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Early-Life Population Parameters and Hatch-Date Analysis of Sharpsnout Seabream (*Diplodus puntazzo* Walbaum, 1792) Juveniles in the Sea of Marmara, Türkiye

Marmara Denizi'nde Sivriburun Karagöz (*Diplodus puntazzo* Walbaum, 1792) Juvenillerinin Erken Yaşam Populasyon Parametreleri ve Yumurtadan Çıkış Analizi

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 10 Sayı: 1 (2024) 27-38

İsmail Burak DABAN[1,*], Yusuf ŞEN[1], Alkan ÖZTEKİN[1], Adnan AYAZ[1], Uğur ALTINAĞAÇ[1], Ali İŞMEN[1], Ahsen YÜKSEK[2], Uğur ÖZEKİNCİ[1], Fikret ÇAKIR[1], Tekin DEMİRKIRAN[1], Gençtan Erman UĞUR[1], Oğuzhan AYAZ[1], Buminhan Burkay SELÇUK[1]

[1]Çanakkale Onsekiz Mart University Marine Science and Technology Faculty Fisheries and Fish Processing Department
[2] İstanbul University, Institute of Science, Marine Biology

ABSTRACT

This research aims to determine early-life population parameters and hatch date of sharpsnout seabream (*Diplodus puntazzo* Walbaum, 1792) juveniles using microstructure analyses of sagittal otoliths collected from the Sea of Marmara, Türkiye. Specimens were collected using an experimental beach seine at 12 stations from November 2021 to March 2022. The mean catch per unit effort (CPUE) was 1.1 individuals per haul, with 44.4% of the total *D. puntazzo* specimens collected at the Erdek Station. A negative allometric growth was calculated from the length-weight relationship equation ($W=0.0178L^{2.698}$). The daily age ranged between 39 days^{-1} and 141 days^{-1}, with a mean of 78.9 ± 2.29 days^{-1}. The daily growth rate and mortality ratio were calculated as 0.213 mm/day and 4.38%, respectively. The hatching mainly occurred in September and October.

Keywords: Microstructure, Sagittal otoliths, Spawning season, Population, Early-life

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* (corresponding author)
E-mail: burakdaban@comu.edu.tr

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ÖZET

Bu çalışmada Marmara Denizi'nde dağılım gösteren sivriburun karagöz (*Diplodus puntazzo* Walbaum, 1792*)* türüne ait juvenillerin otolit mikro-yapısı kullanılarak yumurtadan çıkış analizi ve erken yaşam popülasyon parametrelerinin belirlenmesi amaçlanmıştır. Bireyler Kasım 2021 ile Mart 2022 tarihleri arasında deneysel ığrıp ağı ile 12 istasyondan örneklenmiştir. Çekim başına ortalama bolluk 1.1 adet/çekim olup, toplam bireylerin %44.4'ü Erdek istasyonundan elde edilmiştir. Boy-ağırlık ilişkisi denkleminden ($W=0.0178L^{2.698}$) negatif allometrik büyüme tespit edilmiştir. Bireylerin günlük yaşları 78.9 ± 2.29 gün ortalama ile, 39 gün ile 141 gün arasında değişmiştir. Bireylerin ortalama günlük büyüme oranları ve ölüm oranları sırasıyla 0.213 mm/gün ve %4.38 olarak hesaplanmıştır. Yumurtadan çıkış yoğun olarak Eylül ve Ekim aylarında gerçekleşmiştir.

Anahtar sözcükler: Mikroyapı, Sagittal otolitler, Üreme sezonu, Popülasyon, Erken yaşam

1. INTRODUCTION

Sharpsnout seabream (*Diplodus puntazzo* Walbaum, 1792) is a subtropical fish species belonging to the family Sparidae, which is mostly distributed in coastal areas (Bauchot and Hureau, 1990) of Eastern Atlantic, Mediterranean, (Bauchot and Hureau, 1986) and Black Sea (Aydın, 2019). Also, Bauchot and Hureau (1986) stated that younger individuals are distributed around estuarine areas. It has great economic importance, mainly small-scale fisheries such as gillnet fishery, longline and handline fishery. As with many members of the Sparidae family, hermaphroditism is common, and fertilization and egg development take place in the pelagic environment. Spawning generally occurs in autumn season and after pelagic larval duration (32.7 days), postlarvae settle from the pelagic environment to the demersal habitat (Macpherson and Raventós, 2006).

Although sharpsnout seabream is a well-known fish species around the Mediterranean Sea and worldwide, published scientific knowledge is very scarce in both adults and early life stages. For wild stocks of adults, Palma and Andrade, (2002) studied stock discrimination of adults using morphological differences, Mouine *et al.,* (2012) investigated reproduction biology, Pajuelo *et al.,* (2008) presented gonad development and spawning cycle, Kouttouki *et al.,* (2006) revealed shape variation of wild and reared stocks, Bostancı *et al.,* (2016) investigated otolith morphology, Kraljevic *et al.,* (2007) and Domínguez-Seoane *et al.,* (2006) estimated age and growth. In contrast, the scientific papers related to juveniles remain limited to feeding, enzyme and rearing protocols of reared fish. According to our knowledge, no study has yet been found on the biology of wild stocks, such as daily growth, mortality, hatch-date distribution etc.

Considering the lack of knowledge on population parameters of juvenile sharpsnout seabream, the main aim of this study was to estimate the length-frequency distribution, length-weight relationship, daily growth and daily mortality rates, and hatch date frequency of the *D. puntazzo* stock distributed in the Sea of Marmara, Türkiye.

2. MATERIALS AND METHODS

Experimental beach seine samplings were realised at 12 sampling stations between November 2021 and March 2022. The beach seine used in the scientific samplings had a 30 m wing length, 1.8 m wing height and, 2x2x2 m bag dimensions. The 4 mm nominal bar length was used in the bag net, and the 6.5 mm nominal bar length was used in the wings.

To prohibit bias-related miscalculation, samplings were realised as 2 replications from all 12 stations (Figure 1). While preserving cold-chain, specimens were transferred from the field to the laboratory, immediately. Total length (*TL*) of the individuals was measured with the Digital Caliper (Mitutoyo CD-15 APX) and measured values were converted to 0.01 cm TL units. All individuals were weighed to the nearest 0.001 g total weight (*W*) with a precision scale. The mean abundance of each location was given with Catch per Unit Effort (CPUE) with the unit of fish number per haul. The CPUE was calculated with a given formula:

$$\text{CPUE (n/haul)} = N_i / H_i \quad (1)$$

where N*i* is the total individual number of *D. puntazzo* obtained from *i* station in the study period, and H*i* is the total haul number from the *i* station. The total haul number was detected as multiplication of replication number (two) with the total monthly survey number (four).

To determine daily age, growth, mortality and hatch date frequency, sagittal otoliths of *D. puntazzo* juveniles were grounded and polished with abrasive papers (12 µ, 9 µ, 6 µ, and 3 µ). Otoliths were removed with forceps and pin vises. The right sagittal otoliths were affixed on a glass slide with thermoplastic glue for all examined individuals. After grounding and polishing, daily increment rings were counted from the first visible checkmark succeeding the primordium to the outer edge along the maximum diameter axis, as stated by Brothers, (1984).

Simple linear regressions by least squares between the daily age (A), larval lengths (SL) and juvenile lengths (TL) were used to estimate the daily growth rate (GR). The daily mortality rates were estimated using the slope coefficient in the regression relationship of the ln values of the abundance per length groups. Hatching time was determined by subtracting the daily age of the individual from the sampling date, and the hatch peak and hatch interval were determined for applying the calculation for all sampling months.

3. RESULTS

3.1. Abundance and Spatial Variation

A total of 102 individuals of *D. puntazzo* was obtained from two replicated experimental beach seine sampling from 12 station between December and March. Between all catches from total beach seine sampling, 1.5% of the abundance arose from *D. puntazzo*. The mean CPUE of *D. puntazzo* was calculated as 1.1 n/haul in the Marmara Sea. Between all areas, none of individuals was obtained from S3 (Kumbağ) and S8 (Bursa Ayazma Beach). A 44.4% of the total *D. puntazzo* catch was revealed from S4 (Erdek). Comparatively, S12 (Yalova TİGEM) and S1 (Şarköy) were the other abundant areas, with 10.2% and 8.3% of the total catch, respectively (Figure 1). A 50% of the total *D. puntazzo* catch was sampled in January. December was the second abundant month by 29.2% of frequency. In February and March, the abundance frequency was calculated as 10.4%.

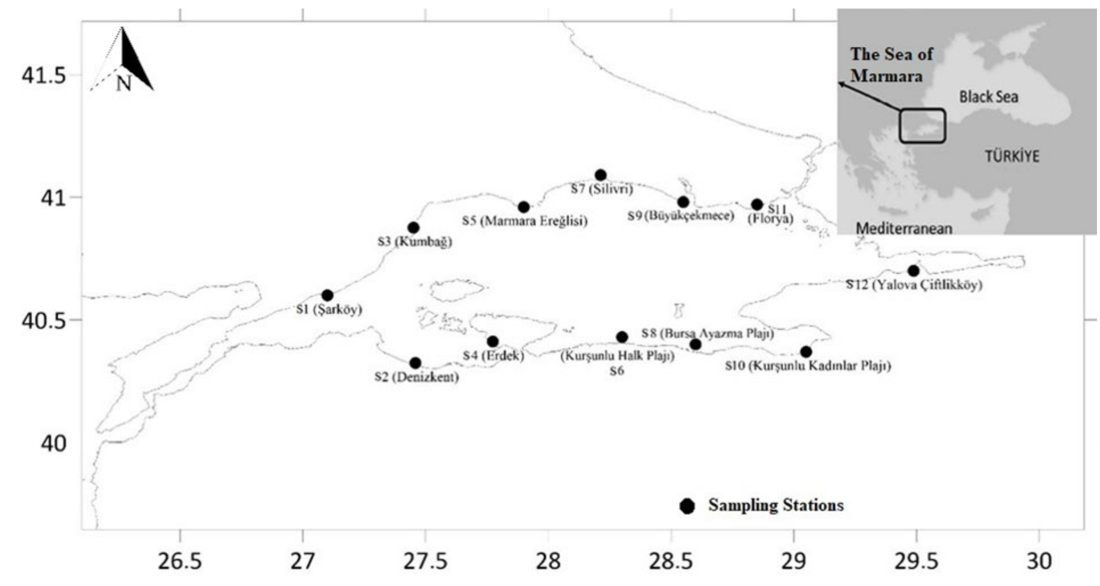

Figure 1. The study area and the beach seine sampling stations located in the Sea of Marmara, Türkiye

3.2. Population Parameters

The mean values of total length (TL), fork length (FL), and total weight (TW) were 36.22 ± 0.45 mm, 33.13 ± 0.42 mm and 0.603 ± 0.024 g, respectively (Table 1). According to length-frequency distribution, a 46.1% of the total *D. puntazzo* individuals consisted of 34 – 38 mm length group. In addition, a 73.6% of the individuals originated in 29 – 38 mm length intervals. A strong linear relationship (r^2: 0.94) was detected between the TL and FL, with a given equation: FL= 0.8962 X TL + 0.6095. An exponential distribution between length – weight relationship (Figure 2) showed that the b value (2.698) statistically differed from 3, and the growth type was estimated as negative allometry.

Table 1. The population parameters of *D. puntazzo* juveniles in the Sea of Marmara, Türkiye (N: Number of fish)

		Total Length (TL, mm)			Fork Length (FL, mm)			Total Weight (g)		
Months	N	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
December 22	30	27.25	50.87	35.50 ± 0.90	23.6	47.08	32.24 ± 0.91	0.295	1.575	0.585 ± 0.048
January 23	52	29.05	46.89	36.92 ± 0.57	26.33	41.89	33.74 ± 0.49	0.2442	1.249	0.609 ± 0.032
February 23	10	31.64	45.72	37.76 ± 1.43	29.07	41.35	34.86 ± 1.36	0.3866	1.264	0.737 ± 0.101
March 23	10	24.52	39.34	33.25 ± 1.31	22.52	36.32	30.80 ± 1.25	0.3156	0.752	0.500 ± 0.043
Total	102	24.52	50.87	36.22 ± 0.45	22.52	47.08	33.13 ± 0.42	0.2442	1.575	0.603 ± 0.024

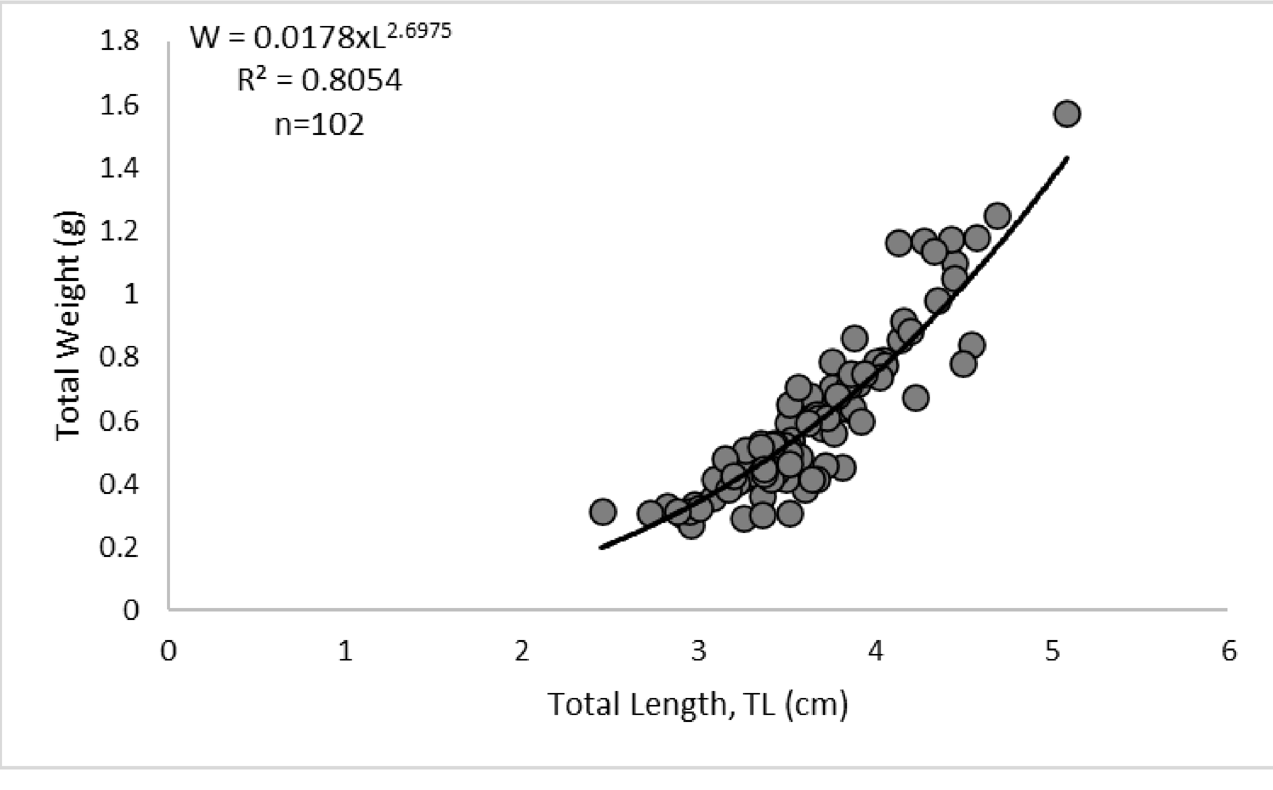

Figure 2. The length – weight relationship of *D. puntazzo* juveniles in the Sea of Marmara, Türkiye

The sagittal otolith lengths (OL) of *D. puntazzo* individuals ranged between 1.377 mm and 2.319 mm, with a mean length of 1.7834 ± 0.019 mm. Otolith width (OWi) of individuals were ranged from 0.819 to 1.842, with a mean value of 1.1487 ± 0.014 mm. A weak linear relationship was found between OL and OWi with a given equation, OWi = 0.5462 X OL + 0.1665

(r^2=0.74). Otolith weights (OW) were distributed between 0.0001 g and 0.0020 g, with a mean of OW= 0.0007 ± 0.000038 g. The relationship between OL and OW was linear (r^2= 0.97), with a given equation: OW= 0.0202 x OL - 0.0028. A weak linear relationship was detected between TL and OL (r^2= 0.65) (Figure 3). Similarly, a very weak relationship was found between individual total weight (TW) and otolith weight (OW) (r^2=0.34).

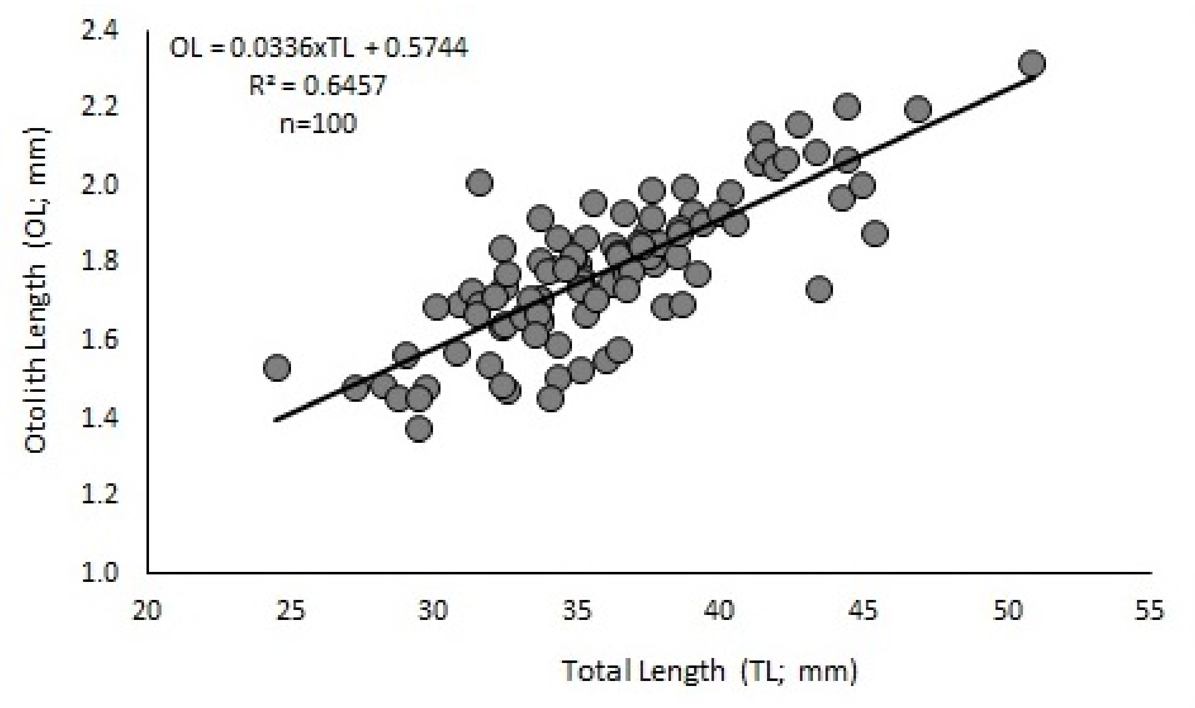

Figure 3. The fish total length (TL) – sagittal otolith length (OL) relationship of *D. puntazzo* juveniles in the Sea of Marmara, Türkiye

3.3. Daily Age, Growth, Mortality and Hatch Date

According to examination of the daily rings of 86 individuals, age ranged between 39 $days^{-1}$ and 141 $days^{-1}$, with a mean of 78.9 ± 2.29 $days^{-1}$. The oldest individual was caught on 22.12.2021, whereas the youngest was collected on 15.03.2022. The mean age at the abundant stations, S4 (35 ind.) and S12 (25 ind.) were determined as 83.3 $days^{-1}$ and 73 $days^{-1}$, respectively (Table 2).

The mean daily growth rate was estimated at 0.213 mm/day (Figure 4). The mean daily growth rate at the abundant stations, S4 (35 ind.) and S12 (25 ind.) were estimated to be relatively the same as 0.211 mm/day. The instantaneous mortality coefficient and daily mortality rate were determined as 4.447 and 4.38%, respectively (Figure 5).

Table 2. Age-length key of *D. puntazzo* juveniles in the Sea of Marmara, Türkiye

	Daily Age							
Length (mm)	20-39	40-59	60-79	80-99	100-119	120-139	140-159	Total
20-24	1							1
25-29		6	1					7
30-34		3	19	2				24
35-39		1	19	10	5			35
40-44			1	4	8	2		15
45-49					1	2		3
50-54							1	1
Total	1	10	40	16	14	4	1	86

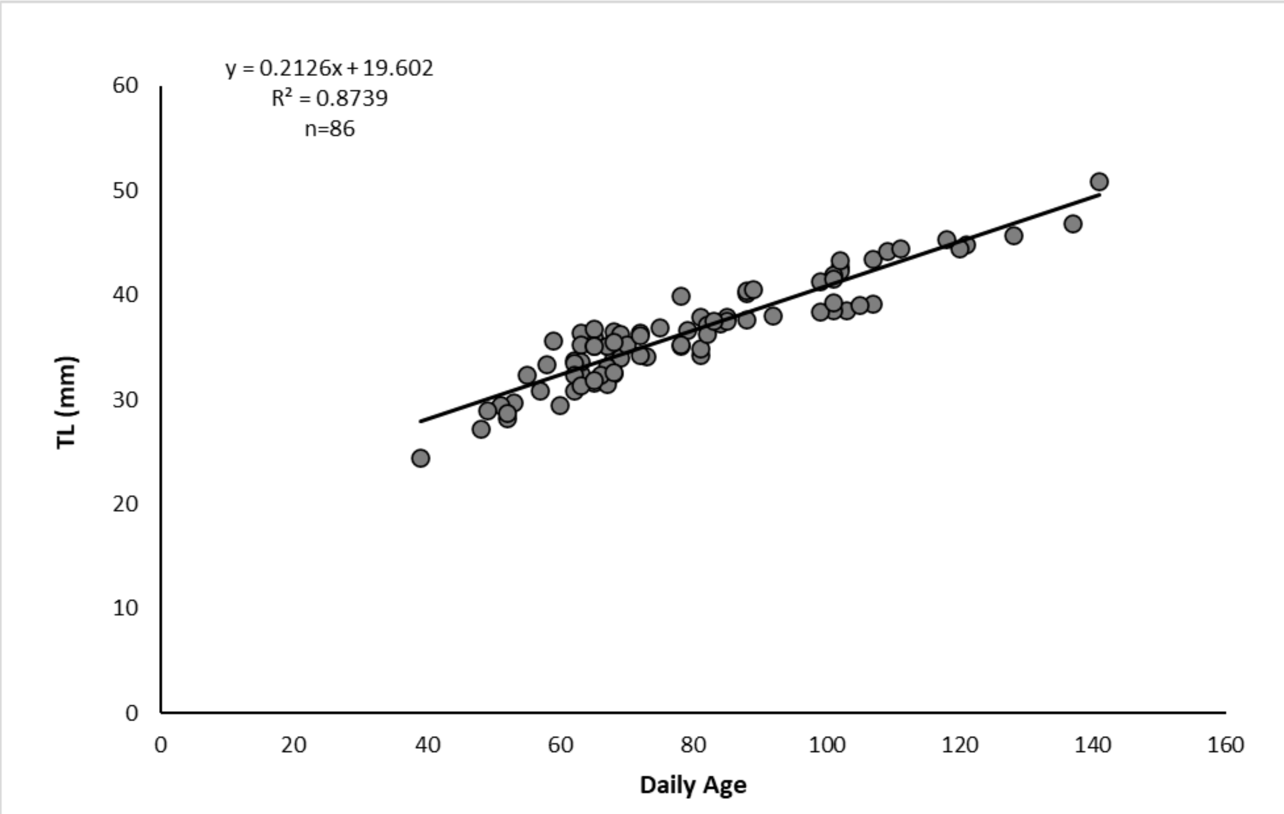

Figure 4. Daily age – total length (TL) relationship of *D. puntazzo* juveniles in the Sea of Marmara, Türkiye

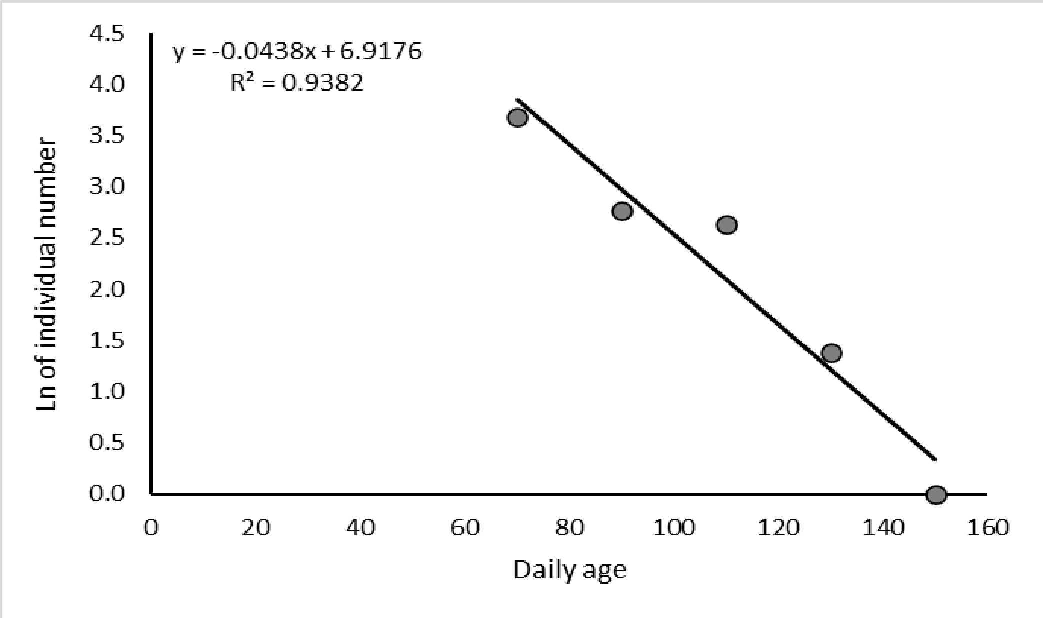

Figure 5. Mortality curve of *D. puntazzo* juveniles in the Sea of Marmara, Türkiye

The hatch date frequency distribution is shown in Figure 6. The hatching times of *D. puntazzo* took place between August 2022 and February 2023, and hatching peaked in October 2022, with 41% of the total individuals. In contrast, 83% of the individuals were hatched between September 2022 and November 2022.

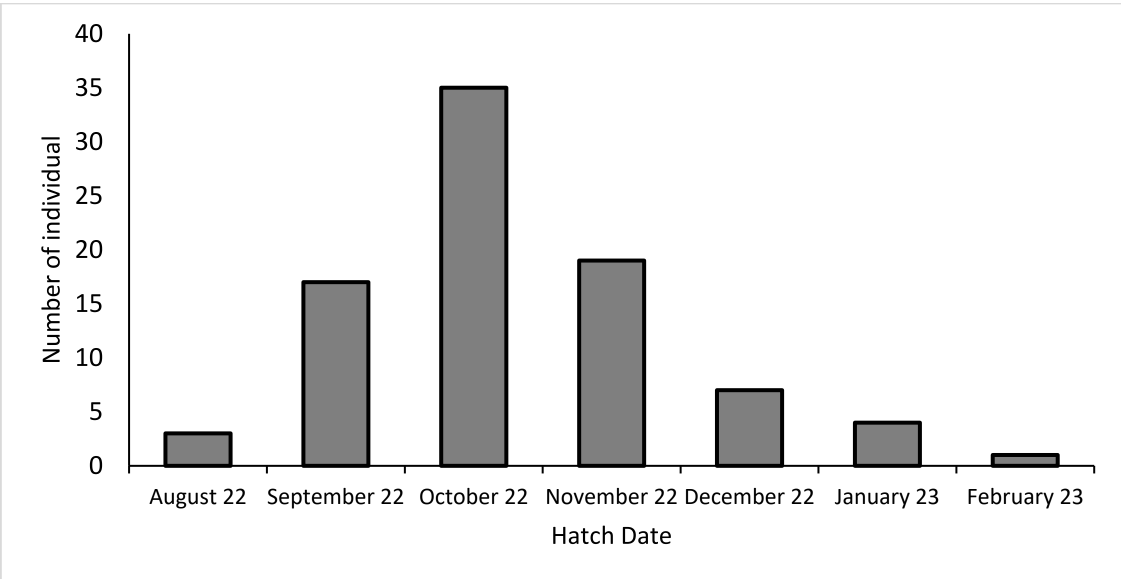

Figure 6. Hatch date frequency of *D. puntazzo* juveniles in the Sea of Marmara, Türkiye

4. DISCUSSIONS

According to ichthyoplankton and adult fish biodiversity results of previous studies (Demirel *et al.,* 2007; Daban *et al.*, 2023; Kara, 2015), Erdek Bay was defined as an area that had the highest biodiversity in the Sea of Marmara. Although *D. puntazzo* juveniles were observed at 10 of the 12 sites, most individuals were found in Erdek Bay (44.4%). The southwestern part of the

Sea of Marmara is under the effect of the more saline Aegean Sea deep water flow, one of the possible factors increasing the biodiversity of Erdek Bay. Also, the geo-morphological structure, which mostly arose from small islands and rocky shelves, may be another factor that increased biodiversity. Besides, Meinesz *et al*., (2009) and Karadurmuş and Sarı, (2022) emphasized that the dense seagrass beds in the coastal areas, may originate growth areas for the newly-settlers. In addition, the nutrient flow by the Gönen Stream may be the other possible factor related to high biodiversity. These factors should explain the high abundance of *D. puntazzo* around Erdek Bay.

As it is known, all other Sparidae family species except *Spondliosoma cantharus* (Linnaeus, 1758) have a pelagic early phase, in which eggs, pre-larvae and post-larvae are distributed in the plankton. Thus, the early development of *D. puntazzo* takes place in the pelagic environment until settlement from the pelagic to the demersal environment. Macpherson and Raventós, (2006) examined the pelagic larval duration (PLD) of *D. puntazzo* around Spain coasts and Gibraltar. They estimated that the PLD of *D. puntazzo* ranged between 19 and 48 days, with a mean of 32.7±4.8 days from the settlement mark on the otoliths of new settlers. The daily age of the youngest individual found in this study (39 days^{-1}) was consistent with the PLD result of the previous study. Besides, the settlement mark observed at this individual was 30 days in this study, supporting the findings of Macpherson and Raventós, (2006).

When compared with the other Sparidae species distributed in the Mediterranean, scientific data on adult fish biology related *D. puntazzo* remain limited to only a few studies (Domínguez-Seoane *et al.,* 2006; Kraljevic *et al.,* 2007). Kraljevic *et al.,* (2007) detected isometric growth type (b: 3.001) and low growth (K: 0.191) rate and long-life span (18 years). Also, similar findings were found by Domínguez-Seoane *et al.,* (2006) in the Canary Islands. Similar slow growth and negative allometry also was detected by Aydın and Özdemir, (2021) in low-saline Black Sea waters. However, the growth trajectories of younger individuals are defined inconsistently with the adults (Froese, 2006; Gordoa and Moli, 1997; Petrakis and Stergiou, 1995). Although knowledge of population parameters is common for lots of adult Mediterranean fish, reported data on the juvenile phase is limited. However, when compared to other species, there are more studies in the literature on juvenile stocks of the Sparidae family and *Diplodus* genus (Ayyıldız *et al.,* 2014; Ayyıldız *et al.,* 2015; Ayyıldız and Altın, 2021; Daban and İşmen, 2022; Di Franco *et al.,* 2011; Matic-Skoko *et al.,* 2004; Matic-Skoko *et al.,* 2007; Planes *et al.,* 1999). This relevance result from this family's economic importance and easy cultural adaptation of this family members. According to our knowledge, the daily growth rate of juvenile *D. puntazzo* was only estimated by Planes *et al.,* (1999) as a 0.160 mm day^{-1} in the Northwestern Mediterranean, which was lower than our finding as 0.213 mm/day. Planes *et al.,* (1999) stated that the low daily growth rate of *D. puntazzo* stemmed from the low sea surface temperature and limited zooplankton abundance in the winter period, when the settlement occurred. Thus, a slight variation in daily growth rate result from higher zooplankton availability in the Sea of Marmara against in the Western Mediterranean. The daily growth rate of *D. vulgaris* was detected as 0.202 mm day^{-1} in the Western Mediterranean (Planes *et al.,* 1999), 0.276 mm day^{-1} in the North Aegean Sea (Ayyıldız *et al*., 2014), and daily growth rate of *Sarpa salpa* was estimated as 0.203 mm day^{-1} in the Adriatic Sea (Matic-Skoko *et al*., 2004). Due to *D. vulgaris* and *S. salpa* also settling in the winter period, similar low daily growth rates supported the hypothesis of Planes *et al.,* (1999). This situation is explained by the low metabolism rate from lower sea water temperatures in winter. Conversely, a higher daily growth rates were found for summer settlers such as *D. sargus* at 0.567 mm day^{-1} (Planes *et al.,* 1999) and 0.460 mm day^{-1} (Ayyıldız and Altın, 2020), and *D. annularis* as 0.369 mm day^{-1} (Ayyıldız *et al*., 2014), and *Lithognathus mormyrus* as 0.325 mm day^{-1} (Ayyıldız *et al*., 2014). According to adult morphometric characteristics, the daily growth rate should reach relatively higher ratios for other family members such as 2.37 mm/day for *Thunnus thynnus* (La Mesa *et al*., 2005) and 23 mm/day for *Xiphias gladius* (Megalofonou *et al.,* 1995).

Mortality rates reveal crucial information related to coming up with next-generation stock capacity. In previous studies, mortality rates were found as 1.8-2.0% for *Alosa sapidissima* (Crecco *et al*., 1983), 22-39% for *Anchoa mitchilli* (Leak and Houde, 1987), 3.6-6.3% *Leiostomus xanthurus* 0.8-3.7% and for *Micropogonias undulatus* (Ross, 2003), 2.9% for *D. annularis* (Ayyıldız and Altın, 2020), 4.6% for *L. mormyrus* (Ayyıldız and Altın, 2021), 1.9% for *D. vulgaris* (Ayyıldız *et al.,* 2015). In this study, the calculated daily mortality (4.3%) rate of *D. puntazzo* showed a similar pattern against other juvenile species. Conversely, no clear relationship pattern between settlement season and mortality rate was shown from the comparison of previous studies. However, Macpherson *et al.,* (1997) found that the Daily mortality of *D. sargus* was higher than *D. puntazzo* and *D. vulgaris* and stated that the mortality possibility may be higher in the warmer settlement period. Leak and Houde, (1987) stated that predation and starvation were the biggest reasons for daily mortality in early life stages. Also, the food competition immediately after the settlement should play an important mortality for demersal juveniles.

The hatch date frequency distribution showed that relatively half of the individuals were hatched in October. Macpherson *et al.,* (1997) and Vigliola *et al.,* (1998) also found that most individuals of *D. puntazzo* hatched in October and November in the Northwestern Mediterranean Sea. Also, the results of adult reproduction biology studies of *D. puntazzo* showed that the spawning period occurred between September and December in the Gulf of Tunis (Mouine *et al.,* 2012), and was detected from September to February in the Canary Islands (Pajuelo *et al*., 2008), and found as September in the Eastern Black Sea (Aydın and Özdemir, 2021), where relatively lower temperate and saline waters against Western Mediterranean. Thus, the adult reproductive characteristics also supported the first hatch date timing of *D. puntazzo*.

5. CONCLUSIONS

Under high fishing pressure and without proper inspection, as in Mediterranean coastal fisheries, the late maturation pattern of the *D. puntazzo* may cause problems in ensuring the sustainability of the species. Thus, the knowledge of fish biology from egg to adult should be clearly examined, and detailed stock situations should be revealed to sustain proper management policy, especially in Turkish waters and Mediterranean coastal areas.

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AUTHORSHIP CONTRIBUTION STATEMENT

İsmail Burak DABAN: Writing-Original draft, data analyses, sampling. **Yusuf ŞEN:** Sampling, laboratuary works, visualization, investigation. **Alkan ÖZTEKİN:** Sampling, laboratuary works. **Adnan AYAZ:** Sampling, laboratuary works. **Uğur ALTINAĞAÇ:** Sampling, laboratuary works. **Ali İŞMEN:** Supervision, data-analyses. **Ahsen YÜKSEK:** Supervision, data-analyses. **Uğur ÖZEKİNCİ:** Laboratuary works, visualization, investigation, **Fikret ÇAKIR:** Laboratuary works, visualization, investigation. **Tekin DEMİRKIRAN:** Sampling, laboratuary works. **Gençtan Erman UĞUR:** Sampling, laboratuary works. **Oğuzhan AYAZ:** Sampling, laboratuary works. **Buminhan Burkay SELÇUK:** Sampling, laboratuary works.

CONFLICT OF INTERESTS

The author(s) declare that for this article they have no actual, potential or perceived conflict of interests.

ETHICS COMMITTEE PERMISSION

No ethics committee permission is required for this study.

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ORCID IDs:
İsmail Burak DABAN:
https://orcid.org/0000-0002-2973-5698
Yusuf ŞEN:
https://orcid.org/0000-0002-0595-4618
Alkan ÖZTEKİN:
https://orcid.org/0000-0003-3914-9788
Adnan AYAZ:
https://orcid.org/0000-0003-4839-9244
Uğur ALTINAĞAÇ:
https://orcid.org/0000-0002-3638-9834
Ali İŞMEN:
https://orcid.org/0000-0003-2456-0232
Ahsen YÜKSEK:
https://orcid.org/0000-0001-7949-3001
Uğur ÖZEKİNCİ:
https://orcid.org/0000-0003-2207-0168
Fikret ÇAKIR:
https://orcid.org/0000-0001-5261-2365
Tekin DEMİRKIRAN:
https://orcid.org/0000-0003-1613-5236
Gençtan Erman UĞUR:
https://orcid.org/0000-0002-3131-9239
Oğuzhan AYAZ:
https://orcid.org/0000-0001-8458-4872
Buminhan Burkay SELÇUK:
https://orcid.org/0000-0003-4650-5592

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