www.trjfas.org
ISSN 1303-2712
Turkish Journal of Fisheries and Aquatic Sciences 15: 625-632 (2015) DOI: 10.4194/1303-2712-v15_3_06

First Record of *Ophelia bicornis* Savigny in Lamarck, 1818 (Polychaeta: Opheliidae) from the Turkish Coast of the Black Sea (Sinop Peninsula) with Ecological Features

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Received 2 February 2015
Accepted 14 August 2015

Abstract

The present paper deals with ecological and morphometric features of *Ophelia bicornis* Savigny *in* Lamarck, 1818 collected monthly from the Sinop Peninsula (Black Sea, Turkey) between August 2009 and July 2010 from 4 stations. This study aimed to report the polychaete for the first time from the Turkish coast of the Black Sea and to determine the population density of *O. bicornis* on the coasts of the Sinop Peninsula. A total of 699 individuals of *O. bicornis* were collected. The maximum and minimum densities were counted at station A in autumn (October, November, respectively). The female individuals of *O. bicornis* were recorded between May and October. The regression formula for the length (mm)–weight (g) relationship was found to be $W=0.0002\times TL^{2.11}$, indicating that the growth for *O. bicornis* is allometric. The statistically significant correlation between percentages of coarse sand and number of individuals and biomass of *O. bicornis* were estimated.

Keywords: *Ophelia bicornis*, Opheliidae, Polychaeta, first record, ecological and morphometric features, Sinop Peninsula.

Ophelia bicornis Savigny in Lamarck, 1818 (Polychaeta: Opheliidae)'in Karadeniz (Sinop Yarımadası)'in Türkiye Kıyılarından İlk Kaydı ve Ekolojik Özellikleri

Özet

Bu makale Sinop Yarımadası'nda (Karadeniz, Türkiye) Ağustos 2009 ve Temmuz 2010 tarihleri arasında 4 istasyondan aylık olarak toplanan *Ophelia bicornis* Savigny *in* Lamarck, 1818'in ekolojik ve morfometrik özellikleri hakkındadır. Bu çalışmanın amacı *O. bicornis*'i Karadeniz'in Türkiye kıyılarından ilk kez rapor etmek ve Sinop Yarımadası kıyılarındaki populasyon yoğunluğunu tespit etmektir. Çalışma bölgesinde toplam 699 adet *O. bicornis* bireyi toplanmıştır. En yüksek ve en düşük yoğunluk A istasyonunda sonbaharda (sırasıyla Ekim, Kasım) saptanmıştır. *O. bicornis*'in dişi bireyleri Mayıs ve Ekim ayları arasında kaydedilmiştir. Boy (mm)-Ağırlık (g) ilişkisi için hesaplanan regresyon formülü $W=0{,}0002\times TL2{,}11$ olarak hesaplanmıştır ve bu sonuç *O. bicornis*'in allometrik olarak büyüdüğünü göstermektedir. *O. bicornis* biyokütlesi ve birey sayısı ile kaba kum tane boyu yüzdesi arasında istatistiksel olarak anlamlı ilişki olduğu tespit edilmiştir.

Anahtar Kelimeler: *Ophelia bicornis*, Opheliidae, Polychaeta, ilk kayıt, ekolojik ve morfometrik özellikler, Sinop Yarımadası.

Introduction

Ophelia bicornis belongs to the family Opheliidae, is represented by 10 genera and approximately 150 species around the world (Rouse and Pleijel, 2001), 5 genera and 18 species in the Mediterranean Sea and 5 genera and 10 species around the coast of Turkey (Çınar *et al.*, 2014). This species was previously reported from two different localities from Turkey as Sea of Marmara and Aegean Sea (Çınar *et al.*, 2014). Therefore, *O. bicornis* is firstly reported from the Turkish coast of the Black Sea in the present paper. The species is considered as characteristic species for sandy bottoms of mediolittoral zone (Ergen, 1976; Öztürk and Ergen, 1994). Besides, this species is commercially important because of its use as fish bait in aquaculture and for leisure fishing in Turkey (Dağli *et al.*, 2005).

Ophelia bicornis is a well studied polychaete around the world and it was reported from the Atlantic, Pacific and Indian Oceans, the Mediterranean and the Black Sea (Wilson, 1948; Maltagliati *et al.*, 2004; Dauvin *et al.*, 2006). Morphological and biological features and

distribution patterns (Harris, 1993, 1994); larval development (Wilson, 1948, 1953); feeding (Wilson, 1955); genetic features (Maltagliati *et al.*, 2004, 2005; Sanna *et al.*, 2005) were well documented by various studies. However population structure and length-weight relationship of *O. bicornis* are unknown. This species was reported by several taxonomical and ecological studies performed in the Black Sea (Jakubova, 1930; Marinov, 1964; Surugiu, 2005).

Ophelia bicornis is in the list of extinct species of Romanian coasts according to the report of International Union for Conservation of Nature Regional Status (BSERP, 2007) and no information is available concerning the status of its population along the Black Sea coasts of Turkey. Therefore it is important to know the population status of *O. bicornis.* The present study provides preliminary information about the general population features of *O. bicornis* collected from the Sinop Peninsula (western Black Sea) between August 2009 and July 2010. Moreover, this study represents the first research on the population features of the species in Turkey and Black Sea coasts and *O. bicornis* was recorded for the first time from the Turkish coast of the Black Sea.

Materials and Methods

Individuals of *Ophelia bicornis* were collected monthly between August 2009 and July 2010 in mediolittoral sand at 4 stations using a 25x25 cm quadrate along the coasts of the Sinop Peninsula (Figure 1). In the field, benthic material was fixed in 4% formalin. In the laboratory, the specimens of *O. bicornis* were sorted from the material and transferred into 70% ethanol. The body length (TL) of each individual was measured by using a digital compass and the biomass (wet weight) value (B) was determined using an analytical balance (with an accuracy of 0.01 mg). Each worm was partly dissected to find out whether it contained gametes or not. The diameter of eggs was measured with an ocular micrometer (with an accuracy of 0.01 mm).

Temperature, salinity, conductivity, pH and dissolved oxygen concentration were determined in the field by YSI 6600 V2 Multi-parameter Water Quality Probe. Sediment samples from each station were taken by a novel for granulometric analysis of the sediment. Sediment particle size was calculated seasonally according to the Wentworth Grain Size Classification (Erguvanlı, 1995).

The Pearson's correlation analysis was performed on the data set to assess the relationship between sediment particle size and population parameters. The length–weight relationship of specimens was determined using the Regression analysis according to the allometric equation $W= aL^b$ where W is the total body wet weight (g), L the body length (mm), and a and b are constants. All analyses were performed by using STATISTICA 7.0 package.

The material was deposited at the Faculty of Fisheries, Sinop University.

Results

Physico-chemical properties

The highest salinity value (18 ‰) was measured in station C in May, while the lowest value (15.60 ‰) was found in station B in November. The maximum temperature value (29.20°C) was measured in station D in July, the minimum value (7.70°C) was in station A in January. pH value ranged from 7.00 (in sta. A, May) to 8.85 (in sta. C, June); conductivity was between 26.70 µS/cm and 29.80 µS/cm (Figure 2). The highest dissolved oxygen concentration was measured as 11.56 mg/l in November in station C. The lowest value was 3.30 mg/l in the same station in March (Figure 2).

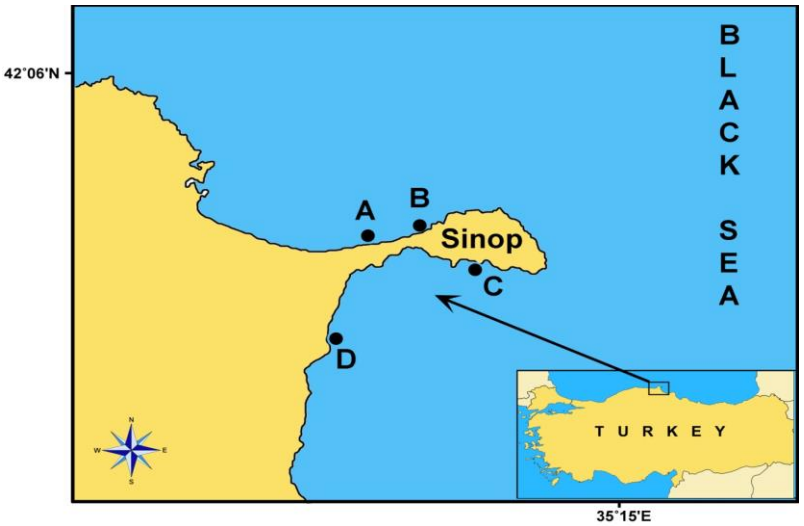

Figure 1. Map showing location of sampling stations in the studied area.

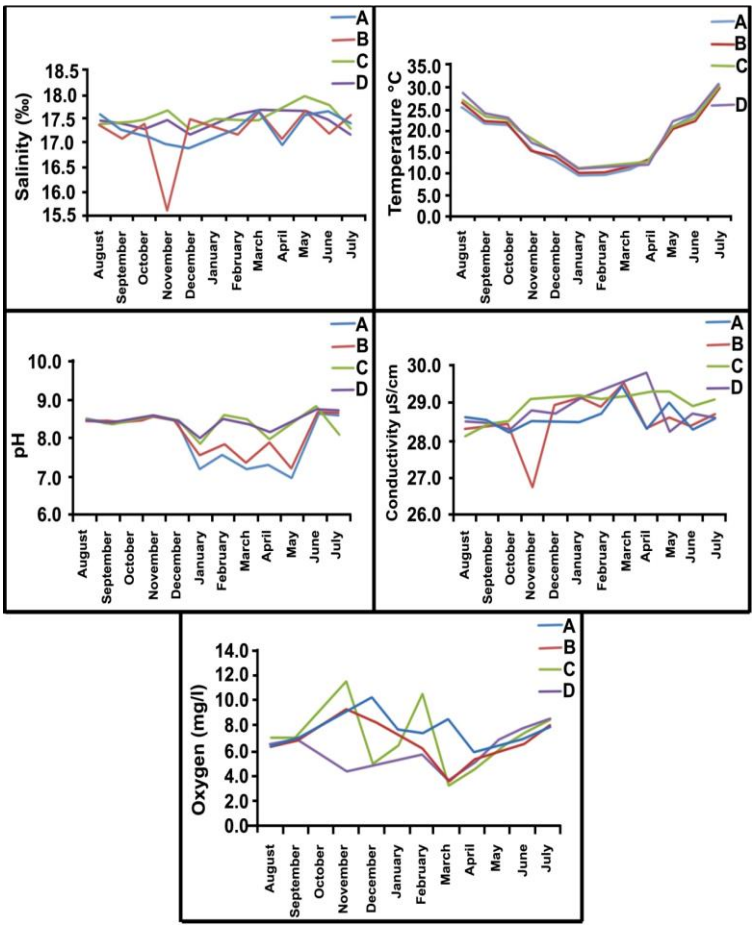

Figure 2. Salinity, temperature, pH, conductivity and dissolved oxygen values during the sampling period.

Sediment Particle Size

According to the analysis, medium sand dominated in stations A and B. Station C was characterized by coarse sand and station D was characterized by medium and coarse sand in summer and autumn and by very coarse sand in winter and spring. The cumulative frequency curve shows the frequency of grains in each size class among stations during seasons (Figure 3).

General Features of *Ophelia bicornis*

Body stout and cylindrical with 32 segments and approximately 38 mm in length. Prostomium small and conical (Figure 4A). Body enlarged anteriorly with a distinct ventral groove started on chaetiger 10. 15 pairs of cirriform branchiae and 15 pairs, present from chaetiger 11 to chaetiger 25. Six pairs of nephridiopores are present. Pigidium with nine small anal papillae (Figure 4B). Colour dark pink or greenish in females (Figures 4A-C) and pale in males.

Ova of *Ophelia bicornis* were scattered in the coelomic cavity (Figure 4A). Mature eggs are generally oval in shape and green or greenish brown in colour, find within the coelom (Figures 4A, C). Unfertilized eggs are small, opaque and disk shaped. Egg membrane is wrinkled and gelatinous. A total of 91 females were found between May and October. Maximum number of females (31) was found at station B in July, minimum number of individuals (1) was observed at stations C and D in October. The biggest egg diameter was measured as 0.20 mm; the smallest was 0.02 mm. The maximum height was 0.36 mm; the minimum height was 0.04 mm. The mean size of eggs was calculated as 0.08±0.006 mm in diameter and 0.12±0.005 mm in height (n=91).

A total of 699 individuals of *Ophelia bicornis* were collected during the study period. Maximum body length (53.90 mm) was calculated at station C in December and the minimum (3.94 mm) at station A in August. The maximum abundance (286 individuals) was observed in autumn, the minimum abundance (103 individuals) was found in winter (Figure 5). Among the seasons, the maximum number of females was determined in summer (62 individuals), the minimum in spring (10 individuals). There was no individual with gametes in winter (Figure 5). As it can be seen in Figure 5 *O. bicornis* seems to reproduce from May to October.

The minimum density of the species in the area was 2 ind.m^{-2} (November), while the maximum was 116 ind.m^{-2} (October) (Figure 6). There was no individuals at stations A and B in April, at station C in March, at station D in September, January, February, March and April (Figure 5). The biomass value of the

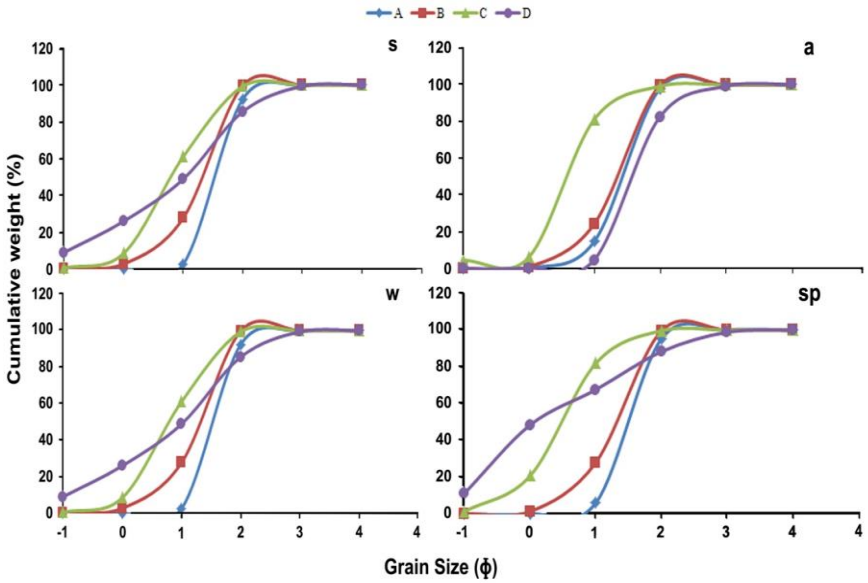

Figure 3. Cumulative frequency curves of sediment weight of the stations according to seasons (s: summer, a: autumn, w: winter, sp: spring).

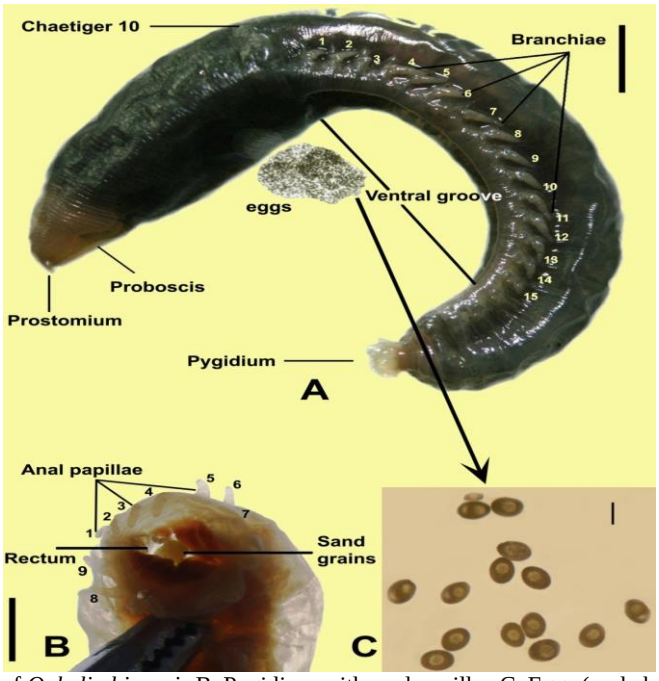

Figure 4. A. General view of *Ophelia bicornis* B. Pygidium with anal papillae C. Eggs (scale bar: A: 3 mm, B: 0.5 mm, C: 120 μm).

species in the area ranged from 0.40 $g.m^{-2}$ (November) to 21.45 $g.m^{-2}$ (October). Station A has the maximum number of individuals and wet-weight value, whereas station D has the minimum.

The length (mm)–weight (g) relationship is presented in the Figure 7. The regression formula for the relationship was found to be $W=0.0002\times TL^{2.11}$, indicating that the growth for *Ophelia bicornis* is allometric (Figure 7).

Pearson's correlation analysis between population parameters and sediment particle size indicated that the percentage of coarse sand was positively ($P<0.05$) correlated with the number of individuals ($r= 0.41$) and with biomass value ($r= 0.44$) (Table 1).

Discussion

The present study reported *Ophelia bicornis* for the first time from the Turkish coast of the Black Sea and examined ecological and morphometric features of the species collected from the Sinop Peninsula.

Several species of polychaetes, significant components of the food web in aquatic environments

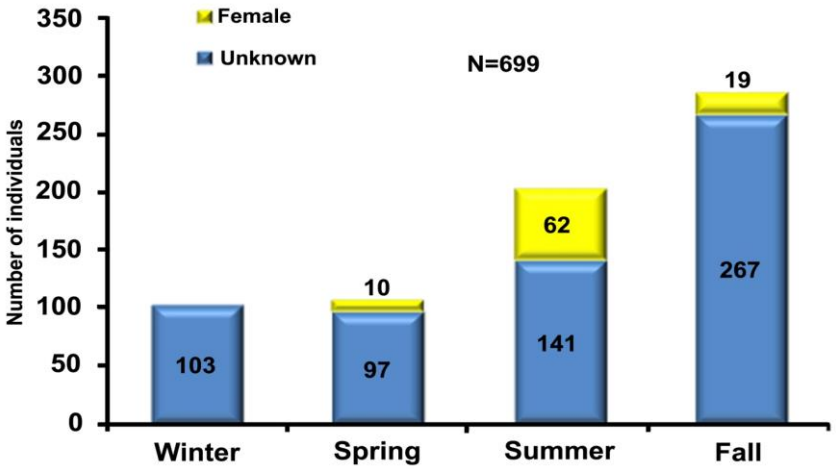

Figure 5. The population abundance of *Ophelia bicornis* according to seasons.

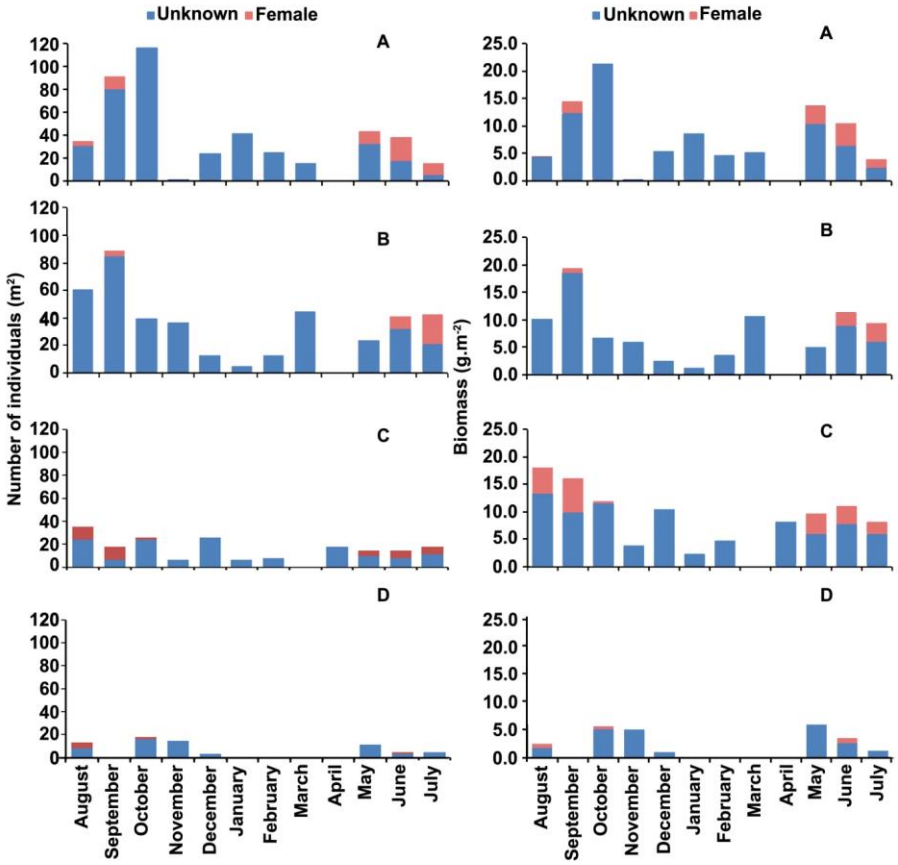

Figure 6. Density and biomass values of *Ophelia bicornis* at different stations during the sampling period.

have economic importance as live fish bait due to the fact that they have a high meat yield and constitute large populations. Among the commercially economic species, Gambi *et al.* (1994) reported that 32 were used worldwide and 8 [*Hediste diversicolor* (O.F. Müller, 1776); *Eunice aphroditois* (Pallas, 1788); *Diopatra neapolitana* Delle Chiaje, 1841; *Sabella spallanzani* (Viviani, 1805); *Marphysa sanguinea* (Montagu, 1815); *Perinereis cultrifera* (Grube, 1840); *Perinereis rullieri* Plato, 1974; *Scoletoma impatiens* (Claparède, 1868)] were used in the Mediterranean as fish baits. Among them, *O. bicornis*, *D. neapolitana*, *H. diversicolor* and *P. cultrifera* are used as fish baits in Turkey (Dağli *et al.*, 2005). This worm is of commercial value in the area and is being used as fish bait for a number of fishes such as Gilt-head sea-bream (*Sparus aurata* Linnaeus, 1758) and European sea bass [*Dicentrarchus labrax* (Linnaeus, 1758)] (Dağli *et al.*, 2005). There is no statistical data concerning the bait worm fishery in Turkey (Dağli *et*

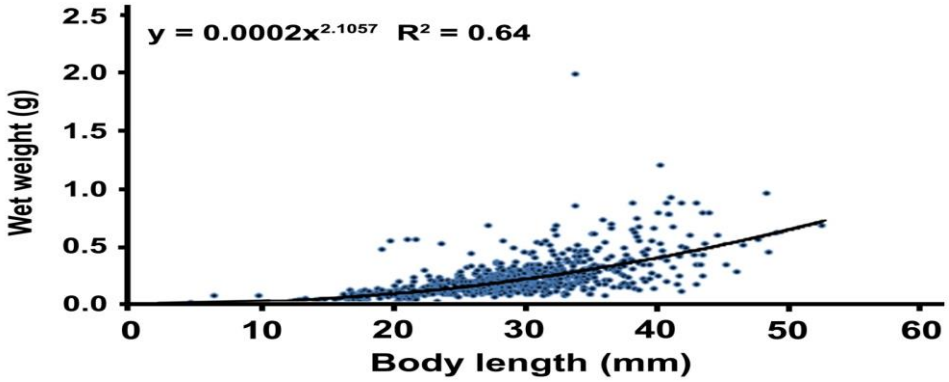

Figure 7. The length–weight relationship of *Ophelia bicornis* at the Sinop Peninsula.

Table 1. Pearson's correlation coefficients between population parameters and percentage of sediment particle size. Bold numbers are statistically significant (P<0.05)

	Num. of individuals	Biomass
Very fine pebble	-0.12	0.08
Very coarse sand	-0.16	0.11
Coarse sand	**0.41**	**0.44**
Middle sand	0.24	-0.03
Fine sand	0.20	0.23
Very fine sand	0.02	-0.12
Silt	-0.13	-0.17

al., 2005). Among the species, *D. neapolitana*, constituting dense populations in Izmir Bay (Aegean Sea) has a major potential to be utilized as fish bait.

Interest in amateur fishing and commercial hand line fishing have a progressive increase in the world and correspondingly in Turkey. Increasing demand accompanies the need for live bait. Live bait stocks are not exactly known in Turkey. Since available baits do not meet demands, overseas import of bait has begun in recent years. The species of the family Nereididae sold as "ocean worm" have started to import from China and find a market in Turkey. Service of such alien organisms as fish baits in Turkey is not a result of a deficiency in bait stocks in the country; instead it is due to the fact that the population stocks of *Ophelia bicornis* and other organisms are not well known in Turkey. *O. bicornis* may be an alternative fish bait in the future because of its common distribution in Turkey. Although Dağli *et al.* (2005) reported that *O. bicornis* has been used as fish bait, there is no economic market in Sinop. Despite the fact that the populations of the species on the coast of Romania are considered as regionally extinct, there is not any negative stress factor such as extreme collection or pollution on the population of the species along Sinop coasts.

No population studies are available on the genus *Ophelia* over the world. Besides, *Diopatra* is among those polychaetes whose population structure is well studied. For instance, Choe (1960) performed a study on the life history of *Diopatra sugokai* Izuka, 1907 and calculated the length–weight relationship of Japanese specimens of *D. sugokai* and estimated the allometric equation for the species as $W= 0.018\times L^{1.86}$. Dağli *et al.* (2005) examined the population structure of *D. neapolitana* in Izmir Bay and found the regression formula for the lenght-weight relationship as $W=0.012\times L^{1.88}$, indicating that the growth for *D. neapolitana* is allometric. We also found an allometric growth for *O. bicornis* in the present study.

The density of *Ophelia bicornis* in the study area had high scores in summer and autumn. This could be explained by reproduction period of the species is between May and October. This may also be associated with hydrodynamic factors as waves and turbulence. Lower hydrodynamic effects are efficient in summer and autumn; individuals of the species could be stated near bottom surface. On the contrary, in winter and spring with high hydrodynamic factors, the species may move deeper zones to tolerate negative effects of waves and turbulence. In the present study, the species was found in deeper zones (50 cm or deeper) and a few number of individuals during highest turbulence; conversely, the species was found in surface bottom (10-20 cm) and many individuals were encountered during lowest hydrodynamic conditions. Wilson (1948) mentioned that *O. bicornis* moves to deeper zones when hydrodynamic conditions occur in the mediolittoral zone. However Öztürk and Ergen (1994) noticed that *O. bicornis* has homogenous spatial distribution during high hydrodynamic conditions, although it moves deeper in the vertical direction in the shores with lower hydrodynamic conditions to find optimal moist environment. Because of all these reasons, water movement could be a very important factor for

distribution, so examining the hydrodynamic conditions as waves, turbulence are required in detail.

The high biomass values were measured between May and July. This could be explained by occurrence of large specimens in these months. A total of 91 female individuals were found in the sampling period. The maximum number of females (31) was counted in July and the mean oocyte diameter was 0.08±0.01 mm and the mean oocyte height was 0.12±0.02 mm. Wilson (1948) reported that *O. bicornis* has green or greenish brown ripe egg in colour with 0.13 mm in diameter and 0.15 mm in height.

Wilson (1955) and Harris (1991) have reported that *O. bicornis*is a detritivorous species. The gut content of *O. bicornis* was examined in the present paper and various sand particles and detritus were found in the coelomic cavity.

This species, known from the Sea of Marmara and the Aegean Sea coasts of Turkey (Çınar *et al.*, 2014), is an euryhaline species since it forms constant populations along the Black Sea coasts with a mean salinity of ‰18. *Ophelia bicornis* is also known to be a sensitive species distributed in clean waters. Ergen (1976) and Öztürk and Ergen (1994) reported the species as being a characteristic for undisturbed mediolittoral zone. Simboura and Zenetos (2002) considered that *O. bicornis* is a sensitive species in Group 1 (sensitive to disturbance) for BENTIX Ecological Quality Index. It could be used as a bio indicator organism to determine clean, unstressed areas and also in ecological monitoring studies because of all these factors. Also, it is suitable for ecotoxicological studies because of its dense populations and ease of sampling.

It is certain that the data obtained on the population density of this species both on the Black Sea and other coasts of Turkey will help future studies. The fact that the population features of this species will be more specifically determined in the coming years through detailed studies on the impact of biotic and abiotic factors on populations is inarguable.

Acknowledgements

We are much indebted to colleagues at Department of Hydrobiology, Sinop University for help in collecting material, to anonymous referees for their constructive comments on the manuscript and to Derya Ürkmez who assisted of English reviewing of the manuscript.

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