saint-Michel is characterized by a broad range of suspended particulate matter. Recently, Cayocca et al. (2008) surveyed the sedimentary processes in a shellfish farming environment in the vicinity of the largest *S. alveolata* reef: while SPM peaks ranged between 200 and 1000 mg L<sup>-1</sup> depending on the flow and ebb conditions, SPM concentrations remained around 50 mg L<sup>-1</sup> over most of the tide period. In the bay of Mont-Saint-Michel, *S. alveolata* reefs are surrounded by oyster and mussel farming structures (Fig. 1), potentially filtering the same food sources but also locally increasing biodeposition rates and hence SPM concentrations. In this bay, largest mudflats and highest SPM concentration are hence found in the closest proximity to shellfish farming structures (Ehrhold et al., 2003). Using troughs specially designed to allow experimentation on large

reef blocks, the objectives of this study were thus (1) to investigate feeding responses (i.e. filtration and feeding activity) of the polychaete *S. alveolata* in relation to seston concentration and (2) to evaluate the filtration of *S. alveolata* reefs in the bay of Mont-Saint-Michel in comparison with the filtration of the main cultivated and natural suspension-feeding species.

2. Materials and methods

2.1. Sampling and conditioning of *S. alveolata*

Portions of reef were taken from the reef located in the eastern part of the bay of Mont-Saint-Michel (i.e. Champeaux reefs 1°29'28.2"O / 48°41'1.15"N; Fig. 1). Samples were extracted with a metal corer of 225 cm<sup>2</sup> surface area (15 × 15 cm) and 15 cm depth, corresponding to the reef layer where *S. alveolata* lives (Gruet, 1971). Five reef blocks were collected under similar environmental conditions (sedimentary processes, hydrodynamics, and bathymetry). Mud deposits were carefully removed in seawater then samples were put in an aquarium containing natural seawater with an open circuit kept at a constant temperature (15 °C). Individuals were fed algal cultures of *Skeletonema costatum*, a ubiquitous diatom widely found in European coastal waters and used in bivalve aquaculture (Barillé et al., 2003). During the acclimation period, dead individuals of *S. alveolata* were removed. Attention was also paid to

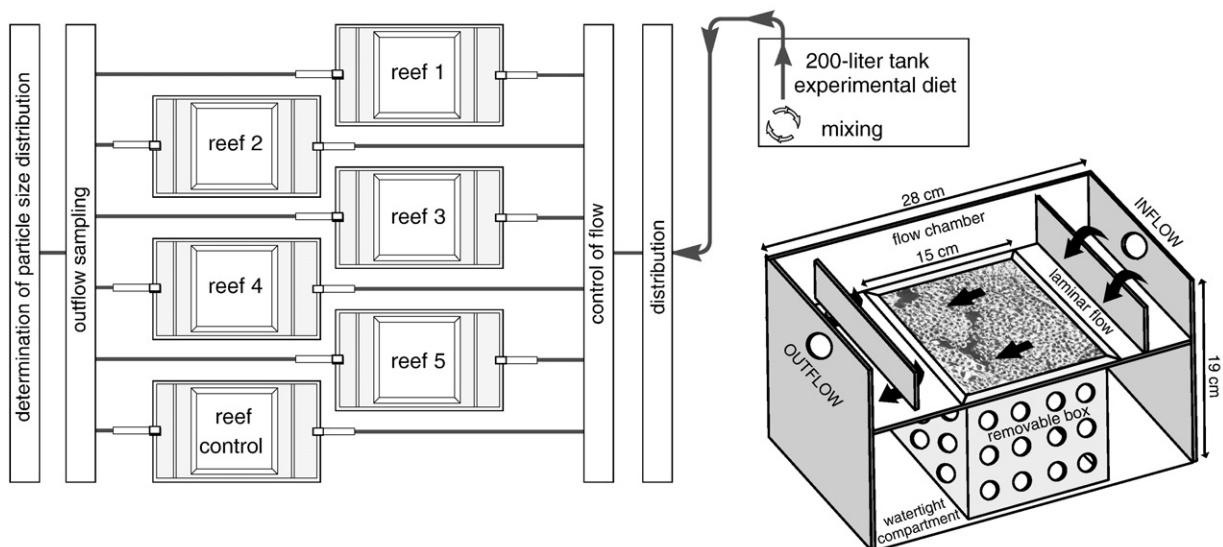


Fig. 2. Experimental set-up with details of the troughs containing *Sabellaria alveolata* reef blocks. Diagram of troughs modified from Dubois et al. (2003).

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