Available online at www.sciencedirect.com
ScienceDirect
Estuarine, Coastal and Shelf Science 72 (2007) 33–41
ESTUARINE COASTAL AND SHELF SCIENCE
www.elsevier.com/locate/ecss

Trophic subsidies of *Crassostrea gigas*, *Mytilus edulis* and *Crepidula fornicata* in the Bay of Mont Saint Michel (France): A $\delta^{13}C$ and $\delta^{15}N$ investigation

Pascal Riera

UMR 7144 CNRS, Adaptation et Diversité en Milieu Marin, Station Biologique de Roscoff, Université Pierre et Marie Curie-Paris VI, CNRS-INSUE, Place Georges Teissier, BP74, 29682 Roscoff Cedex, France

Received 19 May 2006; accepted 3 October 2006
Available online 28 November 2006

Abstract

This study focussed on the determination of the main trophic subsidies for three dominant filter feeding molluscs of the benthic community, namely, *Crassostrea gigas* (Thunberg), *Mytilus edulis* (L.) and *Crepidula fornicata* (L.), cultivated or naturally occurring in the Bay of Mont Michel (France). $\delta^{13}C$ and $\delta^{15}N$ values revealed that the diet of these filter feeders was primarily based on marine plankton together with a lower contribution of the organic matter derived from salt marsh phanerogames, as estimated through the isotopic mixing equations (Isosource). The microphytobenthos inhabiting the intertidal flat and the salt marshes do not contribute significantly to the diet of cultivated and naturally occurring *C. gigas* and *M. edulis*. Hence, in this bay, the major trophic pathways differ from previous results obtained in several coastal systems devoted to shellfish culture. This could result from ecological particularities and/or strong hydrodynamic conditions in the Bay of Mont Michel.

Keywords: filter feeding molluscs; food sources; $\delta^{13}C$ and $\delta^{15}N$; Bay of Mont Saint Michel

1. Introduction

Coastal ecosystems are heavily used for the cultivation of oysters and mussels, which co-occur with other filter feeding invertebrates. The diet of sedentary suspension feeding molluscs, which inhabit these areas, depends on the nature and quantity of the organic particles that are transported by the flood tide and maintained in suspension during immersion. Identifying the major sources of nutrition ultimately used by these consumers is crucial for our understanding of nutrient cycling processes in coastal ecosystems devoted to the cultivation of bivalves.

Intertidal bays are generally characterized by a large number of locally produced and allochthonous food sources for benthic consumers (Currin et al., 1995). This diversity makes it difficult to identify and estimate quantitatively the proportions of the main food sources in the diet of economically important molluscs. In fact, for most benthic invertebrates gut content analyses usually fail to provide this information because the ingested material is generally mixed with very fine sediment and triturated then being rapidly unidentifiable. In addition, food items may be digested with different efficiencies, distorting their real dietary importance (Pinn et al., 1998). Analysis of stable isotope ratios of carbon and nitrogen ($\delta^{13}C$ and $\delta^{15}N$) has been proven to be a useful tool in determining the main energy source for different food chains, and in understanding the functioning of coastal food webs (Fry and Sherr, 1984; Deegan et al., 1990). Moreover, animals which show similar $\delta^{13}C$ and $\delta^{15}N$ are assumed to have similar assimilated food sources insofar as these sources have been proved to be isotopically distinct (McConnaughey and McRoy, 1979). Thus, the use of $\delta^{13}C$ *vs.* $\delta^{15}N$ may also give clues about potential competition for food sources which can occur among co-occurring sedentary species (Riera et al., 2002).

E-mail address: riera@sb-roscoff.fr

0272-7714/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ecss.2006.10.002

The Bay of Mont Saint Michel supports several commercial activities directly dependent on coastal natural resources. This bay sustains one of the most important salt-marsh areas of Europe and a high shellfish culture production. This bay is largely populated by the oyster *Crassostrea gigas* (Thunberg) and the mussel *Mytilus edulis* (L.) which are extensively cultivated. The production of Japanese oysters *C. gigas* (about 5000–6000 T year^{-1}) as well as native oysters (*Ostrea edulis*) estimated at 1000–2000 T year^{-1} and mussels (700–1300 T year^{-1}) increase continuously in the bay (Lefeuvre and Bouchard, 2002). In addition, the invasive common Atlantic slipper limpet *Crepidula fornicata* (L.) reaches a biomass of about 173 000 ± 30 000 T (Lefeuvre and Bouchard, 2002). *C. fornicata* is a marine gastropod native from the east coast of America from Canada to the Gulf of Mexico (Walne, 1956) which was introduced to Europe via the importation of *Crassostrea virginica*. Its expansion has been facilitated by human activities related to aquaculture (Hamon, 1996). In shellfish culture areas where extensive *C. gigas* production occurs (Héral and Deslous-Paoli, 1983) trophic competition between *C. gigas* and *C. fornicata* was hypothesized (Deslous-Paoli, 1985). However, a more recent δ^{13}C and δ^{15}N study in the Bay of Oosterschelde (The Netherlands) suggested that, in shellfish culture areas, *C. gigas* and *C. fornicata* may not necessarily be trophic competitors insofar as food is not limited (Riera et al., 2002).

The contribution of intertidal microphytobenthos to the diet of benthic animals including filter feeders was previously evidenced in coastal ecosystems such as *Spartina alterniflora* salt marshes (USA) and Marennes-Oléron Bay (France) (Haines and Montague, 1979; Riera and Richard, 1996). In the Bay of Mont St Michel, previous results have also pointed out the importance of: (1) benthic diatoms from the salt marshes for the feeding of different macroconsumers inhabiting marshlands, such as *Corophium volutator* (Créach et al., 1997); and (2) the detrital salt marsh organic matter pool consumed by several locally occurring invertebrates, such as the amphipod *Orchestia gammarellus* (Meziane et al., 1997). However, the determination of the most assimilated food source by cultivated bivalves in this bay and, then, a better knowledge of the trophic capacity for filter feeders remain necessary.

I address this question here, concerning support of the benthic food web by sources of organic matter in the Bay of Mont Michel. The study focussed on the determination of the trophic subsidies for three dominant benthic filter feeding molluscs, namely, *Crassostrea gigas*, *Mytilus edulis* and *Crepidula fornicata*. In addition, this study aims to provide information to sustain the management of this shellfish culture areas in which human activities largely influence ecological processes.

2. Materials and methods

2.1. Sample collection and preparation

The Bay of Mont Saint Michel is located in North-west France between Brittany and Cotentin (latitude 48°40N, longitude 1°30′W) as shown in Fig. 1. The bay has an area of approximately 500 km^2, which includes large extent of intertidal salt marshes and mudflats of about 250 km^2. The bay is characterized by a large tidal range, which can attain 12–13 m between spring and neap tides leading to a good mixing and strong currents. Sampling was performed in different vegetation zones and habitats types within the bay. Samples were collected firstly in the west cultivated area of the bay during April–May 2002, and secondly, around the St Anne reef during April–May 2003 (Fig. 1). In fact, at this period, temperature and primary production increase are favorable to an important feeding activity of bivalves following winter in French coastal cultivated areas (Marteil et al., 1976).

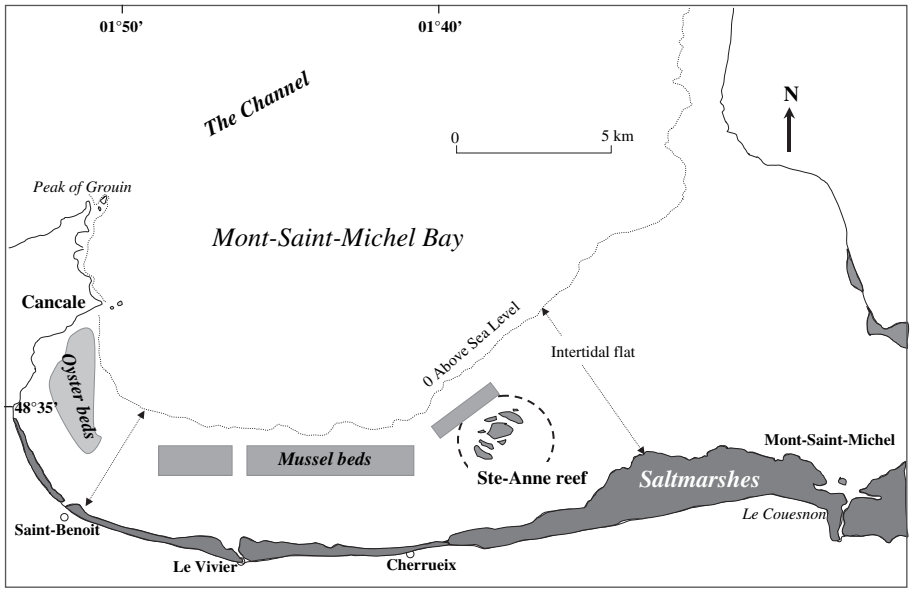

Fig. 1. Bay of Mont Saint Michel and locations of oyster and mussel beds.