



The Abundance and Distribution of the Early Life Stages of Sardine (*Sardina pilchardus*) in Central of the Aegean Sea (Sığacık Bay) and their Interactions with Certain Environmental Factors

Orçin Uygun¹ · Belgin Hoşsucu¹

Received: 14 November 2019 / Revised: 16 April 2020 /
© Springer Nature Switzerland AG 2020

Abstract

The study was carried out on a monthly basis at 16 stations between January 2017 and December 2017 in the Sığacık Bay, Izmir, Turkey. For ichthyoplankton sample collections, vertical (350 µm) plankton tows were carried out using a WP-2-type plankton net with a mouth area of 0.255 m². Depth, temperature, oxygen, pH, salinity, zooplankton volume and chlorophyll-*a* values were detected at each research station in the study. The eggs and larvae of the sardine samples were obtained during the period between December and February, the maximum being in February (mean temperature 15.29 ± 0.57 °C). The mean abundance values of all sardine eggs and larvae in all stations were 78 individuals·10 m⁻². The egg diameter values in sardines were in the range of 1.40–1.69 mm and the oil globule diameter values were in the range of 0.12–0.18 mm. The majority of sardine eggs and larvae were found at the depths of 25–75-m at the stations. The correlation between the abundance of sardine eggs and larvae and environmental variables was determined using the Principal Component Analysis (PCA). There was a positive correlation between sardine eggs and dissolved oxygen (r: 0.75) and a negative correlation between larvae and salinity (r:-0.75). It was concluded that sardine does not prefer Sığacık Bay as a spawning area. However, further ichthyoplanktonic studies considering the fluctuations of pilchard stocks in Sığacık Bay should be carried out for a longer period to better clarify the issue.

Keywords Sardine · Ichthyoplankton · Environmental factors · Aegean Sea

Introduction

Sardina pilchardus (Walbaum, 1792), also known as sardine, is a fully pelagic fish and has an important place in the Mediterranean fisheries (Alvares et al. 2003). The worldwide sardine production was 1.281.39 tons in 2016 (FAO 2018). However, the total production of sardines for 2018 in the Turkish Seas was only 18 tons and the majority of the production was from the Aegean Sea (67.11%) (TÜİK 2019).

Small pelagic fish such as sardines are preferred food sources for humans. They are also of great importance for their role in the pelagic food chain in marine ecosystems. This is associated with their effects on the energy transfer from lower to higher trophic

levels (Cury et al. 2000; Bănaru et al. 2013; Torri et al. 2018). Moreover, the determination of the distribution, abundance, spawning time and area of sardine eggs provide important data that can be used in the adult stock estimations using the Daily Egg Production Method (DEPM) (Parker 1980; Hunter and Lo 1993).

The review of the ichthyoplankton studies in the Aegean Sea revealed that sardine eggs and larvae were obtained in ichthyoplankton and most of the research on the distribution and abundance was carried out in Izmir Bay (Mater 1977, 1981, 1983; Hossucu 1992; Cihangir 1995; Hossucu and Ak 2002; Çoker 2003; Çoker and Mater 2006; Türker Çakır et al. 2005, 2008; Taylan and Hoşsucu 2008, 2011, 2015). However, no similar studies have been carried out in the Sığacık Bay which is in the south of the Izmir Bay. Therefore, this study aimed to reveal the abundance and distribution data of the eggs and larvae of the sardine in Sığacık Bay and to examine their relationship with environmental factors. Also, it was aimed to create a significant database for other studies on bio-ecology, population dynamics and fishery management by examining the distribution and abundance of the early life stages of sardine in Sığacık Bay.

✉ Orçin Uygun
orcin.uygun@ege.edu.tr

¹ Department of Hydrobiology, Faculty of Fisheries, Ege University, Izmir, Turkey

Table 4 Abundance of sardine eggs and larvae in different studies

Reference	Study Area	Max. Egg Abundance (eggs.10 m ⁻²)	Average Egg Abundance (eggs.10 m ⁻²)	Max. Larvae Abundance (larvae.10 m ⁻²)	Average Larvae Abundance (larvae.10 m ⁻²)
Cihangir (1995)	Aegean Sea (Izmir Bay)	15,000			
Çoker (2003)	Aegean Sea (Izmir Bay)	18,030		8270	
Türker Çakır (2004)	Aegean Sea (Edremit Bay)	1372	607	823	187
Koutrakis et al. (2004)	Aegean Sea (Strymonikos and Ierissos Bays)				50–187
Ak (2004)	Mediterranean Sea (Mersin Bay)	80	40	160	80
Zarrad et al. (2008)	Mediterranean Sea (Tunis Bay)	2805	257	288	38
Present Study (2020)	Aegean Sea (Sığacık Bay)	157	49	117	29

Biotic and abiotic factors in the environment can affect the distribution and abundance of fish eggs and larvae (Kingsford et al. 2002). Initially, the distribution of spawning is determined by adult fish; however, the composition of physical and biological factors is effective on the distribution, abundance, survival, and growth of eggs and larvae (Heath 1992; Somarakis et al. 2002).

There are no combined studies involving the physical and biological factors in Sığacık Bay. However, examining the current status of Sığacık Bay according to IMST (2017), it was determined that an “upwelling” occurred in the bay during certain periods causing the cooling of the surface waters and the upwelling water prevented the entry of the Mediterranean waters into the bay. More comprehensive studies are needed to determine the effects of such interactions on the distribution and abundance of sardine eggs and larvae.

There can be large fluctuations in the biomass of small pelagic fishes between different years (Lloret et al. 2004; Torri et al. 2018) and this could have been the case for Sığacık Bay. To monitor these fluctuations, similar studies can be repeated for Sığacık Bay. For sardines, which are important for the Aegean Sea fishery, adult stock estimation studies can be performed using the “DEPM” and the data obtained in this study. Furthermore, the study can help other studies on the physicochemical and ichthyoplanktonic properties of Sığacık Bay.

Acknowledgments This study was funded by the Ege University Rectorate Scientific Research Projects (BAP) Coordination Unit. The study is a part of the Ph.D. thesis, called “Spatial and Temporal Dynamics of Ichthyoplankton Assemblages in Sığacık Bay (Aegean Sea)”. Also, a portion of the study was presented as an oral presentation with an English abstract in the International Ecology 2018 Symposium, Kastamonu, Turkey.

We would like to thank TÜBİTAK, Assoc. Prof. Serkan GÜLSOY and all the researchers participated in the Project entitled “Cluster and Ordination Techniques” (Project No. 1129B3718014202237-A) which we participated in and was supported within 2237-A. We are also grateful to Hüseyin UYGUN, Serkan TEZ, and Burcu TAYLAN for their support in marine studies.

References

- Ak Y (2004) The abundance and distribution of the pelagic eggs and larvae of some teleost fishes in off Erdemli. Ege University, Izmir, Turkey, Mersin. Ph.D. (in Turkish with an abstract in English)
- Alvares F, Cingolani N, Kallianiotis A (2003) Piccoli pelagici: gestione futura delle risorse condivise in Mediterraneo. *Il Pesce* 5:57–65
- Arım N (1957) Marmara ve Karadeniz’de Bazı Kemikli Balıkların (Teleostların) Yumurta ve Larvalarının Morfolojileri ile Ekolojileri. İstanbul Üniversitesi Fen Fakültesi Hidrobiyoloji Araştırma Enstitüsü Hidrobiyoloji Mecmuası. Seri A, Cilt IV. Sayı 1-2. (7-57)
- Bănaru D, Mellon-Duval C, Roos D, Bigot J-L, Souplet A, Jadaud A, Beaubrun P, Fromentin J-M (2013) Trophic structure in the bay of lions marine ecosystem (North-Western Mediterranean Sea) and fishing impacts. *J Mar Syst* 111:45–68. <https://doi.org/10.1016/j.jmarsys.2012.09.010>
- Cihangir B (1995) Abundance and distribution of European pilchard, *Sardina pilchardus* eggs in reproduction period in Izmir Bay, Aegean Sea (in Turkish). *Turkish Journal of Zoology* 19:17–26
- Cihangir B (1996) Reproduction of European pilchard (*Sardina pilchardus* Walbaum, 1792) in the Aegean Sea. *Turkish Journal of Zoology* 20(1):33–50
- Clarke KR (1993) Non-parametric multivariate analyses of changes in community structure. *Aust J Ecol* 18:117–143. <https://doi.org/10.1111/j.1442-9993.1993.tb00438.x>
- Çoker T (2003) The morphology and ecology of the pelagic eggs and larvae of teleost fishes in Izmir Bay. Ph.D. Ege University, Izmir, Turkey (in Turkish with an abstract in English)
- Çoker T, Mater S (2006) Ichthyoplankton species in Izmir Bay (1974–2005). *Ege University Journal of Fisheries and Aquatic Sciences* 23(3–4): 463–472 (in Turkish with an abstract in English)
- Cury P, Bakun A, Crawford RJM, Jarre A, Quinones RA, Shannon LJ, Verheye HM (2000) Small pelagics in upwelling systems: patterns of interaction and structural changes in “wasp-waist” ecosystems. *ICES J Mar Sci* 57:603–618. <https://doi.org/10.1006/jmsc.2000.0712>
- Daban İB, Yüksek A (2017) Ichthyoplankton community of the Dardanelles Strait, Turkey. *Oceanol Hydrobiol Stud* 46(3):253–259. <https://doi.org/10.1515/ohs-2017-0027>
- Dekhnik TV (1973) Ichthyoplankton of the Blacksea. Navkova Dumka, Kiev (in Russian)
- Demir N (1969) The pelagic eggs and larvae of Teleostean fishes in Turkish waters, I. Clupeidae, İstanbul Üniversitesi Fen Fakültesi Mecmuası 34(1–2):43–74