Trawling disturbance on the isotopic signature of a structure-building species, the sea urchin *Gracilechinus acutus* (Lamarck, 1816)

José M. González-Irusta a,*, Izaskun Preciado b, Lucia López-López b, Antonio Punzón b, Joan E. Cartes c, Alberto Serrano b

a Marine Scotland Science, Marine Laboratory, 375 Victoria Road, Aberdeen AB11 9DB, Scotland, UK
b Instituto Español de Oceanografía, Centro Oceanográfico de Santander, Promontorio San Martín s/n, P.C., 39080 Santander, Spain
c ICM-CSIC, Pg. Maritim de la Barceloneta 37-49, 08003 Barcelona, Spain

**ARTICLE INFO**

Available online 3 October 2013

**ABSTRACT**

Bottom trawling is one of the main sources of anthropogenic disturbance in benthic habitats with important direct and indirect effects on the ecosystem functional diversity. In this study, the effect of this impact on a structure-building species, the sea urchin *Gracilechinus acutus*, was studied in the Central Cantabrian Sea (southern Bay of Biscay) comparing its isotopic signature and additional population descriptors across different trawling pressures. Trawling disturbance had a significant effect on the studied descriptors. In trawling areas, this urchin showed significantly lower values of biomass and mean size and significantly higher values of fullness index. Moreover, the trawling disturbance effect was also significant in the isotopic signature of *G. acutus*. Urchins inhabiting untrawled areas showed significant lower values of δ15N than urchins dwelling areas under trawling pressure. The urchins' isotopic enrichment increased along the species ontogeny regardless of the trawling effort level. Stable isotope analyses are a suitable tool to detect trawling disturbance on the trophic pathways but do not suffice to explain these changes, especially if there is a lack of baseline information.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

The ecosystem functional diversity can be disturbed by anthropogenic impacts and fishing is widely recognised as one of the most harmful human activities on marine ecosystems. Bottom trawling, particularly, affects not only the target species but the ecosystem as a whole (Kaiser and Spencer, 1994a, 1994b; Collie et al., 2000; Jennings et al., 2001a) and has been proved to be one of the most damaging fishing activities (Kaiser et al., 2002). The most obvious direct effect of this fishing gear is the removal of benthic and benthos-pelagic species. However, it also causes a wide range of physical effects on the seabed and resident species such as physical alteration of sediments, changes in the community composition and decline in the density and size of individuals (Fanelli et al., 2010, 2011). One of the most important indirect effects of this activity is the impact on the diet and trophic level of the species present in the disturbed ecosystem (Wassenberg and Hill, 1987; Jennings and Kaiser, 1998). Changes in ecosystem trophic-related functions of individual species can be assessed using stable isotope analyses (Gu et al., 1996; Jennings et al., 1997). The advantages of this method over conventional dietary analyses, such as gut content identification, are that isotopic analyses are typically less labour intensive and do not require taxonomic expertise (Sheppard and Harwood, 2005; Guest et al., 2009). Moreover, chemical tracers provide time-integrated information (Tieszen et al., 1983) and back-calculate the trophic level based on the items consumed over a certain period of time, highlighting the nutritional importance of the prey and disregarding incidentally ingested items (Thomas and Cahoon, 1993).

In the Cantabrian Sea (southern Bay of Biscay), the continental shelf is subject to strong fishing pressure and bottom trawling is the main gear used in terms of landings, number of fishing vessels, number of jobs, etc. (Punzón, 2009; Punzón et al., 1999, 2010). Changes in the stable isotope signature of species as a consequence of trawling have been observed in fish (Badalamenti et al., 2008; Fanelli et al., 2010) and invertebrates (Fanelli et al., 2011) but Jennings et al. (2001b) did not observe any change in the isotopic signature of benthic communities under different trawling pressures. In this study, the effect of trawling disturbance on the stable isotope signature of the sea urchin *Gracilechinus acutus* (Lamarck, 1816) was analysed. This species is the most common echinoid in the Cantabrian Sea, dominates the community in several areas of the continental shelf and has been considered a structure-building
benthos in the North coast of Spain (Velasco et al., 2012). In spite of its importance, the biology and the ecology of this urchin are practically unknown and there are no specific studies about their diet. However, the trophic level of this urchin is expected to be disturbed by trawling, as it has been observed feeding on fishing discards (Ecomarg, 2005) and it is highly sensitive to the direct impact of trawling (Serrano et al., 2011; González-Irusta et al., 2012). The main aim of this study is to investigate the effect of different trawling pressures on the size distribution, fullness and isotopic signature in a structure-building species, the sea urchin *G. acutus*.

2. Material and methods

2.1. Study site

The study was carried out in the central Cantabrian Sea continental shelf (southern Bay of Biscay) from Estaca de Bares Cape to Ajo Cape (Fig. 1) at depths between 90 and 220 m. This area provided a wide distribution of the target species and a pronounced trawling gradient. The sea urchin *G. acutus* is a very common species in the area, as it is well distributed across sediment types and depths. The trawling pressure in the central Cantabrian Sea differs between adjacent areas and three sites are present in the study site where trawling is banned: two anti-trawling artificial reefs (Llanes and Calderón) and one area closed to fisheries (Fig. 1). No trawling areas were established as a part of the Spanish Fisheries Policy in the Cantabrian Sea, aiming at improving hake recruitment in nursery areas (Rodríguez-Cabello et al., 2008; Punzón, 2009), whereas anti-trawling artificial reefs (concrete blocks) were located in grounds shallower than 100 m to prevent illegal trawling operations.

2.2. Field sampling

The biological sampling of *G. acutus* was performed on board—the annual oceanographic survey “Demersales”. This survey is carried out annually on the North-Atlantic coast of Spain to evaluate the state of the demersal communities (García-Castrillo and Olaso, 1995; Sánchez et al., 1995; Sánchez and Serrano, 2003; Serrano et al., 2006). The continental shelf is sampled following a randomly stratified design with trawls (ca. 30 min duration, 3 knots speed) carried out with a Baka 44/66 net. Between 2006 and 2009 (within the months of September–October) a maximum of 10 urchins by trawl was measured (horizontal diameter using a Vernier calliper, 0.1 mm) and dissected on board. The total number of *G. acutus* sampled during this period amounted to 432 urchins (sampled in 70 different trawls). The urchins were sampled from areas free of trawling (80 urchins), from areas exposed to low trawling pressure (107 urchins) and from areas exposed to high trawling pressure (245 urchins). For each of these urchins, guts were separated from the body and wet-weighed (0.01 g) obtaining a fullness index for each individual. The fullness index (FI) was calculated according to Régis (1979) and Verlaque and Nedelec (1983):

\[
FI = \frac{(\text{wet weight of gut contents})}{(\text{total wet weight})} \times 100
\]

Additionally, during 2009 all the captured urchins were measured to calculate size distribution (713 urchins) and a sample of muscle tissue from 68 urchins (14, 15 and 39 urchins of each trawling effort level respectively) was collected for stable isotope analyses.