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The role of pelagic fish as forage for the demersal fish community in the southern Bay of Biscay

Izaskun Preciado *, Francisco Velasco, Ignacio Olaso

Centro Oceanográfico de Santander (IEO), Promontorio de San Martín, s/n, P.O. Box 240 39080 Santander, Spain

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Abstract

The small pelagic fish represents the link between nekton and demersal communities, and they are an important food source for some demersal fish species. In the autumns between 1993 and 2002, 74,869 stomach contents of 25 demersal fish species were analysed during the scientific surveys organized by the Instituto Español de Oceanografía. These species represent the demersal fish community of the southern Bay of Biscay. An important part of their diet (39% by volume) was composed of pelagic fish species (e.g. *Engraulis encrasicolus*, *Gadiculus argenteus*, *Micromesistius poutassou*, *Trachurus trachurus*, *Sardina pilchardus, Scomber scombrus*). Among all these prey species, the relevance of *M. poutassou* and *G. argenteus* stood out because of their high abundance both in the diets and during the scientific surveys. The relevance of pelagic fish as prey increased with predator size, reaching more than 60% of the diet by volume in the length range 25–29 cm. However, fish predators larger than 50 cm depended less on pelagic fish (33%), since they were also able to feed on other sources such as megafaunal invertebrates, mainly cephalopods. The pelagic fish resource was primarily exploited by 12 demersal fish species, with *Merluccius merluccius* and *Zeus faber* being the main ones feeding on small pelagics, which was related to the vertical movement of predators and prey through the water column. Survey abundance indices were used as indicators of prey abundance in the ecosystem, both for biomass and number. There was evidence for density-dependant feeding by predators on *E. encrasicolus*, *G. argenteus* and *T. trachurus*, while the main discrepancies between abundance in the stomachs and in the surveys were due to differential availability of prey length classes in the environment. Small prey species and individuals were exploited by most demersal fish while large prey species were less accessible to predators.

Keywords: Trophic relationships; Stomach contents; Pelagic fish; Demersal fish; Prey availability; Bay of Biscay

1. Introduction

The small pelagic fish represents the linkage between mesoplankton, nekton and demersal communities, and they are an important food source for some demersal fish species. Forage fish are considered to be those with a broad geographic distribution and high abundance, and as a result are expected to have a central role in community dynamics (Silva et al., 1997). It is well known that some pelagic fish species are typical forage species for demersal fish, like blue-whiting *Micromesistius poutassou* (Silva et al., 1997; Olaso et al., 1998), sandeel *Ammodytes* sp. (Greenstreet et al., 1998; Svenning et al., 2005; Laurenson and Priede, 2005), herring *Clupea harengus* (Neuenfeldt and Beyer, 2006) or capelin *Mallotus villosus* (Bowering

* Corresponding author. Tel.: +34 942 291060; fax: +34 942 275072.
E-mail address: ipreciado@st.ieo.es (I. Preciado).

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and Lilly, 1992; Pálsson, 1997). Particularly, in the southern Bay of Biscay, the small pelagics constitute an important part of the diet for some demersal fish species, cephalopods and marine mammals (Rasero et al., 1996; Santos et al., 1996; Velasco and Olaso, 1998a,b; Preciado et al., 2006; Preciado et al., 2002). The linkage between the pelagic and demersal ecosystems makes also evident in the vertical migrations of both predators (i.e. demersal fish, deep water sharks: Blaber and Bulman, 1987; Hislop et al., 2000; Madurell and Cartes, 2005) and prey (i.e. fauna dwelling the Benthic Boundary Layer: Mauchline and Gordon, 1991; Cartes et al., 1993; Fock et al., 2002), thus playing a major role in the transport of energy from surface and midwater regions to the demersal and benthic ecosystems.

Drastic changes in the abundance of pelagic fish in marine ecosystems are well documented. However, the causes of these fluctuations are not well understood as yet. In some cases, they are associated with natural environmental effects (Orlova et al., 2005), whereas in others fishing activity is the main threat (Beverton, 1990). Off the northern coast of Spain, several works have been recently conducted on the distribution and biology of pelagic fish species (i.e. Villamor et al., 1997; Carrera et al., 2001; Uriarte and Lucio, 2001; Villamor et al., 2004; Abaunza et al., 2003). In the southern Bay of Biscay, the *Engraulis encrasicolus* stock is seen to have nearly disappeared from the Spanish coast and has lost its spawning grounds (ICES, 2005). It could be expected that these shifts in the abundance in the environment would be reflected in the diet of the main predators.

Stomach content analysis is considered as one of the main tools for understanding the linkages and dependencies within marine ecosystems. The diets of marine fish have been the focus of numerous studies, particularly commercial species in areas where high fishing activity takes place. In this context, the relationship between prey abundance in the stomach contents and in the environment has been studied by many authors (Greenstreet et al., 1998; Velasco et al., 2001, Pinnegar et al., 2003, Serrano et al., 2003, etc.).

Nevertheless, the role of pelagic fish as prey for a high number of demersal fish species in the southern Bay of Biscay has not been described yet. Therefore, the aims of the present work were: (1) to describe the importance of pelagic fish in the diet of main demersal predator fish species on the Cantabrian Sea continental shelf, (2) to explore the relationships between the abundance of pelagic fish in the diet and their abundance in the bottom trawl surveys, and (3) to determine the status of the different pelagic fish species within the Cantabrian Sea food web, providing data on their distribution and abundance.

2. Materials and methods

2.1. Survey design

Bottom trawl surveys were conducted every autumn from 1993 to 2002 by the Instituto Español de Oceanografía (IEO) for demersal fishery assessment in the southern Bay of Biscay (Fig. 1). Trawling operations were carried out during daylight at a speed of 3 knots, using a baka 44/60 otter trawl gear (Sánchez, 1993; ICES, 2002). These surveys followed a random stratified sampling scheme with three depth strata (70–120 m, 121–200 m and 201–500 m) and four geographical sectors, resulting in 12 strata. The number of hauls per stratum was proportional to its trawlable surface. The stratified mean catch weight and number per 30 min tow were used as biomass and numerical abundance indices, respectively, following the methodology described by Cochran (1971) and Grosslein and Laurec (1982).

In each haul, once the fish had been sorted by species 10 specimens per predator were set aside randomly. To examine predator–prey interactions, the size structure of both predators and prey were considered. For commercial species (*Lepidorhombus* spp., *Lophius* spp., *Merluccius merluccius*, *M. poutassou* and *Trisopterus luscus*), 10 specimens per length range were analysed. Length ranges were different for different species (according to their size range) in order to obtain a representative sample. However, in order to compare diet composition between different predators, data were grouped into the same length ranges for all predators: 10–14 cm, 15–19 cm, 20–24 cm,

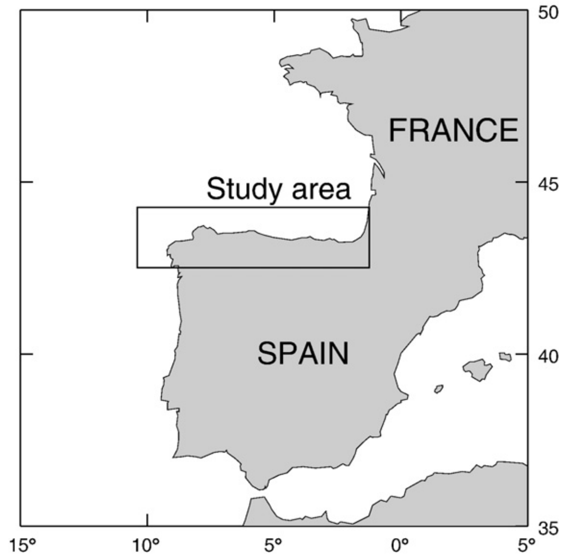

Fig. 1. Map of the study area (southern Bay of Biscay). Only the continental shelf was covered in the stomach sampling.