Continental Shelf Research 31 (2011) 476–487

Contents lists available at ScienceDirect

Continental Shelf Research

journal homepage: www.elsevier.com/locate/csr

Research papers

Study of the trophic web of San Simón Bay (Ría de Vigo) by using stable isotopes

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ARTICLE INFO

Article history:
Received 21 December 2009
Received in revised form
27 September 2010
Accepted 21 October 2010
Available online 30 October 2010

Keywords:
Stable isotope
Food web
Diet analysis
Seagrass
Ría de Vigo

ABSTRACT

Based on the stable isotope composition in ^{15}N and ^{13}C of different potential sources of organic matter and consumers of an intertidal *Zostera marina* meadow located in San Simón Bay (Ría de Vigo, NW of Spain), a simplified food web of this community was reconstructed. For this purpose, some alternatives in different steps of the most used methodology of stable isotope dietary analysis were developed that cope with some of the limitations associated to the interpretation of isotopic signals for food web analysis, those of uncertainty on the fractionation value, mathematical model to use for the diet resolution and shortage of the isotope number for discriminating many food sources. The application of this protocol to the studied community reported similar results to those from other studies based on similar trophic webs, emphasizing the importance of local primary producers, especially microphytobenthos, which could be available for several primary consumers through resuspension forced by tidal hydrodynamic. The good agreement with previous results suggests that the proposed protocol is a feasible alternative to elucidate the most plausible trophic relationships in complex trophic webs using stable isotopes analysis.

1. Introduction

A trophic web describes the feeding behaviour of the organisms in a community (Cohen et al., 1990). From a functional point of view, a trophic web represents the different consumer–resource relationships in the community and the pathways of matter and energy transfer in the ecosystem. Elucidating these relationships is crucial to understanding how ecosystems work as well as predicting potential effects that different stressors such as human activity have on ecosystems (Winemiller and Polis, 1996). Usually, reconstruction of a trophic web is based on the study of anatomic structures related to feeding, direct observation of consumption and the analysis of gut contents (Polunin and Pinnegar, 2002). These methods have limited utility because they can only resolve recent feeding events, and reveal nothing about an organism's long term feeding history. They also require a large number of samples and are very difficult to apply to small consumers or to easily digestible diets. Alternative methods have recently been developed that improve and complement the previous ones (Sheppard and Harwood, 2005; De Lange and Van den Brink, 2006; Carreon-Martinez and Heath, 2010). One such method is the analysis of consumer's stable isotopes ratios. This technique finds potential sources of organic matter exploited by the consumer based on the principle "you are what you eat", which assumes that the isotopic composition of a consumer's body tissue is a direct consequence of the isotopic composition of its food sources (DeNiro and Epstein, 1978). Stable isotopes provide long-term information about a consumer's diet without requiring large sampling periods, and in addition can be applied to all organic matter sources and consumer sizes.

The assimilation of food particles by the consumer causes that the consumer isotopic composition reflects the isotopic composition of the food sources (Fry and Parker, 1979; Haines and Montague, 1979). However, differences in the physical–chemical properties and chemical reaction rates between isotopes cause an enrichment in the proportion of heavier isotopes in the consumer compared to the food sources (Ponsard and Arditi, 2000), in a process is called fractionation (Libes, 1992). By examining the isotopic ratios of various organisms in an ecosystem and accounting for fractionation, trophic ecologists can trace organic matter sources on a community (Peterson et al., 1984; Riera et al., 2000), estimate the trophic level of an organism (Vander Zanden and Rasmussen, 1999; Post et al., 2000) and reconstruct diets and trophic web of a community (Hughes et al., 2000; Pinnegar and Polunin, 2000; Ponsard and Arditi, 2000).

However, using stable isotopes to study trophic ecology presents limitations: (1) The degree to which fractionation occurs depends on different variables such as ecosystem type (France and Peters, 1997), trophic level (Vander Zanden and Rasmussen, 2001)

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doi:10.1016/j.csr.2010.10.010