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Editorial

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Contribution to the Special Issue: "MEDiterannean International Acoustic Survey (MEDIAS)"

The "MEDiterranean International Acoustic Survey": An introduction

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Over five decades, active acoustic methods have been routinely used worldwide for surveying the water column for fisheries research, aiming mostly to derive single-species abundance indices for direct input into stock assessments (Misund, 1997; Simmonds & MacLennan, 2005). It is well known that the most effective monitoring programs globally for forage fish, like small pelagics, are based on fishery-independent surveys such as daily egg production and/or acoustics (Barange *et al.,* 2009). Forage fish productivity can rapidly decline and stock assessments based on catch per unit effort can be slow to detect this change, offering limited value (Essington *et al.,* 2015). A dedicated working group set up in 1984 by the International Council for the Exploration of the Sea, the Working Group on Fisheries Acoustics Science and Technology (WGFAST), following a recommendation from the ICES Fish Capture Committee in 1982. This committee is the major international forum for scientists involved in the fisheries acoustics network; it is used to discuss on-going developments in acoustic trawl surveys. Currently, many small pelagic fish monitoring studies are carried out through acoustic surveys worldwide.

As the Mediterranean is no exception, all anchovy and sardine stock assessments currently carried out by the FAO General Fisheries Commission for the Mediterranean Working Group on Stock Assessment of Small Pelagics (GFCM WGSASP, 2021), rely on acoustics estimates as abundance indices. This is largely attributable to the mandatory acoustic surveys performed under the umbrella of the MEDiterranean Acoustic Survey (MEDIAS). The MEDIAS project (http://www.medias-project.eu/medias/website/) was launched in 2009 following the extensive, regular, and internationally coordinated hydroacoustic surveys that had been initiated within the framework of the EU Fisheries Data Collection Regulation (EC 199/2008), based on the recommendation of the Subgroup on Research Needs of the EU Scientific, Technical and Economic Committee for Fisheries for the Mediterranean EU countries. Since then, the MEDIAS project is required to perform annual surveys, in a standardised way, inform management bodies and provide input for the assessment of European anchovy (*Engraulis encrasicolus*, Linnaeus 1758) and European sardine (*Sardina pilchardus*, Walbaum 1792) stocks.

In less than 13 years, the MEDIAS project had successfully embraced different scientific groups that were already collecting acoustic data within the framework of national surveys, some of them dating back to the 1970s and 1980s. It was a challenge to bring together people from different scientific groups in order to agree on a common survey protocol (MEDIAS, 2021), standardize the work carried out by different institutes with different infrastructure, research vessel capacity, type and frequencies of scientific echosounders, and operating in diverse ecosystems in terms of productivity, topography and fish aggregations. The MEDIAS Steering Committee, which convenes annually, was established by scientists from six European countries (Spain, France, Italy, Slovenia, Malta and Greece) and covers six Mediterranean basins (Iberian Coast, Gulf of Lion, Ligurian and Tyrrhenian Seas, Strait of Sicily, Adriatic Sea, Aegean and the eastern Ionian Sea). It brought together scientists from both the Mediterranean and the Black Sea, from 8 European countries (Spain, France, Italy, Slovenia, Croatia, Greece, Bulgaria and Romania) as well as 4 non EU countries, namely, Morocco, Algeria, Tunisia and Turkey. The latter regularly attend the meetings and adhere to the MEDIAS protocol. The open dialog and commitment to collaboration among members, was key to improving collective knowledge and helped to address many technical issues that arose along the way.

The harmonization of Mediterranean acoustic surveys that allowed to merge datasets collected over large spatial and temporal scales (e.g. Giannoulaki *et al.,* 2011; Tugores *et al.,* 2011; Giannoulaki *et al.,* 2013; Machias *et al.,* 2013; Bonnano *et al.,* 2014; Barra *et al.,* 2015; Giannoulaki *et al.,* 2017), is reflected in the MEDIAS handbook (MEDIAS, 2021). Furthermore, the scientific importance of MEDIAS is mirrored in this Special Issue, which includes selected papers that passed the peer-review process of the Mediterranean Marine Science journal and are

presented in two sections. The papers highlight not only the maturation and standardization of acoustic methods but also the utility of periodic surveys to pursue novel fundamental research.

Section 1: Review and technical issues related to the MEDIAS surveys

- As stated by **Leonori *et al.* (2021)**, in this review paper, early experiments based on acoustic methodology in the Mediterranean date back to the 1950s, with the first pilot studies carried out in the 1970s in the Adriatic Sea, the Baleares Archipelago and the Gulf of Lion. Fisheries acoustics were soon recognized as a powerful tool for monitoring the abundance of small pelagic species and became a common research method that was adopted by several countries. This review summarizes the progress of hydroacoustic surveys conducted by each country over time. The study also presents the steps taken to overcome the challenges faced in achieving standardization among surveys throughout the implementation of the MEDIAS project since 2009. The importance of the paper also lies in presenting the historical time series of biomass for small pelagics in the different areas and the inclusion of decadal maps showing the spatial and temporal distribution of small pelagic species in the European part of the Mediterranean Sea. Furthermore, it discusses the use of MEDIAS data for stock assessment purposes, the potential of the surveys to acquire information on zooplankton, ichthyoplankton and mesopelagic assemblages; it emphasizes the ability to gather auxiliary information for ecosystem-based management as well as the need for further standardization and anticipation of future challenges.

- Due to the sampling strategy used in acoustic surveys, which involves multi-stage acoustic and biological sampling, characterizing their efficiency had been a matter of heated discussion. This topic had remained somewhat dormant for the past decade, but **Barra *et al.* (2021)** successfully revisited this very important issue in the context of MEDIAS. They analyzed the efficiency of acoustic surveys, targeting European anchovy and European sardine, in 10 different areas of the Mediterranean Sea across different biomass levels underlining how different patterns in terms of survey design efficiency occur among areas and species. The results indicate higher survey design efficiency in high productive sectors influenced by river run-off, supporting the hypothesis that higher productivity along with the presence of well-localized enrichment mechanisms could favour a spatially consistent distribution and coherent organization of fish populations thus leading to higher precision estimates with a given transect design.

- Due to the daily change of aggregative behaviour in small pelagic species, acoustic surveys are overwhelmingly conducted during the day. However, sampling over the 24h cycle can be feasible in some locations, provided that diel differences in fish detection, both acoustically and through trawls are known. Working on data collected from three different areas of the Mediterranean basin during both daytime and night-time **Bonnano *et al.* (2021)** aim to estimate a correction factor to compensate for night-time sampling, effectively allowing surveying round the clock, with substantial increases in surveying efficiency

Acoustic surveys present a unique feature; echosounders allow us to look at the ecosystem as a whole – from the surface to the seafloor – within the same dataset. In addition, the survey itself allows the collection of different datasets at the same time. This feature is reflected in the second section of the Special Issue.

Section 2: Mediterranean acoustic surveys as a platform to address ecological and biological issues

- **Hattab *et al.* (2021)** address the applicability of Bergmann's rule to the populations of small pelagic fish species by examining 10 species collected by pelagic trawl hauls performed during acoustic surveys in the Mediterranean Sea. Anchovy, sardine, Atlantic chub mackerel, bogue and blue jack mackerel showed a significant negative effect of temperature on mean body size, with larger individuals being more common at lower temperatures. The adherence of 5 out of 10 pelagic fish to Bergmann's rules strongly suggests that temperature is a major determinant of body size and enables the fish to act as sentinel species for identifying the drivers and consequences of warming on Mediterranean ecosystems.

- *Sardinella aurita* and *Sprattus sprattus* are two species found at the opposite ends of the thermal range. In the Mediterranean Sea, available information is limited due to the low commercial interest for these species. **DeFelice *et al.* (2021)** anticipated this and integrate acoustic estimates from Spanish Mediterranean waters, the Gulf of Lion, the Ligurian and Thyrrenian Seas, the Strait of Sicily and the Adriatic Sea, and examine biomass response to environmental changes highlighting the differences.

- The invasive ctenophore *Mnemiopsis leidyi* has been a subject of extensive scientific discussions during the last fifteen years as the species out-breaks can have massive consequences on fish stocks and marine food webs. **Budiša *et al.* (2021)** investigated the distribution, abundance and diet of this ctenophore in the north-eastern Adriatic from 2016 to 2019 in terms of environmental variables. Going further, by simultaneous monitoring, they revealed that the presence of *M. leidyi* coincided with a reduction in anchovy

abundance, and assumed that the anchovy drop is a consequence of competition for food. The work underlines the potential of MEDIAS to support an ecosystem-based management approach and monitor large-scale changes in macrozooplankton communities and other ecosystem components.

- **Malavolti *et al.* (2021)** evaluated short-term genetic changes of the species in the Adriatic Sea by applying molecular markers in samples of adults and larvae of European anchovy collected from three different areas of the Adriatic Sea potentially belonging to different populations. The results suggest possible reduction in genetic diversity between adults and offspring. As successive mixing in nursery areas – due to passive larval transport by currents – enables the preservation of the population, the findings highlight the need to protect the main nursery areas of the Adriatic in order to avoid critical erosion of genetic diversity over time. Moreover, the authors suggest that the genetic structure of anchovy populations in the Adriatic Sea may be affected by short-term events. The genetic pool may reflect annual differences induced by interactions between biological factors affecting anchovy populations and the complex climatic conditions and oceanographic characteristics of the Adriatic basin.

- Size at first sexual maturity (L_{50}) represents an important life history trait known to display variability due to fishing pressure, geographic gradient and environmental features. It includes basic information for managing and preventing the exploitation of immature individuals. **Ferreri *et al.* (2021)** investigated the L_{50} variability among different areas of the Mediterranean and Black Sea based on samples collected within the framework of the MEDIAS surveys under a standardized protocol. The results evidenced a significant effect of latitude and condition factor as well as differences in L_{50} values among areas and between sexes, with males reaching maturity at shorter length than females. The observed variability at basin scale highlights the importance of considering area and habitat peculiarities into management suggestions.

The MEDIAS project started out as a monitoring survey for single species using single frequency echosounders, currently coping with the challenge to gain a much broader view combining different datasets over large spatial and temporal scales, interpreting large features and patterns in ecology and biology as well as the changes in those patterns. The MEDIAS Special Issue is the first step in this direction.

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