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Biological properties of European bitterling *Rhodeus amarus* (Bloch, 1782) in Dinsiz Stream, Turkey

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Abstract

The aim of this article was to some morphometric characteristics of Rhodeus *amarus* from Dinsiz Stream. A morphological analysis of 21 morphometric characters were done. These characteristics total length (TL); fork length (FL); standard length (SL); predorsal length; dorsal fin base length; dorsal fin length; head length; preorbital length; eye diameter; postorbital length; interorbital distance; body height; preanal distance; anal fin base length; anal fin length; pectoral fin base length; pectoral fin length; ventral fin base length; ventral fin length; caudal peduncle depth and weight (W). The samples were measured weight to the nearest 0.01 g and total, fork and standard length to the nearest 0.01 mm. The total length (TL) and weight (W min-max) of the fish were 4.2- 7.1 cm and 1.699- 7.444 g, respectively.

Keywords: Rhodeus amarus; European bitterling; morphometric properties; Dinsiz Stream Turkey

1. Introduction

Rhoeus amarus (Bloch, 1972) has a wide distribution throughout Europe, where it inhabits a range of standing and slow-flowing habitats (Przybylski & Zieba, 2000; Kottelat & Freyhof, 2007). European bitter *Rhodeus amarus*, a small Cyprinid with a unique reproductive pattern, puts its females in freshwater mussel gills, where embryos develop for several weeks (Smith et al., 2004). Males fertilize the eggs by releasing sperm into the inhalant siphon of the mussel (Smith et al., 2004). The habitat of bitterling is linked to the distribution of freshwater unionid mussels. Typical habitats are river backwaters, oxbows, lakes, ponds, and irrigation canals (Holcik, 1999).

Life expectancy is exceptionally up to five years, but most individuals do not survive in their first reproductive years and the population sizes change drastically over the years (Kottelat & Freyhof, 2007). It is most abundant in wet vegetation and sand silt bottom, lowland ponds, canals, slow-flowing rivers, singles, and still or slow-flowing waters with oxbows and mussels (Kottelat & Freyhof, 2007). It is found among plants in shallow waters, on the sand and muddy bottoms. It attracts attention with its habit of leaving its eggs in the bivalves cavity. It feeds mainly on plants and to a lesser extent with worms, crustaceans and insect larvae (Maitland & Campbell, 1992).

The bitterling oviposits its eggs inside the branchial cavity of the freshwater mussels of Unio and Anodonta species (Reynolds et al., 1997; Smith et al., 2000a, Smith et al., 2000b). To understand how life history features are shaped, the biological features of a fish species must be explored for each habitat, as several studies have revealed the evolution of life-history related to environmental conditions (Roff, 1992; Stearns, 1992).

Some properties of *Rhodeus amarus* was investigated by Przybylski and Garcia-Berthou (2004) in Wieprz-Krzna Canal, Poland (TL mean 37.1-64.4), age and growth of European bitterling; Zaki et al. (2008) in Europea, Transcaucasia, Asia Minor and Eastern Russia, morphological and genetic analysis; Patimar et al. (2010), in Siahroud River Iran, (TL 27-84 cm), life history pattern; Moreva et al. (2017) in Alatyr River, morphological characteristics, reproduction and food habits; Konecna and Reichard (2011), in small lowland river, seasonal dynamics in population characteristics; Bektaş et al. (2013) the phylogenetic position.

The field of fishery science has employed many tools such as genetics and morphometric to differentiate the fish population (Mirr et al., 2013). Morphometric measurements are widely used to identify differences between fish populations (Cheng et al., 2005; Bujl et al., 2008; Tores et al., 2010). Systematic and phylogeographic studies based on morphometry are built on a series of measurements that represent size and shape variation and are continuous data. Morphological characters are widely used in fisheries biology to measure discrepancy and relationships between various taxonomic categories (Turan, 1999). Fish classification systems can facilitate fish counting, stock evaluation of ecological effects,

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monitoring fish behavior (Benson et al., 2009). The present study examines biological properties of *Rhodeus amarus* from Dinsiz Stream.

2. Materials and methods

2.1. Study area

Dinsiz Stream flows from Karasu to the Black Sea by passing through Hendek, Akyazı and Adapazarı districts of Sakarya. Samples were taken from Dinsiz Creek (Fig. 1).

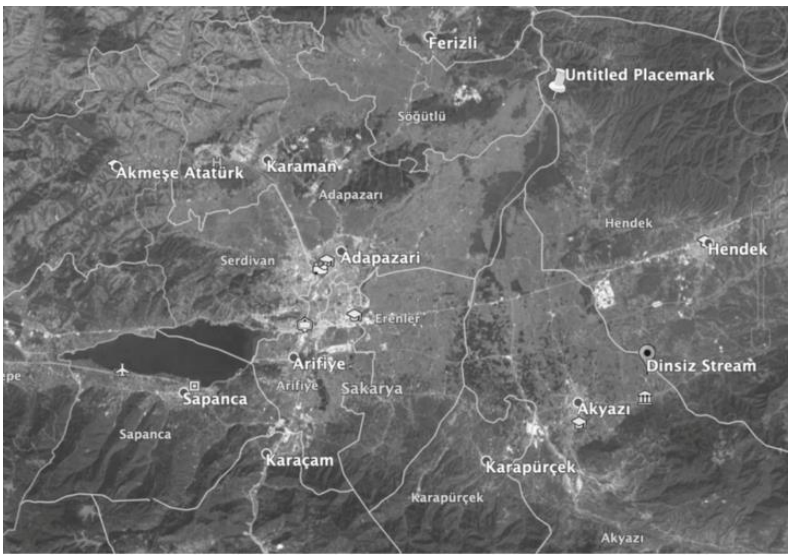

Figure 1. Study area (Dinsiz Stream)

Many streams such as Çark Stream, Dinsiz Stream, Mudurnu Stream, Darıçayır Stream, Karaçay Stream, Akçay Stream, Yırtmaç Stream, Sapanca Stream, Değirmendere are located on the Sakarya River.

2.2. Methodology

The samples, *Rhodeus amarus* were collected from Dinsiz Creek. During the study, 11 fish specimens were caught in 2016. The samples were preserved in %4 formaldehyde solution and measured weight to the nearest 0.01 g and total, fork and standard length to the nearest 0.01 mm. The characteristics were measurements for morphometric characteristics (Fig. 2).

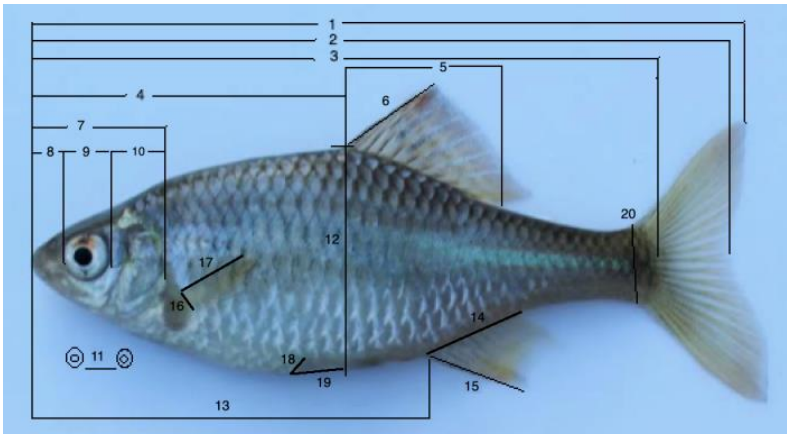

Figure 2. Morphometric characters for distance-based measurements. 1: total length; 2: fork length; 3: standard length; 4: predorsal length; 5: dorsal fin base length; 6: dorsal fin length; 7: head length; 8: pretorbital length; 9: eye diameter; 10: postorbital length; 11: interorbital distance; 12: body height; 13: preanal distance; 14: anal fin base length; 15: anal fin length; 16:pectoral fin base length; 17:pectoral fin length; 18:ventral fin base length; 19:ventral fin length; 20:caudal peduncle depth.

These characteristics were total length; fork length; standard length; predorsal length; dorsal fin base length; dorsal fin length; head length; preorbital length; eye diameter; postorbital length; interorbital distance; body height; preanal distance; anal fin base length; anal fin length; pectoral-fin base length; pectoral-fin length; ventral fin base length; ventral fin length; caudal peduncle depth and weight.

The length-weight relationship equation is the traditional calculation method used to determine the growth characteristics of fish populations. The length and weight values of the species were used for the relationship. The relations between total length (TL) and weight (W) for nearly all species of fishes can normally be represented by the "length-weight relationship" following equation:

$$W = aTL^b$$

W (g) is the weight of fish, L (cm) is the length of fish, “a” and “b” are constants. The parameter 'b' has an important biological meaning for fisheries, indicating the rate of weight gain relative to growth in length or the rate at which weight increases for a given increase in length. The growth is isometric if b=3 and the growth is allometric if b≠3 (negative allometric) (Rickter, 1973). The condition factor (CF) was calculated for all individual fish by using the conventional formula described by (Worthington & Ricardo, 1936):

$$CF = \mathrm{W}\,\frac{100}{L^3}$$

Where CF is condition factor, W (g) is the weight and L (cm) is the length.

3. Result and discussion

The standard length (SL) and weight (W min-max) of the fish were 4.20- 7.10 and 2.00- 3.40 g, respectively. A sample *Rhodeus amarus* was collected from Dinsiz Stream. 21 mensural characters, including SL, FL and TL and W were measured (Table 1). Length-weight relationships of *Rhodeus amarus* species in Dinsiz Stream were determined. The relationship was W= 0.01803262 SL $^{3.1538}$ (R^2= 0.942), W= 0.16594513 TL $^{2.0682}$ (R^2= 0.929) and W= 0.232557684 FL $^{1.8502}$ (R^2= 0.939) for all fish. Length-weight relationships equations for *Rhodeus amarus* are given in Fig. 3.

The condition factor (CF) of *Rhodeus amarus* was determined as 1.943-2.880 and 2.355 for min-max values and mean, respectively in Dinsiz Stream. Esmaeili et al. (2011) determined the average length values TL, FL, SL, head length, head depth, head width, maximum body depth, minimum body dept and weight of Rhodeus amarus individuals in Zarrineh River as 43.25, 39.51, 35.3, 9.39, 8.02, 5.59, 11.88, 3.88, and 1.11, respectively. Li et al. (2020) determined the range length of male as 23.6-33.2 (SL). Besides, according to % SL length value; head length, body depth, orbit diameter, predorsal length and caudal length has been determined as 22.9-25.6, 30.0-37.6, 7.6-9.5, 50.6-57.1 and 22.7-26.4.

Chan (2001) states that morphometric characters can change not only in populations but also in regions. It is stated that there are differences in morphological features and morphometric diversity of the population at the regional level (Francisco et al., 2006). Phylogenetically different freshwater fish have been shown to differ significantly between the ranges of their life stories (Mann et al., 1984; Lobon–Cervia et al., 1991 & 1996). Fish populations vary significantly in maximum size and age among habitats. This is about good habitat quality. Among other species of the Cyprinidae family, *Rhodeus amarus* has been found to have a reasonably short-lived fish and a life span not exceeding five years. The largest specimens of 84 mm (11.14 g) were in close agreements with 87 mm reported by Tarkan et al. (2005) for Ömerli Dam Lake's population of bitterling, another bitterling population in the southern limit of range distribution of this species. In the Elbe River systems, the females were larger than the males (Bauch, 1955), whereas Czech and Slovak's waters showed the opposite (Holcik, 1960).

Allometric growth was noted for several bitterling populations, and only the Severka River bitterling seemed to grow isometrically (b = 2.952) (Holcik,1999). The some properties of *Rhodeus amarus* was investigated by Koutrakis et al. (2003) in Rihios River, 1.2-8.3 (TL), b 3.035; Tarkan et al. (2006) in Marmara Lake, 5.7- 7.0 (TL), b=3.40; Patimar et al. (2010) in Siahroud River, 27-84 mm (TL) and 0.32-11.4 g for males and 30-64 mm (TL) and 0.52-4.06 g for females; Esmaeili et al. (2011) in Lake Orumiyeh, Mean 43.25 (TL), 39.51 (FL); İlhan et al. (2014) in Sakarya 1.60-6.90 cm (TL), 0.06-5.03 g (W), b 2.948, in Yeşilırmak 5.50- 6.90 cm (TL), 2.52-4.83 g (W), b 2.884; in Gediz 2.20-8.30 cm (TL), 0.16-10.65 g (W), b 2.865, in Batı Karadeniz 5.40-7.10 cm (TL), 2.21- 6.22 g (W), b 3.374); İlhan and Sarı (2015) in Marmara Lake, 2.80-6.50 cm (TL), 0.26-4.49 g (W); Saç and Okgerman (2016) in Büyükçekmece Reservoir, 5.3- 8.2 (TL); 1.37-449 g (W) b 2.837; Gaygusuz et al. (2017) in Darlık Stream 1.5-8.6 (TL), 1.4- 7.9 (FL), 1.2- 6.9 (SL); Moreva et al. (2017) in Alatyr River 41-76 mm (FL).

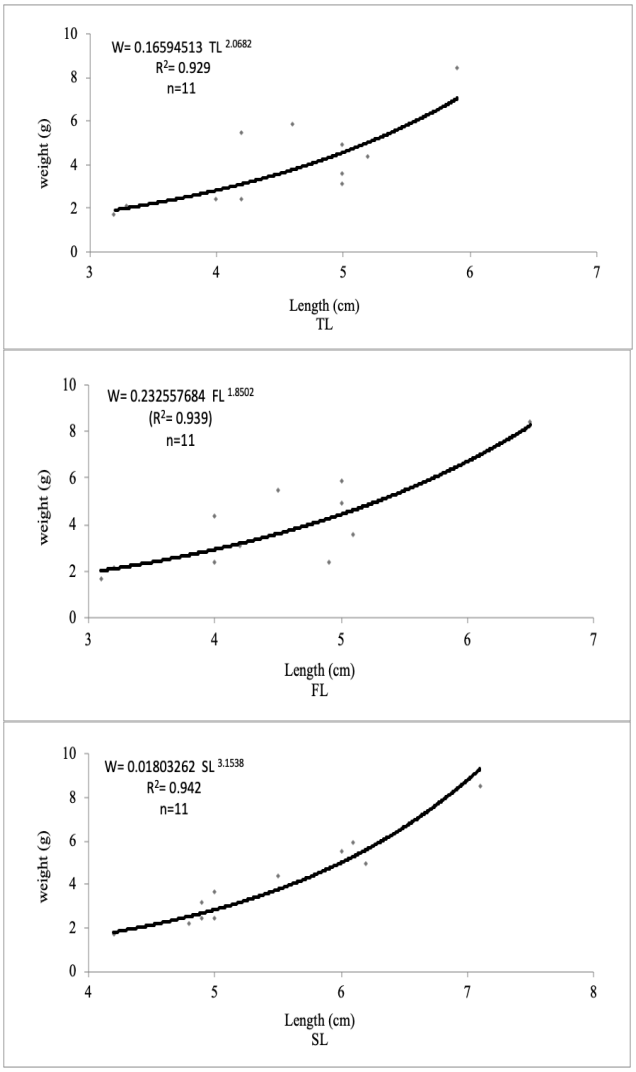

Figure 3. Length-weight relationships of *Rhodeus amarus*

Table 1
Morphometric characteristics of *Rhoeus amarus* specimens.

Parameters	Min	Max	Average	SD	CI	Margin of error	Upper bound	Lower bound
Standard Length	4.200	7.100	5.427	0.837	0.494	0.125	5.922	4.933
Fork Length	3.100	6.500	4.500	0.962	0.569	0.165	5.069	3.931
Total Length	3.200	5.900	4.509	0.823	0.486	0.121	4.995	4.023
Body Weight	2.000	3.400	2.945	0.446	0.263	0.035	3.209	2.682
Head length	0.800	1.500	1.027	0.205	0.121	0.008	1.149	0.906
Preorbital distance	0.600	0.800	0.691	0.083	0.049	0.001	0.740	0.642
Eye diameter	0.700	1.500	1.073	0.228	0.135	0.009	1.208	0.938
Postorbital distance	0.200	0.400	0.300	0.063	0.037	0.001	0.337	0.263
Head depth	0.200	0.400	0.300	0.063	0.037	0.001	0.337	0.263
Predorsal distance	0.200	0.500	0.355	0.104	0.061	0.002	0.416	0.293
Prepelvic distance	0.200	0.600	0.418	0.108	0.064	0.002	0.482	0.354
Preanal distance	0.900	2.400	1.409	0.549	0.324	0.054	1.733	1.085
Pectoral fin - pelvic fin distance	2.200	4.100	2.845	0.497	0.294	0.044	3.139	2.552
Pelvic fin - anal fin distance	0.500	1.200	0.836	0.234	0.138	0.010	0.974	0.698
Body depth	0.400	1.000	0.645	0.181	0.107	0.006	0.752	0.539
Dorsal fin (anterior end) – anal fin distance	0.300	1.500	0.800	0.338	0.200	0.020	1.000	0.600
Dorsal fin (posterior end) – anal fin distance	0.100	0.500	0.300	0.126	0.075	0.003	0.375	0.225
Postdorsal distance	0.500	1.200	0.709	0.221	0.131	0.009	0.840	0.578
Postanal distance	0.200	0.600	0.373	0.127	0.075	0.003	0.448	0.298
Caudal peduncle length (dorsal)	0.400	1.000	0.636	0.169	0.100	0.005	0.736	0.537
Caudal peduncle length (ventral)	0.400	0.800	0.545	0.144	0.085	0.004	0.631	0.460
Caudal peduncle depth	1.699	8.444	4.043	2.031	1.200	0.735	5.243	2.843

4. Conclusion

This article explains the area where *Rhodeus amarus* is located and records the morphometric data of the population. The findings obtained in this study are very important because previous studies on the morphometric properties of *Rhodeus amarus* have not been identified. It is considered that the data

obtained in this article will contribute positively to future studies.

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