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The role of juveniles in structuring demersal assemblages in trawled fishing grounds☆

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ABSTRACT

The capture of large amounts of small, immature fish of commercial species is a serious problem particularly in multispecies fisheries. Moreover, considerable and increasing interest is being devoted by fishery scientists to identify the distribution and habitat needs of species throughout their life cycle. To elucidate species composition, the abundance of juveniles in the demersal assemblages and the role of different life history (juvenile and adult) stages of target species in structuring demersal communities, two bottom trawl surveys were carried out during the autumn 2003 and 2004. Multivariate analyses were performed on density indices of adults and juveniles life stages of 30 target species and total density indices for the remainder of the catch species. Juveniles represent more than 61% of the total catch in both the years investigated and their abundance and spatial distribution was strictly related to the sea bottom biocoenotic features. Most juveniles were concentrated in the coastal shelf area and in particular in the hauls performed on the Coastal Terrigenous Mud biocoenosis (CTM). The demersal assemblages located in the slope stratum showed, in general, a lower concentration of juvenile specimens; however, some facies of the Bathyal Mud biocoenosis that characterizes the deep layer of our study area showed a very high percentage of juveniles. This information improves our understanding of ecosystem functioning and represents a useful basis for providing advice on the management of multispecies demersal fisheries within an ecosystem approach.

1. Introduction

The capture of large amounts of small, immature fish of commercial species is a serious problem that threatens the bio-economic sustainability of fisheries and the renewability of resources (Kennelly, 1995; Ward et al., 2012), particularly in multispecies fisheries (such as Mediterranean fisheries). Despite the adoption of several technical measures (gear and fishing operation) aimed at protecting juveniles, the problems related to the excessive removal of immature specimens are far from being solved (Carbonell, 1997; Stergiou et al., 1998). Moreover, the classical regulation of fisheries has thus far been based on limitations of the fishing capacity (licences), minimum landing sizes, and net mesh sizes, together with temporary fishing closures, but the establishment of no-fishing zones, particularly within nursery areas, has been increasingly advocated as a further component of the fishery management strategy (Maggs et al., 2013). As the selectivity of trawl fisheries cannot be improved beyond a certain level in multispecies demersal fisheries, such as those of the Strait of Sicily, spatial closures on nursery grounds are advocated as a more effective means of limiting the capture of juveniles and enhancing the long-term sustainability of the fishery (Caddy, 2010). Thus, the establishment of networks of fishery restricted areas (FRAs) or marine protected areas (MPAs) to protect target species and the habitats in which they are known to aggregate during the critical phases of their life cycle (e.g., spawning and nursery areas), seems a suitable and recommended management tool within an ecosystem approach (Caddy, 2010; Rijnsdorp et al., 2012). Moreover, within the general framework of an Ecosystem Approach to Fishery Management (EAFM), considerable and increasing interest is being devoted by fishery scientists to identify the distribution and habitat needs of species throughout their life cycle (Tuckey and Dehaven, 2006). Although these studies are conducted at a population level and focus on the fishery target species, they encompass habitat

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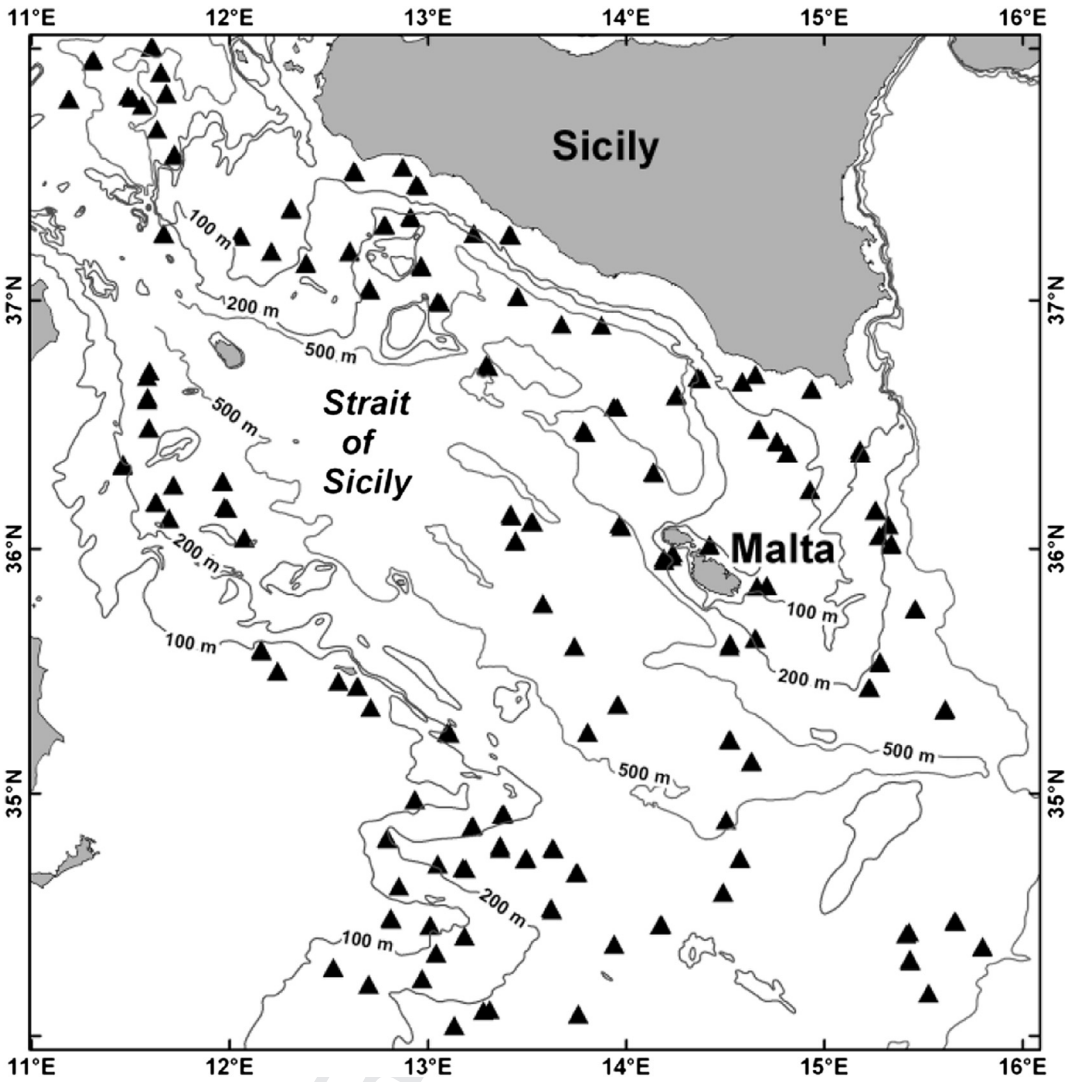

Fig. 1. Map of the Strait of Sicily showing the location of the hauls investigated.

conservation concerns and attempt to explain the spatial organisation of the key life history stages of species by investigating the biotic (benthic biocoenosis, availability of prey, presence of predators) and abiotic factors (hydrological features, sediments, availability of shelters) that may affect them. In particular, the spatial distribution of different life history stages is strictly related to the biotic and abiotic characteristics of the sea bottom, and several reports describe the role and the importance of the following structural habitats to juvenile fish: *Posidonia oceanica* meadows (Francour, 1997; Guidetti, 2000), seagrass (Thayer et al., 1999), oyster reef (Meyer and Townsend, 2000), pelagic Sargassum (Dempster and Kingsford, 2004), mangrove (Laegdsgaard and Johnson, 2001), marsh (Beck et al., 2001) and rocky reefs (Lindeman et al., 2000; Lloret and Planes, 2003). Within this framework, to support fishery management in the Strait of Sicily, which represents one of the most productive areas for demersal resources in the Mediterranean (Fiorentino et al., 2008), the stable nurseries and spawning areas of main commercial species in which the young of the year (YOY) and spawners aggregate, respectively, were mapped in recent years (Fiorentino et al., 2003; Fortibuoni et al., 2010; Garofalo et al., 2010).

However, although information on the spatial distribution of critical phases of the life cycle (e.g., spawning and nursery areas) of commercially valuable species represents a useful tool to manage demersal fishery resources (Berkeley et al., 2004; Kritzer and Sale, 2004), fishery and management research need to bridge several gaps in those regions (such as the Mediterranean) where fisheries are multispecies. In particular, we need to evolve from a single-species paradigm toward a multi-specific approach (Garcia et al., 2003) by analysing more than one nursery or critical habitat at time (Garofalo et al., 2011). In addition, the previous nursery studies were mainly focussed on the spatial distribution of the newly recruited individuals in commercial stocks, i.e., the YOY, thus underestimating the immature portion of the population and the impact of trawl fisheries. Although the YOY spatial distribution of the main portion of the target species is clearly separate from the adults, the spatial distribution of the juveniles usually overlaps with the adult fraction of the population. Attempting to overcome such challenges, this study analysed the demersal assemblages of the shelf and slope strata of the Sicilian side of the Strait of Sicily (South Mediterranean Sea), incorporating information on the abundance of two life stages of the main commercial species (30 target species): the juvenile (from YOY to sub-adult) and adult stages. The distinction of the target species into two different life stages allows us to highlight the relative importance of the life stages (juveniles and adult) of species in structuring demersal

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