RESEARCH ARTICLE

A study on some morphological characteristics of *Astacus leptodactylus* (Eschscholtz 1823) in seven different inland waters in Turkey

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Abstract

This study aimed to determine some morphological characteristics of freshwater crayfish (*Astacus leptodactylus* Eschscholtz 1823) populations in various water resources in Turkey. We present the relationships between total length (TL), carapace length (CL), chelae length (ChL), abdomen length (AL) and total weight (W) for *Astacus leptodactylus* from three lakes, three dam lakes and an irrigation lake. The values of the exponent *b* of the length-weight relationships ranged from 1.0760 to 3.6939 and intercepts from 1.0760 to 3.6939 for combined data. The r^2 values ranged from 0.6599 to 0.9561 and relationships were estimated highly significant (P<0.05). Differences in slopes of regression lines between sexes as well as among locations were not significant, tested by ANCOVA.

Key words: Crayfish, morphometric characteristics, length-weight relationship, allometric growth.

Introduction

Length-weight relationships have several applications, namely, in fish biology, physiology, ecology and fisheries assessment. According to Andrade and Campos (2002), this is widely used in the analysis of fishery data and particularly useful when sampling large species, mostly because of the difficulty and time required to record weight in the field. Length-weight relationships (LWR) for fish are estimation of average weight of the fish of a given length

group (Mendes *et al*. 2004; Tosunoğlu *et al*. 2007). Besides the estimation of weight from length (Beyer 1991), the fish LWR, which describe mathematically the correlation between fish length and weight, are useful for the conversion of growth-in-length equations to growth-in-weight for use in stock assessment models (Lindqvist and Lathi 1983; Deval *et al*. 2007), to estimate stock biomass from limited sample sizes (Verdiell-Cubedo *et al*. 2006). They also allow morphological comparisons among species or among populations of the same species from different habitats and/or regions at similar or different times (Moutopoulos and Stergiou 2002; Etchison *et al*. 2012). At the same time, length- weight relationships for fish were originally used to provide information on the condition of fish and to determine whether somatic growth was isometric or allometric (Ricker 1975). Estimates of the relationship parameters *a* and *b* can be related to ecological processes and life history.

Environmental factors may impact crayfish growth by affecting feeding behavior, foraging efficiency, and the availability and quality of food resources. The relationship between pre-molt and post-molt length has been used to describe growth and the effects of environmental conditions on growth patterns, but the functional relationships vary. Length-weight patterns may have the potential for indicating differential growth that may be associated with the severity of environmental stress across the range of a species (Westman and Savolainen 2002; Olsson 2008).

In the present work we report the length-weight relationships for *Astacus leptodactylus* from diverse geographic areas, describing the variation of the regression parameters among seven different geographical locations.

Material and Methods

A. leptodactylus specimens were collected in seven inland waters: Avşar Dam Lake (1), Çıldır Lake (2), Eğirdir Lake (3), Hirfanlı Dam Lake (4), Keban Dam Lake (5), Porsuk Dam Lake (6) and Karpuzlu Pond (7) (Figure 1).
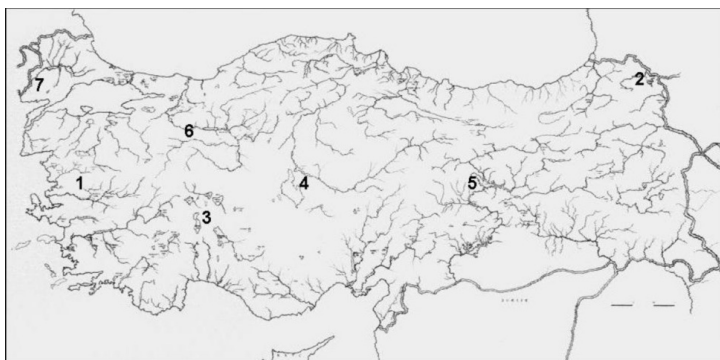

Figure 1. Seven inland waters in Turkey where *Astacus leptodactylus* were sampled in this study

The carapace length (*CL*), chelae length (*ChL*), abdomen length (*AL*) and total length (*TL*) of each specimen were measured with a digital caliper to the nearest 0.1 mm, while weighted to the nearest 0.01 g, and each specimen was sexed (Rhodes and Holdich 1979). LWRs were estimated by fitting an exponential curve, $W = aL^b$, to the data (Ricker 1973; 1975). Parameters *a* and *b* of the exponential curve were estimated by linear regression analysis over log-transformed data (*log W = log a + b log L*), where *W* is the total weight (g), *L* the total length (cm), *a* the intercept (initial growth coefficient or condition factor) and *b* the slope (growth coefficient, i.e., fish relative growth rate), using the least-squares method. The null hypotheses of isometric growth (H_0: $b = 3$) were tested by the *t* –test, using the statistic: $t_s = (b-3)/S_b$, where S_b is the standard error of slope, for α=0.05 (Sokal and Rohlf 1981). For testing significant differences among slopes (*b*) between two regressions for the sexes, a t-test was also used. Additionally, we used analysis of covariance (ANCOVA) to compare more than two slopes when testing for differences in LWR of *A. leptodactylus* at Keban Dam Lake, Porsuk Dam Lake, Karpuzlu Pond, Çıldır Dam Lake, Eğirdir Lake, Hirfanlı Lake and Avşar Dam Lake (Zar 1999). All statistical differences were considered significant at P<0.05.

Results

A total of 1122 *A. leptodactylus* (523 female, 599 male) were collected from three lakes, three dam lakes and an irrigation lake of Turkish inland waters, where the crayfish populations were exploited. TL ranged from 80 to 183 mm. A significant difference in mean TL was found between lakes (F=80.82, P<0.05), except between Avşar Dam Lake and Porsuk Dam Lake (P=0.352). TW ranged from 13.77 to 178.93 g. There was significant difference between lakes in overall weight (F=59.44, P<0.05), while statistically significant difference was not found between Çıldır Lake and Keban Dam Lake (P=0.750). The smallest crayfish specimen was analyzed 801 mm TL and weighed 13.77 g., the biggest specimen was 183 mm TL and weighed 178.93 g, which were caught in the Avşar Dam Lake and Karpuzlu Pond, respectively (Table 1). LWRs of crayfish are summarized in Table 1. The slope of regression lines between male and female derived by ANCOVA indicated significant variation. The slope did not differ indicating a significant variation in the growth pattern between sexes (P>0.05) (Table 1).

The regression equation for the allometric coefficient of *A. leptodactylus* varied between 2.4158 (Porsuk Lake) and 2.958 (Eğirdir Lake) for females, 2.968 (Eğirdir Lake) and 3.439 (Karpuzlu Pond) for males (Table 1). The LWR of combined data of males and females from seven different geographical locations indicated that the value of *b* was above 3. The estimated values of the *b* parameter ranged from 2.4158 to 3.439 (Table 1), corresponding to a median value of 3.0436, whereas 50% of values of *b* were in the interval between 2.8162 and 3.2595. Higher values of the *b* parameter (3.0253–3.335) were found

in this study. The values for allometric coefficient *b* of the LWRs were close to isometric growth for combined values for both sexes in the Keban Dam Lake, Porsuk Dam Lake, Çıldır Lake, Eğirdir Lake, Hirfanlı Dam Lake and Avşar Dam Lake. However, positive allometric growth was suggested for *A. leptodactylus* in the Karpuzlu Pond. The coefficient of determination (r^2) of the LWRs varied between 0.7008 (Porsuk Dam Lake) and 0.8989 (Çıldır Lake) for both sexes combined, with a median value of 0.8814 and the r^2 values were > 0.90 in nine cases for male and female. All models were statistically significant (P<0.05).

The carapace length-weight (CL-W) relationship of crayfish was estimated separately (Table 2). The largest value of the *b* parameter was estimated 3.4572 for male (Keban Dam Lake), while the lowest value was 2.405 for females (Porsuk Dam Lake). The median value of *b* was 2.9807, while 50% of the *b* values were between 2.7745 and 3.1089. The CL-W relationships showed isometric growth except Keban Dam Lake (positive allometry). ANCOVA was performed to compare the slope of regression lines between males and females, and seven different inland waters. The results indicated that there was no significant difference (P>0.05) between sexes for all the chosen variables, while statistically significant differences were found between the seven lakes (P<0.05). All relationships were highly significant (P<0.05), that most r^2 values were greater than 0.9016; except for Porsuk Dam Lake, which showed a good fit to the exponential curve.
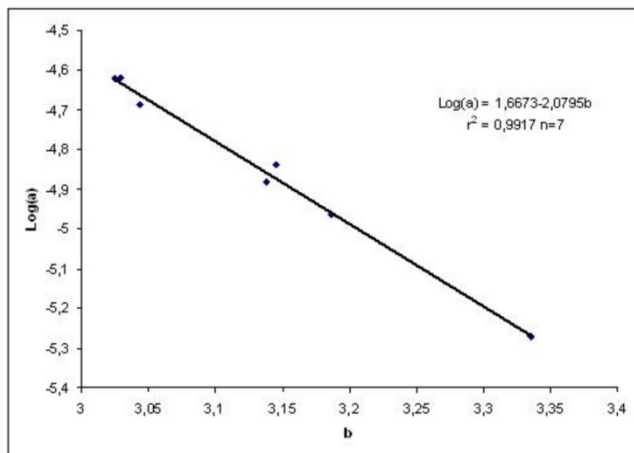

Figure 2. Length-weight relationships (log *a* vs. *b*) for *Astacus leptodactylus* from seven different inland waters in Turkey

The chelae length-weight (ChL-W) relationships indicated a positive allometric growth (*b* values: 1.076-2.1873). A negative allometry growth was observed only in female of the Çıldır Lake, while a positive allometry growth condition

was observed for the rest of samples. The result of ANCOVA showed ChL-W relationships was significantly different between sexes (P<0.05). The coefficient of correlation of the ChL-W relationships ranged between 0.6769 and 0.9409 for male, female and combined sexes. It was also very low (r^2=0.6769) for female in Porsuk Dam Lake, whereas all remaining values of b were higher than 0.7164 (Table 3) and were all statistically significant (P<0.05).

The values obtained for the abdominal length-weight (AL-W) relationship showed negative allometric growth in Porsuk Dam Lake, Hirfanlı Dam Lake and Eğirdir Lake, while isometric growth was seen in Karpuzlu Pond, Çıldır Lake, Avşar Dam Lake and Keban Dam Lake for both sexes combined (Table 4). The values of b ranged from 2.0981 for females in Porsuk Dam Lake to 3.6939 for males in the Çıldır Lake, corresponding to a mean values of 2.8365(±0.3756) and a median value of 2.9072. The significance of variation between the 14 regressions lines were tested by ANCOVA. It was found that there was no significant difference in the regression lines (P>0.05). All AL-W relationships were significant (P<0.05) with r^2 values greater than 0.6599 (Figure 2).

Discussion

In this study, 1122 *Astacus leptodactylus* were measured to present descriptive statistic values for males, females, and combined sexes. It was determined that mean TL, CL, ChL and W of the male individuals was greater than those of the females (s 1, 2 and 3). On the other hand, AL of females was greater than that of males (Table 4). Since the samples of crayfish were provided by an export company, the samples did not include juvenile individuals. Additionally, these data were not representatives of a particular season or time of the year and for comparison purposes should be considered only as mean annual values, as suggested by Petrakis and Stergiou (1995) and Gonçalves *et al*. (1997).

Variation in morphometric traits may also be largely affected by environmental factors such as feeding, behavior, foraging efficiency, and the availability and quality of food resources (Lindquist and Lathi 1983; France 1985). Environmental conditions influence crustacean growth by effecting molt intervals and incremental increases in length and weight.

The relationship between body length and weight is an important and widely used equation in fishery studies, fish length being the easiest parameter to measure, particularly in the field. During their development, crustaceans are known to pass through stages in their life history which are defined by different length-weight relationships. The parameter b is characteristic of species and generally does not vary significantly throughout the year, unlike the parameter a, which may vary daily, seasonally, between different habitats, water temperature and salinity, sex, food availability, differences in the number of specimens examined, as well as in the observed length ranges of the species

caught (Tesch 1971; Kleanthids *et al*. 1999). It is generally accepted that *b* values, if different from 3 indicate that the shape of fish changes with growth, while a value of 3 characterizes an isometric one (Anderson and Neumann 1996). In the present study, growth was isometric for six areas ($P>0.05$) (Alaşehir Lake, Eğirdir Lake, Çıldır Lake, Hirfanlı Dam Lake, Keban Dam Lake and Porsuk Dam Lake) except for Karpuzlu Irrigation Lake, which displayed a positive allometry. Similar results were reported for *Procambarus zonangulus* (Romaire *et al*. 1977), *Procambarus alleni* (Acosta and Perry 2000), *Procambarus leniusculus* (Westman and Savolainen 2002), *Austropotamobius torrentium* (Streissl and Hödl 2002), *Procambarus acutus acutus* (Mazlum *et al*. 2007) and *Procambarus clarkia* (Correia and Costa 1994). Local environmental factors are partly responsible for differences found in Turkey. In the present study the *b* values were estimated between 2.4158 and 3.4390. *b* values identified by other authors varied from 2.1166 to 3.66685 in Turkey (Köksal 1988; Duman and Pala 1998; Köksal *et al*. 2003; Balık *et al*. 2005; Harlıoğlu and Harlıoğlu 2005; Güner 2006; Deniz *et al*. 2010).

The relationships between carapace length and weight have many uses. They are, for example, indicators of condition and can be used to calculate biomass and to estimate the recovery of edible meat from crayfish of various sizes. They also have a practical value since they make it possible to convert length into weight and vice versa. On the other hand, body weight and total length, carapace length and carapace width are the most frequently used dimensions in the study of crustaceans (Atar and Seçer 2003). There are several possible explanations for such a pattern but the most likely in this case being different growth rates between sexes. This pattern can be obtained by the overlapping of two normally distributed cohorts showing different, and in Crustacea step-like, growth rates (Abelló *et al*. 1990). There was non-homogeneity in carapace length-weight relationship of males, females and combine sexes in Alaşehir Lake, Hirfanlı Dam Lake, Keban Dam Lake, Porsuk Dam Lake and Karpuzlu Irrigation Lake, whereas there was homogeneity in males females and combine sexes in Eğirdir Lake and Çıldır Lake. The results obtained from Eğirdir Lake and Çıldır Lake are in good agreement with the previous studies (Harlıoğlu and Harlıoğlu 2005; Bolat 2001) when compared to the carapace length-weight relationship. Isometric growth between 2.7531 and 2.8786 was observed only in females of Eğirdir Lake, Çıldır Lake and Keban Dam Lake. Some crayfish species show allometric differences in growth whereby males develop large chelae and females develop wider abdomens when they become reproductively mature (Lowery 1988). A negative allometric growth condition was observed for Alaşehir Lake, Hirfanlı Dam Lake, Porsuk Dam Lake and Karpuzlu Irrigation Lake populations; such changes in the *b* value may be attributed to certain environmental factors such as over fishing, food competition and the trophic potential of the lakes.

The ChL-W relationships of male, female and both sexes combined showed positive allometric growth ($b<3$), except for Çıldır lake, which displayed a

negative allometry. Similar relations were found for *O. limosus* by Ďuriš *et al.* (2006). The positive allometry in growth of chelae correlated to the sexual maturity of male crayfish (Schulz and Śmietana 2001; Hamr 2002). This may reflect the fact that male chelae undergo allometric growth during ontogeny, while female chelae grow isometrically (Mason 1975; Elser *et al.* 1994). In the current study, the b–values were generally in good agreement with the results obtained from other geographical areas.

The disproportionately rapid growth of chelae in males has been compared with females (Wang *et al.* 2011). Males with large chelae are more successful in copulating with females and often overpower females much larger than themselves (Stein 1976; Buřič *et al.* 2010). Rhodes and Holdich (1979) identified diphasic chelae growth in male and female *Austropotamobis pallipes*; male chelae grew significantly faster than female chelae after sexual maturity. This disparity is primarily due to the accelerated development of the chelae in sexually mature males, whereas chelae of females remain isometric throughout life (Maguire and Dakić 2011). ChL-W relationships are important factors for determining aggressive behavior and competitive outcomes. Because crayfish species compete for limited resources such as food and shelter, space is significant in determining the competitive outcome (Garvey and Stein 1993; Mazlum *et al.* 2007).

The abdomen of juveniles and males grows almost isometrically; on the other hand, the growth observed in female abdomen, correlated to sexual maturity of female crayfish, is positive allometry (Ibbotson and Furse 1995). A large female abdomen may increase the capacity for carrying eggs, which increases the potential reproductive fitness as it is the case of most Decapoda (Grandjean *et al.* 1997). Our results on the regression coefficients for the AL-W comparisons indicated isometric for weight in all treatments. That means the weight increased at a faster rate than the cube of the abdomen length (*i.e.* slope >3.0).

The morphometric characters would be helpful in comparing the same species in different locations. There are different populations of *A. leptodactylus* in Turkey. It can be concluded that the study of morphometric characters could be used to describe populations. This study also provides basic information on the length-weight, carapace length-weight, chelae length-weight and abdomen length-weight relationships that would be useful for sustainable fisheries management, part of recovery programs, or management and conservation activities in the inland fisheries of Turkey. Hence, the results of the study will make useful information, needed for the effective management and utilization of this resource in these areas, where the crayfish occurs.

Table 1. Descriptive statistics and estimated parameters of total length-weight relationships for *A. leptodactylus* (ESC, 1823) in seven different inland waters (M, male; F, female; A, sexes combined; N, number of individuals; Min, minimum; Max, maximum; a, intercept; b, slope; CI, confidence intervals; r^2= coefficient of determination; I, isometric growth; A−, negative allometric growth; A+, positive allometric growth)

Area	Sex	N	Total length (mm) Min.	Max.	Total weight (g) Min.	Max.	a	b	95% CI of b	r^2	Growth Type
ALAŞEHİR LAKE	M	87	80	144	13.81	89.67	0.000009	3.2349	3.149-3.321	0.9429	A+
	F	70	87	143	13.77	71.47	0.00007	2.7698	2.683-2.857	0.9376	A−
	A	157	80	144	13.77	89.67	0.00001	3.1863	3.098-3.274	0.8947	I
ÇILDIR LAKE	M	46	95	139	19.91	93.23	0.000003	3.4355	3.271-3.600	0.9083	A+
	F	55	96	142	21.25	69.72	0.00006	2.7964	2.695-2.898	0.936	I
	A	101	95	142	19.91	93.23	0.00001	3.1381	3.029-3.247	0.895	I
EĞİRDİR LAKE	M	86	102	162	31.32	117.43	0.00003	2,968	2.848-3.089	0.8791	I
	F	73	102	156	25.97	101.44	0.00003	2,958	2.823-3.094	0.8702	I
	A	159	102	162	25.97	117.43	0.00002	3.0293	2.919-3.139	0.8274	I
HİRFANLI DAM LAKE	M	86	91	150	22.68	98.19	0.00001	3.2066	3.108-3.305	0.9269	A+
	F	79	94	140	22.13	63.49	0.00007	2.7791	2.662-2.896	0.8814	I
	A	165	91	150	22.13	98.19	0.00002	3.0253	2.911-3.139	0.8119	I
KEBAN DAM LAKE	M	122	90	141	20.7	85.94	0.000008	3.2841	3.196-3.372	0.9203	A+
	F	70	95	131	22.37	55.89	0.0001	2.7055	2.596-2.814	0.9007	A−
	A	192	90	141	20.7	85.94	0.00001	3.1456	3.031-3.260	0.7982	I
PORSUK DAM LAKE	M	99	92	126	17.44	63.29	0.000005	3.3820	3.226-3.537	0.8328	A+
	F	87	81	124	12.43	38.46	0.0003	2.4158	2.261-2.570	0.7447	A−
	A	186	81	126	12.43	63.29	0.00002	3.0436	2.896-3.191	0.7008	I
KARPUZLU IRRIGATION LAKE	M	73	72	183	11.11	178.93	0.000004	3.4390	3.351-3.527	0.9561	A+
	F	89	71	153	10.09	92.19	0.00005	2.8360	2.737-2.935	0.9051	I
	A	162	71	183	10.09	178.93	0.000005	3.3355	3.246-3.424	0.8987	A+

Table 2. Descriptive statistics and estimated parameters of carapace length-weight relationships presented for *A. leptodactylus* (ESC, 1823) in the seven inland waters (M, male; F, female; A, sexes combined; N, number of individuals; Min, minimum; Max, maximum; a, intercept; b, slope; CI, confidence intervals; r^2 = coefficient of determination; I, isometric growth; A−, negative allometric growth; A+, positive allometric growth)

Area	Sex	N	Carapace length (mm)		Total weigth (g)		a	Regression parameters		r^2	Growth Type
			Min.	Max.	Min.	Max.		b	95 %CI of b		
ALAŞEHİR LAKE	M	87	42.5	77.3	13.81	89.67	0.0002	3.0900	2.996-3.184	0.9479	I
	F	70	39.9	66.24	13.77	71.47	0.0007	2.6908	2.581-2.801	0.9132	A−
	A	157	39.9	77.3	13.77	89.67	0.0002	2.9807	2.911-3.051	0.9388	I
ÇILDIR LAKE	M	46	47.6	72.83	19.91	93.23	0.00008	3.2397	3.055-3.424	0.9167	I
	F	55	44.2	72.15	21.25	69.72	0.0006	2.7231	2.548-2.898	0.9002	I
	A	101	44.2	72.83	19.91	93.23	0.0002	3.0060	2.874-3.137	0.9016	I
EĞİRDİR LAKE	M	86	51.59	78.07	31.32	117.43	0.0002	3.0116	2.893-3.130	0.9175	I
	F	73	29.42	80.57	25.97	101.44	0.0004	2.8786	2.768-2.989	0.9217	I
	A	159	29.42	80.57	25.97	117.43	0.0002	2.9763	2.899-3.053	0.9274	I
HİRFANLI DAM LAKE	M	86	31.17	77.71	22.68	98.19	0.0002	3.0808	2.949-3.213	0.904	I
	F	79	45.08	68	22.13	63.49	0.0008	2.6873	2.579-2.795	0.9142	A−
	A	165	31.17	77.71	22.13	98.19	0.0003	2.9387	2.853-3.024	0.9095	I
KEBAN DAM LAKE	M	122	45.09	71.41	20.7	85.94	0.00004	3.4572	3.325-3.589	0.9215	A+
	F	70	46.88	62.53	22.37	55.89	0.0004	2.8260	2.691-2.961	0.8826	I
	A	192	45.09	71.41	20.7	85.94	0.00004	3.4209	3.319-3.522	0.9066	A+
PORSUK DAM LAKE	M	99	46.34	65.91	17.44	63.29	0.0002	2.9907	2.807-3.174	0.8475	I
	F	87	44.4	60.69	12.43	38.46	0.0021	2.4050	2.218-2.592	0.7477	A−
	A	186	44.4	65.91	12.43	63.29	0.0003	2.9139	2.788-3.039	0.8356	I
KARPUZLU IRRIGATION LAKE	M	73	38.4	100.31	11.11	178.93	0.00009	3.2142	3.097-3.331	0.9345	I
	F	89	45.74	77.37	10.09	92.19	0.0008	2.4869	2.543-2.817	0.862	A−
	A	162	38.4	100.31	10.09	178.93	0.0001	3.1278	3.048-3.208	0.9294	I

Table 3. Descriptive statistics and estimated parameters of chelae length-weight relationships were presented for both sexes of *A. leptodactylus* (ESC, 1823) in the seven different inland waters. (M, male; F, female; A, sexes combined; N, number of individuals; Min, minimum; Max, maximum; a, intercept; b, slope; IC 95%, confidence intervals; r^2= coefficient of determination; I, isometric growth; −A, negative allometric growth; +A, positive allometric growth)

Area	Sex	N	Chelae length (mm)		Total weight (g)		Regression parameters			r^2	Growth Type
			Min.	Max.	Min.	Max.	a	b	% 95 CI of b		
ALAŞEHİR LAKE	M	61	28.04	89.49	17.75	89.67	0.0542	1.6773	1.618-1.722	0.9409	A+
	F	59	24.13	60.6	13.77	71.47	0.0436	1.8255	1.726-1.925	0.8602	A+
	A	120	24.13	89.46	13.77	89.67	0.1867	1.3798	1.328-1.431	0.8601	A+
ÇILDIR LAKE	M	30	29.24	76.55	19.91	93.23	0.079	1.6448	1.544-1.752	0.9023	A+
	F	30	27.25	44.56	21.25	69.72	0.0167	2.1873	2.016-2.358	0.8583	A-
	A	60	27.25	76.55	19.91	93.23	0.1278	1.5842	1.507-1.661	0.8828	A+
EĞİRDİR LAKE	M	60	33.49	87.64	33.02	117.43	0.1089	1.5662	1.493-1.639	0.8878	A+
	F	60	31.09	78.67	28.7	101.44	0.0477	1.8696	1.789-1.949	0.9092	A+
	A	120	31.09	87.64	28.7	117.43	0.4649	1.2287	1.166-1.292	0.768	A+
HİRFANLI DAM LAKE	M	60	31.3	77.22	22.68	98.19	0.1899	1.4196	1.339-1.500	0.8424	A+
	F	60	25.09	49.39	22.13	63.49	0.1014	1.6522	1.542-1.762	0.8004	A+
	A	120	25.09	77.22	22.13	98.19	0.4022	1.2475	1.190-1.305	0.8032	A+
KEBAN DAM LAKE	M	60	33.11	81.98	20.7	85.94	0.1024	1.5412	1.478-1.604	0.9112	A+
	F	60	25.69	45.09	22.37	55.89	0.108	1.6114	1.478-1.744	0.7164	A+
	A	120	25.69	81.98	20.7	85.94	0.6702	1.0760	1.028-1.124	0.812	A+
PORSUK DAM LAKE	M	51	22.71	64.85	22.4	63.29	0.1147	1.5271	1.451-1.603	0.8936	A+
	F	58	24.73	42.23	17.85	38.46	0.2775	1.3110	1.189-1.433	0.6769	A+
	A	109	22.71	64.85	17.85	63.29	0.5629	1.1108	1.049-1.172	0.7553	A+
KARPUZLU IRRIGATION LAKE	M	55	25.33	117.37	11.11	178.93	0.0971	1.6051	1.546-1664	0.9336	A+
	F	63	21.44	59.63	10.09	92.19	0.1168	1.6242	1.549-1.699	0.8897	A+
	A	118	21.44	117.37	10.09	178.93	0.2899	1.3553	1.313-1.398	0.9007	A+

Table 4. Descriptive statistics and estimated parameters of abdominal length weight relationships were presented for both sexes of *A. leptodactylus* (ESC, 1823) in the seven different inland waters. (M, male; F, female; A, sexes combined; N, number of individuals; Min, minimum; Max, maximum; a, intercept; b, slope; IC 95%, confidence intervals; r^2= coefficient of determination; I, isometric growth; −A, negative allometric growth; +A, positive allometric growth)

| Area | Sex | N | Abdominal length (mm) | | Total weight (g) | | Regression parameters | | | | Growth |
			Min.	Max.	Min.	Max.	a	b	% 95 CI of b	r^2	Type
ALAŞEHİR LAKE	M	87	35.43	69.63	13.81	89.67	0.0003	2.9475	2.778-3.117	0.837	A+
	F	70	44.56	76.76	13.77	71.47	0.0008	2.6080	2.461-2.754	0.8473	A+
	A	157	35.43	76.76	13.77	89.67	0.0002	3.0227	2.878-3.167	0.787	I
ÇILDIR LAKE	M	46	47.54	66.77	19.91	93.23	0.00001	3.6939	3.282-3.978	0.8456	I
	F	55	47.18	69.85	21.25	69.72	0.0005	2.7459	2.535-2.956	0.8629	I
	A	101	47.18	69.85	19.91	93.23	0.0003	2.9332	2.743-3.123	0.8074	I
EĞİRDİR LAKE	M	86	48.81	84.95	31.32	117.43	0.0005	2.8461	2.666-3.026	0.8125	I
	F	73	52.87	89.58	25.97	101.44	0.0004	2.8014	2.703-2.899	0.9334	A-
	A	159	48.81	89.58	25.97	117.43	0.0018	2.5013	2.336-2.667	0.6599	A-
HİRFANLI DAM LAKE	M	86	41.18	82.83	22.68	98.19	0.0003	2.9909	2.836-3.146	0.8653	I
	F	79	48.92	72	22.13	63.49	0.0002	2.9719	2.847-3.096	0.9074	I
	A	165	41.18	82.83	22.13	98.19	0.0012	2.5776	2.425-2.730	0.7076	A-
KEBAN DAM LAKE	M	122	44.91	65.59	20.7	85.94	0.0002	3.0589	2.921-3.197	0.8943	I
	F	70	48.08	68.47	22.37	55.89	0.0024	2.3693	2.226-2.512	0.8256	A-
	A	192	44.91	69.59	20.7	85.94	0.0003	2.9072	2.733-3.081	0.7019	I
PORSUK DAM LAKE	M	99	43.72	60.64	17.44	63.29	0.0001	3.2259	3.014-3.437	0.8259	I
	F	87	45.4	65.88	12.43	38.46	0.0066	2.0981	1.967-2.229	0.8146	A-
	A	186	43.72	65.88	12.43	63.29	0.0051	2.1938	2.062-2.325	0.7191	A-
KARPUZLU IRRIGATION LAKE	M	73	33.6	83.14	11.11	178.93	0.00009	3.2584	3.101-3.415	0.8902	I
	F	89	50.74	78.44	10.09	92.19	0.0009	2.6102	2.473-2.747	0.8557	A-
	A	162	33.6	83.14	10.09	178.93	0.0001	3.2037	3.053-3.354	0.7966	I

Türkiye'de 7 farklı içsu kaynağından yakalanan *Astacus leptodactylus* (Eschscholtz 1823)'un bazı morfolojik özelliklerinin incelenmesi üzerine bir çalışma

Özet

Bu çalışmada, Türkiye'nin farklı tatlı su kaynaklarındaki tatlı su istakozu (*Astacus leptodactylus* Eschscholtz 1823)'un bazı morfolojik ve populasyon karakterlerinin belirlenmesi amaçlanmıştır. *Astacus leptodactylus*'un toplam boyu (TL), karapaks boyu (CL), chelae boyu (ChL), abdomen boyu (AL) ve yaş ağırlığı arasındaki ilişki üç göl, üç baraj gölü ve bir sulama göletin için gösterilmiştir. Boy ağırlık ilişkisinde tüm bireyler için *b* değeri 1,0760-3.6939 ve *a* değeri 1.0760-3.6939 arasında bulunmuştur. Korelasyon katsayı değeri r^2= 0,6599-0.9561 arasında olup aralarında güçlü bir ilişki olduğu belirlenmiştir (P<0.05). Dişi ve erkek bireyler arasında regresyon eğim çizgisinin farklılığı ANCOVA testi ile test edilmiştir. Kerevit örneklerinin elde edildiği bölgeler arasındaki farklılıklar da farklı bulunmuştur.

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