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Environmental processes driving anchovy and sardine distribution in a highly variable environment: the role of the coastal structure and riverine input

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ABSTRACT

Engraulis encrasicolus and *Sardina pilchardus* stocks are highly variable in terms of recruitment, biomass and spatial distribution. Changes in habitat conditions may influence both the survival of the early life stages and the adult stages. Detailed studies on the spatial distribution and habitat selection of such species have been performed in different areas of the world, highlighting the importance of environmental processes. The present study analyzes the spatial distribution of anchovy and sardine in the Tyrrhenian Sea in relation to environmental heterogeneity. Four acoustic surveys were carried out in this area in the period 2009–2014. Analysis of the environmental dataset permitted identification, in two specific areas, of a pattern of variables driving enrichment processes and impacting on the habitat suitability of the two species. In the northern and central parts of the study area, both anchovy and sardine showed a marked preference for shallower areas characterized by lower salinity. In these areas, PCA results on an environmental dataset highlighted a strong link between primary production, particulate organic carbon, distance from the mouth of the river, salinity and depth. A less clear picture was obtained for the southern part of the Tyrrhenian sea, characterized by a narrow continental shelf, moderately complex coastline morphology and the presence of very small rivers. Most of the anchovy biomass was found to be located in enclosed areas (gulfs) under the influence of relatively small rivers. This finding, taking into account that the surveys were carried out during the anchovy spawning period, highlights for such species a positive effect of the interaction between coastal morphology and riverine input, probably favoring food supply and retention of spawning products.

Key words: echosurvey, hydrology, riverine input, small pelagics, Tyrrhenian Sea

INTRODUCTION

Anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) stocks in the Mediterranean Sea are highly variable in terms of their recruitment, biomass and distribution (Basilone *et al.*, 2006; Palomera *et al.*, 2007). For such species, characterized by a relatively short life cycle and fast growth of the early stages, changes in habitat conditions may influence both the survival of the early life stages, from eggs to juveniles, thus affecting the recruitment success (Lasker, 1975; Cury and Roy, 1989; Bakun, 1996; Schwartzlose *et al.*, 1999; Cuttitta *et al.*, 2003; Bonanno *et al.*, 2006, 2013; Basilone *et al.*, 2013), and the adult stages (Paramo *et al.*, 2003; Patti *et al.*, 2004; Basilone *et al.*, 2006; Santojanni *et al.*, 2006; Ganias *et al.*, 2007; Planque *et al.*, 2007; Tsagarakis *et al.*, 2008; D'Elia *et al.*, 2009).

In recent years, thanks to available time series on small pelagic fish species (mainly anchovy and sardine) collected during acoustic surveys in some areas of the Mediterranean sea, detailed studies on the spatial distribution and habitat selection of such economically important species have been performed (Bellido *et al.*, 2008; Giannoulaki *et al.*, 2008; Bonanno *et al.*, 2014a), highlighting the importance of specific

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