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EDITORIAL
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Editorial: Biological and Ecological Studies on Marine Ichthyoplankton

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Editorial on the Research Topic

Biological and Ecological Studies on Marine Ichthyoplankton

Ichthyoplankton (including fish eggs and larvae), belonging to the early life stages, is important for the growth and development of communities (Shan et al., 2004; Lechner et al., 2016). Although this stage is short for the fish life history, it is the most vulnerable stage in the whole life development cycle, which could change quickly in response to environmental variations (Downie et al., 2020). The quantity and survival of ichthyoplankton reflects the biomass and interannual dynamics of future fish stocks (Butler et al., 2003). It provides the basis for the recruitment of fish stocks and the sustainable use of fishery resources. Therefore, understanding the distribution patterns of ichthyoplankton and exploring the abiotic and biotic factors influencing the distribution patterns are crucial for assessing fish recruitment and stock restoration. Moreover, ichthyoplankton plays an important role in the energy transfer of estuarine ecosystems, which is a key link in the aquatic food web (Wan and Sun, 2006). Despite the fact that ichthyoplankton plays such important role in the ecosystem, researchers have not paid enough attention to it. Possible reasons for this, at least in part, are the difficulties in species identification. At present, more than 36,058 fish species have been identified as adults (Fricke et al., 2021), but only approximately 10% of these can be identified as larvae or postlarvae, while less than 10% of eggs can be identified to species (Shao et al., 2001). Currently, this situation is gradually being improved by the combination of morphology and DNA barcoding identification methods.

However, limited by the life history characteristics of ichthyoplankton, research on sample collection, species identification, community structure changes, and responses to environmental and climate changes at this stage is lagging and weak. Thus, investigating and evaluating the ichthyoplankton community not only could lay a foundation for understanding the status of fish stocks, determining spawning sites and spawning cycles, and explicating fishery management, but also help to clarify the energy flow and material circulation of estuarine ecosystems.

Altogether, thirteen articles are accepted in this topic, covering nine region including Yangtze River Estuary (China), Sansha Bay (China), Beibu Gulf (China), Pearl River Estuary (China), Macclesfield bank (China), Ninety East Ridge (Eastern Indian Ocean), northern Gulf of Mexico (Mexico), Norwegian coast (Norway) and Barents Sea. Among which seven focused on the community structure of ichthyoplankton (Wang et al.; Hou et al.; Jiang et al.; Zhang et al.; Huang et al.; Hou et al.; Vikebø et al.; Chen et al.; Endo et al.; Long et al.; Wang D et al.; Chen et al.), three explored the feeding characteristics of ichthyoplankton (Vikebø et al.; Chen et al.; Endo et al.), one discussed the selection of spawning habitat by ichthyoplankton (Wang et al., 2021), one assessed the

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feasibility of 6 sampling design for ichthyoplankton (Long et al.), and one systematic review of estuarine ichthyoplankton studies (Zhang et al.).

Overall, the studies jointly form the latest advances in current research on the ecology and biology of ichthyoplankton. DNA barcoding, as a complementary tool for morphological identification, is gradually being applied in ichthyoplankton classification (Kerr et al., 2020). It has been affirmed to be effective in identifying fish eggs and larvae and has shown potential in ichthyoplankton assemblage and ecology studies.

Community structure, including species composition and distribution, has long been one of the most important studies on the ichthyoplankton. Temporally, the high abundance of ichthyoplankton (Pearl River Estuary) mainly occurred in spring and autumn (Hou et al.); spatially, the high density of ichthyoplankton (Sansha Bay) occurred near the coastline (Jiang et al.). The species composition of ichthyoplankton communities in different areas differed greatly, which may be related to the ecological habits of ichthyoplankton and environment. Therefore, the factors affecting the community structure of ichthyoplankton have become the other key concerns of researchers. Ichthyoplankton assemblage structure appears to be strongly influenced by temperature, salinity, water depth, distance from shore, Chlorophyll *a*, and sea level anomalies. Interestingly, 80% articles on environmental factors affecting the structure of ichthyoplankton communities concluded that temperature was the main influencing factor. For estuarine or inshore ichthyoplankton community, temperature and salinity were the most important factors (Wang D et al.; Jiang et al.; Wang et al.; Hou et al.); while, for ocean community, sea surface height correlated with ichthyoplankton abundance the most (Zhang et al.); for coral reef community, the larval fish assemblage showed distinct spatial differences responding well with the geographical conditions, and the most reef-associated fish occurred inside the Atoll, and the abyssal fish presented near the edge (Huang et al.). In addition, Wang et al. characterized the dynamics of larval fish assemblages across epipelagic, mesopelagic, and bathypelagic (0-1,500 m) regions of the Gulf of Mexico, which indicated the abundance of ichthyoplankton decreased with increasing depth, and the pelagic upper layer was significantly higher than the pelagic lower layer and the deep sea in terms of abundance and diversity.

Moreover, the spawning habitat selection mechanism under the locally varying environmental conditions was explored based on a case study of *Coilia mystus* in the Yangtze Estuary by Wang et al., which are helpful in gaining a comprehensive understanding of fish spawning habitat selection mechanism in the estuarine areas and conductive to the protection of the population. Long et al. established six stratified schemes for monitoring *C. mystus* in the Yangtze estuary to evaluate its performance in different sample sizes, providing references to future sampling designs for ichthyoplankton in the estuary area.

In addition, quantity, quality and timing of food are critical to the replenishment and survival of juvenile fish populations (Swalethorp et al., 2014). Chen et al. detected the gastrointestinal contents of larvae and early larvae of small yellow croaker in the Yangtze Estuary to reveal its feeding habits during the settlement period. Vikebø et al. and Endo et al. evaluated the effects of food and environmental factors on the growth and survival of Northeast Pacific cod by combining multiple models.

Furthermore, estuarine ichthyoplankton over the last 60 years (1951–2022) were reviewed, it focus on evaluation of ichthyoplankton published studies, community structure and factors affecting community structure. The review emphasized that an increase in the amount of research on estuarine ichthyoplankton over time, but it was mainly concentrated in developed countries. Importantly, climate change indirectly affects the community structure of ichthyoplankton by altering the spawning habitat, spawning time, and egg hatching time. The movement of spawning sites poleward and the advance of spawning time have become a consistent trend (Zhang et al.).

Indeed, the oceanic marine environment is changeable, and ichthyoplankton in different sea areas are affected by different variables, even producing multivariable synergistic effects. Therefore, strengthen long-term monitoring of ichthyoplankton in important marine areas will not only understand the variations in the community structure and protect their spawning sites and habitats, but will also provide a rich theoretical basis for the restoration and sustainable development of fish resources.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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