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Ecosystem Reaction of Small Pelagic Fish to Different Environments

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Abstract

The impact of environmental factors on the spatial distribution of fish species has been highlighted in a number of recent scientific papers, highlighting the need for the fisheries scientific community to look into habitat choice of commercially important fish species in addition to biomass estimates. Although predominantly oligotrophic, the Mediterranean Sea is distinguished by considerable habitat variety, making it a suitable study place to examine how tiny pelagic adapt to various environmental factors. In this study, the North Aegean Sea and the Strait of Sicily, two regions of the Mediterranean Sea that significantly differ in terms of environmental regimes, are used to evaluate the habitat selection of European sardines (Sardina pilchardus) and anchovies (Engraulis encrasicolus). Investigating the elements affecting anchovy and sardine habitat choices involved using a number of environmental characteristics. For this, data from acoustic surveys gathered between the summers of 2002 and 2010 were used. The full dataset in each region was subjected to the quotient analysis in order to compare or contrast the "mean" spatial behavioral patterns of each species and to determine the relationship between high density values and environmental variables. Selected environmental variables underwent principal component analysis in order to pinpoint the environmental regimes that support the two ecosystems. The results of the investigation showed that both species' spatial distribution was influenced by the choice of bottom depth and the availability of food. Additionally, PCA analyses showed that the observed preference for shallower waters is mostly related to particular environmental processes that boost local productivity. Even though the two regions exhibit significant differences in hydrodynamics, the two species' common trends in habitat selection appear to be driven by the oligotrophic nature of the study areas, emphasizing the importance of regions where the "ocean triad hypothesis" is met by local environmental regimes.

Keywords: Environmental factors; Spatial distribution; Fisheries scientific community; Hydrodynamics

Introduction

Finding appropriate habitat for pelagic fish species has been one of the main difficulties facing the fishery research community in recent years [1]. Although it is widely acknowledged that fish species choose their "favourable" habitat according to the "ideal and free distribution" theory, a variety of factors can modulate this tendency, making it challenging to understand how fish species choose their own "favourable" habitat in various sea areas.

Small pelagic fish habitat selection has recently been the subject of several studies using a variety of approaches, including generalized additive modeling, quotient analysis, randomization testing, and geostatistical analysis. Environmental preferences vary greatly depending on the species and the surrounding area. Furthermore, the preferred ranges may differ significantly even when the same environmental variable is determined to be influential across different places [2]. According to widespread consensus, the Mediterranean Sea is an oligotrophic region that is also highly variable in terms of hydrography, bathymetry, and productivity [3]. The population dynamics and distribution patterns of sardines (Sardina pilchardus) and anchovies (Engraulis encrasicolus), which make up a significant portion of the Mediterranean's small pelagic fish catches, are known to be highly reliant on the environment.

The current study examines and highlights differences in the habitat selection behavior of anchovy and sardine in two areas: The Strait of Sicily and the North Aegean Sea. It makes use of a sizable environmental dataset made up of in situ measurements and satellite data [4]. Due to its location as the area bridging the two major basins of the Mediterranean Sea, the Strait of Sicily is characterized by a complicated circulation. When compared to Levantine Intermediate Water (LIW), which is saltier and colder, the Modified Atlantic Water (MAW), which is fresher and warmer, flows in the upper layer towards the eastern Mediterranean basin [5]. The motion of the MAW, which splits into the Atlantic Tunisian Current (ATC) going southward and the Atlantic Ionian Stream (AIS), a meandering surface current flowing towards the Ionian Sea, controls the general surface circulation pattern locally [6]. In the summer, the water in the Atlantic that the AIS is directing south of Sicily is warmer than the water in the same depth to the north [7]. The Adventure Bank Vortex (ABV) and a nearly constant upwelling around the southern side of the island are both created by the AIS motion. The Black Sea water (BSW), which enters the North Aegean Sea through the Dardanelles Strait, is the main cause of the North Aegean Sea's high hydrological complexity [8]. The Limnos-Imvros stream (LIS), which transports waters from the Black Sea into the Samothraki plateau and creates a persistent anticyclone system, is a major factor in the overall circulation [9]. Local productivity is increased by BSW outflow and its advection in the North Aegean Sea results in high hydrological and biological complexity [10]. The productivity locally is increased by the presence of numerous sizable rivers that run into semi-closed basins like Thermaikos Gulf.

Materials and Methods

Without any restrictions, data from two sea areas were collected for the study [11]. The Italian and Greek Coastal Guards granted us the

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appropriate authorizations for working at sea in National waters in the North Aegean Sea and the Strait of Sicily, respectively [12]. Between 35°N and 38°N latitudes and 11°E and 16°E longitudes in the Strait of Sicily; and between 38°N and 41°N latitudes and 22°E and 27°E longitudes in the North Aegean Sea

As the involved Institutes (IAMC-CNR and HCMR) were mandated by their Ministries to carry out the data collection within the framework of the European Data Collection Framework, we state that no specific permissions were required for the surveyed area both in the Strait of Sicily and in the North Aegean Sea [13].

We can attest that neither endangered nor protected species were used in the field studies. During the studies at sea, biological samples (anchovies and sardines) were obtained using a pelagic trawl net with the main objective of assessing species composition and size class's distribution [14]. The specimens used for the study were already dead when they arrived on board within the trawling net due to the minimal resistance of small pelagic fishes to catch with net.

Results

The environmental dataset analysis made it possible to draw attention to the key environmental differences between the two sites [15]. In particular despite the fact that the magnitude of the difference in the two locations' UML temperatures was not particularly large (Mann-Whitney U Test, p0.001) (slightly higher UML temperature values in the North Aegean Sea than in the Strait of Sicily) [16]. In contrast, the median UML salinity in the Strait of Sicily was lower than in the North Aegean Sea (Mann-Whitney U Test was significant at p0.001); this difference is probably attributable to the influence of the fresher BSW in the upper layer. UML thickness in both areas displayed comparable values (i.e., no discernible difference), with a median value in the range of 24.0 m to 37.0 m. Additionally, the North Aegean Sea's salinity levels were much lower than those found in the Strait of Sicily, despite the latter region's slightly higher median temperature in the BL [17]. The MAW flowing on the southern continental shelf south of Sicily is the primary cause of these environmental conditions in the BL. A correlation analysis between bathymetry and all environmental variables was performed in each location to prevent any potential interactions with bottom depth.

Discussion

It is known that anchovies and sardines are distributed throughout a variety of temperate zone ecosystems that significantly differ in terms of oceanographic features and productivity, i.e., highly productive regions like the California Current, the Humboldt Current, the waters off South Africa, the western Pacific Ocean, the waters off Australia, and the Northeast Atlantic up to the North Sea [18]. Additionally, they disperse in enclosed basins like the Mediterranean Sea and the Black Sea. In terms of hydrography, bathymetry, and productivity, the latter is very varied. It includes a variety of habitats, such as open spaces with robust upwelling and intricate water circulation that exhibits high dynamics in the upper layer, like the Strait of Sicily, and semi-closed basins with shallow water, like the North Aegean Sea.

Conclusion

Although the "ocean triad" hypothesis was first discovered in upwelling regions, it appears to be well applicable to coastal regions as well, where physical processes that increase productivity are thought to be primarily in charge of the spatial organisation of plankton concentration, which in turn drives the spatial distribution patterns of anchovy and sardine. These oceanographic regimes are modified to account for the unique characteristics of each ecosystem in terms of their strength and scope. The main distinction between the Mediterranean and other, more productive ecosystems (such as southern Africa, the California Current, the Humboldt Current, and the Black Sea) is not due to variations in the preferential range of variables like temperature or salinity, but rather to the absence of extended horizontal migrations for small pelagic fish in the Mediterranean. Sardines and anchovies in this basin do not migrate far between their feeding, spawning, and juvenile habitats. In contrast to upwelling habitats, these zones appear to overlap significantly. In addition, the current study has demonstrated that, in line with other findings sardine and anchovy ecosystems exhibit a significant degree of overlap. The current study has demonstrated that although the two ecosystems in question share a major portion of the two species' vast range region, local productivity patterns are mostly responsible for this overlap. In contrast to upwelling ecosystems, habitat growth is less noticeable between years of low and high abundance because suitable habitat is still found in places that are rich in food or that trap food even in years of high abundance.

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Conflict of Interest

None

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