Journal of Sea Research 99 (2015) 107–117

Contents lists available at ScienceDirect

Journal of Sea Research

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

Habitat influence in the morphological diversity of coastal fish assemblages

Marc Farré *, Antoni Lombarte, Laura Recasens, Francesc Maynou, Victor M. Tuset

Institut de Ciències del Mar (ICM-CSIC), Passeig Marítim de la Barceloneta 37-49, 08003 Barcelona, Catalonia, Spain

ARTICLE INFO

Article history:
Received 9 December 2014
Received in revised form 9 February 2015
Accepted 7 March 2015
Available online 14 March 2015

Keywords:
Morphology
Ecological structure
Environmental factors
Fish assemblages
Morphospace
Mediterranean Sea

ABSTRACT

Ecological diversity based on quantitative data is widely used to characterize biological communities, but recently morphological and functional traits have also been used to analyse the structure of fish assemblages. This diversity and structure is usually linked to variables such as habitat complexity and composition, depth, and spatial and temporal variations. In this study, several fish assemblages off the Catalan coast (NW Mediterranean) were ecologically and morphologically analysed and compared. The morphological analysis was performed from body shape of fish species using geometric morphology. Moreover, a canonical correspondence analysis (CCA) was used to analyse the effect of local environmental variables such as habitat, locality and depth on the composition and abundance of assemblages. The results revealed greater differences among assemblages in the clustering performed from morphological data, which is linked to habitat complexity, than those shown by the ecological analysis. Moreover, the CCA analysis indicated that type of substratum and the location significantly influenced the composition and structure of the fish assemblages. These results evidenced that morphology provides different and complementary information than ecological analysis because it allows to predict the ecological and functional habits of species within the community, helping to improve the understanding of the fish assemblages structure.

1. Introduction

There exist a wide number of studies regarding the effect of environmental factors in the structure and organization of fish assemblages. The circulation of water masses and currents, temperature, oxygen concentration and productivity have been considered factors influencing the structure of fish assemblages at large scale (García-Charton and Pérez-Ruzafa, 2001; Guidetti, 2000; La Mesa et al., 2010; Letourneur et al., 2001). Whereas, other variables such as the type of bottom (Demestre et al., 2000; Félix-Hackradt et al., 2014; Macpherson, 1994), depth (Gaertner et al., 1999, 2005; Menezes et al., 2006; Mérigot et al., 2007), habitat complexity (Gratwicke and Speight, 2005; Kovalenko et al., 2012; McCormick, 1994) or the influence of terrestrial inputs in special zones such as estuaries and coastal lagoons (Akin et al., 2005; Franco et al., 2006; Maci and Basset, 2009) are contemplated also as key factors structuring biological communities but affecting at smaller scales.

However, in the nearshore fish assemblages, the habitat complexity and type of bottom are likely the two key factors. Several studies have demonstrated that the habitats formed by mixture of bottoms (i.e., coral reefs or seagrass meadows) contain greater diversity of fishes (García-Charton and Pérez-Ruzafa, 2001; Montaña and Winemiller, 2010). Usually, these complex habitats lead to an intense interspecific competition favouring the morpho-functional differentiation of species within assemblages (Gratwicke and Speight, 2005; Montaña et al., 2014; Price et al., 2011). Thus, fishes acquire singular behaviours in relation to their lifestyle and role within the community, such as the capture of food items (Costa and Cataudella, 2007; Labropoulou and Eleftheriou, 1997; Norton, 1995; Svanbäck and Eklöv, 2002), competition for resources (Peres-Neto, 2004), strategies of predators to capture preys (Eklöv and Svanbäck, 2006), territorial behaviours (Almany, 2004; Pitcher, 1986), and locomotion (Blake, 2004; Yamanoue et al., 2010). Therefore, the interspecific morpho-functional variation within fish assemblages can help to understand its structure and dynamics (Gatz, 1979; Langerhans et al., 2003; Montaña and Winemiller, 2010; Winemiller, 1991); and even, it can also be used as a measure of biodiversity that captures more ecological properties of fish assemblages than a simple enumeration of species (Farré et al., 2013; Foote, 1997; Karr and James, 1975; Ricklefs, 2010) or as a prediction tool of invasion and coexistence phenomena (Azzurro et al., 2014). In addition, morphological traits of species are also useful to detect variations in the structure of assemblages caused by natural or external perturbations (Lombarte et al., 2012; Villéger et al., 2010), whereas simple ecological measures are unable to determine these changes within communities. Therefore, the incorporation of new approaches, such as morphological and functional information of species, to studies that only use ecological parameters such as specific richness, dominance or evenness, is

* Corresponding author. Tel.: +34 932 309 500; fax: +34 932 309 555.
E-mail address: farre@icm.csic.es (M. Farré).

http://dx.doi.org/10.1016/j.seares.2015.03.002
1385-1101/

important to improve the knowledge about the dynamics of communities (Farré et al., 2013; Somerfield et al., 2008).

In the Mediterranean Sea, very few studies had tried to explain the morpho-functional diversity and structure of fish communities (Albouy et al., 2011; Recasens et al., 2006). Recently, morphological analyses have been accepted as valid methods to define the community structure, offering an additional option when ecological or functional information of communities is absent or scarce (Farré et al., 2013; Lombarte et al., 2012). The aims of this study are (i) to characterize coastal fish assemblages of the Mediterranean Sea in relation to composition and abundance of species, (ii) to describe morphologically these assemblages from body fish shape and compare them to assess their variability, and (iii) to test how environmental factors (substrate composition, depth or location) affect the structure of the assemblages.

2. Material and methods

2.1. Study area

Two coastal zones off the Catalan coast (NW Mediterranean Sea) were studied (Fig. 1). The rocky shores of the NW Mediterranean present a set of geologic and hydrologic characteristics that gives the zone a relatively high species richness compared with other habitats of the Mediterranean (García-Charton et al., 2008; Harmelin-Vivien et al., 2008). The littoral demersal fish fauna is dominated primarily by families such as Labridae, Sparidae, Mullidae, Serranidae and Scorpaenidae, which represent up to 50–70% of the total biomass (García-Rubies, 1999; Gordoa, 2009; Macpherson et al., 2000, 2002).

The first study area was located in the vicinity (buffer zone) of the Medes Islands Marine Reserve (500 ha), near to the fishing port of L'Estartit and close to the mouth of the Ter River (henceforth, "Northern zone"). This marine reserve was established in 1983 to preserve its especially rich marine habitat, which primarily includes rocky substrates as well as several areas with sandy and muddy bottoms. Given its situation and dimensions, it is considered a small-sized MPA, as are most Mediterranean MPAs (Fraschetti et al., 2005; García-Rubies and Zabala, 1990; Tunesi et al., 2006). The marine reserve comprises an integral reserve or no-take zone (referred to as NTZ; 93 ha) where all fishing activities have been banned since 1991 and a buffer zone (418 ha) where only artisanal fishing by the local fleet is allowed (approximately 12 boats of less than 15 m in length using set gear only). Commercial fishing by the local fleet extends well beyond the boundaries of the buffer zone (the activity area of the fleet is approximately 3800 ha, Stelzenmüller et al., 2007).

In the second zone selected for the study, data were obtained from two nearby localities: Vilanova i la Geltrú and Calafell (henceforth "Central zone"). In Vilanova i la Geltrú, a total fleet of 21 artisanal netter boats was in operation (Maynou et al., 2011). The marine substrates of Vilanova are characterized by a wide sandy bottom with small interspersed rocky zones, rocky bottoms and a fragmented and dispersed seagrass meadow. In addition, samples from an artificial reef and rocky substrate surrounded by sandy bottom patches were incorporated from the nearby locality of Calafell (Recasens et al., 2006). Artificial reefs have been shown to be an effective approach to the prevention of illegal trawling in littoral zones and facilitate the feeding, spawning and protection of several fish species, producing significant changes in the species composition of assemblages (Charbonnel et al., 2002; Claudet et al., 2006).

2.2. Sampling

A total of 51 and 35 monthly experimental fishing samples, covering the entire year, were analysed in the Central and Northern zone, respectively. In the Central zone, the specimens were caught by small vessels

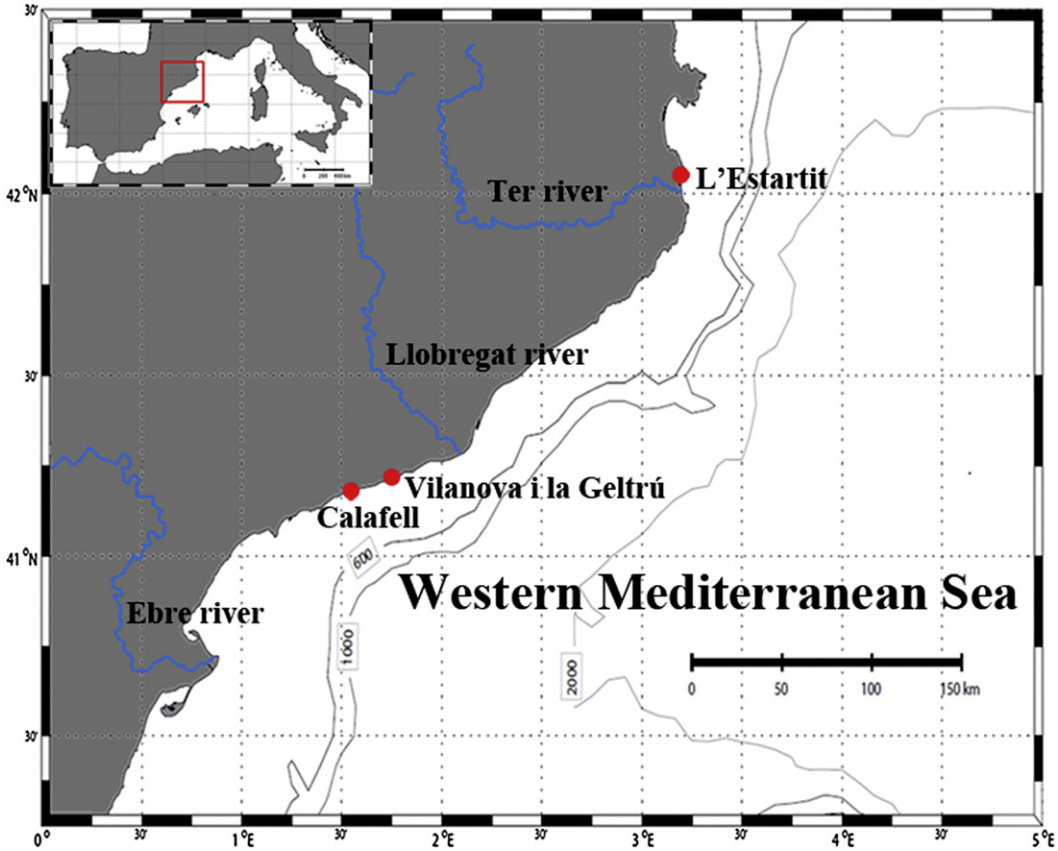

Fig. 1. Geographical localization of study areas: Vilanova i la Geltrú-Calafell or Central zone and L'Estartit or Northern zone.