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RESEARCH ARTICLE/ARAŞTIRMA MAKALESİ

A Contribution to the Distribution of *Rhynchocalamus melanocephalus* (Jan, 1862) in Turkey

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Abstract

Objective: The black-headed ground snake, *Rhynchocalamus melanocephalus*, has a very narrow distribution area in the Hatay province of Turkey. A limited number of reported populations of this snake species is known. The present study aims to show that the distribution area of the species in Turkey can include different parts of the Hatay province or the surrounding provinces.

Materials and Methods: One adult individual (1 ♂) was caught from Gözlüce, Yayladağı-Hatay (GPS Data, N: 36° 00ˈ 54.1ˈˈ and E: 35° 58ˈ 51.6ˈˈ, 66 m a.s.l.). Sex was identified by the absence/presence of palpable hemipenis pockets. The morphometric features of the individual were measured to the nearest 0.01 mm using a digital caliper.

Results: According to the literature, the known records of the species in Turkey were only limited to four localities in the Hatay province. The present study provided a new locality (Gözlüce) of the species in the Yayladağı district of the Hatay province. The number of supralabial plates (SRL) is 6-6 and the number of sublabial plates (SL) is 7-7 in the male specimen of Gözlüce. The number of ventral plates (V) is 182 and the number of longitudinal dorsal scale rows at mid-trunk between ventrals (LDS) is 15. Snout-vent length (SVL) is 231.84 mm and tail length (TL) is 50.73 mm. Pholidolial characteristics and morphometric measurements of the Gözlüce specimen were found similar to the other Turkish specimens given in the literature.

Conclusion: The new locality record (Gözlüce-Yayladağı) of *Rhynchocalamus melanocephalus* revealed that the species can also be found in different parts of the Hatay province or in the surrounding provinces. In order to reveal the distribution area of this snake species in Turkey, it is necessary to conduct further field studies in the surrounding areas where the species can potentially spread.

Keywords: The black-headed ground snake, New locality record, Gözlüce, Hatay

Introduction

The black-headed ground snake, *Rhynchocalamus melanocephalus* (Jan, 1862), is distributed along the eastern Mediterranean including Cyprus, Egypt, Jordan, Lebanon, Syria, and Turkey (Avcı *et al.*, 2007; Olgun *et al.*, 2007; Avcı *et al.*, 2009; Amr *et al.*, 2012; Avcı *et al.*, 2015; Ŝmíd *et al.*, 2015; Tamar *et al.*, 2016; Tamar *et al.*, 2020; Baran *et al.*, 2021; Yaşar *et al.*, 2021). The taxon, known as a polytypic species, was changed to a monotypic species by Avcı *et al.* (2015). Smid *et al.* (2015) also supported this. The records on the distribution of the species in Turkey only consist of four localities in the Hatay province. The species was firstly reported 20 km South of Harbiye, Hatay by Franzen & Bischoff (1995), and following that Avcı *et al.* (2008) recorded three new localities (Sofular Village, Harbiye-Hatay; Kuruyer Village, Hatay; Güveççi Village, Yayladağı-Hatay) in Turkey.

The present study provides a new locality record (Fig. 1) of the species in Gözlüce (Yayladağı, Hatay. Morphological comparison was made of the Gözlüce specimen with the others reported from the Hatay province.

Material and Methods

During the field surveys in 2018, a male individual (KZL-456/2018, 1 ♂, 02 August 2018, Gözlüce, Yayladağı-Hatay, leg. U. BÜLBÜL) of *R. melanocephalus* (Fig. 2A) was observed in Gözlüce Yayladağı, Hatay province (Fig. 2B; GPS Data, N: 36° 00' 54.1'' and E: 35° 58' 51.6'', 66 m a.s.l.).

Sex was identified by the absence/presence of palpable hemipenis pockets. The specimen was caught by hand.

Mensural and meristic data were recorded by following the system of Avcı *et al.* (2008). All pholidolial characters were examined under the stereo microscope, and all specimens' morphometric features were measured using a digital caliper to the nearest 0.01 mm. The following pholidolial characteristics were evaluated: PrO (number

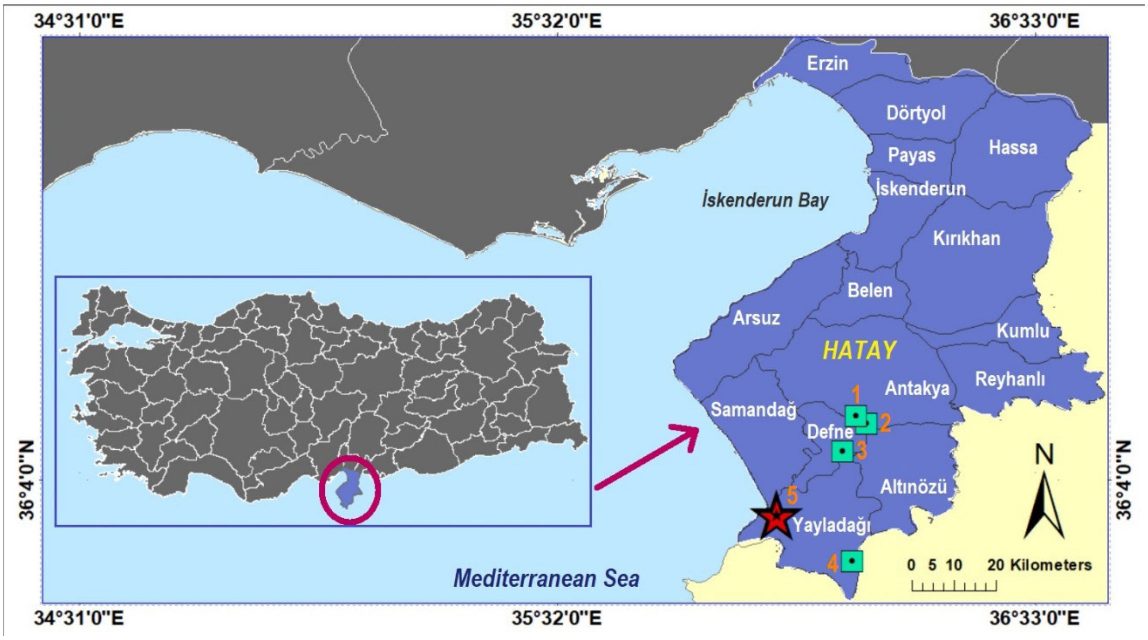

Figure 1. A map showing the distribution areas of *Rhynchocalamus melanocephalus* in Turkey. The red star (locality 5) shows the new locality (Gözlüce Neighborhood, Yayladağı-Hatay) found in this study. The green squares represent previous locality records in literature. 1- Sofular Village, Harbiye-Hatay (Avcı *et al*., 2008), 2- Kuruyer Village-Hatay (Avcı *et al.*, 2008), 3- 20 km south of Harbiye (Franzen & Bischoff, 1995), 4- Güveççi Village, Yayladağı-Hatay (Avcı *et al*., 2008).

Figure 2. A) A male individual of *Rhynchocalamus melanocephalus* in the Gözlüce population.
B) A general view from the habitat of *Rhynchocalamus melanocephalus* in the Gözlüce neighborhood of Yayladağı-Hatay.

of preocular plates, left-right); PoO (number of postocular plates, left-right); T (number of temporal plates, left-right); PoT (number of post temporal plates, left-right), SRL (number of supralabial plates, left-right); SL (number of sublabial plates, left-right); G1 (number of gular scales surrounding the last sublabials); G2 (number of the gular scales in a row between posterior infralabials); D+T (number of the Dorsal+Temporal scales surrounding the posterior margin of the parietals); V (number of ventral plates); LDS (number of longitudinal dorsal scale rows at mid-trunk between ventrals 85-95); and S (number of subcaudal plates).

The morphometric measurements in this study were: rostrum height (RH), rostrum width (RW), distance between the nostrils (ND), diameter of eyes (DOE), pileus length (PL), pileus width (PW), head height (HH), supraocular length (SOL), frontal width (FW), frontal length (FL), anterior inframaxillar length (AIML), posterior inframaxillar length (PIML), snout-vent length (SVL), tail length (TL), and pairs of lower labials in contact with anterior chin shields (PLL).

Results

Laudakia stellio (Linnaeus, 1758), *Mediodactylus orientalis* (Stepánek, 1937), *Ophisops elegans* (Ménétries, 1832), *Phoenicolacerta laevis* (Gray, 1838), and *Testudo graeca* (Linnaeus, 1758) were the sympatric reptile species observed in the study site. The vegetation of the new locality area (Gözlüce) consists of *Ceratonia siliqua*, *Olea europaea*, and *Laurus nobilis*.

The mean annual temperature and precipitation over the past 80 years in the Gözlüce site were 18.3°C and 96.79 mm, respectively, according to data of the 6th Meteorology Regional Directorate Hatay. During the month of August, when the individual of *R. melanocephalus* was caught, the mean temperature and precipitation were 27.9°C and 17.6 mm, respectively.

Table 1. Comparison of pholidolial characteristics and morphometric measurements of the Gözlüce-Yayladağı specimen of *Rhynchocalamus melanocephalus* with those given by Avcı et al. (2008) and Franzen & Bischhoff (1995). For other abbreviations, see text. IN: Internasal triangular (d) or trapezoid shaped (t).

	This Study (Gözlüce, Yayladağı specimen)	**Avcı et al. (2008) (2 male specimens from Sofular, Harbiye-Hatay; 1 female specimen from Kuruyer-Hatay; 1 male specimen from Güveççi, Yayladağı-Hatay, respectively)**				**Franzen & Bischoff (1995) 1 specimen from 20 km south of Harbiye, Hatay**
Character	**1 ♂**	**1st ♂**	**2nd ♂**	**1 ♀**	**1 ♂**	(sex is not given)
PrO	1-1	1-1	1-1	1-1	1-1	-
PoO	1-1	1-1	1-1	1-1	1-1	-
IN	t	d	t	t	t	d
T	1-1	1-1	1-1	1-2	1-1	-
PoT	2-2	2/2	2-2	2-2	2-2	-
SRL	6-6	6-6	6-6	5-6	6-6	6-6
SL	7-7	7-7	7-7	8-8	7-7	8-8
G1	10	10	10	11	10	-
G2	1	1	1	1	1	-
D+T	11	9	11	11	11	
V	182	180	184	198	184	201
LDS	15	15	15	15	15	15
S	55	55	54	53	56	56
SVL	232	235	190	301	214	305
TL	51	51	39	61	47	66
RH	1.58	1.60	1.44	1.62	1.36	-
RW	2.46	2.50	2.02	2.50	2.10	-
ND	2.48	2.52	2.02	2.62	2.36	-
DOE	1.44	1.46	1.36	1.70	1.20	-
PL	7.38	7.44	6.52	7.36	6.42	-
PW	3.68	3.70	3.26	4.46	4.04	-
HH	2.86	2.82	2.38	3.38	3.26	-
SOL	0.76	0.80	0.70	0.78	0.70	-
FW	2.18	2.20	2.16	2.60	2.10	-
FL	2.58	2.62	2.40	2.70	2.50	-
AIML	1.56	1.52	1.40	1.74	1.60	-
PIML	1.28	-	-	1.32	1.28	-
PLL	3-4	3-3	3-3	3-4	3-4	3-3

Pholidolial characteristics: SRL is 6-6 and SL is 7-7 in the male specimen. V is 182 and LDS is15. S is 55 and PoT is 2-2.

Morphometric measurements: SVL is 231.84 mm and TL is 50.73 mm. HH is 2.78 mm, while RH and RW are 1.58 mm, and 2.46 mm, respectively.

Comparisons of pholidolial characteristics and morphometric measurements of the Gözlüce specimen of *Rhynchocalamus melanocephalus* with those in the study of Avcı *et al.* (2008) and Franzen & Bischoff (1995) are given in Table 1.

Color-pattern

In the Gözlüce specimen; the dorsal color of the head and neck was glossy black. The black nuchal band reaches the ventral scales. The ground color of dorsum was yellowish-brown and there was no maculation. The spots on the dorsal formed a line on the tail. The ventral side was yellowish-white without any maculation (Fig. 2).

Discussion

In the present study, I provided a new locality record (Gözlüce-Yayladağı) of *R. melanocephalus* from the Hatay province of Turkey. According to the literature, the known records of the species in Turkey were only limited to the four localities in the Hatay province.

Pholidolial characteristics and morphometric measurements of the Gözlüce specimen were found similar to the other Turkish specimens reported (Franzen & Bischoff, 1995; Avcı *et al*., 2008). Dorsal scales were smooth in 15 rows at mid-body (between ventrals 85-95) in the Gözlüce specimen. Rostrale enlarged and extended backward between internasals. Similar findings were reported by Avcı *et al.* (2008). Subcaudal plates of the Gözlüce specimen were 54 pairs. Franzen & Bischoff (1982) observed 57 pairs of subcaudals and Avcı *et al.* (2008) reported 53-56 pairs of subcaudals. According to Reed & Marx (1959), the numbers of diagnostically important pholidosis characters (supralabials and sublabials) of *Rhynchocalamus melanocephalus* were 6-6 (left-right) and 7-7 (left-right), respectively. Similarly, the numbers of supralabials and sublabials in the specimen of Gözlüce were found as 6-6 and 7-7, respectively.

The new locality record (Gözlüce-Yayladağı) of *Rhynchocalamus melanocephalus* revealed that the species can also be found in different parts of the Hatay province or in the surrounding provinces. The importance of continuing field surveys is clearly evident.

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RESEARCH ARTICLE/ARAŞTIRMA MAKALESİ

Burned Area and Fire Severity Prediction of a Forest Fire Using a Sentinel 2-Derived Spectral Index in Çanakkale, Turkey

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Abstract

Objective: The objective of this study was to determine the extent and degree of severity of a burned area resulting from a forest fire using Sentinel 2 remote sensing data in Çanakkale, Turkey within the Mediterranean Basin, an area of the world where forest fire occurrence and severity are increasing.

Materials and Methods: Pre and postfire Sentinel images were obtained. The Normalized Burn Ratio (NBR) index was calculated for each scene. Then the difference NBR (dNBR) was calculated by subtracting the postfire NBR from the prefire NBR. dNBR ranges were classified into fire severity categories. A map with 20 m spatial resolution displaying the burned area and fire severity was generated from the classified dNBR image. Finally, a forest stand map of the burn area was laid over the fire severity map to examine the relationship between fire severity and stand and cover types.

Results: Approximately 1400 ha of area was predicted to have been burned. Twenty nine, 21, 42, and 8% of the burned area was identified as low, moderate low, moderate high, and severely burned using the dNBR index, respectively.

Conclusions: The overlay of the stand map on the burn severity map revealed that the forested areas were more severely burned compared to the agricultural sections. dNBR is an effective index to delineate fire area extent and identify fire severity. Sentinel 2 data provide a fast and accurate means to monitor forest fire extent and severity due to its improved spatial and temporal resolution.

Keywords: Wildfire, Forest, Çanakkale, Sentinel 2, Normalized Burn Ratio

Introduction

Wildfires are natural disasters that lead to functional and structural changes in ecosystems. The quantity and frequency of forest fires have been increasing in recent years in different parts of the globe (Hirschberger, 2016). Global climate change is an important contributor to this increasing trend in forest fire occurrence (Mack, et al., 2021). The Mediterranean Basin is one of the most sensitive regions to be affected by the warming effects of climate change. Studies show that wildfire activity is expected to increase across the Mediterranean Basin due to climate change (Turco, et al., 2018; Ruffault, et al., 2020), land use change, and short-sighted fire management policies (Moreira, et al., 2020). Human-induced land use changes include: agricultural land abandonment, expansion of mismanaged tree plantations, expansion of the wildland-urban interface, and introduction and invasion by fire-promoting exotic species. Short-sighted fire management policies aim to minimize burned areas in the short term without long term considerations to reduce fire hazard and risk. The combination of these land use and fire management policies along with the effects of climate change is likely to result in large and intense fires, larger burned areas and catastrophic socio-economic and ecological impacts (Moreira, et al., 2020; Pausas & Keeley, 2021). The western and southern parts of Turkey lie within the Mediterranean Basin, where long and dry summers are typical, with sclerophyllous vegetation making conditions favorable for fire occurrence. Not surprisingly, numerous forest fires have occurred in

Turkey in recent years, resulting in both property and life losses. Consequently, it is necessary to monitor the extent and severity of forest fires in this region.

Fire and burn severity often are used interchangeably, especially by fire ecologists. Even though both terms refer to the effects of fire on above and belowground components, there are some differences between the two terms, as discussed by Lentile et al. (2006) and Veraverbeke et al. (2010). To put it simply, fire severity specifically refers to first-order effects of fire (i.e. effects caused by the fire only) (Key & Benson, 2006), short-term severity (the pre-recovery phase after a fire) (Key & Benson, 2006) and initial assessment, which is executed immediately after the fire occurrence without much lag time (Key, 2006). Based on this information, the term "fire severity" has been adopted in this article since it is more aligned with the objectives and methodology of the study. Fire severity involves the loss or decomposition of organic matter above and belowground. As such, it includes the effects of fire on soil and plants (Keeley, 2009). Having sound information on fire severity helps ecologists and resource managers to plan postfire rehabilitation and remediation, since they gain a better understanding of the impact of fire on biotic and abiotic components of an ecosystem (Key & Benson, 2006).

However, ground surveys to detect the extent of burned areas and determine fire severity are difficult and costly because of complex terrain, large and inaccessible areas, and bad weather conditions, including smoke and high temperatures. On the other hand, remote sensing provides an easy, rapid, and accurate means to detect forest fire extent and fire severity. Even though there are numerous methods used for burned area detection, such as change detection (Liu, et al., 2020), image classification (Mitri & Gitas, 2004), spectral mixture analysis (Smith et al., 2007), and surface temperature inversion (Mukherjee, et al., 2018), spectral-index based methods are the most common due to their simplicity, intuitiveness, and accuracy. The rationale in using spectral indices for fire detection lies in the differential reflectance response of burned surfaces over near infrared (NIR) versus shortwave infrared (SWIR) regions of the electromagnetic spectrum (EM). Following a fire, reflectance in the NIR decreases, while the reflectance in SWIR increases. Among these indices, the Normalized Burn Ratio (NBR) index is one of the most widely used and tested to determine burnt area and fire severity in different geographic locations (Atun, et al., 2020; Adagbasa, et al., 2018; Saputra, et al., 2017; Schepers, et al,. 2014; Veraverbeke, et al., 2010; Escuin, et al., 2008; Roy, et al., 2006; Epting, et al., 2005; Garcia & Caselles, 1991). Difference NBR (dNBR) allows for the delineation of a burned area and categorization of the burned area into different fire severity classes using the pre- and postfire images (Key & Benson, 2006).

Medium resolution satellite data, such as Landsat (with 30 m spatial resolution), have been used to detect the extent of burned areas using NBR (Adagbasa, et al., 2018; Liu, et al., 2020). Sentinel 2 Earth Observation (EO) satellites launched in 2015 (Sentinel 2A) and in 2017 (Sentinel 2B) provide higher quality remote sensing data with improved spatial resolution (20 m) and a combined temporal resolution of 5 days compared to Landsat, which is important for disaster monitoring, including fires. Sentinel data are available free to users and have been tested for different applications. NBR derived from Sentinel data have been employed to detect fire extent and burn severity in different locations. For example Atun et al. (2020) used Sentinel 2 images to determine burnt forest area in Greece using NBR and NDVI. Teodoro & Amaral (2019) analyzed the affected areas from forest fires in Portugal using Sentinel 2 data. Sentinel 2 data were used to detect burned area and severity levels in Spain by Amos et al. (2019). Masshadi & Algancı (2021) examined the effectiveness of NBR and other indices to determine fire extent and severity in Turkey using Sentinel 2 data. Nasery & Kalkan (2020) tested dNBR derived from Sentinel 2 data to detect burn area and fire severity in Turkey. However, the use of recent Sentinel 2 EO satellite data for fire area and severity prediction is more limited compared to the older EO remote sensing data like Landsat.

In this study, the efficacy of using Sentinel 2 data to characterize the extent and fire severity of a fire in Çanakkale, Turkey was tested. The study site was situated in northwestern Turkey within the Mediterranean Basin. Using the recent Sentinel 2 EO data for this purpose, this study is expected to contribute to our knowledge in remote sensing of fire in an area of the world that will have a greater occurrence and more severe forest fires. Specific objectives of the study are to determine i) the extent of the burned area, and ii) the fire severity resulting from a forest fire in Çanakkale, Turkey using the dNBR index derived from Sentinel 2 data.

Material and Methods

Study site

A forest fire broke out near Ilgardere village in the Gelibolu district of Çanakkale Province on July 6, 2020 (Figure 1). The fire quickly spread in the W-SW direction with

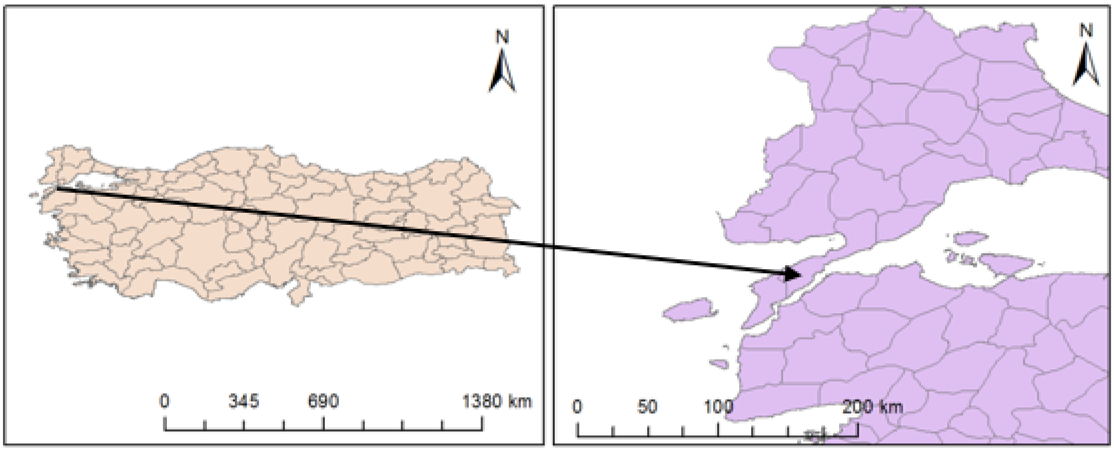

Figure 1. Location of fire site within Turkey.

the help of strong winds out of the NW at an average speed of 30 km/h on July 6. Wind gusts up to 60 km were observed on July 6 and the fire could not be contained until the next morning (Url 1). A considerable swath of area dominantly comprised of forest and some agricultural lands was burned.

Data and Methods

Sentinel 2 images with level 2A processing were acquired for pre- (July 4, 2020) and postfire (July 9, 2020) dates. Sentinel level 2A products are radiometrically and geometrically corrected (including orthorectification and spatial registration). Level 2A products provide Bottom of Atmosphere (BOA) reflectance images derived from the associated Level-1C products. Each Level-2A product is composed of 100x100 km^2 tiles in UTM/WGS84 projection (ESA, 2015). The Normalized Burn Ratio (NBR) spectral index was calculated according to the formula

$$NBR = \frac{(NIR - SWIR)}{(NIR + SWIR)}$$

where NIR and SWIR represent the near infrared and shortwave infrared bands, respectively (García & Caselles, 1991). Sentinel 2 bands 7 and 11, corresponding to 783 nm and 1613 nm central wavelengths, respectively, with 20 m spatial resolution, were used for the NIR and SWIR regions. The NBR index was calculated for both dates using the respective images. The NBR index is a more powerful tool to better understand fire extent and severity when the difference between pre and postfire conditions is used. Therefore, difference NBR (dNBR) was calculated according to the formula

$$dNBR = NBRprefire - NBRpostfire$$

The rationale in using dNBR stems from the fact that NBR values will be negative for areas without vegetation, such as after a fire, and positive for vegetated areas. Therefore, in the difference image, negative values will represent unburned and regenerated areas while positive values will represent burned areas of varying severities. Based on this, the following thresholds were used to determine both the extent and severity levels of the fire (Key & Benson, 2006) (Table 1).

Table 1. dNBR ranges used to classify fire severity levels.

Severity level	dNBR range (not scaled)
Enhanced regrowth	-0.500 - -0.101
Unburned	-0.100 – 0.101
Low severity	0.100 – 0.269
Moderate low severity	0.270 – 0.439
Moderate high severity	0.440 – 0.659
High severity	0.660 – 1.300

(dNBR value ranges are flexible; scene-pair dependent; shifts in thresholds +100 points are possible. dNBR less than about –550, or greater than about +1,350 may also occur, but are not considered burned. Rather, they likely are anomalies caused by misregistration, clouds, or other factors not related to real land cover differences).

A dNBR map displaying the extent and severity levels of the fire was generated.

A forest stand map of the burn area was laid over the fire severity map to examine the relationship between fire severity and stand and cover types. Average dNBR values corresponding to the stand types were calculated using zonal statistics.

Results

Pre- and postfire images of the burn site are shown in Figure 2. The borders of the burned area can be seen clearly in the postfire image.

The extent and the severity of the fire are shown in Figure 3. NBR is very effective in delineating the fire extent. The borders of the fire area are clearly evident. Additionally, the variation in the severity of the fire is also visible (Figure 3).

The predicted burn severity types according to dNBR are listed in Table 2. According to the map, approximately 1400 ha of the area was burned. Most of this burned area was of moderate high severity (42%) followed by low severity (29%), moderate low severity (21%) and high severity (8%). The majority of the burned area (63%) was classified as moderately burned, where moderate high severity burn areas constituted twice the size of moderate low severity burn areas (Table 2).

Table 2. Fire severity levels and associated burned areas.

Severity level	Area (ha)	Percent (%)
Low severity	417	29
Moderate low severity	295	21
Moderate high severity	591	42
High severity	107	8

There was a more uniform gradation of burn severity in the east (E) and southeast (SE) sections of the area where there was a large moderate high severely burned swath surrounded by thin stretches of moderate low severity and low severity burn areas. There was a more fragmented severity distribution in the other directions. Small fragments of severely burned areas were scattered among moderate high severity burn sections in the north (N) and southwest (SW) directions. Similarly, moderate high and moderate low severity burn areas were surrounded

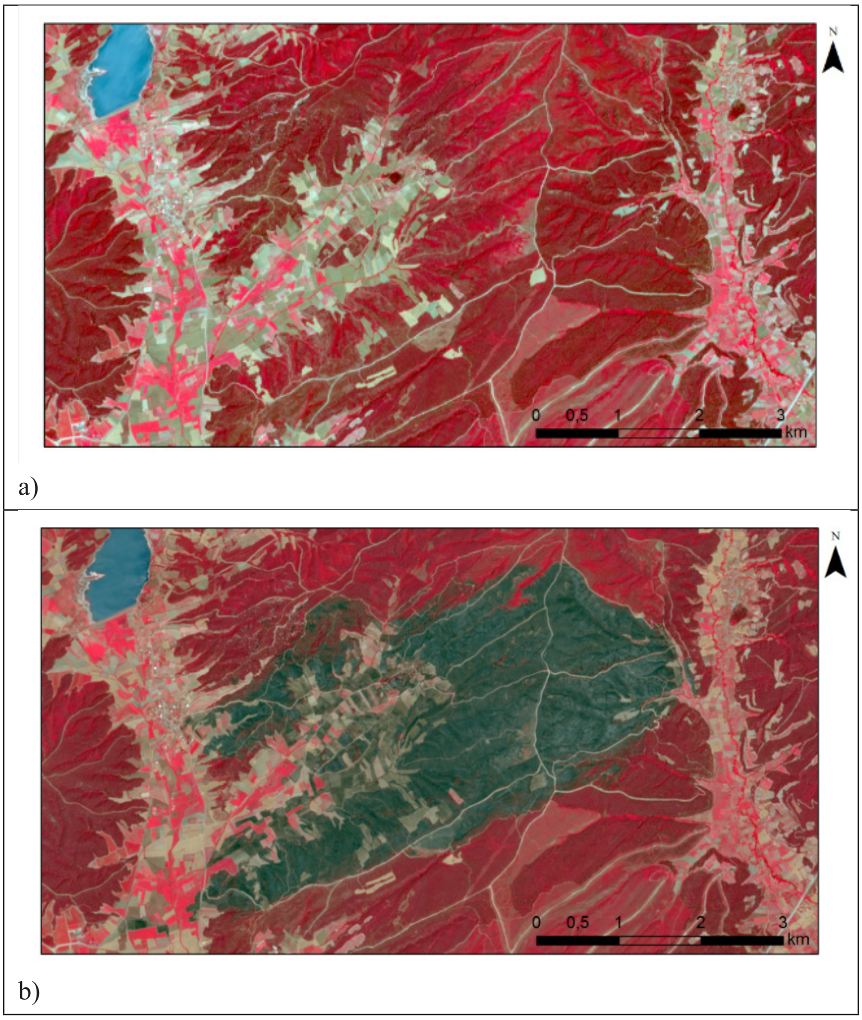

Figure 2. Sentinel 2 NIR color composite images of a) prefire on July 4, 2020, and b) postfire on July 9, 2020.

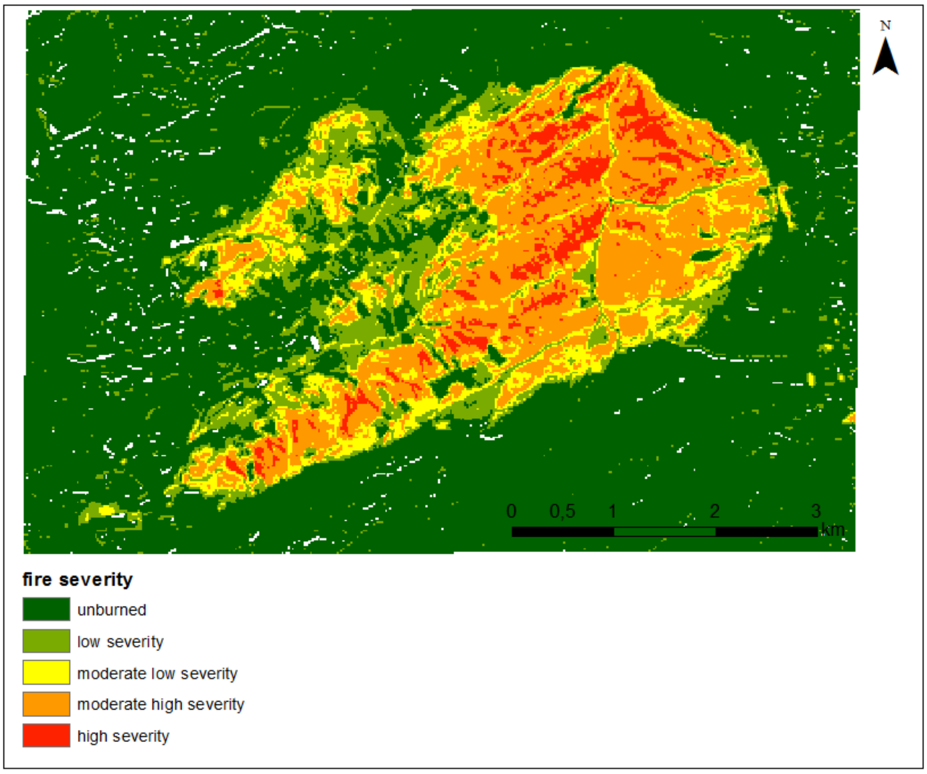

Figure 3. The extent and severity of the fire determined according to the dNBR index.

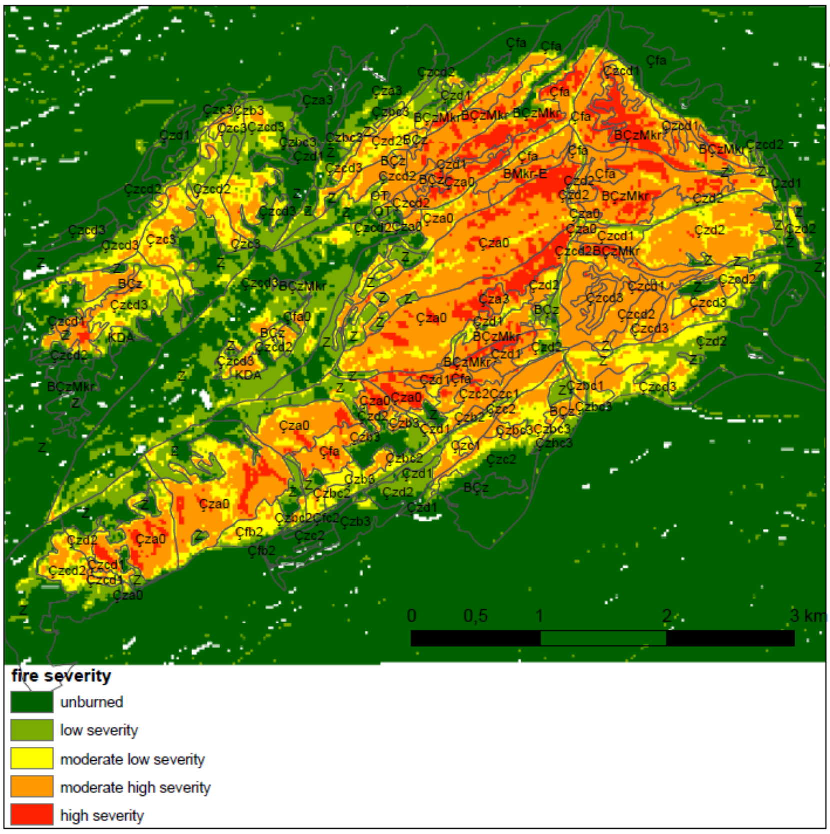

Figure 4. Forest stand map overlaid on the fire severity map. On the stand map Çz, Çf, and M stand for Turkish red pine, stone pine, and oak, respectively. OT: forest soil without trees; KDA: Non-cadastral area with trees; Z: agriculture; B: degraded stand. Lower case letters a-b-c-d represent stand development stages based on diameter at breast height values and numbers 1-2-3 indicate stand canopy closure ratios.

by low severity burn sections towards the western (W) flanks of the burn area.

The overlay of the stand map on the burn severity map revealed that the forested areas were more severely burned compared to the agricultural sections which are located to the W and SW of the burn area (Figure 4). The majority of the severely and moderate high severely burned areas were covered by pine stands composed of dominantly Turkish red pine (*Pinus brutia*) (Table 3). There also were small stands of stone pine (*Pinus pinea*) and oaks (*Quercus* spp.) on the severely and moderate high severely burned areas. The majority of the agricultural fields were unburned or burned with low severity (Table 3). The Turkish red pine stands within the periphery of the agricultural fields had low or moderate low severity burn (Figure 4). The majority of the agricultural areas burned consisted of wheat and olive crops.

Tablo 3. Stand types affected by the fire with associated average dNBR values and fire severity categories.

stand	mean dBNR	fire severity category
Çfc2	-0,01	unburned
Z	0,08	unburned
Çza3	0,09	unburned
Çzb3	0,17	low severity
Çzc2	0,25	low severity
BÇz	0,26	low severity
Çzbc3	0,26	low severity
Çzcd2	0,28	moderate low severity
OT	0,28	moderate low severity
KDA	0,29	moderate low severity
Çfa	0,31	moderate low severity
Çfb2	0,31	moderate low severity
Çzd1	0,31	moderate low severity
Çzc3	0,31	moderate low severity
Çzcd3	0,33	moderate low severity
Çzd2	0,33	moderate low severity
Çzbc2	0,33	moderate low severity
Çzc1	0,36	moderate low severity
Çfa0	0,37	moderate low severity
Çzbc1	0,41	moderate low severity
Çzcd1	0,51	moderate high severity
BÇzMkr	0,51	moderate high severity
Çzb2	0,54	moderate high severity
Çza0	0,54	moderate high severity
BMkr-E	0,59	moderate high severity

Discussion

Agricultural areas had lower degrees of fire severity compared to the forested areas. This difference is primarily related to the amount of fuel between the two ecosystems. Forested areas contained more flammable fuel in a continuous fashion compared to the agricultural areas. Also the presence of different agricultural crops and their different growth stages affect the spread and severity of the fire. For example, some of the agricultural lands were planted with sunflower, which was in its green vegetative phase at the time of the fire, and as a result these fields partially blocked the spread of the fire. The green vegetative phase of the agricultural crops are clearly visible in the NIR color composite image as seen in the red-colored regular geometric patterns (Figure 2). On the other hand, some of the agricultural fields were burned, which probably correspond to wheat fields that were in the maturity phase and completely dry, serving as flammable fuel. Others factors like topography, meteorological conditions including wind speed, direction, and humidity, and accessibility limitations could contribute to fire severity and how the fire spreads. Better management of firefighting as fire duration increases and as the fire approaches settled areas may also contribute to a fire's extent.

It is important to note that the aggregation of dNBR values in Table 3 reduces the variation that can be seen in Figure 4. Averaging is useful to show the general trends and get a quantitative estimate of fire severity values of different stand types affected by the fire, but the stand map overlay on the fire severity map displays more detail in terms of fire severity distribution. The two approaches combined provide a more accurate characterization of fire severity across the landscape.

The size of the burned area predicted in the study is greater than the area reported by the authorities and the media immediately after the fire was extinguished (url -1, 2 and 3). Authorities and media outlets reported 450 ha of burned area, which is about one third the size of the area (~1400 ha) that was identified in this study. A similar situation was reported by Nasery & Kalkan (2020) in İzmir, Turkey, who determined an approximately 14 times greater burned area than the one reported by the authorities and news agencies. Teodoro & Amaral (2019) also estimated greater burned areas using Sentinel 2 derived indices compared to the ones reported by the authorities in forest fires in Portugal.

The temporal resolution of Sentinel 2 increased from 10 to 5 days with the launch of the second satellite (2B). In the current study, this improvement made it possible to focus solely on the effects of fire right after the fire's occurrence while disregarding the effects of ecosystem processes such as recovery and regeneration. As Teodoro & Amaral (2019) noted, ecosystem processes can change the reflection over the NIR and SWIR portions of the EM and lead to different dNBR values, making it impossible to separate the effects of fire versus recovery and regeneration, as has been highlighted by Veraverbeke et al. (2010).

Results of the study agree with others. Amos et al. (2019) showed that Sentinel 2 data can be used successfully to discern the burn area and severity of a fire in NE Spain, which is located in a similar climate and vegetation to the current study. Likewise, Mallinis et al. (2018) found that dNBR index derived from Sentinel 2A was accurate in forest fire severity assessment and mapping in Mediterranean pine ecosystems in NE Greece. Delegido et al. (2018) reported improved prediction of fire severity using Sentinel 2 data in Argentina. Teodoro & Amaral (2019) found that Sentinel 2 data were more accurate in estimating burn area and fire severity levels in forest fires in Portugal.

Conclusions

This study examined the utility of recent Sentinel 2 satellite data to delineate fire area extent and identify fire severity of a forest fire that occurred in Çanakkale, Turkey, within the Mediterranean Basin, a particularly sensitive area of the world expected to have a greater occurrence and more severe forest fires. dNBR index was derived using the pre and postfire Sentinel images. A map with 20 m spatial resolution showing the fire area and fire severity levels was generated. The distribution and fire severity patterns reflect the characteristics of the different cover types in the area. Most of the burned area was pine forest composed of Turkish red pine. There were also patches of agricultural fields burned in the fire. Forested areas burned more severely compared to the agricultural fields primarily because they contained greater quantities of flammable fuel. Characteristics of agricultural crops, such as growth stages, played a role in the way the fire spread. Sentinel 2 data provide a fast and accurate means to monitor forest fire extent and fire severity as a result of its improved spatial and temporal resolution.

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RESEARCH ARTICLE/ARAŞTIRMA MAKALESİ

Atatürk Baraj Gölü'nde (Türkiye) Yaşayan *Carassius gibelio* (Bloch, 1782) türünün mtDNA COI ve cyt b Analizi

Arif Parmaksız[1], Aynur Demir[1]

Öz

Amaç: Bu çalışmanın amacı, Atatürk Baraj Gölü'nde yaşayan *C. gibelio* türünün mtDNA COI ve Cyt b gen bölgelerine ait sekanslara dayalı olarak gen bankasındaki sekanslarla karşılaştırılması ve filogenetik analizlerin yapılmasıdır.

Materyal ve Yöntem: Atatürk Baraj Gölü Bozova bölgesinde yaşayan hedef türe ait bireyler balıkçılardan rastgele seçilerek satın alınmıştır. Total DNA izolasyonu, GeneJET Genomic DNA Purification Kit (Thermo Scientific) kullanılarak kas dokusundan protokol talimatları doğrultusunda yapılmıştır. Daha sonra mtDNA COI ve Cyt-b bölgelerine ait özgül primerler kullanılarak ilgili bölgeler PCR yöntemi ile çoğaltılmıştır. Elde edilen PCR ürünleri Agaroz jelde yürütülmüş ve ürün oluşturan örnekler seçilerek hizmet alımı şeklinde ticari firmaya gönderilmiş ve 3500 XL Genetic Analyzer cihazı ile dizi analizi yaptırılmıştır.

Bulgular: mtDNA COI ve cyt b gen bölgeleri için sırayla 620 ve 580 bp uzunlukta sekanslar elde edilmiştir. mtDNA COI bölgesi için daha önce Türkiye'de yaşayan bireylerle aynı haplotipler tespit edilmesine rağmen mtDNA Cyt b gen bölgesi için daha önce tanımlanmayan yeni bir haplotip tespit edilmiştir.

Sonuç: Atatürk Baraj Gölü'nde yaşayan *C. gibelio* türüne ait bireylerin mtDNA COI ve Cyt b gen bölgelerine ait sekans analizleri ilk defa bu çalışmada yapılmış ve gen bankasındaki verilerle karşılaştırılmıştır.

Anahtar Kelimeler: Atatürk Baraj Gölü, *Carassius gibelio*, mtDNA, COI, cyt b

mtDNA COI and cyt b Analysis of *Carassius gibelio* (Bloch, 1782) Living in Atatürk Dam Lake (Turkey)

Abstract

Objective: The aim of this study is to compare the *C. gibelio* species living in Atatürk Dam Lake with the sequences in the gene bank based on the sequences of the mtDNA COI and Cyt b gene regions and to perform phylogenetic analyzes.

Material and Methods: Individuals of the target species living in the Bozova region of Atatürk Dam Lake were randomly selected from fishermen and purchased. Total DNA isolation was performed from muscle tissue using the GeneJET Genomic DNA Purification Kit (Thermo Scientific) according to the protocol instructions. Then, using specific primers of mtDNA COI and Cyt-b regions, the relevant regions were amplified by PCR method. The obtained PCR products were carried out in Agarose gel and the samples forming the product were selected and sent to the commercial firm as service procurement and sequence analysis was performed with the 3500 XL Genetic Analyzer device.

Results: Sequences of 620 and 580 bp in length were obtained for the mtDNA COI and cyt b gene regions, respectively. Although the same haplotype was detected for the mtDNA COI region with individuals living in Turkey before, a new haplotype was detected for the mtDNA cyt b gene region that was not previously defined.

Conclusion: Sequence analyzes of mtDNA COI and cyt b gene regions of individuals belonging to the *C. gibelio* species living in Atatürk Dam Lake were performed for the first time in this study and compared with the data in the gene bank.

Keywords: Atatürk Dam Lake, *Carassius gibelio*, mtDNA, COI, cyt b

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Giriş

Güneydoğu Anadolu Projesi (GAP), tarımsal olarak üretim kapasitesini arttırmış, oluşturduğu Atatürk Baraj Gölü sayesinde de büyük bir su ürünleri potansiyeline sahip hale gelmiştir (Oymak, 2000; Oymak, vd., 2011). Bunun değerlendirilmesi için göl suyuna sazan yavrusu bırakılarak balıklandırma çalışmaları yapılmıştır. Böylece Fırat Nehri'nde doğal olarak yaşayan balıkların yanı sıra dışarıdan da balık yavruları eklenerek balıkçılık faaliyetlerinin arttırılması sağlanmıştır. Bu balıklandırma çalışmaları vasıtasıyla göl suyunda istilacı balık türleri de bölgeye yerleşmiştir. Tatlı su ekosistemlerinin yabancı balıklar tarafından istilası, endemik ve yerli türlerin yerel yok oluşları da dahil olmak üzere doğal biyolojik çeşitlilik için önemli sonuçlara yol açabilmektedir (Gozlan, vd., 2010; Mollot, vd., 2017; Jackson, vd., 2017). Son yıllarda ülkemizde bulunan endemik türlerin de dahil olduğu iç sularda havuz balıkları (*Carassius* sp.) önemli bir tehdit haline gelmiştir (Uğurlu & Polat, 2007). Bu tehdit doğal türlerin habitatlarını önemli derece etkilemekte olup yerel türlerin hızla azalmasına ve havzalardaki balıkçılık faaliyetlerinin sona ermesine neden olmaktadır (Leung, vd., 2002).

Atatürk Baraj Gölü'nde yaşayan doğal balık türleri; aşırı avlanma, istilacı türlerin baskın duruma geçmesi ve habitat kaybı gibi faktörler nedeniyle her geçen gün daha da artan baskılara maruz kalmakta olup, ekonomik türlerin popülasyonlarının birey sayıları azalmakta ve bununla birlikte tür kaybına neden olmaktadır (Parmaksız, vd., 2022a). Atatürk Baraj Gölü'nden balıkçılık yaparak geçinen tecrübeli yöre balıkçılarından alınan bilgilere göre, atılan ağlardan çıkan balıklardan yarısına yakınının *Carassius gibelio* olduğu ve bu türün birey sayısının her geçen gün hızla arttığı, eğer bu şekilde devam ederse önümüzdeki zamanlarda ağlarda sadece bu balığa rastlanma ihtimalinin yüksek olduğu belirtilmiştir (Parmaksız, vd., 2022b).

Carassius gibelio (Bloch, 1782) Cyprinidae familyasına ait bir tür olup, Uzakdoğu Asya kökenlidir, istilacı özelliğe sahip olmasından dolayı günümüzde dünyadaki iç su sistemlerinin birçoğunda görülmektedir (Ağdamar, 2017). Bu balık türünün istilacı karakterindeki en temel biyolojik tehdit üremesi olup, ginogenetik üreme özelliğinden dolayı bulunduğu habitatlarda hızla baskın konuma geçebilmektedir (Ağdamar, 2017). Biyolojik ve ekolojik özelliklerine bağlı olarak, girdiği ortamlardaki yerli balık türlerinin populasyon yoğunluğunu olumsuz yönde etkilemektedir (Tarkan, vd., 2012a). İstilacı balık türleri hem balıkçılık hem de biyolojik çeşitlilik için tehdit unsurudur (Erdem, vd., 2014). Bu nedenle ortamdaki istilacı balıkların tür tespiti yapılarak bir mücadele programının ortaya konulması hem bilimsel hem de ekonomik açıdan önem arz etmektedir.

Bu çalışmanın amacı; *C. gibelio* için mtDNA COI ve cyt b markörleri ile sekans analizleri yapılarak (i) tür tanımlanması yapmak, (ii) elde edilen sekansları gen bankasına yüklemek, (iii) gen bankasındaki verilerle karşılaştırılması yapılarak bu ortama nereden geldiğine dair tahminler yürütmektir.

Materyal ve Yöntem

Bu çalışmada, Atatürk Baraj Gölü Bozova bölgesinde avlama yapan yöre balıkçılarının 2021 yılı Aralık ayında tezgahlarında satılan ve rastgele seçilen 10 adet *C. gibelio* örneği materyal olarak kullanılmıştır. Alınan örnekler soğuk zincir uygulanarak laboratuvara getirilmiştir. Örnekler morfolojik olarak değerlendirilmiş ve hedef tür olduğu tespit edilen örneklerden kas dokusu alınarak %90 etanol içeren mikrosantrifüj tüplerine konulmuş, DNA izolasyonu yapılıncaya kadar -20ºC de bekletilmiştir.

DNA İzolasyonu ve PCR

Total DNA izolasyonu, GeneJET Genomic DNA Purification Kit (Thermo Scientific) kullanılarak kas dokusundan protokol talimatları doğrultusunda yapılmıştır. Protokol sonrası DNA varlığını kontrol etmek için tüm bireylere ait DNA örnekleri SYBR Green eklenen % 0,8'lik agaroz jeldeki kuyucuklara yüklenmiş, elektroforezde yürütülerek, (UV) ışık veren cihazda görüntülenmiştir (Smart View Pro Imager System, Major Science).

Bu çalışmada PCR işlemi Thermal Cycler (BIO-RAD T100^{TM}) cihazında gerçekleştirilmiştir. mtDNA COI gen bölgesinin çoğaltılması için kullanılan primer dizisi Darabi vd. (2014) çalışmasından alınmıştır (COI-625F: 5' TCA ACC AAC CAC AAA GAC ATT GGC AC-3'; COI-625R: 5' GAC TTC TGG GTG GCC AAA GAA TCA-3'). Tüm PCR reaksiyonları, her bir primerden 0,5 mM, her dNTP'den 0,2 mM, 1x PCR tamponu, 2,5 mM MgCl2, 1 birim Taq polimeraz ve yaklaşık 90 ng DNA içeren toplam 25 ul hacimde gerçekleştirilmiş, PZR koşulları ise; 95°C'de 3 dak. ilk denatürasyon, 95°C'de 45 s., 62°C'de 45 s. bağlanma ve 72°C'de 1 dak. uzama olmak üzere toplam 35 döngü gerçekleştirilmiş, son olarak örnekler 72°C'de

10 dakika tutularak sonlandırılmıştır (Parmaksız & Eskici, 2018).

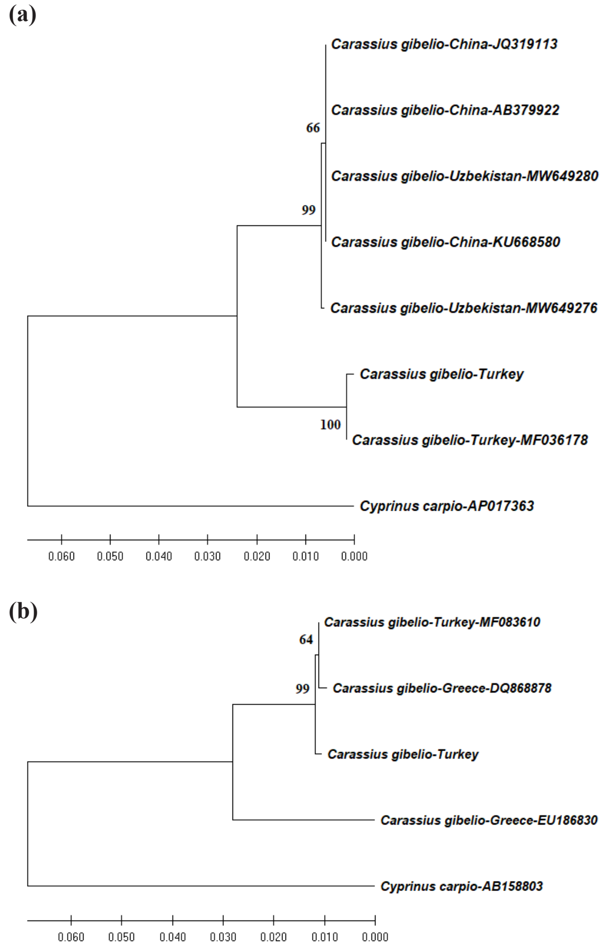
mtDNA Cyt b gen bölgesi için kullanılan primer dizisi Briolay vd., (1998) çalışmasından alınmıştır (L15267 F: 5' GTT TGA TCC CGT TTC GTG TA-3'; H15891 R: 5’AAT GAC TTG AAG AAC CAC CGT-3’). Tüm PCR reaksiyonları, her bir primerden 0,5 mM, her dNTP’den 0,2 mM, 1x PCR tamponu, 2,5 mM MgCl2, 1 birim Taq polimeraz ve yaklaşık 60 ng DNA içeren toplam 25 ul hacimde gerçekleştirilmiş, PZR koşulları; 95°C’de 3 dak. ilk denatürasyon, 95°C’de 30 s. denatürasyon, 57°C’de 30 s. bağlanma ve 72°C’de 45 s. uzama olmak üzere toplam 35 döngü gerçekleştirilmiş, son olarak örnekler 72°C’de 10 dak. tutularak sonlandırılmıştır (Parmaksız & Şeker, 2018).

Veri Analizi

Elde edilen PCR ürünleri ticari firmaya gönderilmiş ve 3500 XL Genetic Analyzer cihazı ile DNA dizi analizi yaptırılmıştır. Daha sonra mtDNA COI ve Cyt b sekanslarına ait ham veriler FinchTV 1.4 programı kullanılarak değerlendirilmiş ve BioEdit software version 7.2.5 programı kullanılarak tüm bireylerin sekansları hizalanmıştır. Gen bankasındaki en yüksek benzerlik gösteren mtDNA COI ve Cyt b bölgesine ait sekanslar çalışmaya dahil edilmiştir. Komşu birleştirme ağacı (Neighbor joining tree) filogenetik analizler K2 parametresi modeline göre MEGA X programında gerçekleştirilmiş ve filogenetik ağaç oluşturulmuştur (Kumar, vd., 2018). Ağaç kolları (Nodların) güvenirliğinin test edilmesinde Bootstrap testi (1000 tekrarlı) kullanılmıştır.

Bulgular

Bu çalışmada Atatürk Baraj Gölü’nde istilacı olarak yaşayan ve son zamanlarda birey sayısında artış tespit



Şekil 1. mtDNA sekanslarına dayalı Komşu Birleştirme (NJ) ağacı. ((a) COI, (b) cyt b)

edilen *C. gibelio* türüne ait bireylerin mtDNA COI ve cyt b gen bölgelerine ait dizi analizleri ilk defa bu çalışmada yapılmış ve gen bankasındaki verilerle karşılaştırılmıştır. mtDNA COI ve cyt b gen bölgeleri için sırayla 620 ve 580 bp uzunlukta sekans elde edilmiştir. Bu sekans sonuçları BLAST’lama yapılarak benzerlikler ortaya çıkarılmıştır (Tablo 1).

Tablo 1. Bu çalışmada elde edilen sekanslarla NCBI veri tabanındaki sekanslarla karşılaştırılması

	Ülke	Erişim Numarası	Benzerlik Oranı (%)	Kaynak
COI				
	Türkiye	OP242171	100	Bu çalışma
	Türkiye	MF036178	100	Ağdamar & Tarkan, 2019
	Çin	KU668580	96.14	Yayınlanmamış
	Özbekistan	MW649280	96.14	Sheraliev & Peng, 2021
	Çin	JQ319113	96.14	Cheng, vd., 2012
	Çin	AB379922	96.14	Komiyama, vd., 2009
	Özbekistan	MW649276	95.97	Sheraliev & Peng, 2021
Cyt b				
	Türkiye	OP173205	100	Bu çalışma
	Türkiye	MF083610	99.82	Ağdamar & Tarkan, 2019
	Yunanistan	DQ868878	99.66	Tsipas vd., 2009
	Yunanistan	EU186830	95.85	Tsipas, vd., 2009

Tablo 1'de COI bölgesine ait sekansların analizinde bu çalışmada elde edilen tek haplotipin, Ağdamar & Tarkan (2019) çalışmasıyla Türkiye'den alınan bireylerin haplotipi ile aynı olduğu, Çin ve Özbekistan örnekleri ile % 96.14 ila % 95.97 arasında benzerlik gösterdiği belirlenmiştir. Fakat cyt b bölgesi analizinde, bu çalışmadaki bireylerin sekanslarının, gen bankasına kayıtlı olan haplotiplerden farklı ve yeni bir haplotip olduğu belirlenmiştir. En yakın haplotip olan Türkiye örneğine %99.82, Yunanistan örneklerine ise %99.66 ila %95.85 benzerlik göstermektedir.

Şekil 1a ve 1b'de hem COI hem de cyt b bölgesine dayalı komşu birleştirme ağaçlarında dış grup olarak gen bankasından dizileri alınan *C. carpio* kullanılmıştır ve ağaçlarda farklı dal üzerinde bulunmaktadır. Şekil 1a'daki ağaçta çalışmamızda elde edilen haplotip ile Ağdamar & Tarkan (2019) örneklerinin olduğu haplotip aynı olduğu için diğer ülkelerin örneklerinden ayrı bir dal üzerinde konumlanmıştır. Türkiye'deki örneklerin ise Antalya ve Uşak popülasyonlarından olduğu belirlenmiştir (Ağdamar & Tarkan, 2019). Şekil 1b'deki ağaçta, çalışmamızda elde edilen haplotip yeni bir haplotip olduğu için ayrı bir dal üzerinde konumlanmıştır.

Tartışma ve Sonuç

Gümüşi havuz balığı olarak bilinen *C. gibelio* üreme kapasitesi yüksek, çevresel değişimlere oldukça uyumlu bir istilacı tür olduğundan dolayı, giriş yaptığı yeni habitatlarda bile kısa bir sürede baskın tür haline gelebilmektedir (Yerli, vd., 2014). Bu tür, 1980'li yıllarda Trakya Bölgesi'nden verilen ilk kaydını takiben bazı Avrupa ülkelerinde olduğu gibi Türkiye iç sularında da sorun olmaya başlamış (Yerli, vd., 2014) ve gün geçtikçe çoğalan ekolojik ve ekonomik olarak ağır tahribatlara neden olmuştur (Ağdamar, 2017). Türkiye'nin farklı lokalitelerinden alınan örnekler üzerine yapılan genetik çalışmalar neticesinde bu türün ülkemize doğrudan veya taşındığı diğer ülkeler (özellikle Orta ve Doğu Avrupa) üzerinden giriş yapmış olabildiği ifade edilmiştir (Ağdamar, 2017). Aynı ihtimal bu çalışmada yapılan haplotip analizlerinde de ortaya çıkmıştır. Çünkü mtDNA COI bölgesine ait bulunan haplotip Tablo 1 de görüldüğü gibi Türkiye örnekleri ile %100 benzerlik göstermiş, cyt b haplotipi ise farklı çıkmasına rağmen en yüksek benzerliği %99.82 ile yine Türkiye örnekleridir. Şanlıurfa için bu istilacı türün ilk kaydının 2008'de olduğu tespit edilmiş (Tarkan vd., 2012a) ve buna rağmen tüm baraj gölü içerisinde baskın duruma geçmeyi başarmıştır. Baskın duruma geçmesinin sebeplerinden bazıları; hızlı bir şekilde üreme boyuna ulaşması, çok sayıda ve uzun periyotta yumurta bırakması, diğer sazangillere ait spermlerin kullanarak üreyebilmesidir (Ağdamar, 2017). Böylece Atatürk Baraj Gölü'nde *C. gibelio* yoğunluğunun artması, yerli ve ekonomik türlere ait bireylerin ise azalmasına neden olmaktadır (Parmaksız vd., 2017). Yöre balıkçıları ile yapılan durum değerlendirmesinde, bu durumu son yıllarda fark ettiklerini ve bu şekilde devam etmesi durumunda ekonomik türlerin tamamen ortadan kaybolacağını tahmin ettiklerini ifade etmişlerdir. Tarkan vd. (2012b), altı yıllık süreçte Marmara Bölgesi'ndeki Ömerli Baraj Gölü'nde yaşayan *C. gibelio* ile yerli ve ekonomik türlerin yoğunluk durumları çalışmış olup, yerli türlerin popülasyon yoğunluklarının önemli düzeyde azaldığını ve *C. gibelio* populasyonunun ise tam tersine arttığını tespit etmişlerdir. Atatürk Baraj Gölü'nde de benzer sonuçların oluştuğu tahmin edilmektedir. Bu yüzden bu tür ile ciddi bir mücadele programı düzenlenmelidir. Özellikle baraj gölünde yoğun olarak bulunan popülasyonların tespit edilmesi ve mümkün olduğunca üreme dönemine girmeden ortamdan avlanarak uzaklaştırılmalıdır. Çünkü bu çalışmada, sınırlı sayıda bireyle çalışılmasında bile cyt b gen bölgesi açısından yeni bir haplotip tespit edilmiş olması ve farklı bölgelerde yaşayan popülasyonlarda yeni varyasyonların ortaya çıkması genetik çeşitlilik seviyesinin arttığının göstergesi ve adaptasyon yeteneğinin gün geçtikçe arttığının bir ispatıdır. Bu türün tercih edilme ve tüketilme oranı diğer balıklara oranla daha az olduğu için gıda sektöründe işlenip daha cazip hale getirilmesi de önem arz etmektedir. *Carassius gibelio* türüne ait aminoasit değerlerinin diğer türlere göre daha farklı olduğu ve bundan dolayı bazı protein diyetlerinin hazırlanmasında bu türden faydalanılması, aminoasit bakımından daha zenginlik kazandırabilir (Parmaksız vd., 2022b).

Bundan sonra yapılacak çalışmalarda Atatürk Baraj Gölü ve Fırat Nehri boyunca bu türe ait popülasyonlar belirlenip, D- Loop ve mikrosatellit gibi marker sistemleri kullanarak popülasyonların genetik çeşitlilik sevileri tespit edilip, çeşitliliği en yüksek olan popülasyondan başlamak üzere mücadeleye hızlı bir şekilde başlanılması önerilmektedir.

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RESEARCH ARTICLE/ARAŞTIRMA MAKALESİ

Length-Weight Relationship, Condition Factor, and Gonadosomatic Index of Endemic *Alburnus istanbulensis* (Battalgil, 1941) in Two Different Habitats: Karamenderes River and Bayramiç Reservoir (Çanakkale, Turkey)

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Abstract

Objective: The first aim of this study is to describe the length, weight, condition factor, and GSI of *Alburnus istanbulensis* (Battalgil, 1941) in two different connected habitats (stream habitat and reservoir lake) in Karamenderes River, Çanakkale. The second aim is to state the growth type of this species in the sampled habitat using the length-weight relationship (LWR) model.

Materials and Methods: The sampling areas are Bayramiç Reservoir and two tributaries on Karamenderes River, which feed the reservoir. Sampling was conducted between May 2016 and June 2017, and depending on the habitat types, different gears were used in the samplings. $W=aL^b$ equation was used to calculate the length-weight relationship, $K=100\times W/L^3$ equation for the condition factor, and $GSI=W_G\times 100/W$ equation for the gonadosomatic index.

Results: The results showed that the mean fork length of specimens in reservoir and stream habitats were 11.86±1.83 cm and 7.69±3.56 cm, respectively, and body weight of the specimens in the reservoir and stream habitats were 19.28±8.99 g and 8.17±10.82 g, respectively. The condition factor was higher in the reservoir habitat and GSI values were higher in the stream habitats. The growth for all the specimens was positive allometric (b=3.13), whereas in the reservoir habitat the growth was isometric (b=2.99) and in the stream habitat the growth was positive allometric (b=3.12).

Conclusions: Determining the biological characteristics of an endemic species makes an important contribution to the conservation of the species. In the Çanakkale region, data on LWR, growth, condition, and GSI values were not available with the valid name of the species. Therefore, this study is important in terms of presenting new data in the Çanakkale region with the valid name of the species. The findings of this study indicate that the *A. istanbulensis* species exhibited habitat-dependent differences in LWR, growth, and condition.

Keywords: Growth, Biological characteristic, Fish biology, Reservoir habitat, Stream habitat

Introduction

In fish biology, it is important to make estimations of biological traits for population growth characteristics, and this plays a crucial role in the conservation biology of the population. The length-weight relationship is an important parameter that gives information about population growth (Beverton & Holt, 1957; Froese, 2006). During the course of their lives, freshwater fish can be limited to newly developed habitats like reservoirs as an alternative to having access to a diverse range of natural habitats, or the natural stream continuity might be disrupted for them by the presence of a reservoir. As a result, it is reasonable to anticipate that fish species' biological characteristics, such as growth parameters, will change based on their respective habitats (Schlosser, 1995).

Due to the location at the crossroads of neighbouring regions with varying ecological and geographical characteristic, Türkiye's freshwater fish species have high diversity and endemism (Hrbek et al., 2004; Perea et al., 2010; Çiçek et al., 2018; Bektaş et al., 2020). According to the present ichthyofauna, Türkiye is inhabited by 384 species of freshwater fish, 208 of which are endemic (Çiçek et al., 2020). The *Alburnus* genus has 24 species in Türkiye, 17 of which are endemic to Türkiye (Bektaş et al, 2020; Çiçek et al., 2020), while the genus has 48 species worldwide (Froese & Pauly, 2022). The species *Alburnus istanbulensis* (Battalgil, 1941) is one of the endemic species in Türkiye. Formerly named *Chalcalburnus chalcoides* and *Alburnus chalcoides*, it spreads throughout the Thrace region of Türkiye (Özuluğ & Freyhof, 2007) (Figure 1). According to the IUCN Red List, the species is in the Least Concern (LC) status (Freyhof, 2014). This species migrates upstream to spawn, and juveniles migrate downstream in the fall of that year or in the spring of the following year (Kottelat & Freyhof, 2007). Because the building of dams causes disruptions in the migration pathways of migratory populations, there is a loss of population quantities before they can reach their breeding sites. As a consequence, they attempt to live in tiny ponds and reservoir lakes as a result of this disruption (Kottelat & Freyhof, 2007; Freyhof, 2014).

There have been studies on *A. istanbulensis* species distribution (Sarı et al., 2006; Özuluğ, 2008; Geiger et al., 2014; Saç & Özuluğ, 2014; Boll et al., 2016; Gaygusuz et al., 2017; Saç & Özuluğ, 2017a,b,c; Özuluğ & Saç, 2019; Sarı et al., 2019; Çiçek et al., 2020), maturity and gonadosomatic index (Tarkan et al., 2005; Tarkan et al., 2012; Hamzaoğlu et al., 2015), parasites (Kırcalar & Soylu, 2014), and feeding characteristics (Yalçın Özdilek & Jones, 2014; Yalçın Özdilek et al., 2019). However, there are limited studies on length-weight relationships and length-weight distributions (Tarkan et al., 2005; Tarkan et al., 2006; Saç & Okgerman, 2016; Gaygusuz et al., 2017; Saç et al., 2019), and age distribution (Başdemir et al., 2010; Çiçek et al., 2015) with *A. istanbulensis*'s former name (*C. chalcoides* and *A. chalcoides*). Since endemic species are important species in their distribution ranges, it is also important to define their biological characteristic in different habitats. In this context, this study will fill the gap in the literature on *A. istanbulensis* and present the difference in the biological features between an interrupted habitat (reservoir) and native habitat (stream). The first aim of this study is to describe the length, weight, condition factor, and GSI of *Alburnus istanbulensis* (Battalgil, 1941) in two different connected habitats (stream habitat and reservoir lake) in Karamenderes River, Çanakkale. The second aim is to state the growth type of this species in the sampled habitat using the length-weight relationship (LWR) model.

Material and Methods

Sampling area and laboratory studies

Karamenderes River arises from the Kaz and Ağı Mountains and runs into the Dardanelles. The flow rate of the river is 65-1530 m^3 (min.-max.) and it is approximately 109 km long (Baba et al., 2007). The sampling area is Bayramiç Reservoir (39° 48.66′ N - 26° 41.09′ E) and two tributaries (Çalıoba 39° 46.72′ N - 26° 42.24′ E and Mollahasanlar 39° 47.33′ N - 26° 43.0′ E) which feed the reservoir. The reservoir was built in 1986-1996 for irrigation purposes, its body is filled with soil, the total body volume is 4.0 hm^3, its height is 55.5 m from the foundation, the total storage volume is 86.5 hm^3, and the lake area is 5.847 km^2 when the water level is at its normal level (Akbulut et al., 2006). The sampling areas map is shown in Figure 2.

The samplings were carried out monthly between the months of May 2016 and June 2017, and in accordance with the habitats, two separate catching techniques were applied in order to carry out the samplings. In the river habitats, electroshocks from a backpack were used, and

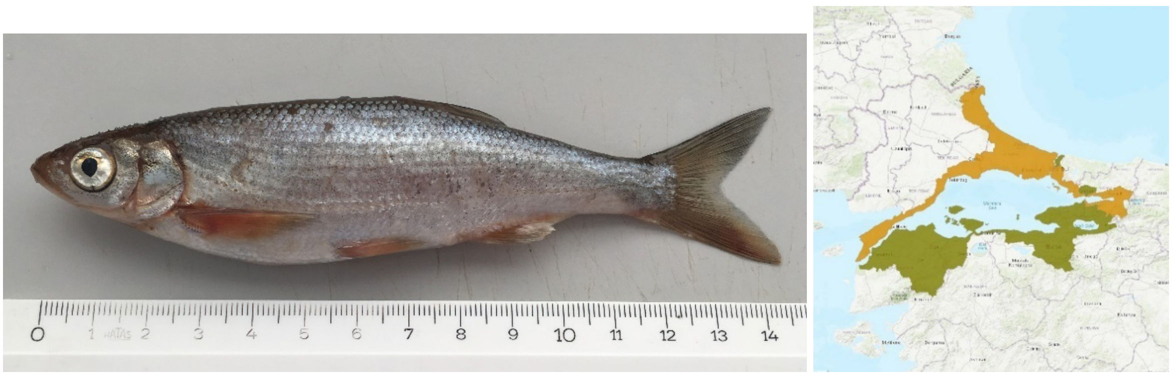

Figure 1. Photo of *Alburnus istanbulensis* specimens (photo: Partal N) and the distribution map according to IUCN (Freyhof, 2014).

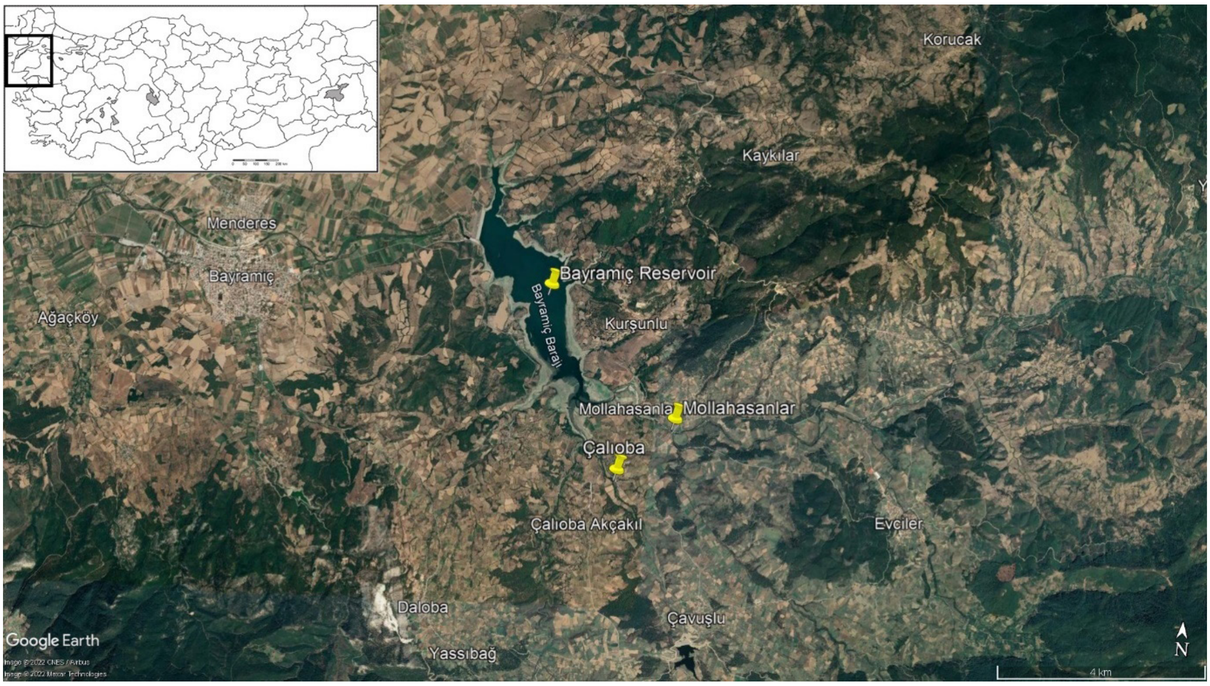

Figure 2. Map of sampling areas (Google Earth, 2022).

in the reservoir, a seine net with a 10-mm mesh, a 2-meter depth, and a 70-meter length was utilized. Despite monthly samplings, there were several months when fish could not be caught in both reservoir and stream habitats.

Following sampling, the specimens were kept in clove oil treatment under ethical guidelines before being transported to the laboratory (Prince & Powell, 2000). After the sampling, fish were brought to the laboratory and kept at -20ºC until the dissection process. The fork length (FL) of the specimens was measured with a ruler to the nearest 0.1 mm. The body weight (W) and gonad weights of the specimens were weighed with a digital balance to the nearest 0.1 g. The maturity and sexes (juvenile, female, and male) of the specimens was determined by macroscopic identification (Wootton, 1990).

Data analysis

The descriptive analysis of species characteristics is given as mean values, standard deviation, and minimum and maximum values. Descriptive statistics were grouped as all specimens, habitats, sex/maturity and given according to body weight, fork length, condition factor, and GSI. The LWR equation was determined from $W=aL^b$ and it was transformed to the linear model equation as $\log W=\log a+b\log L$. According to both equations, W is the body weight (g) of fish, L is the fork length (cm) of fish, *a* is the regression intercept, and *b* is the slope/growth coefficient. The estimate of 95% confidence limits (Cl) for *a*, *b*, and the coefficient of determination (r^2) was determined (Froese, 2006). The growth type was determined according to the *b* value as suggested by Bagenal (1978). The Fulton's condition factor was determined from the $K=100\times W/L^3$ equation (Le Cren, 1951). The specimens' gonadosomatic index (GSI) was determined from the $GSI=W_G\times 100/W$ (W_G: Weight of gonad, g) (Wootton, 1990). The GSI was calculated according to the determined sexes of the specimens.

The analysis of LWR was made with the FSA package in R Software (Ogle, 2018; R Core Team, 2022). The figures were produced with the ggplot2 package in R Software (Wickham, 2016; R Core Team, 2022).

Results

The specimens of *A. istanbulensis* were sampled from Karamenderes Rivers' two stream tributaries and Bayramiç Reservoir and the specimens were grouped as stream and reservoir specimens. The total number of *A. istanbulensis* specimens was 352 in the whole samplings. The specimens' percentage in reservoir (52.3%) was higher than stream specimens (47.7%). The specimens' descriptive statistics are given in Table 1. The sex of 262 out of 352 specimens was determined, and the weight, fork length, condition, and GSI values of the specimens whose sex could not be determined were not included in the analyses related to sex.

Table 1. Descriptive statistics of *A. istanbulensis* specimens (n: Number of specimens; sd: Standard deviation; min: Minimum value; max: Maximum value).

	Weight, g			Fork length, cm			Condition factor			GSI		
	n	**mean±sd**	**min-max**	**n**	**mean±sd**	**min-max**	**n**	**mean±sd**	**min-max**	**n**	**mean±sd**	**min-max**
All specimens	352	13.98±11.35	0.27-53.5	351	9.9±3.5	3.1-17.0	349	1.03±0.13	0.56-1.88	249	1.63±1.87	0.03-9.73
Habitat												
Stream	168	8.17±10.82	0.27-53.5	168	7.69±3.56	3.1-17.0	166	0.98±0.15	0.56-1.88	159	1.91±2.06	0.03-9.73
Reservoir	184	19.28±8.99	0.79-52.61	183	11.86±1.83	4.2-16.5	183	1.07±0.1	0.86-1.76	90	1.14±1.34	0.06-8.25
Sex/Maturity												
Juvenile	63	0.87±0.43	0.27-2.91	63	4.48±0.65	3.1-7.0	62	0.93±0.17	0.56-1.88	57	0.49±0.59	0.03-2.9
Female	52	14.08±10.38	1.73-47.66	52	10.47±2.69	5.9-16.8	53	1.02±0.1	0.79-1.3	51	2.54±2.52	0.36-9.73
Male	147	15.43±11.69	0.93-53.5	146	10.52±2.9	4.6-17.0	145	1.04±0.11	0.8-1.3	141	1.76±1.71	0.06-6.78

The monthly variation of the FL, W, condition factor, and GSI values were illustrated in Figure 3. In the stream, smaller specimens were captured throughout the autumn and winter months, whilst larger specimens were captured during the spring months. On the other hand, larger individuals were found in the habitat of the reservoir during the hot summer days. The reproductive period of this species is represented by an increase in GSI and

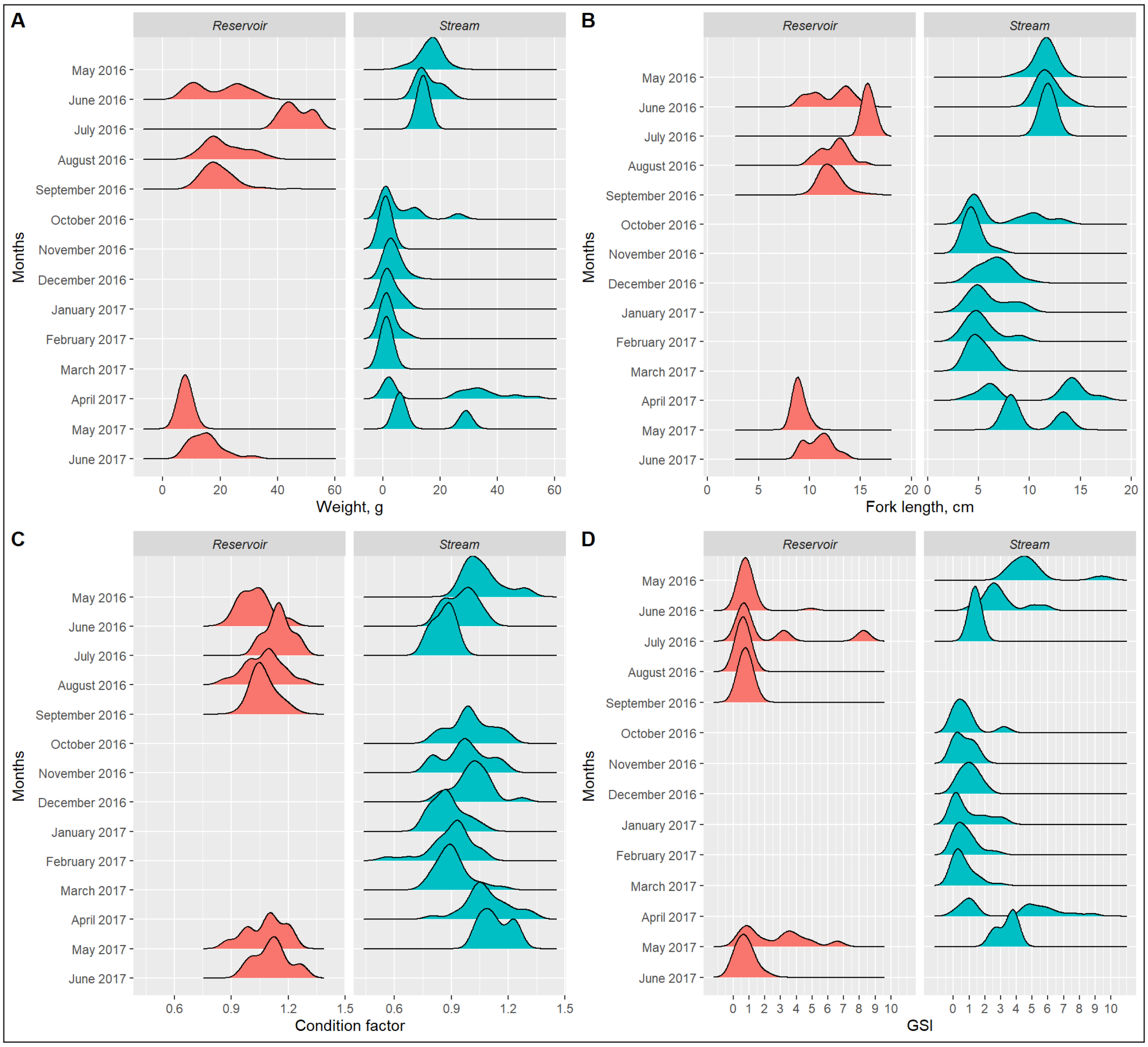

Figure 3. The monthly variation of the W (A), FL (B), condition factor (K), and GSI (D) values.

condition factor values during the spring months, which is consistent with the size distribution seen in stream and reservoir habitats. The maturity percentage of the mature specimens was 75.95% and of the immature specimens was 24.05%. There were no immature specimens in the reservoir. The sexes of 199 specimens were determined by macroscopic identification and the female:male ratio was determined to be F:M = 1:2.83. In the reservoir habitat F:M was determined to be 1:3.04 and in stream habitat F:M was 1:2.55.

The weight frequencies were evaluated according to the habitats, and it was determined that the frequent weights in stream habitats were 0.27-2.91 g (Figure 4A). In the reservoir habitat, the highest weight frequency was determined to be 18.01-19.88 g. The fork length frequencies of the specimens were evaluated according to the habitats, and it was determined that the small specimens were frequently present in streams while the larger specimens were in the reservoir habitats (Figure 4B). When the condition factors of the specimens were evaluated, it was determined that the condition factors of the specimens in the reservoir habitat were higher than in the stream habitat (Figure 4C). The GSI frequency values of the specimens were between 0.06-1.33% both in reservoir and stream habitats (Figure 4D). These values were more frequent in the reservoir habitats than in the stream habitats.

The difference in both fork lengths and body weights between reservoir and stream specimens was statistically significant (fork length t: 13.97; $p<0.05$; body weight t: 10.5; $p<0.05$). Additionally, the condition factor values were statistically significant between the reservoir and stream habitat specimens (t: 7.8; $p<0.05$). According to the GSI values, the difference between the reservoir and stream habitats was statistically important (t: 3.36; $p<0.05$). While the GSI values in the reservoir habitats for females and males were statistically important (t: 2.25; $p<0.05$), on the other hand, stream habitats for females and males were not statistically important (t: 1.6; $p>0.05$).

The LWR of all specimens was determined to be logW=-2.12+3.13logFL (r^2=0.99) (Figure 5A). The *LWR* of specimens was determined in the reservoir habitat to be logW=-1.96+2.99logFL (r^2=0.97*)* and in stream habitats to be logW=-2.11+3.12logFL (r^2=0.99) (Figure 5B). All specimens' growth was defined positive allometric (*b*=3.13), the reservoir specimens' growth was defined isometric (*b*=2.99), and the stream specimens' growth was defined positive allometric (*b*=3.12) (Table 2). The LWRs linear model parameters are given in Table 2.

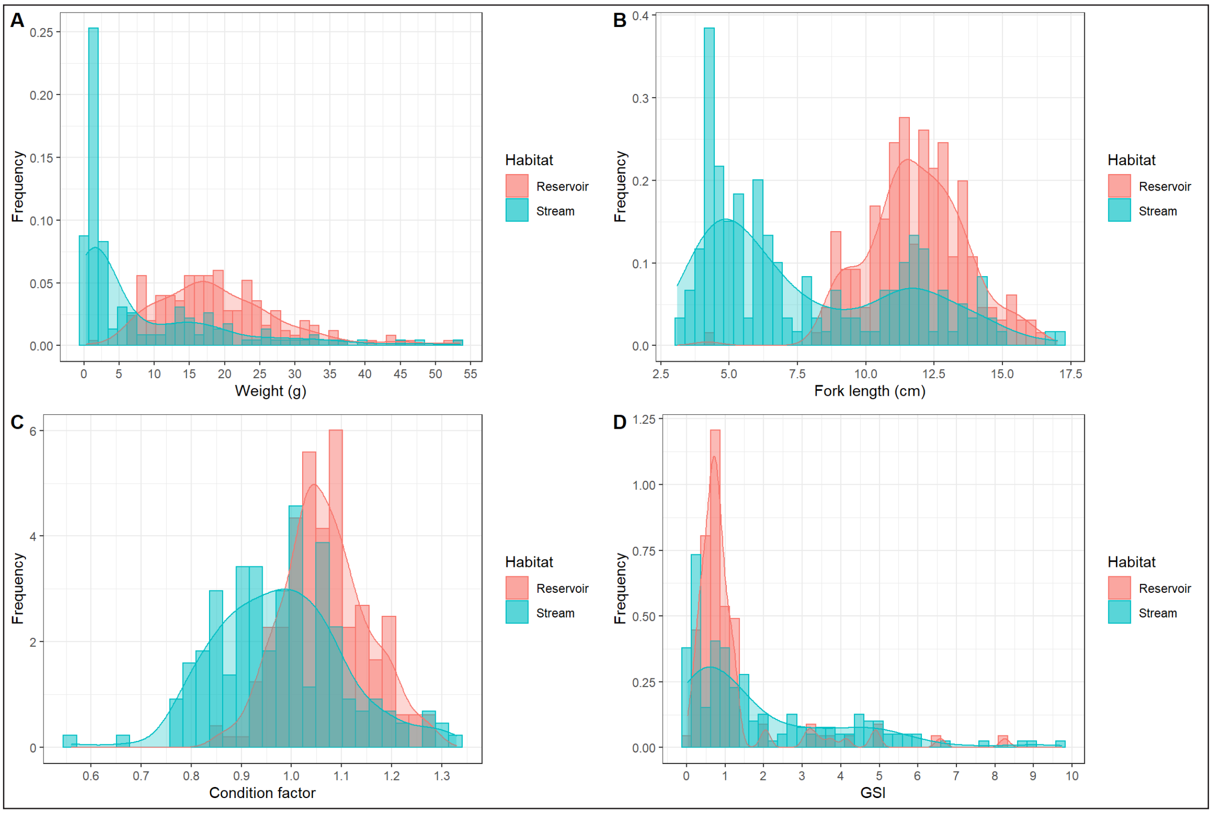

Figure 4. The frequencies and densities of weight (A), fork length (B), condition factor (K), and GSI (D) according to habitats.

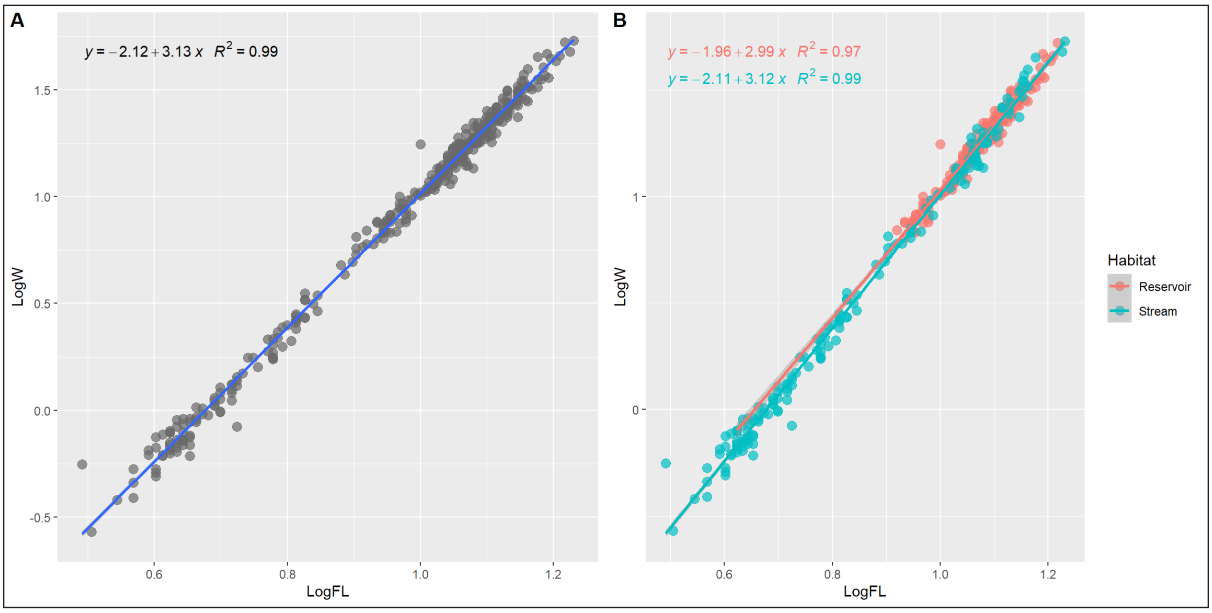

Fig. 5. The length-weight relationship of *A. istanbulensis* for all specimens (A) and habitats (B).

Table 2. The length-weight relationships parameters according to all, reservoir, and stream specimens (*n*: Number of specimens; *a*: Intercept of linear regression; *b*: Slope of linear regression; *CI*: Confidential interval; r^2: Coefficient of determination (*R<0.05*)).

Parameters of the length-weight relationships									
Group	***n***	***a***	***95% CI of a***		***b***	***95% CI of b***		r^2	***Growth type***
All specimens	352	0.0076	0.007	0.008	3.1333	3.105	3.161	0.99	Positive allometric
Reservoir specimens	184	0.0109	0.009	0.014	2.9858	2.896	3.068	0.97	Isometric
Stream specimens	168	0.0078	0.007	0.008	3.1219	3.077	3.166	0.99	Positive allometric

Discussion

There are limited studies on the biological characteristics of *A. istanbulensis* in the literature. The majority of the studies in the literature include information on their distribution area and/or abundance in the communities in distribution areas (Sarı et al., 2006; Özuluğ, 2008; Geiger et al., 2014; Saç & Özuluğ, 2014; Boll et al., 2016; Gaygusuz et al., 2017; Saç & Özuluğ, 2017a, b, c; Özuluğ & Saç, 2019; Sarı et al., 2019; Çiçek et al., 2020). Therefore, this study is important in terms of filling the gaps in the literature about the biological characteristics of *A. istanbulensis*.

Although the length and weight distributions of *A. istanbulensis* species in river habitats are comparable to those found in the literature (Başdemir et al., 2010; Yalçın Özdilek & Jones 2014), they are not the same as those found in reservoir habitats. In reservoir habitats, the length and weight distributions of *A. istanbulensis* species are more variable. The weight and fork length ranges of specimens were found to be lower in the Bayramiç Reservoir compared to what was described in the literature for the reservoir (Çiçek et al., 2015; Saç & Okgerman, 2016). Except in Darlık Dam, the specimens' fork lengths were lower than in Bayramiç Reservoir (mean: 6.0±2.7 cm; min-max: 1.9–14.5 cm) (Gaygusuz et al., 2017). In the current research, the seine net was used along the coastline of the reservoir; however, in the aforementioned literature, a broad variety of mesh sizes were utilized, which most likely sampled the pelagic, deeper area of the reservoir. Therefore, the gear selectivity might be the reason why smaller specimens were sampled in the reservoir's habitat as compared to what was reported in the literature, because it is well documented that the genus *Alburnus* spreads via pelagic herds in the environs of reservoirs and lakes (Kottelat & Freyhof, 2007).

In terms of the condition factor values, the results were comparable to those found in the previous research conducted in reservoir habitats (Çiçek et al. 2015; Saç

& Okgerman, 2016). The estimated mean value of the condition factor for the samples from the Bayramiç Reservoir was higher than the calculated value for the samples from the Karamenderes River. The higher condition factor value in reservoir habitat than that in the stream habitat might be explained by various reasons such as age, sex, sexual maturity, feeding characteristics, gonad status, habitat, and length and weight distribution of specimens (Le Cren, 1951; Kırankaya et al., 2014). Even though every single specimen in the Bayramiç Reservoir had attained maturity, the mean GSI value of the reservoir was lower than that of the stream specimens. This was due to the fact that the reservoir was much larger. Therefore, it is not entirely accurate to suggest that reaching sexual maturity is the sole factor contributing to the higher condition value. There is no information available on condition factors in river habitats; nevertheless, the current condition factor value that was estimated for stream specimens represented the first data for this species.

Regarding the GSI values of the species, the GSI values are higher for both sexes in the Darlık Dam (Female: 0.19-16.05; Male: 0.25-8.63) (Hamzaoğlu et al., 2015) than that in this study (Female: 0.36-8.25; Male: 0.06-4.91) for Bayramiç Reservoir specimens. Additionally, the GSI values of the species in the earlier study, which was carried out in the Ömerli Reservoir, ranged from 8.2 to 9.9 between 2002 and 2007 (yearly values) (Tarkan et al., 2012). Among the general characteristics of the *Alburnus* genus, it is known that populations in lakes with reservoirs lay eggs in the entrance branches of the reservoirs (Kottelat & Freyhof, 2007). The results of this study support the general reproduction characteristics of the genus *Alburnus* due to its higher GSI values in stream habitats (mean GSI: 1.91±2.06; min-max: 0.03-9.73).

When the length-weight relationships of the species were compared with the studies conducted in the stream habitats, it was ascertained that while isometric (b=2.99) growth was reported in the study of Çakırköy Stream in Çanakkale (Başdemir et al. 2010), positive allometric growth (b=3.12) was found in Karamenderes River. However, it was found that the growth of specimens in the reservoir habitats was isometric in both Bayramiç and Büyükçekmece Reservoirs (Saç & Okgerman, 2016). In the previous study conducted in the Marmara region, positive allometric growth was observed in Ömerli Reservoir, Terkos Reservoir, and Sapanca Lake, whilst negative allometric growth was observed in Büyükçekmece Reservoir (Tarkan et al., 2006). It has been observed that the *A. istanbulensis* species growth in Bayramiç Reservoir differed from that in other Marmara region reservoirs and natural lakes (Tarkan et al., 2006). According to this study, the population of *A. istanbulensis* in Bayramiç Reservoir grows slowly compared to the stream habitat. It is possible to conclude that both the length-weight relationship and the growth parameters were influenced by hereditary and environmental factors (Svanbäck & Eklö, 2002). The *A. istanbulensis* populations in this research were influenced by the ecological circumstances of the habitats in which they are found, suggesting that the Karamenderes and Bayramiç Reservoir populations are not genetically isolated. Further research is needed about the habitat and ecological preferences of this species.

The occurrence of the alien species *Atherina boyeri* was reported in the previous study at the Bayramiç Reservoir (Partal et al., 2019). It is known that *A. boyeri* species are distributed in the pelagic zone in reservoir/lake habitats (Kottelat & Freyhof, 2007). Considering that the two species share the same habitat, the effects of *A. boyeri* on *A. istanbulensis* are highly likely in the following years. For this reason, the community relations of the endemic *A. istanbulensis* species with other alien/invasive and native species in the distribution area should be studied in detail.

Determining the biological characteristics of an endemic species makes an important contribution to the conservation of the species. In the Çanakkale region, data on LWR, growth, condition, and GSI values were not available with the current name of the species. Therefore, this study is important in terms of presenting new data in the Çanakkale region with the current name of the species. The conclusions of this study Show that *A. istanbulensis* species showed different LWR, growth, and condition characteristics according to the stream and reservoir habitats.

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SHORT COMMUNICATION/KISA BİLDİRİ

New Record of the Pelagic Octopods *Argonauta argo* (Linnaeus, 1758) off the Shore of the Northern Tip of the Gulf of Aqaba in Jordan

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Abstract
A few specimens of the pelagic octopod *Argonauta argo* (Linnaeus, 1758) were found after they were washed up by currents along the northern beach of the Gulf of Aqaba in Jordan. This article describes this record and provides a review of the species' sightings worldwide and their importance as prey in maintaining an ecological balance.
Keywords: *Argonauta argo*, Gulf of Aqaba, Jordan, Pelagic Octopods

Introduction

Jordan's Gulf of Aqaba extends for 27 km with a minimum width of 5 km and a maximum of 20 km (al Tawaha et al., 2019). Hulings (1979) stated the gulf to have minimal semi-diurnal tides ranging from 90–100 cm. Wind is considered the major force in water movement and transportation in the Gulf (Assaf & Anati, 1974), and the current has a clockwise direction (Hulings, 1979). The seawater temperature in the northern part of the Gulf of Aqaba ranges between 21-27º C (Al-Rousan et al., 2002; Manasrah et al., 2006), and has high salinity between 40.3-40.6 PSU (Manasrah et al., 2004).

The *Argonauta argo* is a species of pelagic octopod that inhabits the Mediterranean and other warm and temperate seas (Roper et al., 1984; Grove, 2014). Knowledge about their distribution is derived from Adam (1960), who described this species as being found between Cyprus and Turkey. Specimens have been reported from the Andaman Sea as a part of the Indian Ocean (Roper et al., 1984). Additionally, Ruby & Knudsen (1972) mentioned *Argonauta* but offered no additional records in their review of Cephalopoda from the Mediterranean 23° east of the meridian. In addition, this species was reported in the Western Pacific from Southern Hokkaido in Japan to New Zealand (Okutani et al., 1987; Nesis, 1987) and from California to Peru (Nesis, 1987). Records of this species have also been confirmed from the Western Atlantic (Nesis, 1987; Hochberg et al., 1992). This paper deals with the first observation of *Argonauta argo* in the Jordanian side of the Gulf of Aqaba and reaffirms its presence in the Red Sea.

Method

A few specimens of *Argonauta argo* were found along the shore of the northern beach at Aqaba in Jordan, where they were collected and identified by observing their morphometric features. *Argonauta argo* consists of a narrow keel with two rows of sharp tubercles along its length. This laterally compressed and calcareous structure increases in thickness to form a horn.

Results and Discussion

The first record of *Argonauta argo* in Jordan was confirmed in March 2021 after finding a few specimens washed up on the northern beach of the Gulf of Aqaba (see Figures 1 & 2). Records of this species in the Red Sea are very rare (Adam, 1960) and date from long ago. Therefore, this record is important as it confirms the existence of this species in the semi-closed Gulf of Aqaba. Specimens were reported in the Gulf of Eilat near the Jordanian borders after a southern storm almost 32 years ago (Mienis, 1980; Popper et al., 1990). Additional records were obtained from Wulker (1920), who examined several shells from Kosseir in the Stuttgart Museum. An extensive study was performed earlier on Red Sea cephalopods, but no records had been provided for the *Argonauta argo* (Adam, 1942, 1960).

Figure 1. Argonauta argo from the northern tip of the Gulf of Aqaba (© Mr. Kais Asfour).

Figure 2. *Argonauta argo* shell (© Mrs. Karen Asfour)

Argonauta argo is a cephalopod that survives at depths ranging between 0-200 m. The maximum mantle length in females is able to reach 12 cm, with a maximum shell length of 30 cm. The male is a shell-less dwarf, with the third left arm being a hectocotylus and a maximum total body length of 2 cm and maximum mantle length of approximately 7 mm (Roper et al., 1984, Mangold & Boletzky, 1987). This species tends to gather at the sea surface where it achieves neutral buoyancy (Jereb et al., 2014), while a few shells have been found washed up on beaches (Oliver, 1914). This can explain why few specimens have been found along the beach of the northern tip of the Gulf of Aqaba. The diet of *A. argo* consists of pelagic mollusks, small fish, and crustaceans (Orga, 2006). This animal is additionally considered prey for tunas, swordfish (Peristeraki et al., 2005), loggerhead turtles (Frick et al., 2009), seabirds (Nesis, 1977), and dolphins (Blanco et al., 2005; 2006).

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ERRATUM/DÜZELTME

Erratum to: New record and rare occurrence of European eel (*Anguilla anguilla*) from freshwater bodies in Karaburun Peninsula (İzmir, Türkiye): Anthropogenic pressures on the fish movements

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Erratum

After publication of the original article [1], it came to the authors' attention that there was an inadvertently missed information in Acknowledgement section.

The published version of Acknowledgement section is:

Acknowledgement

This study was financially supported by the T.C. Ministry of Environment, Urbanisation and Climate Change; General Directorate for Protection of Natural Assets. Fish samples gathered in this study were obtained from the project named "The Terrestrial Biodiversity Research Project of Karaburun-Ildır Bay Special Environmental Protection Area". The authors thank the T.C. Ministry of Environment, Urbanisation and Climate Change; General Directorate for Protection of Natural Assets for permission of the article publication.

The correct version of Acknowledgement section is:

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References

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