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Short communication

Trophic plasticity of the gastropod *Hydrobia ulvae* within an intertidal bay (Roscoff, France): A stable isotope evidence

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ABSTRACT

The study investigated the trophic ecology of the gastropod *Hydrobia ulvae* in different habitat types within an intertidal bay. The results point out two major trophic pathways involving *H. ulvae* in this bay. On the one hand, in sandy/muddy sediments *Hydrobia* derives most of its energy from allochtonous detritus derived from *Enteromorpha* sp and the total SOM pool. In addition, in these sediments, the phototrophic purple bacteria mats played a substantial trophic role in the diet of *Hydrobia.* On the other hand, in a *Spartina maritima* marsh, the gastropod appears firstly dependent of autochtonous detritus derived from this plant. The minor contribution of microphytobenthos to the diet of *Hydrobia* is consistent with a relatively low presence of epipelic diatoms at the sampling sites. These results provide evidence that the trophic ecology of *H. ulvae* inhabiting intertidal sediments is quite plastic and does not necessarily rely primarily on microphytobenthos. Consequently, in a single bay, the small spatial scale variability in the origin and availability of detritus have direct implications on the food incorporation by *H. ulvae*.

1. Introduction

In intertidal habitats, the high diversity of organic matter sources makes it difficult to determine the most important trophic pathways, and generates an important detrital organic matter pool (Mann, 1988) which can be used differently by animals. Hence, there is no paradigm stating, which main source of organic matter fuels the food web of coastal areas, and how dietary contributions can shift spatially and/or temporally for the most relevant species of these areas (Kwak and Zedler, 1997). *Hydrobia ulvae* (Pennant) is characteristically an inhabitant of intertidal mudflats and muddy/sandy sediments, which can also be found abundantly in a wide variety of intertidal substrata, including saltmarshes or macroalgae assemblages when present at sediment or rocky surface (Newell, 1965). Where abundant, the population densities of this gastropod can reach 30.000 ind m^2 as reported by Barnes and Greenwood (1978) who provide to *H. ulvae* a key trophic role as primary consumer and as prey for birds and fishes. Previous results concerning the dietary patterns of *H. ulvae* provided evidence of (1) its preferential trophic link with benthic diatoms in various intertidal mudflats in Western Europe (Lopez and Kofoed, 1980; Morrisey, 1988; Haubois et al., 2005) and (2) its influence on benthic diatom assemblages (Hagerthey et al., 2002). In the Aber bay of Roscoff, *H. ulvae* was reported to reach maximum densities of about 10 000 ind/m^2 (Rullier, 1959). Interestingly, in this bay, dense purple sulfur bacteria mats are commonly observed at the sediment surface, and reach their maximum development during summer (Riera, pers. obs.). These sulphide-oxidizing bacteria were hypothsized to contribute significantly to trophic transfers in salt marshes (Howarth and Teal, 1980). However, the possible contribution of purple bacteria to the diet of Hydrobiids remains unknown, especially as other coexisting food sources are potentially available to the gastropods. The ecological situation of the Aber bay during summer was, then, favourable to examine the significance of purple bacteria mats as food source of *H. ulvae* as compared to the other co-existing sources. In addition, in this bay, *H. ulvae* occurred abundantly in a localised *Spartina maritima* marsh allowing to investigate the trophic role of the organic matter derived from the *Spartina* for *H. ulvae.*

$\delta^{13}C$ and $\delta^{15}N$ distributions have further shown promise as a tool that provide a time-integrated measure of food web relationships. $\delta^{13}C$ show little enrichment ($\leq$1‰), then being useful for the identification of the organic matter sources at the base of food chains. Because $\delta^{15}N$ of a consumer ultimately builds on the stable nitrogen isotope composition of food sources sustaining the food web, $\delta^{15}N$ can efficiently complement $\delta^{13}C$ in distinguishing among various possible diet sources.

The aim of this study was to survey the abundantly represented *H. ulvae* in different habitat types within a single intertidal bay in order (1) to determine the degree of dependence of this gastropod on locally occurring organic matter sources including purple bacteria mats and (2) to answer the question the possible trophic plasticity at small spatial scale.

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2. Material and methods

2.1. Sampling site

The study was conducted in the Roscoff Aber Bay, which is about 2 km long and 1 km wide, and includes different types of intertidal sediments. The bay is shallow (average depth 4 m), totally located above the mid-tide level, has strong currents, and a tidal range of about 4 m that leads to generally good mixing and high turbidity (Chauris, 1988). The southern end of the bay is limited by a dike, which contains a sluice-gate that allows river input (Fig. 1). In this bay, three intertidal stations corresponding to three habitat-types for *H. ulvae* have been considered. The "River station" located at the river entrance into the bay consists of estuarine muddy-sandy sediments extensively covered by stranded *Enteromorpha* sp and purple bacteria mats. The "Sandy station" consists of sandy sediments largely covered by stranded *Enteromorpha* sp and purple bacteria mats during summer. The third station, located in the southern part of the bay, is colonised by a small *S. maritima* marsh from about 40–50 m in length and width. In this bay, organic matter content in muddy/sandy and *Spartina* sediments was measured between 2.5 and 4.5% while sandy sediments show values between 0.6 and 1.2% (Riera, data not published). From a recent study (Hubas et al, 2006), the median grain size of the River station corresponded to very fine-sand sediments (132 ± 54 μm), while close to the sandy station fine-sand sediments (215 ± 43 μm) were reported. Unfortunately, no values are available for the *Spartina* marsh, but from its location within the bay the sediment grain size appears close to the Sandy station (Riera, pers. obs.).

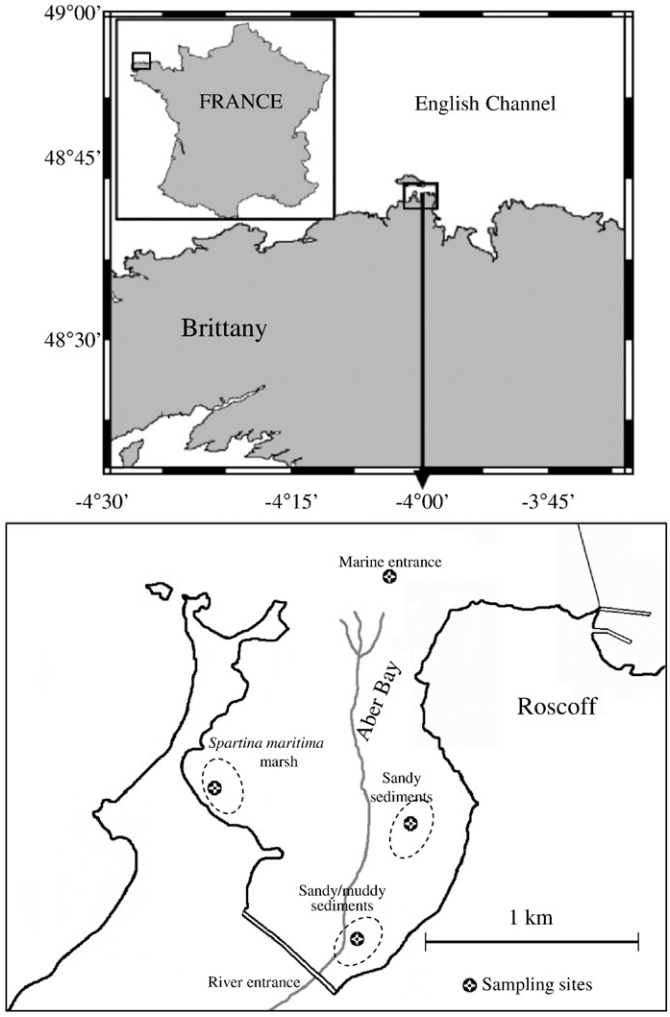

Fig. 1. Location of the sampling station in the Roscoff Aber Bay (France).

2.2. Collection and sample preparation

Samples of organic matter sources and individuals of *H. ulvae* were collected during August 2004. The densities of *H. ulvae* were monitored at the three sampling sites. Five replicate samples were taken at each site with a rectangular 2 cm deep scoop of area 0.01 m^2. Samples were sieved on site through a 1.0 mm mesh sieve, and the retained material was transported to the laboratory and the numbers of living *Hydrobia* counted over a light box. At low tide, sediment samples were taken by scraping the upper 1 cm of the sediment. For the measurements of stable isotope ratios of the sedimented organic matter (SOM), the sand was sieved to a grain size of <63 m to separate sand grains from most of the SOM. Then, the SOM fraction <63 m was acidified (10% HCl) rinsed several times with distilled water, dried (60 °C) and ground to powder. The stranded *Enteromorpha* sp was abundantly present at the sediment surface and easily identified to genus level (Cabioc'h et al., 1992). The detrital *Enteromorpha* sp was rinsed with filtered seawater (precombusted GF/F) to clean off epibionts, treated with 10% HCl to remove any residual carbonates, and rinsed with distilled water.

At the marine entrance of the bay, POM (suspended particulate organic matter) was sampled by collecting 2-l bottles of water at high tide (±1 h) from a depth of about 50 cm below the water surface. POM was obtained by filtration on precombusted Whatman GF/F glass fiber membranes within 2 h after collection. Subsequently, the membranes were acidified (10% HCl) in order to remove carbonates, briefly rinsed with Milli-Q water, freeze-dried and kept at −32 °C until analysis. At low tide, live and dead leaves of *S. maritima* were collected by hand and prepared as for *Enteromorpha* sp. Subsequently, the samples were dried (60 °C) and ground to powder using a mortar and pestle. Sample of free-living purple bacteria were collected in the field where dense purple mats developed at the sediment surface. These photosynthetic purple bacteria were collected by suction pipetting samples from the surface of creek sediment. At the laboratory, the samples were observed under magnifying glass to remove carefully any remaining detritus and dried at 50 °C. In the Aber bay of Roscoff, purple bacteria mats were reported to be mostly associated with the decomposition of *Enteromorpha* sp and were dominated by the purple sulphur bacteria *Thiorhodobacter* spp (Rullier, 1959).

H. ulvae was collected from the surficial sediment at low tide close to the quadrats used for density estimation. Specimens were taken by hand and kept alive overnight at the laboratory in filtered water from the sampling site to allow evacuation of gut contents. Then, they were killed by freezing, dissected and the flesh quickly treated with 10% HCl to remove any carbonate debris from the shell and rinsed with distilled water. They were then freeze-dried, ground to a powder using mortar and pestle and kept frozen until analysis.

2.3. Stable isotope measurements

Carbon and nitrogen isotope ratios were determined using a Fisons CN analyser coupled with a Finnigan Delta S mass spectrometer, via a Finnigan Con-Flo III interface. Data are expressed in the standard δ unit notation.

$$\delta X = [(R_{sample} / R_{reference}) - 1] \times 10^3$$

With $R = {}^{13}C/{}^{12}C$ for carbon and ${}^{15}N/{}^{14}N$ for nitrogen. The standard deviation of repeated measurements of $\delta^{13}C$ and $\delta^{15}N$ values of a laboratory standard was 0.10‰ versus V-PDB and 0.13‰ versus at-air,