




Population structure and some growth properties of endemic *Aphanius marassantensis* Pfliegerer, Geiger & Herder 2014 in Süreyyabey Dam Lake, Turkey

Semra Benzer

Gazi University, Gazi Faculty of Education, 06500, Teknikokullar, Ankara, Turkey

Correspondence

Semra Benzer; Gazi University, Gazi Faculty of Education, 06500, Teknikokullar, Ankara, Turkey

 sbenzer@gazi.edu.tr and sbenzer@gmail.com

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Abstract

The present study was carried out to assess the population structure, growth and condition factor of *Aphanius marassantensis* Pfliegerer, Geiger & Herder 2014 in Süreyyabey Dam Lake, Turkey. The age of *A. marassantensis* ranged between 0+ and 3+ years. The sex percentage was determined as 62.30% males and 37.70% females. Total length and body weight of individuals ranged from 2.8 – 4.10 cm and 0.305 – 1.371 g respectively. The von Bertalanffy growth equations were calculated as $L_t = 384.001 [1 - e^{-0.235(t + 0.88)}]$; $W_t = 1365.52 [1 - e^{-0.235(t + 0.88)}]^{3.1217}$. The condition factor for all individual was 1.676.

Keywords: *Aphanius marassantensis*; growth; Süreyyabey Dam Lake; von Bertalanffy's parameters

1 | INTRODUCTION

Anatolia, also known as Asia Minor is regarded as the centre of diversity of the killifish genus *Aphanius* (Wildekamp *et al.* 1999). *Aphanius* is currently represented by at least 14 extant species in Anatolia, 12 of which are endemic (Pfliegerer *et al.* 2014). The species name of *Aphanius marassantensis* was updated as *Anatolichthys marassantensis* in the study by Freyhof and Yoğurtçuoğlu (2020), but explanations against this name were made (Teimori *et al.* 2020). The typical habitats of *Aphanius* in this region are springs, small creeks and marshes (Hrbek *et al.* 2002). The ecological tolerance of *Aphanius* permits *Aphanius* populations to persist in restricted and extreme habitats (Wildekamp *et al.* 1999).

Due to their role in the food chain and the number of endemic species in their genus, they are very important for ecosystems (Leonardos and Sinis 1999). They used *Aphanius* for biological control against mosquitos (WHO 2003; Yıldırım and Karacuha 2007). The *Aphanius* population, previously known as endemic *Aphanius*

danfordii, was defined as *Aphanius marassantensis* in Kızılırmak (Pfliegerer *et al.* 2014). The occurrence of this species at Yeşilirmak Basin has been reported earlier (e.g. Hrbek *et al.* 2002; Benzer 2018).

Aphanius species has been examined for parasitic fauna (Öztürk and Özer 2008); age, sex structure, and growth (Karslı and Aral 2010; Güçlü 2012; Yoğurtçuoğlu and Ekmekçi 2013, 2015; Keivany and Zaman-Faradonbe, 2016; Sarı *et al.* 2017; Freyhof *et al.* 2017; Benzer 2018; Yoğurtçuoğlu and Freyhof 2018; İnnal *et al.* 2019; Teimori *et al.* 2019; İnnal 2020; Erguden 2020; Yoğurtçuoğlu *et al.* 2020); feeding behaviour (Yıldırım and Karacuha 2007); DNA properties (Esmaili *et al.* 2020). Length-weight relations (LWRs) are applied for the evaluation of fish stocks and give information on their growth and condition patterns (Ricker 1973). LWRs of fishes are important in fisheries and biology and ecology of fishes (Froese 2006). The study aimed to provide the growth characteristics of *Aphanius marassantensis* in Süreyyabey Dam Lake.

2 | METHODOLOGY

2.1 Study area

Süreyyabey (Çekerek) Dam Lake is located 82 km north-east of Yozgat and lies within the coordinates 35°28'N – 35°33'N latitudes and 39°55'E – 40°03'E longitudes. Fish specimens ($n = 326$; male = 212, female = 114) were caught by commercial fishermen while fishing *Atherina boyeri*, which was traded from Süreyyabey Dam Lake between April 2016 and April 2017.

Sex was determined by external morphologic characteristics. Males have 6 – 10 dark grey (or black in breeding conditions) vertical bars. The dorsal and anal fins are pale grey, but fully black in breeding conditions. The caudal fin is colourless with two vertical thin black to grey bars. Females have irregular dark grey spots on both sides of their silver body and lighter interconnected spots on their dorsal side. All the fins are colourless (Yoğurtcuoğlu and Ekmeççi 2014). The samples were preserved in 4% formaldehyde solution and transported to the laboratory and measured weight to the nearest 0.001 g and lengths to the nearest 0.01 mm.

2.2 Growth equations

TABLE 1 Total length, weight and condition factor of *Aphanius marassantensis* in Süreyyabey Dam Lake.

Age	N	Female			N	Male		
		TL ± SE	W ± SE	CF ± SE		TL ± SE	W ± SE	CF ± SE
0+	38	2.56±0.14	0.276±0.06	1.619±0.23	96	2.63±0.10	0.308±0.06	1.688±0.27
1+	61	3.26±0.19	0.620±0.17	1.765±0.33	104	3.02±0.17	0.480±0.11	1.717±0.22
2+	13	3.78±0.17	1.068±0.21	1.967±0.27	10	3.71±0.16	1.060±0.06	2.082±0.16
3+	2	4.35±0.21	1.906±0.00	2.332±0.34	2	4.05±0.07	1.371±0.00	2.165±0.11

N, number of fish; TL, total length (cm); W, weight (g); CF, condition factor. All $p > 0.05$.

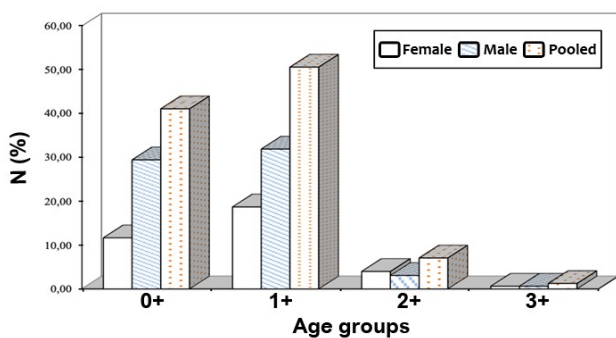


FIGURE 1 The age distribution of *Aphanius marassantensis* in Süreyyabey Dam Lake.

4 | DISCUSSION

In this study, the age range of *Aphanius marasantensis* in Süreyyabey Dam Lake was determined between 0+ to 3+. The age range of *A. anatolia* was investigated by Güçlü (2012) in Eğirdir Lake and recorded between I and IV years. Whereas this was 0 – II years in Sırakaraağaçlar Stream for *A. chantrei* (Karslı and Aral 2010) and 0 – VI years for *A. fasciatus* in Greece (Leonardos and Sinis 1999) (Table 2).

The relations between length (L) and weight (W) for nearly all species of fishes can normally be represented by the "length-weight relationships" as $W = aL^b$ (Ricker 1973). Growth was estimated using the von Bertalanffy (VB) growth equations, $L_t = L_\infty [1 - e^{-K(t-t_0)}]^b$ $W_t = W_\infty [1 - e^{-K(t-t_0)}]^b$ (Sparre and Venema 1992). The condition factor (CF) was calculated for all individual fish for *Aphanius marassantensis* by using the conventional formula described as $CF = W \frac{100}{L^3}$ (Worthington and Ricardo 1936).

3 | RESULTS

The length and weight of *Aphanius marasantensis* varied from 2.3 – 4.5 cm and 0.196 – 1.906 g respectively. Mean (\pm SD) length and weight were 2.96 ± 0.4 cm and 0.48 ± 0.3 g respectively. The female to male population ratio was 0.54 : 1 and the composition and sex ratios of age groups in the population are shown in Table 1 and Figure 1. Length-weight and von Bertalanffy equations were examined and the results for female and male individuals are shown in Figures 2 – 3.

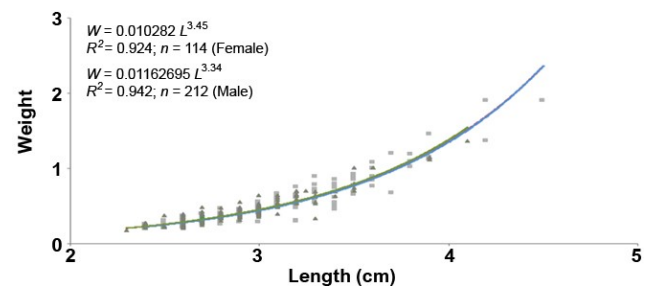


FIGURE 2 Length-weight relationships of *Aphanius marassantensis* in Süreyyabey Dam Lake.

The age composition showed that males were dominant in the higher age classes. The number of males in 0+, 1+ and 2+ year age groups was more than the number of females (Table 1). The maximum age of *Aphanius* species varies between 2+ and 7+ (Leonardos and Sinis 1999; Kamal *et al.* 2009). However, the length and weight of females were higher than males in upper age classes. This may be a result of the early maturation of males, consuming their energy for reproduction rather than growth (Wootton 1990). Female length and weight were greater than male in 1+, 2+ and 3+ year age groups (Table 1). The range of length and weight, a and b value of LWR param-

eters, number of individuals, total age, von Bertalanffy parameters (W_{∞} , L_{∞} , k , t_0) and condition factor (CF) have been summarised in Tables 2 – 3.

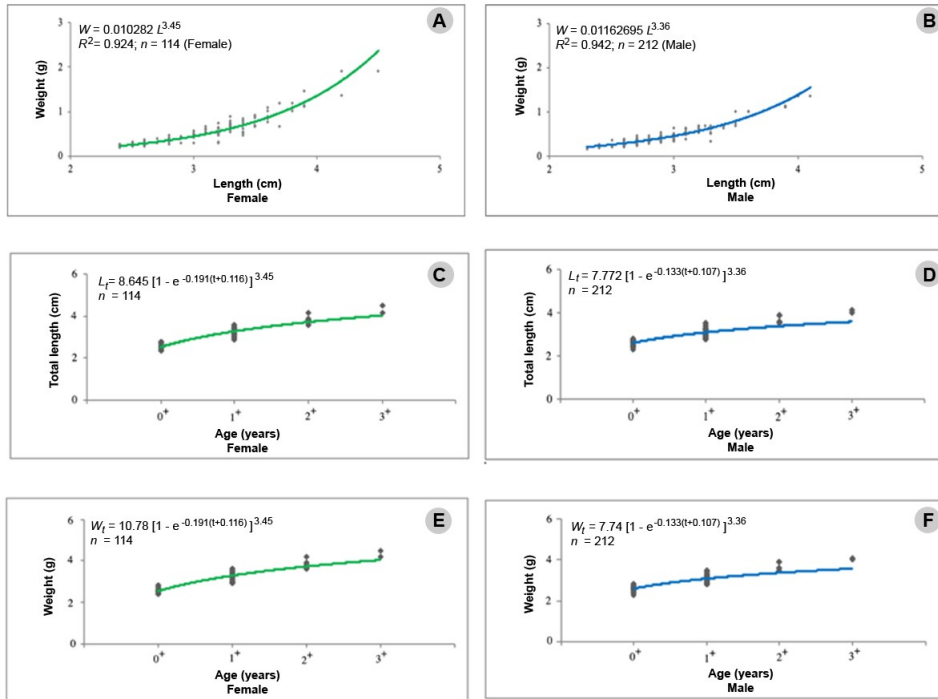


FIGURE 3 LWR equation of female (A); LWR equation of female (B); VB equations for length-age of female (C) and male (D); VB equations for weight-age of female (E) and male (F).

TABLE 2 LWR parameters of *Aphanius* spp. in literature.

References Area	Species	Age	N	TL	W	a	b	r ²
Innal <i>et al.</i> (2019)	<i>A. iconii</i>	4	206 ^c	2.1–4.2	0.102–0.800	152 10 ⁻⁴	2.71	0.92
Lake District	<i>A. saldae</i>	4	525 ^c	2.8–5.2	0.180–1.030	133 10 ⁻⁴	2.59	0.91
	<i>A. sureyanus</i>	4	350 ^c	1.2–4.5	0.029–1.025	77 10 ⁻⁴	3.22	0.96
	<i>A. transgrediens</i>	4	165 ^c	2.0–6.1	0.088–2.330	118 10 ⁻⁴	3.03	0.97
	<i>A. transgrediens</i>	144	2.0–4.7	0.15–1.94	262 10 ⁻⁴	2.66	0.939	
Sarı <i>et al.</i> (2017) Lake Acıgöl	<i>A. transgrediens</i>	16	2.3–4.0	0.32–0.82	145 10 ⁻⁴	3.06	0.939	
		160	2.0–4.7	0.15–1.94	237 10 ⁻⁴	2.73	0.936	
	<i>A. dispar</i>	-	10 ^c	2.6–3.5	0.22–0.57	105 10 ⁻⁴	3.24	0.97
Faradonbe (2016) Zohreh River	<i>A. marassantensis</i>	-	385 ^c	2.39–6.60	0.23–6.83	111 10 ⁻⁴	3.40	0.965
Yoğurcuoğlu and Ek- mekçi (2015) Hirfanlı Resorvoir	<i>A. dandfordii</i>	5	1224 ^a			3 10 ⁻⁶	3.46	0.978
			1010 ^b			4 10 ⁻⁶	3.45	0.964
			2252 ^c			4 10 ⁻⁶	3.44	0.977
Güçlü 2012 Lake Eğirdir	<i>A. anatoliae</i>	3	251 ^a	2.1–5.28				
			271 ^b	1.6–4.3				
			522 ^c			232 10 ⁻⁴		0.826
Karslı and Aral (2010) Sırakarağaçlar Stream	<i>A. danfordii</i>	3	233 ^a	1.8–5.0	0.11–2.67	135 10 ⁻⁴	3.2	0.989
			219 ^b	1.9–4.8	0.11–1.77	144 10 ⁻⁴	3.2	0.983
			452 ^c	1.8–5.0	0.11–2.67	139 10 ⁻⁴	3.2	0.987
This study Süreyyabey Dam Lake	<i>A. marassantensis</i>	4	114 ^a	2.9–4.5	0.29–1.91	0.1 10 ⁻⁶	3.45	0.924
			212 ^b	2.8–4.1	0.31–1.37	1.1 10 ⁻⁶	3.36	0.942

^a female; ^b male; ^c all fish; N, number of fish.

TL, total length; W, Weight; a, constant; b, allometry coefficient; r², correlation coefficient

TABLE 3 von Bertalanffy parameters and condition factor parameters of *Aphanius* spp. in literature.

References Area	Species	Age	N	W_{∞}	L_{∞}	k	t_0	CF
Yoğurtcuoğlu and Ekmekçi (2012)	<i>A. dandfordii</i>	5	1224 ^a 1010 ^b 2252 ^c		126.63 61.2	0.09 0.19	2.35 2.76	
Kızılırmak Basin Güçlü (2012) Lake Eğirdir	<i>A. anatoliae</i>	3	251 ^a 271 ^b 522 ^c		54.51	0.28	1.36	
Karslı and Aral (2010) Sırakaraağaçlar Stream	<i>A. danfordii</i>	3	233 ^a 219 ^b 452 ^c					
This study	<i>A. marassantensis</i>	4	112 ^a 212 ^b	10.78 7.74	8.645 7.772	0.191 0.133	0.116 0.107	2.03 2.85

^a female; ^b male; ^c all fish; N, number of fish.

The *b* value in fish varies depending on sex, age, season, physiological conditions, growth and feeding status of fish (Ricker 1973). For the study of *A. marassantensis* in the present study, the *b* values (female: 3.45; male: 3.36) were in agreement with some previous studies (Table 2). Condition factor, one of the important indicators of growth, varied between 2.03 to 2.85 for *A. marassantensis* in Süreyyabey Dam Lake. Fish that are heavier in a given size are considered to have better condition.

5| CONCLUSIONS

The main purpose of the present investigation was to study growth in *Aphanius marassantensis*. Thus, the present study provides the information on the population structure (age, growth and sex ratio) of a member (*Aphanius marassantensis*) of the Cyprinodontidae family in Süreyyabey Dam Lake which might be of interest for the sustainable management of the population in the study area.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

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S Benzer  <https://orcid.org/0000-0002-8548-8994>