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Editorial: Elasmobranch – fisheries interactions in the Mediterranean

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Editorial on the Research Topic
Elasmobranch – fisheries interactions in the Mediterranean

The intricate balance of marine ecosystems relies heavily on the presence of apex predators, and among them, elasmobranchs stand out as formidable top predators. These enigmatic creatures play a pivotal role in maintaining the health and equilibrium of marine environments (Myers et al., 2007). However, despite their ecological significance, elasmobranch populations are experiencing a concerning global decline, primarily attributed to the intersection of anthropogenic disturbances and shifting environmental conditions. A particular impact is due do different fishing activities, not only the "industrial" ones, but also artisanal fisheries was demonstrated to negatively affect elasmobranchs populations (Tiralongo et al., 2018; Mancusi et al., 2020).

At the forefront of these threats is the pervasive impact of fishing activities, posing a substantial challenge to the conservation of elasmobranchs worldwide. Overfishing, coupled with unintended interactions in non-targeted fisheries, has emerged as a significant driver behind the diminishing populations of these iconic marine species. The repercussions of these trends are further exacerbated by the escalating demands on global fisheries and the concurrent depletion of fish stocks, foreshadowing an ominous trajectory for elasmobranchs in the decades to come (Pacuoreau et al., 2021).

Nowhere is this crisis more evident than in the Mediterranean, where elasmobranchs, including various shark and ray species, are experiencing a precipitous decline. Numerous studies have meticulously documented the detrimental impacts of fishing activities on these charismatic creatures, unraveling a complex web of consequences ranging from direct catches to ecosystem-wide damage and disturbances in the marine food web.

In response to this urgent need for understanding and action, this Research Topic serves as a dedicated platform to consolidate and disseminate the latest scientific insights into the intricate dynamics between elasmobranchs and fishing activities in the Mediterranean Sea. The focal point of this endeavor is to explore the multifaceted ways in which these marine predators are affected—both directly through targeted and non-

targeted catch, and indirectly through the far-reaching consequences of ecosystem damage and disruptions to the delicate balance of the food web (Barría et al., 2018; Tiralongo et al., 2020). Within the RT, a total of 4 novel and impactful articles covering diverse topics were published.

In the study of Di Crescenzo et al., the focus is on understanding the population genetic structure of the blackmouth catshark (*Galeus melastomus*), a species that is frequently caught unintentionally in commercial fisheries and is potentially vulnerable. The researchers utilized a novel set of nuclear DNA markers, specifically 129 microsatellite loci (Simple Sequence Repeats, SSRs), to investigate the population genetics of *G. melastomus*. The study covered specimens collected from eight geographically distant areas in the Mediterranean Sea and North-eastern Atlantic Ocean. The findings revealed a weak but discernible genetic structure within the blackmouth catshark population. Notably, there was clear evidence of genetic differentiation of *G. melastomus* from Scottish waters compared to other population samples, indicating genetic structuring in the Mediterranean Sea and adjacent North-eastern Atlantic. Individual and frequency-based analyses identified a genetic unit formed by individuals in the Tyrrhenian Sea and the Strait of Sicily, distinct from the rest of the Mediterranean and Portuguese samples. Bayesian analyses further revealed separation in the easternmost Aegean sample and the mixed nature of other Mediterranean and Portuguese samples. The results support the hypothesis that ecological and biological factors, along with abiotic drivers such as water circulations, temperature, and bathymetry, influence the dispersion of *G. melastomus*. This information contributes valuable insights into the connectivity of this deep-water species, providing essential tools for estimating its response to anthropogenic impacts. Overall, the study emphasizes the significance of understanding the ecology and genetics of deep-sea sharks, particularly those prone to incidental capture in commercial fisheries, in order to implement effective measures for the conservation of elasmobranch communities.

The study of Melis et al. focuses on the small-spotted catshark, *Scyliorhinus canicula*, which is one of the most abundant and frequently caught cartilaginous fishes in the Mediterranean Sea and adjacent areas. The research, conducted using microsatellite markers, aims to provide a population genetic analysis of this species at both small and large spatial scales. The analyses revealed significant genetic differences within the Mediterranean, particularly between the Western and Eastern basins, as well as between the Mediterranean and the Northeast Atlantic Ocean. Contrary to the hypothesis of genetic homogeneity, the results indicated a complex genetic structuring for *S. canicula* in the Mediterranean Sea. The study suggests that the Strait of Gibraltar does not act as a complete barrier to the exchange of individuals between the Atlantic Ocean and the Mediterranean Sea for small-spotted catsharks. Within the Western basin, the small-spotted catsharks in Sardinian waters were found to be strongly differentiated from others in the region, such as those in the eastern Tyrrhenian Sea and the southernmost part of the Algerian basin. Additionally, these Sardinian populations were identified as demographically stable. The study discusses various mechanisms, both biological and abiotic, including migratory behavior, waterfronts, and oceanographic discontinuities, to explain the observed genetic differences. Overall, the genetic data presented in the study, at both local and regional levels, serve as valuable baseline information. This information can be instrumental for the temporal monitoring of populations and assessing the potential effects of current or future fishing, management, and conservation measures on small-spotted catshark populations in the Mediterranean Sea and adjacent regions.

The study of Ruiz-García et al. provides valuable insights into the current bycatch rates of chondrichthyans in the commercial bottom trawling fishery in the western Mediterranean. The research accurately portrays the unaltered practices of the local fleet, shedding light on the impact of fishing activities on chondrichthyan species. In the studied fishing grounds, which ranged from 50 to 800 meters deep, a total of 17 species were recorded, comprising 7 sharks, 9 batoids, and 1 chimaera. Despite this diversity, the total catch was dominated by a few key species. The study goes beyond mere documentation of bycatch rates and explores the factors influencing the distribution and structure of chondrichthyan communities. Using analysis of community structure, including multidimensional scaling and analysis of similitude, as well as generalized linear mixed models, the researchers assessed the impact of environmental and fishing-related factors on community descriptors. The findings emphasize the need to consider both natural environmental conditions and human-induced factors in understanding the spatial distribution patterns of chondrichthyan communities. Key results indicate that depth plays a pivotal role as the primary driver of community structure, with deeper areas within the fishing grounds hosting higher chondrichthyan diversity. Sea bottom temperature and substrate type were identified as additional factors influencing community distribution, with substrate effects varying based on the intensity of fishing pressure. Notably, the study underscores the negative impact of increasing fishing effort on the density, biomass, and diversity of chondrichthyans. In conclusion, this research not only outlines the current state of bycatch rates in the western Mediterranean but also delves into the complex interplay between environmental factors and fishing activities. The findings contribute crucial information for developing effective conservation and management strategies to mitigate the adverse effects of bottom trawling on chondrichthyan populations in the region.

The study of Bottaro et al. sheds light on the vulnerability of deep-sea Chondrichthyes, emphasizing the challenges in assessing the impact of deep-sea fisheries on these species. Due to their late maturation, extreme longevity, low fecundity, and slow growth rates, deep-sea Chondrichthyes, including sharks, are particularly susceptible to human impacts. Complicating matters further, many of these species are bycatch, often discarded at sea or landed under generic commercial-species codes. The scarcity of information in fishery datasets and the limited availability of species-specific life history data pose significant challenges to the management of deep-sea Chondrichthyes. The kitefin shark (*Dalatias licha*), a cosmopolitan elasmobranch inhabiting continental and insular shelf-breaks and slopes in warm-temperate and tropical waters, serves as a case study. This species is frequently caught as bycatch in deep-sea trawling and is classified as "Endangered" by the IUCN Red List for all European waters, including the Mediterranean Sea. The study presents findings based on the examination of 78

specimens of kitefin sharks collected over three years in the Ligurian Sea (NW Mediterranean) as bycatch from deep-water fisheries. The individuals varied in total length (380 to 1164 mm) and weight (198 to 8000 g). The sex ratio of immature and mature individuals was dominated by males, with adult males observed throughout the year and mature females observed only in spring-summer, suggesting a spatial segregation between genders. The kitefin shark's diet primarily consisted of bony fish, particularly Macrouridae, and other small sharks (e.g., *Galeus melastomus* and *Etmopterus spinax*). Notably, the shark's gut contents included plastic items and parasites. These findings underscore the rarity and complex ecology of the kitefin shark, highlighting the urgency of initiatives for monitoring and conservation. The study emphasizes the need for increased efforts to understand and mitigate the threats faced by deep-sea Chondrichthyes, particularly those vulnerable to deep-sea trawling activities.

In conclusion, these four scientific studies provide a comprehensive overview on different aspects of the complex dynamics surrounding elasmobranch populations in the Mediterranean Sea. The first study delves into the genetic structures of elasmobranchs, offering crucial insights into the connectivity and distribution patterns of species such as the blackmouth catshark and the small-spotted catshark. Understanding these genetic intricacies is paramount for the formulation of effective conservation strategies. The subsequent studies shift the focus to the impact of fishing activities on elasmobranch communities. Whether it be through the intricacies of deep-sea trawling or the challenges posed by artisanal and commercial fisheries, the findings underscore the vulnerability of these marine predators. The documented decline in populations and the identification of distinct genetic units emphasize the urgency of adopting sustainable management practices. Moreover, the studies shed light on the broader ecological implications of fishing activities, revealing not only direct consequences through targeted and non-targeted catches but also indirect effects on ecosystem dynamics and food-web structures. The intricate interplay between environmental factors, anthropogenic drivers, and the unique biological characteristics of elasmobranchs underscores the need for a holistic approach to conservation. Collectively, these studies contribute valuable data and insights that are essential for informed decision-making and policy formulation. The urgency of addressing the challenges faced by elasmobranchs in the Mediterranean Sea cannot be overstated, and the knowledge derived from these studies serves as a foundation for collaborative efforts aimed at ensuring the sustainability and resilience of these iconic marine species in the face of ongoing environmental changes and fishing pressures.

Author contributions

FT: Writing – original draft, Writing – review & editing. BL: Writing – review & editing. GM: Writing – review & editing. DT: Writing – review & editing. CB: Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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