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Predata on Some Morphometric Characters and Condition Factors of Crayfish, *Astacus leptodactylus* (Eschscholtz, 1823) from Kılıçkaya Reservoir, Sivas, Turkey

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Abstract: *The aim of this study is to provide initial data on some morphometric characters and condition factors of inland water crayfish, Astacus leptodactylus (Eschscholtz, 1823) from Kılıçkaya Reservoir in Turkey. The study was performed between August and October 2014. Differences of sex groups were also investigated. Sampled population was composed of 40% female and 60% male specimens. Results of the study can be summarized as follows; the mean carapace length 53.80±7.66 mm, mean carapace width 28.80±3.56, mean abdomen length 57.80±5.07 mm, mean abdomen width 20.60±2.07 mm, mean cheliped length 46.40±15.40 mm, mean cheliped width 17.80±4.60 mm, mean total length 111.60±12.07 mm, mean total weight 37.63±16.49 mm and mean condition factor 2.58±0.29 mm from Kılıçkaya Reservoir. The obtained predata results were compared with other studies from different aquatic habitats.*

Keywords: *Crayfish, Condition Factors, Morphometric Characters, Kılıçkaya Reservoir.*

1. INTRODUCTION

Crayfish play an important role in the natural balance of inland ecosystems, influencing the distribution and abundance of other aquatic organisms through their omnivory and bioturbatory behaviour. Crayfish that is a very good of economic value have a key role organism in protecting of the ecological balance of inland water resources [1, 2]. Crayfish shows distribution in many parts of the world is the invertebrate animals that has an economic and ecological importance. Crayfish has two species, which are *Astacus leptodactylus* and *Austropotamobius torrentium* in Turkey. *A. leptodactylus* in Anatolia, it has a qualify that only species in the source of many inland water as natural distribution. Supply of this species is only from crayfish fisheries and nearly all the production is exported. This species is not only important for its economic value but also for its important role playing in inland aquatic food web. *Austropotamobius torrentium* is the only species that not natural for inland waters of Turkey and first time recorded 2005 within the boundaries of Kırklareli Velika creek, and Madara creek in 2007. However, *Austropotamobius torrentium* is of little commercial interest because it relatively small size [3-5]. *A. leptodactylus* is widely distributed in lakes, reservoirs, ponds and rivers throughout the Turkey. Until the end of 1984, it has been the most important inland fisheries product in Turkey. However, the spread of the crayfish plaque in inland waters in 1984, declined the production values sharply in Turkey [4]. After the crayfish disease in 1985, stocks dropped rapidly and production, which totaled 7.936 tons in 1984, decreased to 324 tons in 1992 [6]. In 2013, crayfish production was 532.1 tons in inland waters of Turkey [7]. *A. leptodactylus* has also been uncontrollably transferred in recent years into many inland ecosystems in Turkey to establish new populations and to restore the crayfish stocks devastated by the plague disease. Therefore, the distribution of all populations of *A. leptodactylus* in Turkey is not known completely [8]. *A. leptodactylus* has no commercial importance for Kılıçkaya Reservoir. Because it is not commercially catch in Kılıçkaya Reservoir. In addition, to the best of our knowledge no information currently exists on the some morphometric characters and condition factors of *A. leptodactylus* from Kılıçkaya Reservoir. The main objective of the present study is to get information on the some morphometric characters and condition factors of *A. leptodactylus* from Kılıçkaya Reservoir. This information can be useful in the species conservation and the development of sustainable management strategies for the fisheries of Kılıçkaya Reservoir.

2. MATERIALS AND METHODS

2.1. Study Area

The study area is Kılıçkaya Reservoir located at Central Anatolian region of Turkey. Kılıçkaya Reservoir is 25 km north of town of Suşehri 158 km northeast of Sivas province in center east of Turkey. Geographical coordinates of Kılıçkaya Reservoir are 40° 14' 0" N and 38º 11' 0" E. The Kılıçkaya Dam was constructed between 1980 and 1989 on the Kelkit Stream, a tributary of Yeşilırmak River. Kılıçkaya Dam is a 132 m high rockfill a power plant. The water of Kılıçkaya Reservoir is mainly used for production of electrical energy, commercial fishing, irrigation, and recreation. The European catfish, Silurus glanis is intensively catch for commercial fishing in Kılıçkaya Reservoir. The substratum of the reservoir is generally muddy. The surface area and maximum depth of the Kılıçkaya Reservoir are 64.4 km^2 and 100 m respectively [9].

2.2. Sample Collection and Data Analysis

Specimens of *A. leptodactylus* were collected from Kılıçkaya Reservoir by nets of 30 and 50 mm mesh sizes equipment, respectively between August and October 2014 and preserved 5% solution of formaldehyde. The specimens was sorted into 2 groups based on sex. Some morphometric characters such as the carapace length (CL) in mm, carapace width (CW) in mm, abdomen length (AL) in mm, abdomen width (AB) in mm, cheliped length (ChL) in mm, cheliped width (ChW) in mm, total length (TL) in mm and total weight (TW) in g of the samples were measured by following [10, 11]. All of the morphometric characters were measured using digital calipers (0.01 mm of precision). The total weight of each specimen was taken using a digital balance with a precision of 0.0001 g. The condition factor (K) was calculated from the formula, $K = 100W/L^3$, where W (g) is observed total body weight and L (cm) is total body length [12]. SPSS for windows version 17.5 statistical software was used for all data analysis.

3. RESULTS

A total of five specimens of *A. leptodactylus* (3 male and 2 female) were collected from Kılıçkaya Reservoir. Sex composition was 60% male and 40% female in Kılıçkaya Reservoir. The sex ratio coincides with the *A. leptodactylus* caught in Kılıçkaya Reservoir where males are the dominant sex. Some morphometric characters and condition factors of *A. leptodactylus* from Kılıçkaya Reservoir are given for males, females, and combined sexes in Table 1. The mean carapace length of *A. leptodactylus* samples from Kılıçkaya Reservoir was 53.80 mm (±SD 7.66; min. 46 mm; max. 65 mm). The mean carapace length of males was 54.00 mm (±SD 9.85; min. 46 mm; max. 65 mm) and mean carapace length of females was 53.50 mm (±SD 6.36; min. 49 mm; max. 58 mm) from Kılıçkaya Reservoir. The mean carapace width of *A. leptodactylus* samples from Kılıçkaya Reservoir was 28.80 mm (± SD 3.56; min. 25 mm; max. 34 mm). Mean carapace width of males was 29.33 mm (±SD 4.51; min. 25 mm; max. 34 mm) and mean carapace width of females was 28.00 mm (±SD 2.83; min. 26 mm; max. 30 mm) from Kılıçkaya Reservoir (Table 1).

Table1.*Some Morphometric Characters and Condition Factors of Astacus leptodactylus from Kılıçkaya Reservoir.*

SMC	Males				Females				Males+Females			
	Min.	Max.	Mean	±SD	Min.	Max.	Mean	±SD	Min.	Max.	Mean	±SD
CL	46	65	54.00	9.85	49	58	53.50	6.36	46	65	53.80	7.66
CW	25	34	29.33	4.51	26	30	28.00	2.83	25	34	28.80	3.56
AL	53	66	59.33	6.51	55	56	55.50	0.71	53	66	57.80	5.07
AW	18	23	21.00	2.65	19	21	20.00	1.41	18	23	20.60	2.07
ChL	32	66	46.67	17.47	33	59	46.00	18.38	32	66	46.40	15.40
ChW	12	23	18.33	5.69	14	20	17.00	4.24	12	23	17.80	4.60
TL	99	131	113.33	16.26	105	113	109.00	5.66	99	131	111.60	12.07
TW	23.27	65.18	42.39	21.19	27.37	33.62	30.50	4.42	23.27	65.18	37.63	16.49
CF	2.40	2.91	2.74	0.29	2.33	2.36	2.35	0.02	2.33	2.91	2.58	0.29

Explanations: SMC - some morphometric characters, CL - carapace length, CW - carapace width, AL - abdomen length, AW - abdomen width, ChL - cheliped length, ChW - cheliped width, TL - total length, TW - total weight, CF - condition factor, Min. - minimum, Max. - Maximum, ±SD - standard deviation in the table.

The mean abdomen length of *A. leptodactylus* samples from Kılıçkaya Reservoir was 57.80 mm (±SD 5.07; min. 53 mm; max. 66 mm). The mean abdomen length of males was 59.33 mm (±SD 6.51; min. 53 mm; max. 66 mm) and mean abdomen length of females was 55.50 mm (±SD 0.71; min. 55 mm; max. 56 mm) from Kılıçkaya Reservoir. The mean abdomen width of *A. leptodactylus* samples from Kılıçkaya Reservoir was 20.60 mm (± SD 2.07; min. 18 mm; max. 23 mm). The mean abdomen width of males was 21.00 mm (±SD 2.65; min. 18 mm; max. 23 mm) and mean abdomen width of females was 20.00 mm (±SD 1.41; min. 19 mm; max. 21 mm) from Kılıçkaya Reservoir (Table 1).

The mean cheliped length of *A. leptodactylus* samples from Kılıçkaya Reservoir was 46.40 mm (±SD 15.40; min. 32 mm; max. 66 mm). Mean cheliped length of males was 46.67 mm (±SD 17.47; min. 32 mm; max. 66 mm) and mean cheliped length of females was 46.00 mm (±SD 18.38; min. 33 mm; max. 59 mm) from Kılıçkaya Reservoir. The mean cheliped width of *A. leptodactylus* samples from Kılıçkaya Reservoir was 17.80 mm (± SD 4.60; min. 12 mm; max. 23 mm). Mean cheliped width of males was 18.33 mm (±SD 5.69; min. 12 mm; max. 23 mm) and mean cheliped width of females was 17.00 mm (±SD 4.24; min. 14 mm; max. 20 mm) from Kılıçkaya Reservoir (Table 1).

The value of the total body length for male crayfish varied from to 99 to 131 mm (113.33 mm), for female crayfish from 105 to 113 mm (109.00 mm), and for the combined sexes crayfish from 99 to 131 mm (111.60 mm). The value of the total body weight for male crayfish varied from to 23.27 to 65.18 g (42.39 g), for female crayfish from 27.37 to 33.62 g (30.50 g), and for the combined sexes crayfish from 23.27 to 65.18 mm (37.63 mm). The condition factor is calculated as 2.40-2.91 for males, and 2.33-2.36 for females. The obtained values for all individuals (Table 1) indicate that the mean condition factor is 2.58±0.29 from Kılıçkaya Reservoir.

4. DISCUSSION

Concentrations the preliminary data is first study on some morphometric characters and condition factors of *A. leptodactylus* from Kılıçkaya Reservoir in Turkey. The morphometric characters would be helpful in comparing the same species in different locations. There are different populations of *A. leptodactylus* in the World and Turkey. It can be concluded that the study of morphometric characters could be used to describe populations [13]. In general, while the body weight of the male individuals of crayfish is greater, and their walking legs and their cheliped wider and longer, the females have a wider and longer abdomen [14]. It has been found in most of the studies done on *A. leptodactylus* in Turkey that due to the size of their walking legs and their weight, male individuals have a greater average length and weight compared to female individuals [14-16]. Similarly, the mean values that have turned out to be higher for the male population are carapace length, carapace width, abdomen length, abdomen width, cheliped length, cheliped width, total length, total weight and condition factor. All the mean values measured are larger for the male population in comparison to the female population in Kılıçkaya Reservoir. The minimum carapace length is calculated for males (46) as well as maximum (65) from Kılıçkaya Reservoir. Similarly, the mean value is greater for males and it is 54.00, while for females is 53.50. The mean carapace length of all *A. leptodactylus* samples was found to be 53.80±7.66 in Kılıçkaya Reservoir (Table 1). The mean carapace length for *A. leptodactylus* from different habitats in Turkey were reported as 49.94 mm in Eğirdir Lake, 49.13 mm in İznik Lake, 50.59 mm in Hirfanlı Dam Lake [17], 48.40 mm in the Thrace region ponds of Turkey [18], 45.00 mm in Keban Dam Lake [19], 54.70 mm in Dikilitaş Pond [20], 49.67 mm in Mogan Lake [21], 53.74 mm in Eğirdir Lake [22], 52.46 mm in Çıldır Lake [23] and 56.18 mm in Aktaş Lake [24]. The mean carapace length of *A. leptodactylus* in Kılıçkaya Reservoir is greater than those in Eğirdir Lake, in İznik Lake, in Hirfanlı Dam Lake [17], in the Thrace region ponds of Turkey [18], in Keban Dam Lake [19], in Mogan Lake [21] and in Çıldır Lake [23]. The mean carapace width of all *A. leptodactylus* samples was found to be 53.80±7.66 in Kılıçkaya Reservoir (Table 1). The mean carapace width for *A. leptodactylus* from different habitats in Turkey were reported as 23.13 mm in Eğirdir Lake, 21.27 mm in İznik Lake, 26.06 mm in Hirfanlı Dam Lake [17], 23.70 mm in the Thrace region ponds of Turkey [18] and 54.30 mm in Dikilitaş Pond [20]. The mean carapace width of *A. leptodactylus* in Kılıçkaya Reservoir is smaller than this in Dikilitaş Pond [20].

The mean abdomen length was 59.33±6.51 mm for male, 55.50±0.71 mm for female and 57.80±5.07 mm for all individuals in Kılıçkaya Reservoir (Table 1). The width of male crayfish abdomens was larger than female crayfish abdomens. The mean abdomen length for *A. leptodactylus* from different

habitats in Turkey were reported as 31.51 mm in Terkos Lake [16], 51.88 mm in Eğirdir Lake, 51.33 mm in İznik Lake, 54.18 mm in Hirfanlı Dam Lake [17], 52.60 mm in the Thrace region ponds of Turkey [18], 56.80 mm in Dikilitaş Pond [20] and 39.56 mm in Mogan Lake [21]. The present study was also found that the mean abdomen length was greater than those in Terkos Lake [16], in Eğirdir Lake, in İznik Lake, in Hirfanlı Dam Lake [17], in the Thrace region ponds of Turkey [18], in Dikilitaş Pond [20] and in Mogan Lake [21]. The mean abdomen width of all *A. leptodactylus* samples was determined as 20.60±2.07 in Kılıçkaya Reservoir (Table 1). The mean abdomen width for *A. leptodactylus* from different habitats in Turkey were reported as 28.70 mm in Terkos Lake [16], 23.94 mm in Eğirdir Lake, 20.27 mm in İznik Lake, 26.00 mm in Hirfanlı Dam Lake [17], 22.2 mm in the Thrace region ponds of Turkey [18], 19.80 mm in Dikilitaş Pond [20] and 33.31 mm in Mogan Lake [21]. The present study was also found that the mean abdomen width was greater than this from Dikilitaş Pond [20].

The minimum cheliped length is calculated for males (32 mm) as well as maximum (66 mm) from Kılıçkaya Reservoir. Similarly, the mean value is greater for males and it is 46.67 mm, while for females is 46.00 mm. The mean cheliped length of all *A. leptodactylus* samples was found to be 46.40±15.40 in Kılıçkaya Reservoir (Table 1). The mean cheliped length for *A. leptodactylus* from different habitats in Turkey were reported as 52.85 mm in Terkos Lake [16], 40.44 mm in Eğirdir Lake, 43.53 mm in İznik Lake, 32.53 mm in Hirfanlı Dam Lake [17], 37.70 mm in the Thrace region ponds of Turkey [18], 75.90 mm in Dikilitaş Pond [20] and 39.33 mm in Mogan Lake [21]. The present study was also found that the mean abdomen width was smaller than those from Terkos Lake [16] and Dikilitaş Pond [20]. The mean cheliped width of all *A. leptodactylus* samples was found to be 17.80±4.60 in Kılıçkaya Reservoir (Table 1). The mean cheliped width for *A. leptodactylus* from different habitats in Turkey were reported as 16.53 mm in Terkos Lake [16], 13.88 mm in Eğirdir Lake, 15.00 mm in İznik Lake, 13.36 mm in Hirfanlı Dam Lake [17], 13.10 mm in the Thrace region ponds of Turkey [18], 14.10 mm in Dikilitaş Pond [20] and 16.85 mm in Mogan Lake [21]. Our results were found to be greater than in previous studies.

The total length of *A. leptodactylus* population in Kılıçkaya Reservoir ranged from 99 to 131 mm. The mean total lengths of female 109.00±5.66 g were lower than mean total lengths of male 113.33±16.26 in the study area. The mean total length of all *A. leptodactylus* samples was determined as 111.60 ±12.07 in Kılıçkaya Reservoir (Table 1). The mean total length for *A. leptodactylus* from different habitats in Turkey were reported as 102.26 mm in Dikilitaş Pond [6], 91.06 mm in Demirköprü Dam Lake [15], 121.33 mm in Terkos Lake [16], 102.90 mm in the Thrace region ponds of Turkey [18], 93.0 mm in Keban Dam Lake [19], 112.30 mm in Dikilitaş Pond [20], 103.65 mm in Mogan Lake [21], 106.31 mm in Eğirdir Lake [22], 154.35 mm in Keban Dam Lake [25] and 94.75 mm in Keban Dam Lake [26]. According to these data on *A. leptodactylus* from the Terkos Lake [16], the Dikilitaş Pond [20] and the Keban Dam Lake [25] show that they are large specimens in terms of total length.

The total weight of *A. leptodactylus* population in Kılıçkaya Reservoir ranged from 23.27 to 65.18 g. The mean total weights of female 30.50±4.42 g were lower than mean total weights of male 42.39±21.19. The mean total weight of all *A. leptodactylus* samples was determined as 37.63 ±16.49 in Kılıçkaya Reservoir (Table 1). The mean total weight for *A. leptodactylus* from different habitats in Turkey were reported as 32.66 g in Dikilitaş Reservoir [6], 25.03 g in Demirköprü Dam Lake [15], 52.25 g in Terkos Lake [16], 31.50 mm in the Thrace region ponds of Turkey [18], 26.6 g in Keban Dam Lake [19], 46.87 g in Dikilitaş Pond [20], 32.11 g in Mogan Lake [21], 40.33 g in Eğirdir Lake [22], 37.72 g in Çıldır Lake [23], 41.82 g in Aktaş Lake [24], 25.44 g in Keban Dam Lake [25] and 23.61 g in Keban Dam Lake [26]. According to these data on *A. leptodactylus* from the Terkos Lake [16], the Dikilitaş Pond [20], Eğirdir Lake [22], Çıldır Lake [23] and Aktaş Lake [24] show that they are large specimens in terms of total weight.

Condition factor values were assessed for male, females and pooled data. The condition factor is the best control of the morphological structure of the *A. leptodactylus* nutrition and development. The minimum condition factor is calculated for females and it is 2.33, while the maximum calculated is for males and it is 2.91 (Table 1). The obtained mean value of condition factor for males is 2.74±0.29, while for females is slightly lower and it is 2.35±0.02 in Kılıçkaya Reservoir. The mean condition factors have slightly greater values in males than in females. The mean value of condition factor for all individuals in the present study was found to be 2.58±0.29 which being very close to unity,

indicates that the *A. leptodactylus* is in good condition. Similarly, Aydın et al. [14] recorded a mean condition factor value of 2.6 for *A. leptodactylus* in İznik Lake. Also, Kaya [22] reported the value of the mean condition factor to be 3.31 for *A. leptodactylus* in Eğirdir Lake for all individuals. The present study was also found that the mean condition factor was smaller than those from Eğirdir Lake [22]. However, the fact that different values have been obtained may be due to differences in the ecological characteristics of the reservoir, different depths of hunting, or that the hunting is carried out at different times.

5. CONCLUSION

The present study provide the first data on the some morphometric characters and condition factors of *A. leptodactylus* population from Kılıçkaya Reservoir. First of all, the conservation of the *A. leptodactylus* is of great importance in Kılıçkaya Reservoir. According to the morphometric characteristics and condition factors of the *A. leptodactylus*, it can be concluded that Kılıçkaya Reservoir has good ecological conditions. Continuous monitoring of *A. leptodactylus* populations is very important for sustainable ecosystem management. Therefore, it would be advisable to collect more abundant study material and to conduct more detailed studies in the Kılıçkaya Reservoir.

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