CHAPTER 16

ICHTHYOPLANKTON OF THE SEA OF MARMARA

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Abstract

In this paper, ichthyoplankton studies in the Sea of Marmara are evaluated summarized. The chronological records of ichthyoplankton studies were listed, whilst temporal and spatial variations in fish egg and larvae biodiversity were discussed. The ecological role of fish eggs and larvae as an indicator were shown. The first study dealt with ichthyoplankton in the Sea of Marmara, as well as in Türkiye was carried out in 1957. In total, eggs and/or larvae of 76 fish species belonging to 32 families were identified in the Marmara Sea from 1993 to 2022. The biodiversity of fish eggs and larvae appears to increase around the southwestern part of the Marmara Sea. In the ichthyoplankton, the European sprat *Sprattus sprattus* and the anchovy *Engraulis encrasicolus* are the most abundant species in the winter and summer periods, respectively. The inflow intensity and the direction of the upper current layer from the Black Sea represent a significant constraint on spatial variation. Pollution, global warming, acidification, and excessive, illegal fishing and recent mucilage events are threats causing ecological changes in the ichthyoplankton in the Sea of Marmara. The decrease in the stocks of migratory fish such as mackerel and bluefish in recent years, the breaking of the food chain due to overfishing of sprat before mucilage, and the gradual decrease in the egg and larval biomass of sardines provide essential evidence in this regard. Although many valuable studies have been conducted, continuous systematic monitoring studies should be undertaken from specific fixed stations reflecting spawning seasons and spawning areas to understand the impact of environmental variations on fish stocks, to develop sound advice to fisheries management authorities.

Keywords: Fish eggs, larvae, spatial, temporal, variation

1. Main Characteristics the Sea of Marmara with Respect to Ichthyoplankton

The Sea of Marmara has diverse habitats for several local populations of fish and is a very important transport corridor for the migration of some other fish. Polat and Tuğrul (1996) defined the Sea of Marmara, Çanakkale Strait, and Istanbul Strait as the "Turkish Strait System" (TSS) altogether. The Aegean Sea and the Black Sea interconnect through the TSS. The Sea of Marmara is a semi-enclosed basin, with an area of 11,500 km^2 and a water volume of 3378 km^3 (Polat and Tuğrul, 1996). In the TSS, a two-layered stratification and current system is observed, which is caused by the level and density difference of the neighboring seas (the Aegean Sea and the Black Sea). Thus, a two-layered stratification is formed as upper layer and lower layer, which originated from the Black Sea and Aegean Sea, respectively. The salinity difference between these layers is shown as the most crucial factor for the continuity of these stratifications. The two different water bodies are separated from each other by a strong pycnocline roughly occurring at 25 m depths (Beşiktepe et al., 1994). Due to this two-layered water body, complex flow systems are formed, and therefore seasonal and discontinuous mixtures of organic and inorganic substances emerge. The Marmara Sea embodies lots of economical fish species, both demersal and pelagic species, such as Anchovy, Sardine, Bluefish, Hake, Whiting, etc. There has been a decrease in the amount of seafood caught in recent years. While it was in second place after the Black Sea with 52 thousand tons in 2018, it ranked last with 14 thousand tons in 2021 (TUIK, 2022). The populations of these fish is abundant in the Marmara region, resulting in job opportunities due to the commercial facilities.

Untreated and/or insufficient treated wastewater increases nutrient load and causes significant pollution (Burak et al., 2021). Besides, the Marmara Sea is one of the most important sea routes for marine transportation. Thus, oil spill-related marine traffic accidents, bilge, ballast, and wastewater release by vessels cause an significant pollution load for the Sea of Marmara (Doğan and Burak, 2007). The pollution load is transported from the northeastern Marmara region, where it is the most concentrated, to other regions by current flow. The upper layer current is loaded with organic and inorganic pollutants around İstanbul, where the most polluted area, and carrying them through the western Marmara Sea (Polat and Tuğrul, 1996). Unfavorable conditions stemming from pollution and global warming favoring also the establishment of alien species have caused mucilage events in 2007, 2013, and 2021. The Sea of Marmara has revealed a threat to aquatic life in recent years. The environmental problems have increased and become frequent, day by day. The distinct effects of these problems on aquatic organisms and systems are still being investigated.

2. The Ecological Importance of Ichthyoplankton for the Sea of Marmara

Ichthyoplankton are the planktonic eggs and larvae of fish and form part of the plankton assemblages during their development (Borja et al., 2019). Ichthyoplanktonic studies reveal essential findings for determining the spawning season and spawning area of the fish species (Hempel, 1973). Ichthyoplankton surveys enable us to investigate fish biodiversity (Mavruk et al., 2023), regardless of the commercial fishing effort (Govoni, 2005), and make it possible to reveal the biodiversity with lower costs and save times compared to other biological sampling techniques (Yüksek, 1993). In addition, early life dynamics can be used for determining the recruitment potential of the early life stages of fishes (Houde, 1997), helping in estimating stock size (Lockwood, 1988). The abundance and biodiversity of ichthyoplankton are rapidly affected by the changes in the hydrographic conditions (Brodeur et al., 1985). Therefore, fish larvae could be a sensitive indicator of climate change due to potential shifts in spawning and migration timing and changes in larval growth (Auth et al., 2017).

Fertilization of the great majority of teleost fish eggs takes place in the pelagic environment. Because early-stage fish eggs and larvae are not active swimmers, the spatial variation of ichthyoplankton in the Sea of Marmara directly reflects the flow conditions in the upper layer, which mostly drift in the direction of the current. The upper layer discharge transports fish eggs and larvae of some species from the Black Sea to the Marmara Sea via Istanbul Strait and from the Marmara Sea to the Aegean Sea through Çanakkale Strait. For example, *Pomatomus saltatrix* is known as a migratory fish species, which realizes spawning migration from the Mediterranean to the Black Sea in the spring-summer period. Although it is known that it spawns in the Black Sea, the eggs and larvae drift with the upper current system of Black Sea water through the Marmara Sea and are also sampled from Golden Horn (Demirel, 2015).

3. Chronology of Ichthyoplankton Studies in the Marmara Sea

For the Marmara Sea, ichthyoplankton studies have been an important research area from the past to the present. However, since the studies were carried out by a few researchers with low technological equipment at large time intervals, long-term data monitoring sets could not be created.

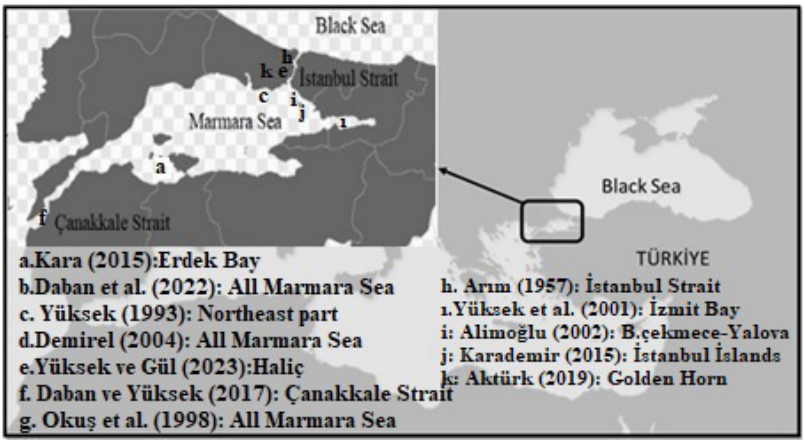


Figure 1. Sampling stations in the Sea of Marmara from previous studies.

The first study on ichthyoplankton in the Marmara Sea and Türkiye was carried out by Arım (1957). The marine surveys were conducted with the monitoring program of the Hydrobiology Research Institute of Istanbul University in the entire Marmara Sea basin, in the first 12 miles of the Black Sea entry of Istanbul Strait, and around the Trabzon coasts between 1953 and 1955. Researchers examined the ecology and morphology of the eggs and larvae belonging to 7 teleost fish species (*Engraulis encrasicolus, Sardina pilchardus, Scomber scomber, Trachurus trachurus, Trachurus mediterraneus, Mullus surmuletus,* and *Mullus barbatus*). Arım (1957) has found the eggs and larvae of *E. encrasicolus, M. barbatus, M. surmuletus,* and *T. mediterraneus* in both the Marmara Sea and the Black Sea, whereas *T. trachurus, C. pilchardus,* and *S. scomber* were observed only in the Marmara Sea. In this study, eggs and larvae of *M. barbatus and M. surmuletus* were observed between May and July. *S. scomber* and *Trachurus trachurus* were detected between March and June. *E. encrasicolus* was sampled from April to October, whereas *S. pilchardus* was from December to June.

Later, Demir (1958) studied on the eggs and larvae of deep water fish species, Demir (1961) worked on fish eggs and larvae of *Scomber colias*, Demir (1982) examined the postlarvae and juvenile of *Gaidropsarus mediterraneus*, and *G. biscayensis*, Yüksek (1993) worked fish eggs and larvae of northeastern part of Marmara Sea, Yüksek and Mater (1994) studied on fish eggs and larvae of *Diplodus annularis* and *Sprattus sprattus* in the northeastern part of Marmara Sea, Okuş et al. (1998) examined autumn and winter ichthyoplankton in the 64 stations located in the whole Marmara Sea, Yüksek et al. (2001) revealed ichthyoplankton abundance, variation and biodiversity after a big disaster, 17 August 1999 Gölcük earthquake, Deval et al. (2002) studied the variation of *S. sprattus* fish eggs and larvae, Alimoğlu (2002) worked fish eggs and larvae in the northeastern Marmara Sea, Demirel (2004) determined summer season ichthyoplankton

in the 63 stations located in the whole Marmara Sea, Yüksek et al. (2006) detected the ichthyoplankton biodiversity of extremely polluted Golden Horn Estuary, Yüksek ve Yılmaz (2008) worked on the effect of stress conditions stemmed from pollution on ichthyoplankton around Golden Horn, Kara (2015) investigated the fish egg and larvae distribution in the Erdek Bay, Karademir (2015) detected ichthyoplankton composition aroun İstanbul Islands, Yüksek and Gül (2016) examined distribution of ichthyoplankton in the İstanbul Strait, Daban and Yüksek (2017) revealed ichthyoplankton community of Çanakkale Strait, Aktürk (2019) identified ichthyoplankton biomass and biodiversity around Golden Horn, Daban et al. (2022) determined the winter period ichthyoplankton at 32 stations located whole Marmara Sea (Table 1).

Table 1. Sampling specifications and results of ichthyoplankton studies realized in the Sea of Marmara

Author/Year	Sampling area	Station number	Haul type	Sampling time	Species number
Arım (1957)	İstanbul Strait	*	*	All year	7
Yüksek (1993)	Bakırköy-Marmara Ereğlisi	18	Vertikal / Horizontal	Nisan 1990-Şubat 1991	40
Okuş et al. (1998)	All Marmara region	64	Vertikal / Horizontal	September-December	Total:23 September: 16 December: 14
Yüksek et al. (2001)	İzmit Bay	34	Vertikal	August 1999-May 2000	23
Deval et al. (2002)	All Marmara Region	28	Oblique	November 1998 -August 2000	*Sprattus sprattus*
Alimoğlu (2002)	Büyükçekmece-Yalova	9	Vertikal	January 1998-December 2000	27
Keskin (2002)	Erdek Bay	12	Beach Seine Net	January 2000- January 2002	Juvenile: 80
Demirel (2004)	All Marmara Region	1994:27 1997:50 2000:63	Vertikal	Ağustos 1994; Temmuz 1997; Ağustos 2000	1994:4 1997:12 2000:21
Yüksek et al. (2006)	Golden Horn	Ver: 3 Hor:2	Vertical / Horizontal	February 1999-December 2002 (bimonthly)	1999:16 2000:24 2001:27 2002:28
Kara (2015)	Erdek Bay	19	Vertikal / Horizontal	March 2011 - February 2012	57
Karademir (2015)	İstanbul İslands Region	8	Vertikal / Horizontal	August 2014 November 2014 February 2015 May 2015	20
Daban & Yüksek (2017)	Çanakkale Strait	3	Vertikal / Horizontal	March 2012 - February 2013	50
Aktürk (2019)	Golden Horn	6	Vertikal / Horizontal	June 2015- May 2016	33
Kaman (2021)	Erdek, Gemlik, İzmit Bays, İstanbul islands	16	*	Winter-Summer	*
Daban et al. (2022)	All Marmara Region	32	Vertical / Horizontal	December 2021-March 2022	20

4. Biodiversity of Ichthyoplanktonic Studies in the Marmara Sea

In total, eggs and/or larvae of 76 fish species belonging to 32 families were identified in the Marmara Sea. Among them, 2 of 76 species were identified at genus levels, which were *Thunnus* sp. and *Lepadogaster* sp. Sparidae is the most diverse family represented with 10 species. Labridae, Clupeidae, Triglidae, Scombridae, and Soleidae are shown as other common families. The most abundant fish species are stated as *Engraulis encrasicolus* among the spring-summer spawners and *Sprattus sprattus* among the autumn-winter spawners. 19 of 76 species (*S. pilchardus, S. aurita, M. merluccius, G. mediterraneus, M. merlangus, C. saliens, C. lucerna, D. labrax, S. cabrilla, T. trachurus, D. annularis, B. boops, M. barbatus, C. lyra, S. colias, A. laterna, B. luteum, P. lascaris,* and *M. variegatus*) were more abundant compared to other species sampled. Among 76 fish species, 17 species were found relatively rare such as *S. rhombus, Thunnus sp., S. sarda, S. scombrus, P. pictus, C. pusillus, C. maculatus, Lepadogaster sp., S. pavo, E. vipera, M. muelleri, P. bogaraveo, H. dactylopterus, H. hippocampus, N. ductor, Z. faber, S. maderensis* and *C. caelorhincus* (Table 2).

Table 2. Ichthyoplankton biodiversity in the Marmara Sea

Family	Species	Fish Eggs	Fish Larvae	
			Prelarvae	Postlarvae
ENGRAULIDAE	*Engraulis encrasicolus* (Linnaeus 1758)	X	X	X
CLUPEIDAE	*Sardina pilchardus* (Walbaum 1792)	X	X	X
	Sardinella aurita Valenciennes 1847	X	X	X
	Sardinella maderensis (Lowe 1838)	X[1]		
	Sprattus sprattus (Linnaeus 1758)	X	X	X
MACROURIDAE	*Coelorinchus caelorhincus* (Risso 1810)	X[1]		
MERLUCCIIDAE	*Merluccius merluccius* (Linnaeus 1758)	X	X	X
LOTIDAE	*Gaidropsarus mediterraneus* (Linnaeus 1758)	X	X	X
	Gaidropsarus biscayensis (Collett, 1890)			X[3]
GADIDAE	*Merlangius merlangus* (Linnaeus 1758)	X	X	X
	Micromesistius poutassou (Risso, 1827)	X[6]		
MUGILIDAE	*Chelon auratus* (Risso, 1810)	X[1]		
	Chelon saliens (Risso, 1810)	X[2]	X[2]	X[2]
	Mugil cephalus Linnaeus, 1758	X[1,6]		
ZEIDAE	*Zeus faber* Linnaeus 1758			X[1]
SYNGNATHIDAE	*Syngnathus typhle* Linnaeus 1758			X[1]
	Hippocampus hippocampus (Linnaeus, 1758)			X[6]
SCORPAENIDAE	*Scorpaena scrofa* Linnaeus 1758	X[1]		X[1]
	Scorpaena porcus Linnaeus 1758	X[6]		X[4]

SEBASTIDAE	*Helicolenus dactylopterus* (Delaroche, 1809)	X[1,6]		
TRIGLIDAE	*Chelidonichthys lucerna* (Linnaeus 1758)	X	X	X
	Lepidotrigla cavillone (Lacepede, 1801)	X[6]		X[1]
	Trigla lyra Linnaeus 1758	X[1]		
	Eutrigla gurnardus (Linnaeus, 1758)			X[6]
MORONIDAE	*Dicentrarchus labrax* (Linnaeus, 1758)	X	X	X
SERRANIDAE	*Serranus cabrilla* (Linnaeus, 1758)	X	X	X
	Serranus hepatus (Linnaeus, 1758)	X		X[1]
	Serranus scriba (Linnaeus, 1758)	X[1,6]		
CARANGIDAE	*Trachurus trachurus* (Linnaeus, 1758)	X	X	X
	Trachurus mediterraneus (Steindachner, 1768)	X[5]		
	Naucrates ductor (Linnaeus, 1758)	X[6]		
SPARIDAE	*Dentex dentex* (Linnaeus 1758)	X[1]		
	Diplodus annularis (Linnaeus 1758)	X	X	X
	Diplodus puntazzo (Walbaum 1792)	X[1]		
	Diplodus sargus (Linnaeus 1758)	X[1,6,5]		
	Lithognathus mormyrus (Linnaeus 1758)	X[1]		
	Boops boops (Linnaeus, 1758)	X[2,6]	X	X
	Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	X[2]		
	Sparus aurata Linnaeus, 1758	X[5,6]		
	Pagellus bogaraveo (Brünnich, 1768)	X[2]		
	Spicara maena (Linnaeus, 1758)	X[6]		
SCIANIDAE	*Sciaena umbra* Linnaeus 1758	X		X
STERNOPTYCHIDAE	*Maurolicus muelleri* (Gmelin, 1789)	X[4,8]		
MULLIDAE	*Mullus surmuletus* Linnaeus 1758	X		
	Mullus barbatus Linnaeus 1758	X	X[1]	X[1]
LABRIDAE	*Coris julis* (Linnaeus 1758)	X		
	Ctenolabrus rupestris (Linnaeus 1758)	X		X[6]
	Symphodus ocellatus (Linnaeus 1758)	X		X[1]
	Symphodus tinca (Linnaeus 1758)	X[6]		X[1,6]
	Symphodus rostratus (Bloch, 1791)	X[6]		
TRACHINIDAE	*Trachinus draco* Linnaeus 1758	X[1,6]		X[6]
	Echiichthys vipera (Cuvier 1829)	X[1]		
URANOSCOPIDAE	*Uranoscopus scaber* Linnaeus 1758	X[1,4,6]		
BLENNIIDAE	*Blennius ocellaris* Linnaeus 1758			X[1,6]
	Salaria pavo (Risso 1810)			X[1]
GOBIESOCIDAE	*Lepadogaster* sp.			X[1]

CALLIONYMIDAE	*Callionymus pusillus* Delaroche 1809	X[1]		
	Callonymus lyra Linnaeus 1758	X	X	X
	Callonymus maculatus Rafinesque 1810	X[1]		
GOBIIDAE	*Pomatoschistus minutus* (Pallas 1770)		X	X
	Pomatoschistus pictus (Malm, 1865)			X[2]
	Gobius niger Linnaeus 1758			X
CENTROLOPHIDAE	*Centrolophus niger* (Gmelin, 1789)			X[6]
SCOMBRIDAE	*Scomber colias* Gmelin, 1789	X[1,4,6,7]	X[7]	X[7]
	Scomber scombrus Linnaeus, 1758	X[6]		
	Sarda sarda (Bloch, 1793)	X[6]		
	Thunnus sp.	X[1]		
PLEURONECTIDAE	*Platichthys flesus* (Linnaeus 1758)			X[1,8]
BOTHIDAE	*Arnoglossus thori* Kyle 1913			X[1]
	Arnoglossus kessleri Schmidt 1915			X[1]
	Arnoglossus laterna (Walbaum 1792)	X[1,2,6]	X[6]	X[6]
SOLEIDAE	*Buglossidium luteum* (Risso 1810)	X	X	X
	Solea solea (Linnaeus 1758)	X[1,8]		
	Pegusa lascaris (Risso 1810)	X	X	X
	Microchirus variegatus (Donovan 1808)	X	X	X
SCOPHTHALMIDAE	*Scophthalmus rhombus* (Linnaeus, 1758)	X[2]		X[2]

Note: X refers to species found in several previous studies. X[1,2,3,..etc.]: refers to species only found by limited area and study. Captions: 1: Kara, 2015; 2: Daban et al., 2022; 3: Demir, 1982; 4: Demirel, 2004; 5: Yüksek ve Gül, 2023; 6: Daban ve Yüksek, 2017; 7: Demir, 1961; 8: Okuş et al., 1998

In addition to ichthyoplankton studies, some juvenile and adult fish composition studies have been investigated. Keskin (2002) detected 80 juvenile fish species around Erdek Bay. Arslan-İhsanoğlu and İşmen (2020) identified 42 teleost and 7 cartilaginous demersal fish species with beam trawl between October 2011 and February 2014. Daban et al. (2021) determined a total of 61 teleosts and 12 cartilaginous fish species with bottom trawl sampling between March 2017 - December 2018 at 34 stations with monthly samplings. Altuğ et al. (2011) determined 43 demersal fish species around Erdek Bay with bottom trawl in July 2006 and June 2007.

5. Spatial and Temporal Variations of Ichthyoplankton in the Sea of Marmara

The scientific knowledge on spatial variation of ichthyoplankton in the Marmara Sea is relatively poor due to limited spatial coverage of most of the relevant studies. While in some of these ichthyoplankton studies had a wide spatial coverage, (Okuş et al., 1998; Demirel, 2004; Daban et al., 2022), sampling periods were limited. Okuş et al. (1998) studied 64 sta-

tions located in the entire Sea of Marmara in September and December. Researchers stated that spawning increased around the north of the Marmara Islands area and Gemlik Bay under autumn and winter conditions. Demirel (2004) revealed Marmara Sea ichthyoplankton with studies conducted in August 1994, July 1997, and August 2000 at 27, 50, and 63 stations, respectively. This author stated that Erdek Bay, Marmara Island, the area between Tekirdağ and Şarköy, and Büyükçekmece coasts were the main spawning areas under summer conditions. Also, it was stated that the highest fish egg and larvae biodiversity was observed around the southwestern part of the Marmara Sea. Daban et al. (2022) surveyed ichthyoplankton between December and March at 32 stations, which are located throughout the Sea of Marmara. For winter spawners, the maximum fish eggs and larvae abundance was detected around the Karacabey Floodplain area. Besides, high fish egg abundance was found in the area between Büyükçekmece and Tekirdağ, whereas high fish larvae abundance was detected around Erdek Bay, Karabiga, and Gönen area (southwestern part) in vertical tows. The authors detected that, due to a 90% of the total fish egg abundance and 62% of the total larvae abundance consisting of *S. sprattus*, the spatial variation of total fish egg composition is closely related to the spatial distribution of *S. sprattus.* Moreover, these authors detected that the most important factors of spatial variation of the fish eggs and larvae were the freshwater inputs (Karacabey and Büyükçekmece) and the Black Sea inflow in the Marmara Sea under winter conditions. The highest fish egg biodiversity was also detected in the same areas (Büyükçekmece and Karacabey Floodplain area), whereas the highest fish larvae biodiversity was detected around Büyükçekmece, Erdek Bay, and Gönen estuarine areas. Table 1 shows that fish eggs and larvae of 17 rare species were sampled around Erdek Bay (Kara, 2015) and Çanakkale Strait (Daban and Yüksek, 2017). This finding was the other scientific data for supporting higher biodiversity around the southwestern part of the Marmara Sea. Thus, for spatial manner, the area between Büyükçekmece and İstanbul Strait, the Kacabey Floodplain area, and the area between Gönen Stream and Erdek Bay were critical areas for the Marmara Sea.

Temporal variations of ichthyoplankton in the Sea of Marmara were investigated in some previous studies. Okuş et al. (1998) compared the ichthyoplankton abundance between September and December and stated that spawning increased in December as the winter spawners started to reproduce. Yüksek (1993) studied the ichthyoplankton composition of the northeastern Sea of Marmara and stated that the number of species increased between May and July, whereas it decreased in September and October. Kara (2015) revealed that the minimum ichthyoplankton biodiversity was seen in March and April, and maximum biodiversity was detected in July around Erdek Bay, the southwestern Sea of Marmara. Daban and Yüksek

(2017) stated that the highest fish egg and larvae biodiversity was detected in June in the Çanakkale Strait (Dardanelles). The dominant fish species of ichthyoplankton were found to be the same among varied locations. Yüksek (1993) detected abundant fish species such as *Gaidropsarus mediterraneus* and *Sprattus sprattus* in the winter period, whereas *Diplodus annularis* and *Mullus barbatus* in the summer period. Daban and Yüksek (2017) stated that the most dominant species was *S.sprattus* among fish eggs in the Çanakkale Strait, and the highest number of *S. sprattus* eggs were sampled in March. In addition, the authors stated that the most abundant fish larvae species was detected as *E. encrasicolus*, and between all year-round highest total larvae abundance was seen in August. Conversely, authors detected that a lower abundance of eggs and lack of earlier egg phases of E. encrasicolus showed that it did not spawn in the Dardanelles Strait, and the spawned eggs developed while drifting from the spawning grounds in the Sea of Marmara to the sampling area.

6. Ecological Indicator Role of Ichthyoplankton in the Marmara Sea

In previous years, Golden Horn faced severe pollution stemming from industrial discharges and non-treated domestic discharges. With this pollution, hydrogen sulfide formed and affected aquatic organisms. In the early 1990s, surface discharges were taken under control, and the rehabilitation process started. Yüksek et al. (2006) investigated changes in biodiversity of the highly polluted Golden Horn Estuary following the improvements in water quality. During the rehabilitation process, ichthyoplankton was applied as one of the leading ecological indicators. The physical quality of fish eggs and larvae provided an essential indicator for habitat health. The samplings were realized between 1999 and 2002, and all eggs and larvae collected in 1999 appeared to be dead before sampling. With the rehabilitation process, the eggs and larvae of 16, 24, 27, and 28 fish species were identified in 1999, 2000, 2001, and 2002, respectively. Mortality rates decreased from 100% in 1999 to 40% in 2002. Thus, ichthyoplankton results clearly reflect the habitat health, as proven in another study carried out by Mavruk et al. (2015).

Daban et al. (2022) investigated the effects of mucilage on the early life stages of fish in the Sea of Marmara. In this study, authors hypothesized that if fertilization could not occur while the dense mucilage period, the postlarvae and juveniles of some reference species might not be present in the samples a certain period of time after the mucilage. Juvenile individuals of the species whose reproduction coincides with the intensive mucilage period were detected after mucilage, and it was observed that the mucilage did not have a significant adverse effect on the development of their early life stages. Daban et al. (2022) detected the eggs and larvae of 20 winter spawner species just after the mucilage event. When the results were compared

with the results of previous studies performed mucilage-free healthy ecosystem times, it was seen that biomass and biodiversity of ichthyoplankton results were found to be similar. As in previous studies, the most abundant fish egg and larvae species were found belonging to *Sprattus sprattus*. At the time of the study period (December 2021 and March 2022), the authors did not find abnormalities in dissolved oxygen values. It is well known that the low levels of dissolved oxygen may cause mortalities in ichthyoplankton due to their low tolerance (Breitburg et al., 2001). It is believed that laying eggs during the first spring and summer season requires choosing deep water locations with low mucilage effects and high oxygen levels.

Here, ichthyoplankton studies undertaken in the Sea of Marmara are summarized. Constantly changing environmental conditions, such as global warming, pollution, microplastics etc., are increasing along with their negative impact on fauna and flora in the Marmara Sea. To understand the effects of environmental variations on fish stocks, ichthyoplankton studies should be carried out as continuous monitoring studies from determined fixed stations.

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