

Length-Weight Relationships of *Paraphanius similis* in Mamasın and Seyhan Reservoirs (Turkey)

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Abstract

The length-weight relationship of *Paraphanius similis* in the Mamasın (Aksaray) and Seyhan (Adana) reservoirs were studied on the basis of n=193 fish specimens (n_{females}=85; n_{males}=108). Fish samples were collected using seine net net in 2016 year. The length-weight relationship was found as $W=0.011 L^{3.589}$ (r=0.982) for females and $W=0.015 L^{3.406}$ (r=0.939) for males in Mamasın Reservoir; it was found as $W=0.017 L^{3.083}$ (r=0.980) for females and $W=0.008 L^{3.725}$ (r=0.974) for males in Seyhan Reservoir. The present study considers the first record and comprehensive information on the length-weight relationship of *P. similis* in the Mamasın Reservoir. The results of this study might support to the conservation of this species and contribute the knowledge on its ecology and biology.

Keywords: Endemic species, freshwater fishes, killifish, Cyprinodontidae.

Mamasın ve Seyhan Barajlarında Dağılım Gösteren *Paraphanius similis*'in Boy-Ağırlık İlişkisi (Türkiye)

Öz

Mamasın (Aksaray) ve Seyhan (Adana) barajlarındaki *Paraphanius similis* türünün boy-ağırlık ilişkisi n=193 (n_{dişi}=85; n_{erkek}=108) balık ölçümü yapılarak incelenmiştir. Balık örnekleri 2016 yılında ıgırıp kullanılarak toplanmıştır. Boy-ağırlık ilişkisi Mamasın Barajı'ndaki dişi bireyler için $W=0.011 L^{3.589}$ (r=0.982) olarak, erkek bireyler için $W=0.015 L^{3.406}$ (r=0.939) olarak; Seyhan Barajı'ndaki dişi bireyler için $W=0.017 L^{3.083}$ (r=0.980) olarak; erkek bireyler için $W=0.008 L^{3.725}$ (r=0.974) olarak bulunmuştur. Bu çalışma, *P. similis*'in Mamasın Barajı'nda kaydı verilen ve türün oradaki boy-ağırlık ilişkisi hakkında bilgi içeren ilk çalışmadır. Çalışmanın sonuçlarının türün ekolojisi ve biyolojisi hakkında bilgi sahibi olunmasına katkıda bulunması ve türün azalmakta olan popülasyonunun korunmasını desteklemesi beklenmektedir.

Anahtar Kelimeler: Endemik türler, tatlısu balığı, dişli sazancık, Cyprinodontidae.

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1. Introduction

Aphanius genus belong to the Cyprinodontidae fish family. Distinctly the other species of the family which are native to America, *Aphanius* species are native to southern Europe, southwestern Asia and northern Africa. Some of the species in the genus are microendemic species and live in to only a very small region.

Aphanius is a very rich genus with most of the identified species endemic to Turkey (Kosswig, 1955; Wildekamp et al., 1999; Yoğurtçuoğlu and Ekmekçi, 2013). The genus *Aphanius* have more than 20 species which are distributed along the ancient coast of the Tethys Sea (Kosswig, 1955; Villwock and Franz, 1972; Wildekamp et al., 1999). *Aphanius* members are Cyprinodontiform fishes and their distribution has also been effected by glacial period and interglacial period differences in the Mediterranean Sea (Wildekamp et al., 1999).

There are many study about the species and subspecies of the genus *Aphanius* in Turkey (Wildekamp et al., 1999). Molecular phylogeny and biogeography of the *Aphanius* genus have been searched (Hrbek et al., 2002). There is a comprehensive study about their genetic relationships between Anatolian species and subspecies of *Aphanius* (Bardakçı et al., 2004; Hrbek and Meyer, 2003). There is a study about on their population and growth features of *A. anatoliae* (Güçlü et al., 2007). Moreover there is a study for a new genetic structure of the killifish family Aphaniidae, with the description of *A. teimorii* (Freyhof and Yoğurtçuoğlu, 2020).

The genus *Aphanius* has an important genus for fish biodiversity but it has no economic importance. According to the IUCN Red List, some of the genus members are seriously threatened. In addition, some of the species of this genus uses for aquariums and also they are using in laboratory studies (Güçlü, 2003; Sezen, 2011).

Paraphanius similis (namely *Aphanius mento*) distributes in shallow freshwater close to vegetation. They feed on crustaceans, insect larvae, algae and breeds during the warmer months of the year (Krupp and Schneider, 1989). They are subtropical species and they live in 10-25°C (Baensch and Riehl, 1985). Reproduction period of the species is from May to July (Güçlü, 2003; Küçük and İkiz, 2004). In reproduction period, the color of male specimens are dark blue or navy-blue, while females are gray, brown or green. Their maximum length is 5 cm (Huber, 1996). They can easily maintain in the aquarium (Huber, 1996).

They spread in the southeast and west of Iraq, in the north of the Arabian Peninsula, Syria, in the coastal river systems in Lebanon, Syria and Israel (Wildekamp, 1993). In Turkey, they were recorded in Seyhan and Ceyhan rivers (in Elbistan District), the branches of the Fırat River, Kırkgöz Spring (Antalya), Aksu Stream (Antalya), Yeşilada (Samandağ) and Akgöl (Konya) lakes (Güçlü, 2003).

In the literature, there are many studies about on *P. similis* which are focusing on their systematic features, morphologic characters, growth parameters, feeding, reproduction characters and their embryological and larval development periods (Wildekamp et al., 1999; Güçlü and Küçük, 2008; Sezen, 2011; Güçlü and Küçük, 2011; Alagöz Ergüden, 2015).

The field area of the present study were Mamasın and Seyhan reservoirs. Mamasın Reservoir is located in the Central Anatolia Region (38°24'05" N, 34°07'57" E). It is on Ulurmak Stream, 12 km east of Aksaray (Gücünkaya) and it uses for the purpose of irrigation. Seyhan Reservoir is located in Mediterranean Region of southern Turkey (37°02'56" N, 35°18'54" E). It is 15 km above Adana (Çukurova) and it is a reservoir built to save Adana from the flood caused by the Seyhan River. The reservoir shows typical Mediterranean climate characteristics with considerable seasonal variation.

P. similis was reported as *A. mento* for the first time in 2005 in the Seyhan Reservoir (Alagöz Ergüden and Göksu, 2012) and a study provided the information on their population structure (Ergüden, 2020). However, there is no previous data or length–weight relationship (LWRs) records were available for *P. similis* for Mamasın Reservoir.

The aim of the present paper was to present the LWRs for two *Aphanius* from two reservoirs in Turkey. The present study considers the length–weight relationships of *P. similis* for Mamasın Reservoir first time.

LWRs are essential data for biodiversity of fishes and fisheries management. It is using different types of fishery researchs. The data of LWRs is notable for understanding the actual situation of the fish stock (Petrakis and Stergiou, 1995). In addition to, the data enable comparisons between populations of the species living in different ecosystems (Sangun et al., 2007). These data provide to compare the characteristics of the fish populations (Moutopoulos and Stergiou, 2002).

2. Materials and Methods

2.1. Study area and sampling

Fish specimens (Figure 1) were captured by seine net from two different localities Mamasın and Seyhan reservoirs in 2016 year (in May) then preserved in a 5% formaldehyde solution and transported to the laboratory for later examination. In sex determination external coloration of the individuals were checked. Identification of the specimens was achieved according to literature (Wildekamp et al., 1999; Hrbek and Wildekamp 2003; Pflieger et al., 2014; Freyhof and Yoğurtçuoğlu, 2020).



Figure 1. Male (top) and female specimens of *Paraphanius similis* in Mamasin Reservoir (samples preserved in formaldehyde).

2.2. Data analyses

The total length (L) of each *P. similis* specimen was measured with a vernier caliper to the nearest 0.05 mm, and weighed with a digital scale to the nearest 0.01 g. specimens. The correlation coefficient was calculated (Zar, 1999) and a correlation coefficient significance control test was applied. The equation $W = aL^b$ was used to put forth the LWRs in the study (Ricker, 1973). In the equation, W is the total weight (g), L is the total length (cm), and a (intercept) and b (slope) are regression constants (Zar, 1999). Standard error of the constants a and b were estimated. The student t-test was used to determine the growth types for the female and male specimens according to their localities (Pajuelo and Lorenzo, 1998).

3. Results and Discussion

3.1. Length and weight distribution

Due to the sexual dimorphism in *P. similis*, the LWRs parameters were calculated separately for the female and male specimens. A total of 106 *P. similis* were measured in Mamasin Reservoir and a total of 87 *P. similis* were measured in Seyhan Reservoir for determining their length and weight distribution and their LWRs. *P. similis* specimens length and weight distribution and their standard error according to the sexes were given below for the study areas Mamasin and Seyhan reservoirs (Table 1).

Table 1. The length and weight distribution, mean length and weight and their standard errors of *P. similis* in Mamasın and Seyhan reservoirs.

Locality	Sex	n	L _{min}	L _{max}	L _{mean} ±SE	W _{min}	W _{max}	W _{mean} ±SE
Mamasın Reservoir	F	31	3.3	5.2	4.40±0.557	0.73	3.77	2.35±0.924
	M	75	3.2	5.0	4.56±0.277	0.77	3.56	2.74±0.515
Seyhan Reservoir	F	54	2.7	4.5	3.42±0.401	0.39	1.71	0.79±0.314
	M	33	2.3	3.8	2.92±0.385	0.20	1.30	0.50±0.256

The mean length of the females and males were found as 4.40 cm, 4.56 cm; the mean weight of the females and males were found as 2.35 g, 2.74 g in Mamasın Reservoir, respectively.

The mean length of the females and males were found as 3.42 cm, 2.92 cm in Seyhan Reservoir. The mean weight of the females and males were found as 0.79 g, 0.50 g in the same study area. According to the study results Mamasın Reservoirs member's mean total length and mean weight were found bigger than the Seyhan Reservoirs. Since the sampling season is the same in both researching area (in May), the reasons for this difference could be thought due to food sources or competition with the other species in the habitats. In the sampling period, *Gambusia holbrooki* were detected in the Seyhan Reservoir with *P. similis*, however there was no other species in the sampling in Mamasın Reservoir.

3.2. Length-weight relationships

The sample size (n), estimated parameters of the LWRs (*a* and *b*), coefficient of regressions, standard error of *a*, *b*, *r*, t-test results and growth types are given in Table 2.

Table 2. LWRs parameters of *P. similis* are given for Mamasın and Seyhan reservoirs.

Reservoir	Sex	n	a	SE _a	b	SE _b	r	SE _r	t _{test}	GT
Mamasın	F	31	0.011	0.002	3.589	0.128	0.982	0.093	t _{cal} = 4.601 > t _{0.05, n=31} = 2.03	A (+)
	M	75	0.015	0.003	3.406	0.087	0.939	0.082	t _{cal} = 4.666 > t _{0.05, n=75} = 1.99	A (+)
Seyhan	F	54	0.017	0.002	3.083	0.087	0.980	0.073	t _{cal} = 0.954 < t _{0.05, n=54} = 2.00	I
	M	33	0.008	0.001	3.725	0.157	0.974	0.116	t _{cal} = 4.617 > t _{0.05, n=33} = 2.03	A (+)

P<0.05, SE: Standard error, GT: Growth type, A (+): Positive allometric growth, I: Isometric growth, Cal: Calculated.

P. similis specimens correlation coefficient, r=0.982 and r=0.939 in Mamasın Reservoir for females and males, respectively. Similarly, in Seyhan Reservoir r=0.980 and r=0.974 in females and males. The correlation coefficient results in both study area showed that they are highly correlated.

The *b* constant typically close to three, therewithal it has a value between two and four. A value of three, shows that the fish grows symmetrically or isometrically; other values indicate fish has an allometric growth (growth type might be positive or negative) (Tesch, 1971).

In the current study, positive allometric growth were found in females and males in Mamasın Reservoir. Similarly, positive allometric growth were found in males in Seyhan Reservoir, distinctly isometric growth type were found in females. It was exposed that the Seyhan Reservoir's females had smaller b constant than the Mamasın Reservoir's females. The main reason of this situation might be the annual temperature differences between the cities. Cause of the higher annual temperature in Adana, the Seyhan Reservoir's females might be had reproduced before than Aksaray and might be weight loss after reproduction.

Comparison of the LWRs between the present study area results and other studies are shown in Table 3. The range of r and b parameters of the present study showed similarity in some localities. Constant b varied between 2.225-3.589 and 2.403-3.725 for the females and males, respectively, in terms of location. The highest b constant were found as 3.725 in this study for males in Seyhan Reservoir.

Table 3. LWRs parameters of the *Aphanius* species in the other studies.

Locality	Species	Sex	n	a	b	r
Küçükçekmece Lagoon, İstanbul (Tarkan et al. 2006)	<i>A. fasciatus</i>	F+M	11	0.01820	2.940	0.909
Lake Eğirdir, Isparta (Güçlü, 2012)	<i>A. anatoliae</i>	F+M	522	0.0232	2.322	0.826
Sırakaraağaçlar Stream, Sinop (Karlı and Aral, 2010)	<i>A. danfordii</i>	F	233	0.0135	3.179	0.989
		M	219	0.0144	3.149	0.983
Shalamzar Spring, Iran (Alavi-Yeganeh et al., 2011)	<i>A. vladkovi</i>	F	78	0.00830	3.482	0.989
		M	41	0.01070	3.276	0.962
Ayata Lake, Algeria (Guezi et al., 2017)	<i>A. fasciatus</i>	F	-	0.013	2.848	0.861
		M	-	0.013	2.809	0.863
Etolikon Lagoon, Greece (Leonardos and Sinis, 1999)	<i>A. fasciatus</i>	F	160	0.00826	3.220	0.970
		M	137	0.00758	3.260	0.980
Hirfanlı Reservoir (Yoğurtçuoğlu and Ekmekçi, 2013)	<i>A. danfordii</i>	F	1224	0.00003	3.460	0.978
		M	1010	0.00004	3.450	0.964
Kırkgöz Spring, Antalya (Güçlü and Küçük, 2008)	<i>P. similis</i> (<i>A. mento</i>)	F	342	0.0702	2.225	0.846
		M	312	0.0568	2.403	0.878
Seyhan Reservoir, Adana (Ergüden, 2020)	<i>P. similis</i> (<i>A. mento</i>)	F	318	0.00081	2.464	0.993
		M	516	0.00052	2.635	0.982
Mamasın Reservoir*	<i>P. similis</i> (<i>A. mento</i>)	F	31	0.011	3.589	0.982
		M	75	0.015	3.406	0.939
Seyhan Reservoir*	<i>P. similis</i> (<i>A. mento</i>)	F	54	0.017	3.083	0.980
		M	33	0.008	3.725	0.974

*Present study area.

In this study, LWR parameters in Seyhan Reservoir is similar to *A. vladkovi* (Alavi-Yeganeh et al., 2011) and *A. danfordii* (Yoğurtçuoğlu and Ekmekçi, 2013); but different from *A. fasciatus* (Guezi et al., 2017) and *P. similis* (Güçlü and Küçük, 2008). These situations may be caused by reproduction periods and the habitat differences.

In the study in Etolikon Lagoon, it was found positive allometry for females ($b=3.220$) and males ($b=3.260$) for *A. fasciatus* species (Leonardos and Sinis, 1999). In a previous study in Kırkgöz

Spring (Antalya), it was found negative allometric growth for females ($b=2.225$) and males ($b=2.403$) for *P. similis* (Güçlü and Küçük, 2008). Accordingly, one another *Aphanius* species *A. fasciatus* in Ayata Lake, calculated negative allometric growth for females ($b=2.848$) and males ($b=2.809$) (Guezi et al., 2017).

In the previous study in Seyhan Reservoir, the LWR parameters were determined as $a=0.00081$, $b=2.464$, $r=0.993$ in females and $a=0.00052$, $b=2.635$, $r=0.982$ in males (Ergüden, 2020). In the present study, the regression parameters for the same locality were determined as $a=0.017$, $b=3.083$, $r=0.980$ in females, and $a=0.008$, $b=3.725$, $r=0.974$ in males. Both study were highly correlated between length and weight. The present study's b constant was found bigger than the previous study for both sexes. The main reason of the differences might be the sampling period of the species; the previous study samplings was occurred in all seasons (inclusive the winter period); but in the present study sampling was occurred just in May. This situation, might be created some differences in access to food resources and their feeding.

It is famously known that the b constant changes cause of a number of different factors. The most known factors are sex, age, stomach fullness, gonad maturity, fish health and fishing characters (Wootton, 1998). Bagenal and Tesch (1978) remarked that LWRs might be effected by maturity, sex, geographical location and environmental factors. The LWRs constants of a fish population should be attributed to reproduction period, feeding, habitat differences, season period, sampling method etc. (Moutopoulos and Stergiou, 2002). Thus, the differences in the b constant may have been related to the one or more factors mentioned above.

4. Conclusion and Suggestions

In the present study, which is an important part of freshwater fish fauna in our country in terms of endemic species *P. similis*'s LWRs was obtained. Their IUCN Red List category and criteria is Least Concern, moreover, their current population trend is "decreasing" (IUCN 2020).

Within the current study, *P. similis* specimens were sampled in Mamasın Reservoir for the first time. In addition, the actual study considers the first information on the LWRs of *P. similis* in Mamasın Reservoir of Turkey. The basic information on the LWRs for an established population in Mamasın and Seyhan reservoirs, which would be useful for fish biologists to save their populations in Turkey.

Aphanius species are very important part of Turkey's freshwater's ichthyofauna with their endemic characters (Alagöz Ergüden, 2015). Today, *Aphanius* genus under a high risk of extinction caused by different factors such as the habitat loss, invasive species and pollution. The best way to save the population of *P. similis* species is to increase the number of scientific studies about them,

therefore the studies on the species should be increased. As a further study might be about the population structure in the two localities should be investigated. Also, their population structure should be examined. They might be monitoring in the freshwater resources regularly.

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