

An investigation on the population parameters of freshwater crayfish (*Astacus leptodactylus* Esch., 1823) in Lake İznik (Bursa)

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Abstract: Length–weight relationships, distribution of length and weight groups, sex ratio, and length compositions of the crayfish *Astacus leptodactylus* (Esch., 1823) population in Lake İznik (Bursa), along with some reproductive-period characteristics (spawning periods, pleopod egg numbers, and egg incubation periods), were investigated between February 2010 and May 2011. For this purpose, 1897 freshwater crayfish samples (896 female, 1001 male) were collected, using fyke nets of 34-mm nominal bar length. It was observed that females carried pleopodal eggs during the second week of January, and they carried first-stage juveniles during the second week of June. Individuals within the 76–149 mm total length group had approximately 239.95 ± 109.36 pleopod eggs; egg diameter was 2.763 ± 0.150 mm. The mean total length of the individuals was 104.17 ± 14.89 mm for females and 95.71 ± 13.11 mm for males. The mean weight was 32.50 ± 21.83 g for females and 28.82 ± 14.12 g for males. As a result of regression analyses, the length–weight relationship was calculated as $W = 3.10^{-5} TL^{3.011}$ for females and $W = 8.10^{-6} TL^{3.3016}$ for males. These findings show that females of *A. leptodactylus* have isometric growth, but males of this species have positive allometric growth. This study reveals that the *A. leptodactylus* population of Lake İznik demonstrates recovery in its situation.

Key words: Lake İznik, freshwater crayfish, *Astacus leptodactylus*, population characteristics, length–weight relationships, spawning characteristics

1. Introduction

Astacus leptodactylus shows a widespread distribution within inland waters of Turkey. It was the most important inland water product between 1970 and 1985. However, there was a dramatic decrease in its population due to the crayfish plague, which was recorded in Turkey in 1984 (Furst, 1988; Baran and Soylu, 1989; Rahe and Soylu, 1989).

In Turkey, crayfish production was 7936 t in 1984. It dropped to 1565 t in 1987 and 320 t in 1991 (TÜİK, 1984–1991). Furthermore, there have been some fluctuations in crayfish production in the last 25 years. Production was 324 t in 1992, which increased to nearly 1500 t in 1998. While production was 1372 t in 1999, it reached 2317 t in 2004. However, it diminished to 816 in 2007, 1030 in 2010, 609.6 in 2011, and 492 in 2012 (TÜİK, 2013).

Although crayfish are not much consumed in Turkey, fishing of the freshwater crayfish, which are especially sought after in European countries, started in lakes Manyas and Apolyont (Uluabat) at the beginning of 1965. It gained importance with its increasing export volume (Berber

and Balık, 2006). Statistics for the number of freshwater crayfish caught in Turkish inland waters were not routinely recorded until 1976, and the number of freshwater crayfish caught was given as 3.885 t for the first time in 1977 (TÜİK, 1976–1979). Isparta and Bursa were the leading provinces catching freshwater crayfish in those years.

Lake İznik is situated within the borders of the province of Bursa in the Marmara region. The lake, with a surface area of approximately 313 km², has a maximum depth of 65 m and its elevation above sea level is 85 m. The length of the lake is approximately 32 km and the widest point is 12 km. It is the largest natural lake in the Marmara region and the fifth largest in Turkey. There are five streams and ground waters that feed the lake (Aktan and Aykulu, 2001). Lake İznik, which is eutrophic in terms of ecology, is quite rich in diversity of species of fish compared with many other lakes; apart from the crayfish, there are 19 species of fish in the lake (Özuluğ et al., 2005).

After the occurrence of crayfish plague in Turkish inland waters, crayfish stocks in lakes İznik and Apolyont were also negatively affected, and commercial crayfish

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harvesting in Lake İznik could not be done for various reasons after 2002. While it has been stated that the pressure of the crayfish disease in Lake Apolyont is still felt (Bursa Province, Directorate of Food, Agriculture, and Livestock, crayfish harvesting unpublished data), it is also noted that the disease did not have much effect on Lake İznik's crayfish. This could have been caused by a characteristic of the lake water (Ca^{2+} : Mg^{2+} ratio) (Diler et al., 1999; Harlioğlu and Harlioğlu, 2004; Timur et al., 2010; Kokko et al., 2012).

Köksal (1980) analyzed the population characteristics of *A. leptodactylus* from 8 different water sources in Turkey (lakes Eğirdir, Akşehir, Apolyont, Eber, İznik, Manyas, and Terkos, and Miliç Brook); Harlioğlu and Harlioğlu (2005) studied the morphometric features and meat yields of crayfish caught in Lake İznik; Berber and Mazlum (2009) studied the spawning efficiency of crayfish of lakes Apolyont, Manyas, and İznik. However, there are only a few studies on the biological characteristics of Lake İznik crayfish. For example, Balık et al. (2002) studied the stocking density and length composition of Lake İznik's crayfish.

Although Lake İznik had good fishing potential until 1985, commercial crayfish harvesting has not been possible since 2002 (İznik District, Directorate of Food, Agriculture, and Livestock, personal communication). In order to protect the population and to have sustainable fishing, it is also necessary to know the characteristics of the population as well as its size. For this purpose, this research was focused on investigating the length–weight relationship, distribution of length and weight groups, sex ratio, and length compositions, along with some reproductive characteristics (spawning periods, pleopod egg number, and egg incubation periods) of the crayfish living in Lake İznik.

2. Materials and methods

This study was conducted between February 2010 and May 2011; 1897 freshwater crayfish (896 female, 1001 male) samples were used in the study. In order to catch crayfish samples, 80 single-entrance fyke nets, each with 34-mm mesh size, were used. Fyke nets were cast into the water in front of the town of Çakırca, where freshwater crayfish fishing was done intensely in Lake İznik between 1970 and 1985; the nets were collected the following day. Caught crayfish were put into styrofoam boxes and brought live the same day to Kocaeli University Gazanfer Bilge Vocational School.

First, all crayfish were separated by sex and counted. Individuals with symptoms of disease were carefully identified. After this, each crayfish was weighed with a digital scale (0.001 g sensitivity) and their total lengths were measured with a ruler (to the nearest 0.1 mm). Other

body measurements—carapace length, carapace width, abdomen width, cheliped width, cheliped length, and walking legs length—were measured with a digital caliper (to the nearest 0.01 mm). For measuring the body parts, the methods of Rhodes and Holdich (1984) were used. The pleopodal eggs of 60 females (size range: 76–149 mm total length) were counted in the reproductive season of 2011; egg diameters were measured, and egg weights were determined. In measuring the egg diameters, 20 eggs were put in a range and the lengths were measured, and their approximate lengths and weights were calculated.

Freshwater crayfish has a nonlinear relationship between length and weight, as in fishes, that can be expressed as $W = aL^b$ (Le Cren, 1951), where W = weight of the samples in g, L = length of the samples in cm, a and b are constant parameters of the regression equation; b is the slope value of the line in the regression equation giving information about the body shape of the living fish, and a is the intersection point of the regression equation giving information on the food capacity of the environment. In order to determine whether the weight increase of the freshwater crayfish population analyzed was isometric or allometric, the length and weight values underwent regression analysis and coefficients a and b were calculated in accordance with the least-squares method (Ricker, 1975; Pauly, 1984). The t-test was used in order to determine if there was a potential and meaningful difference between the acquired b values and cubic growth. For this process, the standard error of the b values was first calculated, and its relationship with the value in the t distribution table of 95% confidence interval was analyzed (Sokal and Rohlf, 1987). The calculated r (correlation value), shows the relationship between the independent variable (e.g., length) and the dependent variable (e.g., weight) (Romaine et al., 1977; Groves, 1985; Harlioğlu, 1999).

In statistically evaluating the data acquired from the research, the significance tests were done based on the $P = 0.05$ and $P = 0.01$ confidence limits (Ricker, 1973). Microsoft Excel 2002 was used in the analysis of the data.

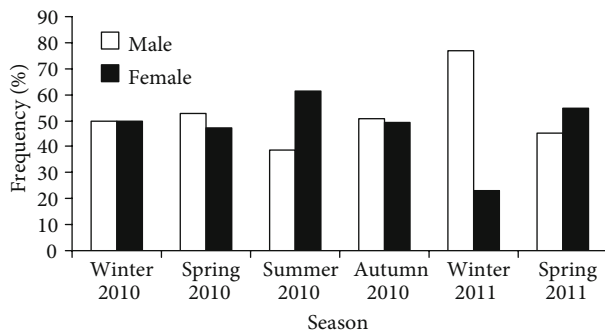
3. Results

During the study, 896 female and 1001 male (a total of 1897) freshwater crayfish were caught from Lake İznik. Of these, 47.23% were female and 52.77% were male (Table 1). Female individuals were caught most often (177) in spring 2011 and 2010 and least often (44) in winter 2011. Male individuals were caught most often (515) in spring 2010 and least often (42) in summer 2010 (Table 1; Figure 1). There were no significant differences between the sexes ($\chi^2 = 0.29$, $P > 0.05$).

The number of individuals that showed the symptoms of disease (uropod erosion, melanization, etc.) within the population by month was found to be higher in males.

Table 1. The ratio of the female and male freshwater crayfish, and of those with symptoms of disease, caught in Lake İznik.

Date	Female				Male				Sex ratio ♀/♂	X ² test (P = 0.05)	Number of individual with disease symptoms	
	n	% (f)	Mean total length (mm)	Mean weight (g)	n	% (m)	Mean total length	Weight, mean			Female	Male
Winter 2010	82	9.15	110.6	37.58	82	8.19	104.2	37.79	1.00/1.00	P > 0.05	3	5
Spring 2010	461	51.45	104.4	32.41	515	51.4	94.3	27.58	0.89/1.00	P > 0.05	11	32
Summer 2010	67	7.48	101.1	26.37	42	4.20	95.7	26.31	1.59/1.00	P > 0.05	6	6
Autumn 2010	65	7.25	93.2	21.72	67	6.69	95.9	28.44	0.97/1.00	P > 0.05	2	3
Winter 2011	44	4.91	101.4	31.03	148	14.80	99.9	36.16	0.29/1.00	P < 0.05	3	8
Spring 2011	177	19.75	106.5	34.31	147	14.70	97.6	64.21	1.20/1.00	P > 0.05	6	15
Total	896	47.23			1001	52.77			0.89/1.00	P < 0.05	31	69

**Figure 1.** Length–frequency distribution of female and male freshwater crayfish.

While the rate of the individuals with symptoms of disease among all the crayfish caught was 5.27% (100), it was 3.45% in females (31) and 6.89% (69) in males (Table 1).

The 1897 crayfish that were caught during the study were analyzed by separating them into 10-mm length groups; it was determined that the total length of the male individuals ranged from 68 to 142 mm and the total length of female individuals ranged from 60 to 149 mm. The average total length was 95.71 ± 13.11 mm in males and 104.17 ± 14.89 mm in females, while the average weight was 28.82 ± 14.12 g in males and 32.50 ± 21.83 g in females.

When all the individuals caught from the population of Lake İznik were considered, even though female individuals were heavier than male individuals and male individuals had greater carapace length and width than females, these differences were not statistically significant ($P > 0.05$). Even though the width and length of the cheliped and the length of the walking legs of the male individuals were greater than those of female individuals, these differences were also not significant ($P > 0.05$). The

differences between the male and female individual body lengths were compared using the t-test.

Of the total number of crayfish caught, 896 were female. When the total length frequencies of the female individuals were analyzed, it was determined that their total length ranged from 60 to 149 mm; 21.1% of these individuals had a length of 90–99.9 mm, 28.01% were 100–109.9 mm, and 23.09% were 110–119.9 mm. The total length distribution of the 1001 male individuals ranged from 68 to 142 mm; 22.9% of these individuals had a length of 80–89.9 mm, 24.2% were 90–99.9 mm, and 23.1% were 100–109.9 mm. The most common total lengths were between 80 and 119.9 mm.

When the proportion and sexual distribution of the population lower and higher than 100 mm are considered (the minimum landing size (MLS) is 100 mm according to Turkish Commercial Fisheries Regulation Notification No: 3/1), it was seen that the rate of male individuals below the MLS was 58.14% while it was 36.27% for the female individuals.

It was observed that Lake İznik crayfish carried pleopod eggs at the beginning of January and that the first-stage juveniles started to hatch at the beginning of the second week in June. The mean number of pleopoda eggs of 60 females (size range: 76–149 mm total length) was 239.95 ± 109.36 . The mean weight of pleopodal eggs was 0.0157 ± 0.0032 g. The smallest crayfish with eggs had a total length of 76 mm and 118 eggs; the female crayfish that gave the most eggs had a total length of 99 mm and gave 529 eggs. The number of female crayfish that were caught during the spawning period, based on the length distribution, is given in Table 2. The percentage of egg-bearing females was 0% in the range of 60–69 mm total length, 23.08% in the range of 70–79 mm total length, 69.49% in the range of 80–89 mm total length, 97.52% in the range of 90–99

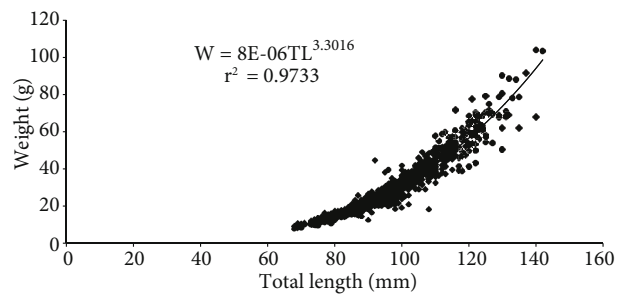
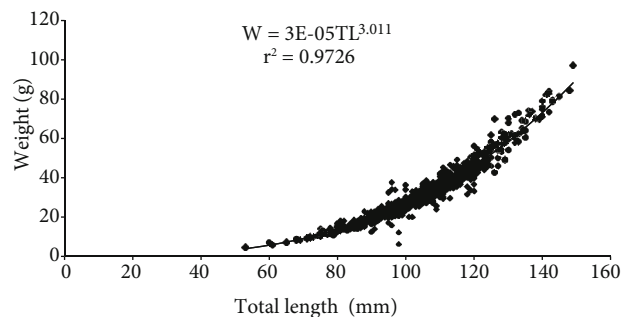
Table 2. Distribution, number, and percentage of female crayfish with eggs and without eggs caught during the spawning period.

Length group (mm total length)	With eggs		Without eggs		Total number of individuals
	Number of individuals	%	Number of individuals	%	
60–69	0	0	5	100	5
70–79	3	23.08	10	76.92	13
80–89	41	69.49	18	30.51	59
90–99	118	97.52	3	2.48	121
100–109	153	98.08	3	1.92	156
110–119	147	98.65	2	1.34	149
120–129	81	98.78	1	1.22	82
130–139	22	100			22
140–149	14	100			14
Total	579	93.24	42	6.76	621

mm total length, 98.08% in the range of 100–109 mm total length, 98.65% in the range of 110–119 mm total length, 98.78% in the range of 120–129 mm total length, 100% in the range of 130–139 mm total length, and 100% in the range of 140–149 mm total length. Among all the female individuals caught, 93.24% of the females were carrying eggs and 6.76% of them were not carrying eggs during this spawning period (Table 2). It was seen that during the crayfish's egg incubation, the average egg diameter and weight increased depending on the month. While the average egg diameter in February 2010 was 2.644 ± 0.130 mm and average egg weight was 0.0123 ± 0.001 g, in March 2010 they were 2.695 ± 0.072 mm and 0.0130 ± 0.001 g, and in April 2010 they were 2.855 ± 0.055 mm and 0.0135 ± 0.001 g.

The linear regression relationship between total length and number of eggs of crayfish was $Y = 3.673x - 149.41$ r^2 : 0.226. Crayfish have a nonlinear relationship between length and weight, as fishes do (Ricker, 1973). The relationship between the body length and weight of crustaceans is commonly defined by regression analysis ($\log y = \log(a) + b \log(x)$). Length–weight relationship equations were calculated, which among the total length and weight values of the population for male, female, and total individuals were, respectively, $W = 8.10^{-6}TL^{3.3016}$ (Figure 2), $W = 3.10^{-5}TL^{3.011}$ (Figure 3), and $W = 2.10^{-5}TL^{3.0351}$.

The b values for the male and female crayfish in the Lake İznik freshwater crayfish population were 3.3016 and 3.011, respectively. According to the regression analysis results, while female individuals and the total showed isometric growth in terms of total length–total weight, male individuals showed positive allometric growth (Table 3).

**Figure 2.** Length–weight relationship for male *A. leptodactylus*.**Figure 3.** Length–weight relationship for female *A. leptodactylus*.

The determination coefficient (r^2) between the length and weight of the freshwater crayfish samples was 0.9733, 0.9726, and 0.9596 for male, female, and total individuals, respectively. These values, being close to 1, determined that there was a positive relationship between length and weight. The r^2 values and the equations that were acquired as a result of regression analyses are given in Table 3.

Table 3. Length–weight parameters for female, male, and all individuals (n: number of individuals, *a*: intercept, *b*: slope, *r*²: coefficient of determination).

	n	<i>a</i>	<i>b</i>	<i>b</i> of 95% confidence limit	<i>r</i> ²	Growth type
Total	1897	0.00002	3.0351	3.0146–3.0555	0.9596	I
Male	1001	0.000008	3.3016	3.2770–3.3262	0.9733	A+
Female	896	0.00003	3.011	2.9869–3.0350	0.9726	I

4. Discussion

Describing the body of the freshwater crayfish population is important for the efficient management and protection of its supply. Biometric analyses are helpful in describing biological examples, especially in crustaceans. In showing the morphological differences between the male and female individuals of freshwater crayfish species, the differences in ratio among the body parts are used. These differences are used in determining the growth characteristics of the freshwater crayfish population, comparing populations of the same species with different regions and classifying freshwater crayfish systematically (Adegboye, 1981; Skurdal and Qvenild, 1986; Harlioğlu, 1999).

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 (Romaine et al., 1977; Rhodes and Holdich, 1979; Harlioğlu and Güner, 2006; Ibarra and Arana, 2012). 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 (Erdemli, 1982; Balık et al., 2005; Büyükçapar et al., 2006; Güner, 2006).

In our study, however, the total length, average carapace length, carapace width, abdomen width, and body weight of the female individuals were greater than those of the male individuals. On the other hand, the cheliped length, cheliped width, and walking leg length of the males were greater. In general, the carapace width among the male individuals of the same length group was wider in comparison to that of female individuals. The female individuals' average length being greater than that of the male individuals in our study, contrary to expectations, enabled female individuals to have total length, carapace length, carapace width, and body weight greater than those of the males. In this study, the total length values of the female and male individuals caught were 104.17 ± 14.89 mm and 95.71 ± 13.11 mm; their average total weights were 32.50 ± 21.83 g and 28.82 ± 14.12 g, respectively. Even though similar findings were reported by Köksal (1980), Erdemli (1982, 1987), Çevik (1993), Harlioğlu (1999), Bolat and Aksoylar (2004), and

Deniz et al. (2010), in studies done in lakes Akşehir, Miliç, Beyşehir, and Terkos male individuals were longer and heavier (Köksal, 1980; Erdemli, 1982; Büyükçapar et al., 2006; Güner, 2006).

Differences in morphometric characteristics can be affected by environmental factors such as the nutritional behaviors of the species, its ability to find food, and the quality of food (Lindquist and Lathi, 1983; France, 1985). The frequency and duration of the molting of the freshwater crayfish, and the increase in length and weight of the individuals, as well as environmental conditions, affect the shell growth. It is thought that the physical and chemical characteristics of Lake İznik play an important role in these differences.

The male to female ratio of all the individuals caught during the study was calculated as 1:0.89. Even though the abundance of the different sexes of the family *Astacidae* in the natural environment varies widely, their sex ratios in most natural crayfish populations are close to 1:1 (Abrahamsson, 1971; Cobb and Wang, 1985; Kirjavainen and Westman, 1999; Berber and Balık, 2006). In some seasons, in the ratios of the individuals caught, sex differences could be seen to a large extent. This is because females and males can engage in different activities seasonally (Westin and Gydemo, 1989; Hudina et al., 2008). As an example, more males can be caught compared to females, especially during the spawning period (Fenouil and Chaix, 1985; Ackefors, 1999; Alekhovich et al., 1999; Grandjean et al., 2000; Capurro et al., 2007). At the same time, the fishing tools that are used for fishing freshwater crayfish may be more effective, and therefore male individuals can be caught, especially in crayfish traps (Krzywosz et al., 1995). Our findings show similar results for the sex ratio for crayfish as those reported in previous studies.

The studies conducted in the inland waters in Turkey determined that the ratio of female individuals was very high in lakes Alaşehir (Köksal, 1980), Manyas (Köksal, 1980), Eğridir, Beyşehir, Apa (Erdemli, 1982), and Işıkli (Güner, 2000); but the ratio of male individuals was high in lakes Apolyont, Eber, İznik, and Terkoz (Köksal, 1980), Akşehir (Erdemli, 1982), Eğridir (Bolat, 1996), İznik (Erdem et al., 2001), and in some ponds in the city of

Tekirdağ (Deniz et al., 2010) and Keban Dam Lake (Ateş and Aksu, 2013). The lakes that have a freshwater crayfish sex ratio close to 1:1 are Miliç Brook (Köksal, 1980), Lake Eber (Erdemli, 1982), Lake Hotamış (Erdemli, 1987), and Lake Seyhan (Çevik, 1993).

The relationship between the body weight, length, and egg fertility of the 60 female crayfish (76–149 mm) with eggs caught during the research was analyzed. The number of eggs that Lake İznik crayfish carried varied from 56 to 529. The biggest female individual (149 mm) carrying eggs was caught in February 2010 and the smallest one (76 mm) was caught in March 2011. This corroborates the difference found in females between these months, and could be related to the difference in average wet weight of each individual egg, since the heaviest egg was 0.022 g and the smallest egg 0.0108 g. The largest egg diameter was 3.021 mm and the smallest egg diameter was 2.504 mm. Huner (1981) stated that the length of the female crayfish is related to the number of eggs they carry, and that individuals of *Procambarus clarkii* (Girard, 1852) with a length of 65 mm carried 100 eggs and individuals of 90 mm carried 300 eggs. Erdemli (1985, 1987) determined a positive correlation between egg productivity and length–weight ratio of the crayfish. It was determined that in Lake Ägeri in Switzerland *A. leptodactylus* had 183 eggs on average (Stucki and Romer, 2001).

A. leptodactylus is one of the most productive species among the local European crayfish and that one female produces 200–400 eggs (Harlıoğlu et al., 2004). In studies conducted in different bodies of water in Turkey, it was stated that the average number of individual eggs was 170 in Lake Eğirdir, 156 in Lake Beyşehir, 149 in Lake Akşehir, 161 in Lake Eber, and 153 in Apa Dam Lake (Balık et al., 2006). Other researchers determined that the average number of eggs was 148 in Lake Eğirdir (Erdemli, 1983), 163 in Lake Hotamış and 158 in Mamasın Dam Lake (Erdemli, 1985), 80–372 in Lake Mogan (Tüzün, 1987), 171 in Seyhan Dam Lake (Çevik, 1993), 277 in Lake Eğirdir (Bolat, 1996), 97–289 in Dam Lake Keban (Duman and Gürel, 2000), 216 in Lake Işıklı (Güner and Balık, 2002), and 305 among the individuals with a length of 47–76 mm in Keban Dam Lake (Harlıoğlu et al., 2004). Erdem et al. (2001) stated in their studies on Lake İznik crayfish that the average number of eggs was 154, and Güven et al. (2002) stated that it was 17–253.

The minimum egg diameter of Lake İznik crayfish was 2.09 ± 0.003 mm, the maximum egg diameter was 3.24 ± 0.003 mm, and the average egg diameter was 2.643 ± 0.003 mm. Among the crayfish from other water bodies in Turkey, egg diameters were 2.444–2.498 mm for lakes Beyşehir, Eğirdir, Akşehir, and Eber (Erdemli, 1982). The egg diameter for Seyhan Dam Lake crayfish (Çevik, 1993) is given as 2.515 mm, 2.43 mm for Lake Hotamış, 2.48

mm for Mamasın Dam Lake crayfish (Erdemli, 1987), and 2.424–2.646 mm for Lake İznik (Güven et al., 2002). According to Vasileva et al. (2006), in Pyasachnik Dam Lake in Bulgaria, they found the number of pleopod eggs of *A. leptodactylus* to be 200.8 ± 89.2 , their weight to be 12.36 ± 1.71 mg, and their diameter to be 2.75 ± 0.17 mm. It was also found that the ones that lived in carp ponds have 162.7 ± 104.1 pleopod eggs, a weight of 13.62 ± 1.72 mg, and a diameter of 2.96 ± 0.2 mm. These values show similarities to the values we gathered in our study. When different populations are compared, differences among the egg diameters are thought to be caused by the differences in the sampling time.

According to the *b* values acquired at the end of the regression analyses between the total length and body weight of the Lake İznik crayfish, female individuals ($b = 3.011$) and female + male individuals ($b = 3.0351$) show isometric growth, and male individuals ($b = 3.3016$) show positive allometric growth (Table 3). However, in previous research, the *b* value showed negative allometric growth in crayfish individuals caught in lakes Beyşehir, Eğirdir, Akşehir, Eber, and Apa Dam Lake (Erdemli, 1982). That research showed negative allometric growth in both males and females in Keban Dam Lake (Harlıoğlu, 1999), and it showed positive allometric growth in male individuals and negative allometric growth in females in Keban Dam Lake (Yüksel and Duman, 2012); the research showed positive allometric growth in male individuals and negative allometric growth in female individuals in Mamasın Dam Lake (Berber and Balık, 2006), and it showed positive allometric growth in male individuals and negative growth in female individuals in Lake Alaşehir, Keban Dam Lake, and Porsuk Dam Lake (Deniz et al., 2013). The number of samples, length and weight distribution of the samples, timing and style of sampling, ecological conditions of habitats, and many more factors like these are thought to be the cause of differences among the calculated *b* values. However, in Lake Çıldır, Hirfanlı Dam Lake, and Karpuzlu Pond, it was stated that male individuals showed positive allometric growth while female individuals showed isometric growth (Deniz et al., 2013). In terms of growth, there are parallels between the findings we collected for Lake İznik and *b* values acquired from Lake Çıldır, Hirfanlı Dam Lake, and Karpuzlu Pond.

Crayfish harvesting continued in the inland waters of Turkey up to 2006 between 15 June and 24 December, and the minimum-length ban applied was 90 mm. In the circular that was prepared after this date, the crayfish catch was applied as 1 November–30 June in and after 2007, and the minimum-length ban became 100 mm (BSGM, 2006). In the published circular, it is noted that when crayfish smaller than 100 mm were found numerically at the rate of 10% or more, all the crayfish, without discrimination,

were to be returned to the water, as long as they were healthy (BSGM, 2012). In a study conducted on Lake İznik freshwater crayfish, it was determined that 42.35% of the crayfish caught from the lake were longer than 100 mm and 57.65% were shorter than 100 mm (Balık et al., 2002). During the research, 47.82% of the crayfish population caught consisted of individuals shorter than the legal length limit (<100 mm). This was not a result of any extreme fishing pressure, but it is thought to be caused by the pressure of environmental conditions (water temperature, food condition, and water quality) or the continuing impact of the crayfish plague. Commercial fishing for crayfish was legally banned in Lake İznik at the beginning of 2002. Köksal et al. (2003) found similar results in the studies they conducted in Lake Dikilitaş. They stated that there is no fishing pressure in this lake,

and even though fishermen fish selectively, the majority of individuals caught are under the legally fishable length.

Our study shows that *A. leptodactylus* has seen improvements in its condition due to the precautions taken for the Lake İznik population; there is no pressure from fishing on the population, and the number of female individuals is very close to that of male individuals. Even more important, the average length of female individuals is longer than that of male individuals; the rate of mating among the couples and therefore the creation of pleopod egg is fairly high, and more than half of the individuals caught had the MLS.

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