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Characterization of the fish assemblage in a Mediterranean coastal lagoon: Lesina Lagoon (central Adriatic Sea)

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HIGHLIGHTS

- Structure and functional aspects of the fish assemblage in a coastal lagoon were studied.
- Fish assemblage showed a low species richness with only two species dominant.
- Fish assemblage exhibited weak spatial and temporal patterns of variation.
- Degree of confinement from the sea affects the assemblage structure.
- The insight may support the sustainable management of lagoon fish resources.

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ABSTRACT

Taxonomic and functional properties and spatial–temporal variations of the small-sized fish assemblage were investigated in the micro-tidal Lesina Lagoon. Sampling was carried out monthly for a year in 9 stations, by means of a 2-mm mesh beach seine. According to the findings, the fish assemblage of Lesina Lagoon showed a low species richness. Marine migrants were the most represented in terms of number of species, with Mugilidae as dominant family. Nevertheless, residents were numerically prevalent, with the two species *Atherina boyeri* and *Aphanius fasciatus* showing the highest abundances. No marine stragglers were found. In addition, the temporal and spatial analysis of the fish assemblage showed weak temporal and spatial patterns of variation. In Lesina Lagoon, the taxonomic and functional structures of the fish assemblage seem to be strongly affected by the high degree of confinement of the lagoon from the open sea, which makes the fish assemblage very susceptible to changes in hydrological and local climatic conditions. The information achieved from this study may be useful for a better management of the natural aquatic resources in Lesina Lagoon and in Mediterranean lagoons.

1. Introduction

Coastal lagoons are recognized as important sites for fish species, providing optimal feeding and nursery grounds and naturally supporting large numbers of fish (Whitfield, 1999). Compared to Atlantic transitional water (TW) systems, Mediterranean coastal lagoons are less affected by the tide and have lower freshwater inputs, while salinity is not significantly reduced and the average water temperature is higher. Because tidal currents are limited, connections with the sea tend to silt up and coastal lagoons become filled in over long periods (Brambati, 1988). The conservation of these important but ephemeral ecosystems is thus closely related to human management, especially in terms of connections with the sea and freshwater inflows (Crivelli and Ximenes, 1992; Quinn et al., 1999). In effect, the interest of human beings for the coastal lagoons is old and due mainly to the high secondary productions that can be obtained from them. A small artisanal fisheries and extensive aquaculture have been practiced for many years in Mediterranean coastal lagoons, exploiting the migratory movements of the euryhaline marine species between marine and lagoon environments. Italian productive management, which envisages hydraulic control as well as bottom dredging or providing basins, has been a reference point for other geographical areas, particularly in Mediterranean region (Ardizzone et al., 1988). These management practices have contributed to preserve the ephemeral lagoon environment over time, so that today are provided within the coastal zone management plans for many Mediterranean lagoons.

The environmental damage of coastal zones, due to the unsustainable exploitation of the many resources concentrated

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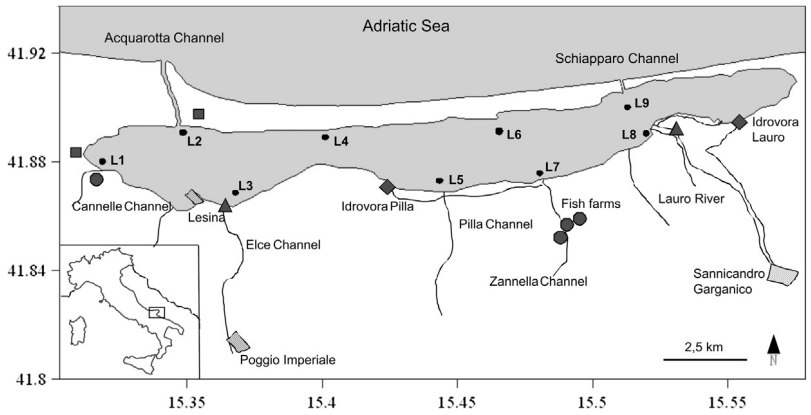

Fig. 1. Map of Lesina Lagoon, showing location of sampling stations, population centers, ◇; drainage pumping stations, ◆; livestock farms, ■; fish farms, ●.

there, and to the negative impacts engendered by human activities (such as input of pollutant wastes), has increased the need for a sustainable management of these areas. Integrated Coastal Zone Management (ICZM) is a concept born during the United Nations Conference on Environment and Development (Rio de Janeiro, Brazil, 1992) precisely to meet this requirement. The scientists agreed that the prejudicial conditions that associate the majority of Mediterranean lagoons were determined by a shortage of lagoon management plans. These deficiencies have led to environmental and socioeconomic issues, including negative effects on lagoons fish communities and the economic activities related (Cataudella et al., 2015). Lagoon management is therefore recognized as the main instrument to preserve the ecological features of lagoons and prevent the depletion of the valuable aquatic resources and degradation of sensitive habitats. This in turn involves a thorough knowledge of Mediterranean lagoons, whose biological communities often differ greatly from each other in terms of species composition and dominance.

It is known that composition, abundance, colonization rates from the sea and distribution patterns of fish in coastal lagoons were affected by morphometric parameters (e.g. surface area, depth, sea inlet width and length), hydrological parameters (e.g. tidal range, current direction and velocity), chemical–physical parameters (e.g. temperature, salinity, turbidity) and biotic variables (e.g. organic matter, bottom vegetation), which interact directly and indirectly with the fishes that live in coastal lagoons (Blaber and Blaber, 1980; Pérez-Ruzafa and Monpeán Mac, 2007; Franco et al., 2008a; Maci and Basset, 2009; Fortes et al., 2014). The existing data on Mediterranean systems describe fish assemblage structures that vary considerably in terms of species composition (Franco et al., 2008a). It can be explained by the small size and the shallow depth of several Mediterranean lagoons, which then turn out to be strongly influenced by the degree of connection with the continental and marine systems (Carrada and Fresi, 1988; Poizat et al., 2004). Salinity seemed to be the major driving factor of spatial patterns of fish fauna in many lagoon systems (Akin et al., 2003, 2005; Pérez-Ruzafa and Monpeán Mac, 2007; Maci and Basset, 2009; Fortes et al., 2014). Moreover, some authors have shown that the organization of fish fauna, as well as that of other biological components, seems also to be regulated by the confinement, i.e. the degree of separation from the marine domain (Guelorget and Perthuisot, 1983), with gradients extending from the sea up into the lagoon (Bouchereau et al., 2000; Mariani, 2001; Franco et al., 2006a).

Lesina Lagoon is one of the largest wetlands of the central and southern Italy. This Lagoon is part of the Gargano National Park and is designated as both Special Protection Area (SPA—IT9110037) and Site of Community Importance (SCI—IT9110015), following the implementation of the Birds and Habitats Directive (2009/147/EC, 92/43/EEC). The Lagoon is assessed as a micro-tidal system with a very shallow water basin, where the mixing of the water column is mainly due to the winds (Crisciani, 1994). Due to the limited tidally-driven exchanges between the lagoon and sea, the hydrology of the Lagoon is strongly influenced by precipitation, evaporation and freshwater inputs, which explain also the heterogeneous spatial distributions of several environmental variables (Roselli et al., 2009). The residence time of the waters is estimated to be about 70–100 days (Manini et al., 2005). The water renewal time of the system shows a clear east–west gradient, with lower values in the eastern part of the Lagoon, where the main fresh water inputs are located (Ferrarin et al., 2014). The east–west gradients in many biogeochemical variables are responsible for the distribution patterns of seagrass species and macrobenthic assemblages (Nonnis Marzano et al., 2003; Sfriso et al., 2006). The influence of the environmental variables on the spatial distribution of fish fauna and the functional and structural aspects of the fish assemblage are still unknown. Although artisanal fisheries is the main human activity in the Lagoon, there are few studies on the fish fauna that relate primarily to the recruitment of economically valuable marine species. In the light of these arguments, this study was carried out with the aim of (a) describe the lagoon fish assemblage, analyzing both its taxonomic and functional features and (b) examine the spatial and temporal variations of the fish assemblage structure in relation with the main environmental factors that typically influence fish species distributions. The insight may be useful to assist the decision-making process towards the sustainable management of local natural resources.

2. Materials and methods

2.1. Study area

Lesina Lagoon is situated on the north side of the Gargano promontory, in the southern Adriatic Sea (41°88′N, 15°45′E) (Fig. 1). The local climate is typically Mediterranean, with warm to hot, dry summers (late June–September) and mild to cool, wet winters (late December–March). Rainfall is generally concentrated in autumn–winter and the annual precipitation amounts about to 400–700 mm (Roselli et al., 2009). Heavy rainfall events are sometimes recorded in spring.

The Lagoon has an area of 51.36 km^2 with an average depth of 0.7 m and a maximum depth of 1.5 m. The catchment basin has an area of about 600 km^2. Two rivers, Lauro and Zannella, together with six intermittent streams and two drainage pumping stations, Lauro and Pilla, represent the main freshwater inputs (D'Adamo et al., 2014). Much of the annual freshwater budget is discharged into the eastern basin, accounting for the east–west salinity

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