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Meat Yield and the Length–Weight Relationships of the Narrow-Clawed Crayfish, *Pontastacus leptodactylus* (Eschscholtz, 1823)

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ABSTRACT

The present study investigated the length-weight relationships and meat yield of narrow-clawed crayfish, *Pontastacus leptodactylus* (Eschscholtz, 1823), in Kocahıdır Irrigation Reservoir. Between July 2015 and June 2016, a total of 653 individuals (255 females and 398 males) were sampled, and their carapace lengths (CL), total lengths (TL), and total weights (TW) were measured. The female-to-male ratio for the entire population was found to be 0.64:1.00. The results showed that the CL of the narrow-clawed crayfish ranged between 37 and 90 mm (39-79 mm for females and 37-90 mm for males), while the TW ranged from 10.10 to 165.61 g (11.13-90.01 g for females and 10.16-165.61 g for males). The TL of female individuals was 114.09 mm, with a weight of 40.43 g, while the TL of male individuals was 116.32 mm, with a weight of 53.45 g. The ratio of individuals above the minimum legal-size limit of 100 mm was determined to be 80.70% for the crayfish population in Kocahıdır Irrigation Reservoir. Regression analysis indicated that the TL-TW and CL-TW relationships for female narrow-clawed crayfish exhibited negative allometric growth, while males showed positive allometric growth in terms of the TL-TW relationship and isometric growth in terms of the CL-TW relationship. Isometric growth was observed in the whole population for both male and female individuals in terms of TL-TW and CL-TW characteristics. Female individuals with carapace lengths ranging from 43-82 mm had a chelae meat yield of 2.48%, an abdomen meat yield of 11.38%, and a total meat yield of 13.85%. Male narrow-clawed crayfish with carapace lengths ranging from 35 to 90 mm had a chelae shear meat yield of 4.13%, an abdomen meat yield of 10.52%, and a total meat yield of 14.64%.

Keywords: Kocahıdır Irrigation Reservoir, Crayfish, Length-weight relationships, Meat yield, Turkey.

1. INTRODUCTION

Freshwater crayfish have long been studied in the fields of physiology and ecology, with research dating back over 130 years, and have become a prominent model organism in the biological sciences (Douglass et al., 1993; McMahon, 2001). This group of decapod crustaceans plays a critical role in the diversity of biological research, including topics such as physiology, ecology, neurobiology, conservation, and evolution. Currently, there are 38 genera and 669 species (692 subspecies) in 5 families identified (Crandall and De Grave, 2017). While

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the number of species is high, approximately 20 species belonging to 3 economically important families (Cambaridae, Parastacidae, Astacidae) can be utilized for both hunting and breeding purposes. Crayfish production occurs through both aquaculture and wild capture fisheries, with crayfish production from fishing estimated to be 15,758 tons worldwide (excluding China) in 2016. In Turkey, freshwater crayfish production began in 1965 with a yield of 270 tons and reached 7,937 tons in 1984, the highest recorded value to date. However, in subsequent years, production declined significantly due to the crayfish plague, overfishing, and water pollution, resulting in a production of 492-696 tons between 2010-2019. As of 2020, production has increased, reaching 1,233 tons (Turkstat, 2022). Kale and Berber (2020) developed different forecasting models to assess the trends in the production of crayfish in Türkiye and the authors reported that the crayfish production in Türkiye tended to decrease. Therefore, appropriate strategies should be planned and implemented to improve the production for legal regulations and fisheries management policies.

Environmental factors such as genetic traits, gender, food availability, and diversity have been shown to play a role in the growth of narrow-clawed crayfish during development (Lindqvist and Lahti, 1983). Furthermore, the selective characteristics of fishing gear used in crayfish populations have been reported to contribute to the variability of length-weight relationships. These differences may arise due to various factors such as photoperiod, population density, nutrient abundance, water level fluctuations, water temperature, and water quality (Huner and Romaire, 1979; Chien and Avault, 1983). Therefore, understanding the length-weight relationship is important for both the management and cultivation of crayfish. The length-weight relationship can be used to determine the condition, biomass, and the amount of edible meat. The above-mentioned factors can cause changes in the relationship between height and weight at different rates from population to population and even from season to season within the same population, all within a complex framework while remaining is consistent with the general characteristics of the species. Berber et al. (2019) compared different stock density for rice-crayfish rearing in controlled environment and noted that the stock density of 25 individuals/m^2 should be applied to gain maximum yield. Kale et al. (2020) reported an albinism and Kale et al. (2021) reported a blue color anomaly for the narrow-clawed crayfish from the Atikhisar Reservoir in Çanakkale, Türkiye. Both papers claimed that these anomalies could be related to environmental factors and/or genetics. Kale et al. (2021) emphasized that this may lead to pressure over the population in the aquatic environment. On the other hand, Mazlum and Uzun (2022) noted that the stocking density significantly affected the growth performance, survival rate, proportion of the cheliped injury, biomass, length distribution, and feed conversion ratio.

From an economic perspective, the quality and quantity of meat yield is of paramount importance in crayfish, given their ecological adaptation. The abdomen meat is the economically assessed part, while the meat in the chelae is also evaluated in the total meat yield. Several factors, such as environmental ecological factors, genetic structure, timing of hunting, and the methods used to determine meat yield, have been identified as key determinants of meat yield in freshwater crayfish (Gürel and Patır, 2001; Erkebay, 2004).

The objective of this study was to assess the length-weight relationship and meat yield characteristics of the narrow-clawed crayfish inhabiting Kocahıdır Irrigation Reservoir.

2. MATERIALS AND METHODS

The present study was conducted between July 2015 and June 2016 in Kocahıdır Irrigation Reservoir (Fig 1), which is a small irrigation pond situated at the entrance of Kocahıdır Village in Edirne Province, İpsala district. The reservoir covers an area of 220 acres when it is full and has limited fishing potential with consistently turbid water. Water levels in the reservoir fluctuate depending on rainfall and groundwater, with irrigation water usage decreasing during the summer months. The average depth of Kocahıdır Irrigation Reservoir is 6-7 meters, and the primarily inhabiting fish species is carp (*Cyprinus carpio*), the most economically important fish species. Additionally, the economically valuable species of the reservoir is the narrow-clawed crayfish, with production starting in 2011. The crayfish production initially reached an average of 2,500 kg in 2011-2013, followed by a decline to 2,000 kg in 2014-2015, and eventually to 1,500 kg after 2016.

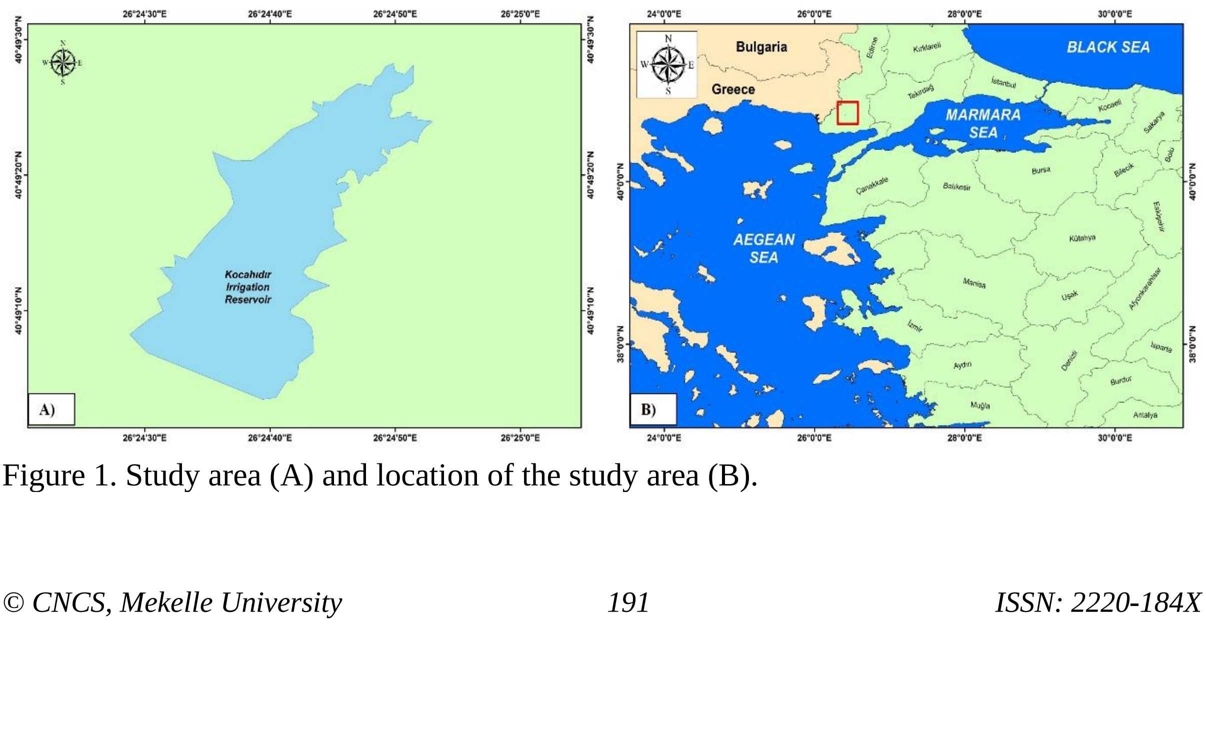

Figure 1. Study area (A) and location of the study area (B).

The fyke-nets, which were deployed in appropriate locations in Kocahıdır Irrigation Reservoir to capture crayfish, were checked periodically. Crayfish captured in the nets were transported in styrofoam containers to the laboratories of the Faculty of Marine Sciences and Technology at Çanakkale Onsekiz Mart University and were analyzed and measured on the same day.

To determine the body weights, precise electronic scales with a sensitivity of 0.01 g were utilized. The total weight (TW), carapace weight (CW), abdomen weight (AW), right claw weight (RCW), left claw weight (LCW), as well as abdomen meat yield (AMY) and claw meat yield (CMY) and total meat yield (TMY) were measured and recorded using these scales.

The weight and length of freshwater crayfish are related by the equation $W = a\ L^b$, where "W" represents weight and "L" represents length. By taking the logarithm of both sides of the equation, the relationship between weight and length can be transformed into a linear form (Ricker, 1973). In this study, the weight-length relationship was investigated with respect to carapace length (CL) versus total weight (TW), total length (TL) versus total weight (TW), and carapace length (CL) versus total length (TL). Regression equations, curves, and correlation coefficients were calculated for length and sex groups, as well as for months.

3. RESULTS AND DISCUSSION

3.1. Sex Compositions

Out of the 653 individuals that were examined in Kocahıdır Irrigation Reservoir, 39.05% were identified as female and 60.95% were male (Table 1). The month with the highest percentage of male individuals was July 2015, with a rate of 9.34% (61 individuals), while the lowest percentage was recorded in September 2015 with 2.91% (19 individuals). The month with the lowest percentage of female individuals was March 2016, with only 0.46% (3 individuals), and the highest was observed in July 2015 with 6.13% (40 individuals). The number of catches in the sample population of female and male freshwater crayfish was found to be statistically significant ($p < 0.05$). The highest number of combined female and male individuals was recorded in July 2015, with a rate of 15.47% (101 individuals). When comparing the ratios of males and females in each month, no significant difference was observed in September, October, November 2015, and January and June 2016. However, in all other months, the difference was found to be significant.

According to the findings, it is believed that the higher number of male crayfish caught during the winter months is due to their increased activity during the mating season compared to females. It is also speculated that females may become active later than males during the spring months and exhibit a passive behavior for protection purposes, as this coincides with the hatching period of their eggs. The female to male ratio in the entire sample population was 0.64/1.00. The highest female to male ratio was observed in September 2015, with a rate of 1.53/1.00, while the lowest was recorded in March 2016, with a ratio of 0.13/1.00.

Table 1. Gender distribution of crayfish caught in Kocahıdır Irrigation Reservoir by months.

Date	***Female (F)***		***Male (M)***		***F+M***		***Sex Ratio***	***X^2 test***
	N	***%N***	***N***	***%N***	***N***	***%N***	♀♀/♂♂	***P=0.05***
Jul.15	40	6.13	61	9.34	101	15.47	0.66/1.00	p<0.05
Aug.15	33	5.05	60	9.19	93	14.24	0.55/1.00	p<0.05
Sep.15	29	4.44	19	2.91	48	7.35	1.53/1.00	p<0.05
Oct.15	28	4.29	27	4.13	55	8.42	1.04/1.00	p>0.05
Nov.15	25	3.83	25	3.83	50	7.66	1.00/1.00	p>0.05
Dec.15	20	3.06	42	6.43	62	9.50	0.48/1.00	p<0.05
Jan.16	19	2.91	29	4.44	48	7.35	0.66/1.00	p<0.05
Feb.16	11	1.68	31	4.75	42	6.43	0.36/1.00	p<0.05
Mar.16	3	0.46	24	3.68	27	4.14	0.13/1.00	p<0.05
Apr.16	12	1.84	25	3.83	37	5.67	0.48/1.00	p<0.05
May.16	11	1.68	32	4.90	43	6.59	0.34/1.00	p<0.05
Jun.16	24	3.68	23	3.52	47	7.20	1.04/1.00	p>0.05
Total	255	39.05	398	60.95	653	100.00	0.64/1.00	p<0.05

The prey composition of crayfish is closely linked to their life cycle. The timing of the fishing season coincides with the feeding, mating, molting, and spawning periods of the crayfish, resulting in differences in the sex composition and quantity of prey caught. Some scientists have suggested that the over-fishing of male individuals in certain months may be due to the selectivity of fishing techniques. They have also reported that male individuals are more susceptible to being captured by fishing gears (Ackefors, 1999; Alekhnovich et al., 1999). Differences in the number of male and female individuals sampled during different seasons are primarily caused by differences in the activities of the sexes (Hudina et al., 2009). Groves (1985), who explained the excess of male individuals using a different approach, found that in regions with intensive fishing, males, which grow faster than females, are more frequently included in the prey composition.

The sex ratio is used as an important factor in stock evaluations. The reproductive balance of species and their capacity for renewal are directly influenced by the sex ratio in the ecosystem. The sex ratio for various populations of crayfish has been found to be 1:1 (Cobb and Wang, 1985). Deterioration in the sexual composition of crayfish may indicate increased fishing pressure on the breeding population, and unsuitable ecological conditions could potentially destroy the reproductive capacity of the species in the future (Mohsenpour Azari et al., 2014).

The numerical difference in the sample population is attributed to the fact that male crayfish exhibit more physical activity compared to egg-bearing females, who have a sedentary lifestyle. This is thought to be due to the difference in molt time between male and female crayfish (Anwand, 1993; Krzywosz et al., 1995).

Sampling methods and the type of fishing gear used can influence the male to female ratio in the sampled population of crayfish and may not always reflect the natural sex ratio of the population. In crayfish fyke-nets sampling, male individuals are often overrepresented and can reach up to 98%. Conversely, in trap-based sampling methods such as traps and similar gear, female individuals are often caught in higher numbers compared to traps, with the female catch rate being 2% and 40% for fyke-nets and traps, respectively, in Okragle Lake (Suwalki-Poland) (Krzywosz et al., 1995).

The imbalance in the sex ratio of catches in fyke-nets or trap-based fishing methods can be attributed to the dominance of male individuals due to their aggression, mobility, and strength, which often prevent smaller and weaker females from reaching the bait. This is not observed in trap-based sampling methods that are less selective and capture all encountered crayfish. Therefore, it can be assumed that the sex ratio in such sampling methods is more representative of the true population.

The fishing of freshwater crayfish is heavily influenced by short-term and long-term (e.g. monthly) changes in water quality and weather conditions. It is reported that crayfish are relatively less active below 10°C and as a result, they are caught at a lower rate in fyke-nets. In our study, it was found that the proportion of crayfish caught during the low temperature months of November, December, and January was not significantly lower compared to other months. Especially in December, the number of crayfish caught at a temperature of 8.8°C was only slightly less than in July and August. Therefore, it is believed that factors other than temperature may affect the amount of fishing.

It has been previously mentioned that many factors affect the fishing yield and consequently the sex composition. Even the underwater location of the traps directly affects the fishing yield, and it is reported that fishermen take more care in placing fyke-nets compared to fish nets (Demirol and Yüksel, 2014).

In natural habitats, the sex ratio of astacid crayfish populations is quite close to each other, and multiple mating is observed (Abrahamsson, 1971; Kirjavainen and Westmann, 1999). Throughout the study, the ratio of female and male freshwater crayfish in the sampling population was determined as 0.64/1.00. The results are quite similar to the research results of Eber Lake (Köksal, 1980), Eğirdir Lake (Erdemli, 1983; Bolat, 1996), Demirköprü Dam Lake (Balık et al., 2005), Apolyont Lake (Berber, 2005), Mamasın Dam Lake (Büyükçapar et al., 2006), Terkos Lake (Güner, 2006), Dikilitaş Pond (Benzer and Benzer, 2015), and Hirfanlı Dam Lake (Benzer et al., 2017).

Studies on *P. leptodactylus* species have also shown that the female/male ratio, which is close to the natural ratio of 1.00/1.00, is found in Eğirdir Lake, Miliç Stream (Köksal, 1980), Akşehir Lake, Eber Lake, and Apa Dam Lake (Erdemli, 1983), Hotamış and Mamasın Dam Lakes (Erdemli, 1985), Seyhan Dam Lake (Çevik, 1993), Diklitaş Pond (Köksal et al., 2003), Keban Dam Lake (Barım, 2007), Yenice Dam Lake (Berber et al., 2010), Thrace Region ponds (Deniz et al., 2013), Gaga Lake (Yılmaz et al., 2011), Mogan Lake (Benzer et al., 2015), and Uluabat Lake (Benzer and Benzer, 2018) locations.

However, in aquaculture studies, it is recommended to adjust multiple female crayfish to one male crayfish to increase the number of eggs carried by female crayfish and to benefit from the ability of male crayfish to fertilize multiple females. Different male-to-female stocking ratios have been used for this purpose. Mackeviciene et al. (1997) used a male/female stocking ratio of 1/1.6 for *A. astacus*; Pursainen et al. (1983) and Keller (1988) used a 1/3 stocking ratio for *A. astacus*; Köksal (1988) used a 1/3 stocking ratio for *P. leptodactylus*; De Luise and Sabbadini (1988) used a 1/3 stocking ratio for *Austropotamobius pallipes*; and Celada et al. (2005) used a 1/4 stocking ratio for *Pacifastacus leniusculus*. However, it has been reported that the best results are obtained with a 1/2 stocking ratio in populations (Erençin, 1975; Groves, 1985; Hessen et al., 1989).

In the present study, female individuals constituted 39.05% of the total individuals captured from Kocahıdır Irrigation Reservoir over a period of one year, while male individuals constituted 60.95%. Proportionally, male individuals were captured the most in March with 88.89% and the least in September with 39.58%, whereas female individuals were captured the most in September with 60.42% and the least in March with 11.11%. The higher capture rate of male crayfish in some months can be explained by their active behavior during the breeding season.

3.2. Length Compositions

During the study, a total of 653 individuals were captured and sorted into 8mm size groups for analysis, with carapace lengths (CL) ranging from 37-90 mm (70-198 mm in total length). It was determined that female crayfish were distributed in the 39-79 mm size range, while male individuals were distributed in the 37-90 mm range. The mean carapace length for all crayfish was calculated as 59.69 mm, while it was 57.58 mm for females and 61.04 mm for males. Crayfish of both sexes were predominantly distributed in the 43-74 mm size range, with the highest proportion (197 individuals) found in the 59-66 mm size range. Male individuals were more numerous in all size groups, except for the 51-58 mm size range, both in terms of numbers and proportions (Table 2). The proportions of female and male crayfish in different size groups were found to be significantly different from each other statistically.

Table 2. Mean size composition of crayfish in Kocahıdır Irrigation Reservoir by sex and size groups.

Length Groups (mm)	♀♀				♂♂				♂♂♀♀			
	N	$\boldsymbol{N^I}$	***%N***	$\boldsymbol{\%N^I}$	***N***	$\boldsymbol{N^I}$	***%N***	$\boldsymbol{\%N^I}$	***N***	$\boldsymbol{N^I}$	***%N***	$\boldsymbol{\%N^I}$
35-42	3	41	1.18	16.08	13	85	3.27	21.34	16	126	2.49	19.3
43-50	38		14.9		72		18.9		110		16.85	
51-58	85	214	33.33	83.92	66	313	16.58	78.64	151	527	23.12	80.7
59-66	93		36.47		104		26.13		197		30.17	
67-74	34		13.33		81		20.35		115		17.61	
75-82	2		0.78		53		13.32		55		8.42	
83-90	-		-		9		2.26		9		1.38	
Total	255		100		398		100		653		100	

Note: N^I= sample size for individuals those TL≥10 cm and TL< 10 cm.

The composition of the size structure of the population is directly influenced by the fishing gear used. In a commercial fishing operation using fyke-nets, the low proportion of individuals with a total length less than 51 mm is mainly due to the use of this fishing gear. The regular sampling of individuals of the same size range using gear such as traps is indicative of a strong relationship between the biology and ecology of the organism and the fishing gear used for sampling (Chybowski, 2007). In this way, by using both fyke-nets and traps, most of the size range of the existing crayfish population in a locality can be sampled. On the other hand, the size structure of samples taken using only selective commercial fyke-nets is understood to reflect only the larger size classes of the natural population. This hypothesis was confirmed by Cukersiz (1989) who reported that the sampled portion of the *A. astacus* population was dominated by large and old crayfish (80-90%).

When examining the proportional and sexual distribution of the population above and below the legal catchable total length (≥10 cm) according to size groups, it was determined that

21.34% of male individuals and 16.08% of female individuals were below the catchable size. The population above the catchable size consisted of 78.64% males and 83.92% females. Overall, 19.3% of the captured individuals were below the catchable size and 80.70% were above it (Table 2, Fig 2).

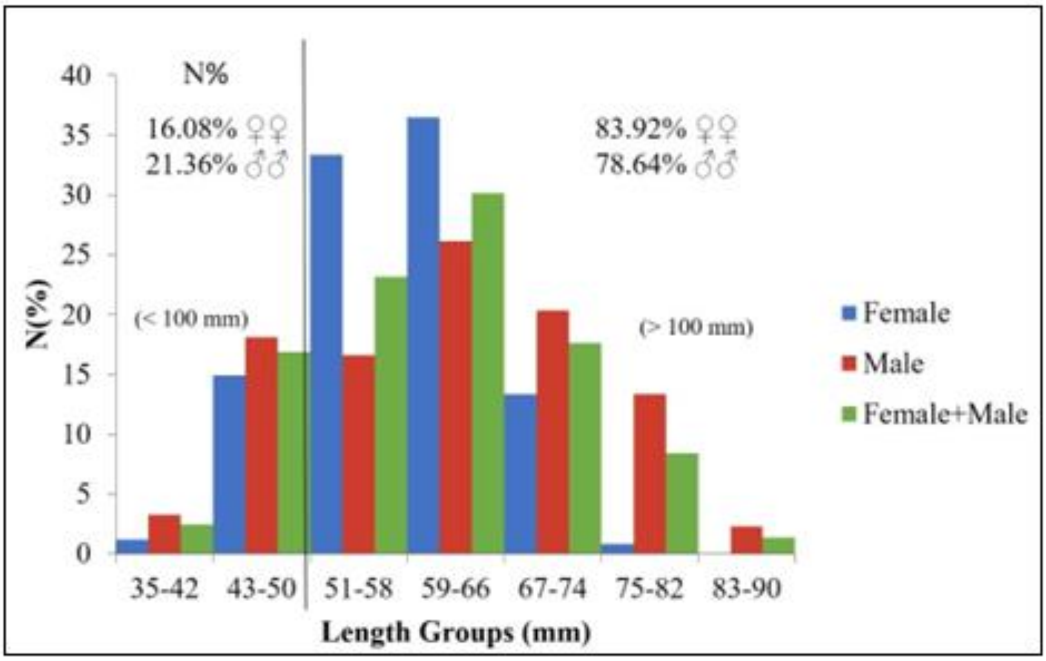

Figure 2. Total size composition of Kocahıdır Irrigation Reservoir crayfish by sex.

Table 3. Proportional representation of harvestable size in *P. leptodactylus* studies, *Legal harvesting size is 9 cm and above.

Location	***Reference***	***TL<100 mm (%)***	***TL≥100 mm (%)***
Apolyont Lake	Berber (2005)*	63.83	36.17
İznik Lake		54.68	45.32
Manyas Lake		72.18	27.82
Eğirdir Lake	Anonymous (1980)*	36.56	63.44
Hotamış Lake,	Erdemli (1985)*	27	73
Mamasın Dam Lake		25	75
Mogan Lake	Tüzün (1987)*	18.72	91.28
Keban Dam Lake	Duman and Pala (1998)*	26.17	73.83
Eğirdir Lake	Bolat (2001)*	26.17	73.83
Dikilitaş Lake	Köksal et al. (2003)*	22.62	77.38
Sera Lake	Erkebay (2004)*	33.95	66.05
Keban Dam Lake	Ateş and Aksu (2013)	47.97	52.03
Keban Dam Lake	Çılğın and Aksu (2015)	54.95	45.05
Keban Dam Lake	Demirol et al. (2015)	58	42
Keban Dam Lake	Dartay and Ataşşahin (2013)	23.4	76.6
Keban Dam Lake	Yüksel and Duman (2012)	36	64
Kocahıdır Irrigation Reservoir	Present study	19.3	80.7

Compared to studies conducted in different locations, the results of this study conducted in Kocahıdır Irrigation Reservoir have shown lower rates of harvestable size compared to only one other study conducted in Mogan Lake (Tüzün, 1987) where a rate of 91.28% was reported (Table 3).

The high proportion of harvestable individuals can be attributed to the closure of fishing activities in Kocahıdır Irrigation Reservoir. It is suggested that the number of individuals may increase in areas where fishing activities are prohibited, and as a result, the growth rate of individuals may decrease due to the decrease in available food resources. Additionally, it is noted that the risk of disease may be higher in such populations (Erkoyuncu, 1995). The average total length being below the harvestable size range (in the sample population) may indicate a crisis in the stock. In inland waters in Turkey, the fishing of individuals smaller than 10 cm is prohibited from December 24 to June 15 (Anonymous, 2002).

3.3. Weight-Length Relationship

The relationship between the length and weight of crustaceans is often analyzed using regression analysis. In this formula, W represents weight, L represents length, a is the intercept, b is the slope, and the relationship is expressed as $W= a L^b$ (Ricker, 1973).

The size-weight relationships of the Kocahıdır Irrigation Reservoir crayfish population were analyzed by linear regression analysis in logarithmic form for males, females, and combined data for CL-TW, TL-TW, and CL-TL. CL-TW relationship graphs were drawn for the entire population, as well as for females, males, and the combined female and male populations (Table 4).

Table 4. CL-TW, TL-TW, CL-TL equations, and correlation values with significance checks (1(p<0.05), 2(p<0.01), 3(p>0.01)) for Kocahıdır Irrigation Reservoir crayfish population.

Sex	*Log y= Log a + b Log X*	*CL/TL±SE*	*a±SE*	*b+SE*	*r+SE*
♀♀	Log TW= -4.1523 + 2.789 Log TL	0.51	0.000071±0.14	2.789±0.068 [2]	0.932±0.063 [1]
♀♀	Log TW= -3.39106 + 2.82713 Log CL	±0.0015	0.00041±0.115	2.82713±0.0652 [2]	0.939±0.06 [1]
♀♀	Log CL= -0.14982 + 0.928 Log TL		0.70824±0.046	0.928±0.0223	0.934±0.021 [1]
♂♂	Log TW= -4.45146 + 2.9704 Log TL	0.52	0.0000354±0.107	2.9704±0.0517 [3]	0.945±0.079 [1]
♂♂	Log TW= -3.2335 + 2.7547 Log CL	±0.0014	0.00058±0.094	2.7547±0.053 [2]	0.934±0.086 [1]
♂♂	Log CL= -0.31032 + 1.0143 Log TL		0.4894±0.034	1.0143±0.0165	0.952±0.025 [1]
♀♀♂♂	Log TW= -4.4212 + 2.9418 Log TL	0.49	0.000038±0.094	2.9418±0.046 [3]	0.93±0.081 [1]
♀♀♂♂	Log TW= -3.3271 + 2.8009 Log CL	±0.001	0.00047±0.0734	2.8009±0.0414 [2]	0.936±0.078 [1]
♀♀♂♂	Log CL= -0.278 + 0.996 Log TL		0.527±0.029	0.996±0.014	0.942±0.025 [1]

The CL/TL values varied between 0.49 and 0.52 for males, females, and both sexes combined. These results were consistent across all samples, whether they were combined or separated by sex. (Table 4). Based on this data, it was assumed that the CL values were equal to half of the TL values. This assumption is supported by previous studies, including Lindqvist and Louekari (1975); Köksal (1980); and Bolat (2001).

According to the results obtained from regression analyses, a negative allometric growth pattern was observed in both TL-TW and CL-TW relationships in female individuals, while a positive allometric growth pattern was observed in TL-TW relationship and an isometric growth pattern was observed in CL-TW relationship in male individuals. In the entire population including both female and male individuals, an isometric growth pattern was determined in both TL-TW and CL-TW relationships (Table 4).

While growth in length is in the growth period of freshwater crayfish, the rate of weight growth is largely influenced by feeding characteristics such as gender, food diversity, and occupancy rate, in addition to genetic traits and some environmental factors, (Lindqvist and Lahti, 1983). Furthermore, it has been reported that the selectivity characteristics of the fishing gear used also play an important role in determining different growth properties in length-weight relationships. These differences may arise from a range of factors, such as photoperiod, population density, food abundance, water level fluctuations, water temperature, and water quality (Huner and Romaire, 1979; Chien and Avault, 1983). Therefore, understanding length-weight relationships is essential for the culture and management of crayfish, as they can be used to express the condition, calculate biomass, and determine the amount of edible meat. These factors, while remaining within the general characteristics of the species, can cause changes in the relationship between length and weight in different proportions from population to population, even within the same population from season to season, over time, and in different habitats, within a complex whole.

Freshwater crayfish generally grow in length during their development process. However, the rate of weight growth is largely influenced by feeding characteristics such as gender, food diversity, and occupancy rate, in addition to genetic traits and some environmental factors (Lindqvist and Lahti, 1983). Berber and Kale (2018) reported that growth in length was at a significant rate contrary to growth in weight. It has also been reported that the selectivity characteristics of the fishing gear used play an important role in determining different growth properties in length-weight relationships. These differences may arise from a range of factors, such as photoperiod, population density, food abundance, water level fluctuations, water temperature, and water quality (Huner and Romaire, 1979; Chien and Avault, 1983). Therefore, understanding length-weight relationships is essential for the culture and management of crayfish, as they can be used to express the condition, calculate biomass, and determine the amount of edible meat. These factors, while remaining within the general characteristics of the species, can cause changes in the relationship between length and weight in different proportions from population to population, even within the same population from season to season, over time, and in different habitats, within a complex whole.

In studies conducted on *P. leptodactylus,* different length-weight equations have been obtained (Table 5). The *b* parameter obtained from the growth equations is characteristic of the species and generally does not vary significantly, unlike the *a* parameter which can vary daily and seasonally, depending on different habitats, water temperature and salinity, gender, food availability, and sample size (Kleanthids et al., 1999).

Table 5. Growth equation parameter values calculated from research conducted in different localities.

Location	***Sex***	***N***	***Growth Equation Parameters***		***r***
Mogan Lake (Tüzün, 1987)	♂♂	669	a= 0.000012	b= 3.1758	-
	♀♀	822	a= 0.00002	b= 3.0498	-
Seyhan Dam Lake (Çevik, 1993)	♂♂	150	a= 0.000009	b= 3.2464	-
	♀♀	150	a= 0.000023	b= 3.0385	-
Ayrancı Dam Lake (Erdem and Erdem, 1994)	♂♂♀♀	170	a= 0.000054	b= 3.0154	-
Eğirdir Lake (Bolat, 1996)	♂♂	505	a= 0.000019	b= 3.1258	-
	♀♀	307	a= 0.000087	b= 2.7749	-
Keban Dam Lake (Duman and Pala, 1998)	♂♂	257	a= 0.000005	b= 3.3772	0.993
	♀♀	177	a= 0.000011	b= 3.1462	0.994
Keban Dam Lake (Harlıoğlu, 1999)*	♂♂	208	a= 0.00093	b= 2.6689	0.923
	♀♀	242	a= 0.00159	b= 2.5152	0.882
Eğirdir Dam Lake (Bolat, 2001)*	♂♂	1250	a= 0.00039	b= 2.9896	0.963
	♀♀	550	a= 0.00009	b= 2.6946	0.975
İznik Lake (Erdem et al., 2001)	♂♂♀♀	250	a= 0.000074	b= 3.0041	-
Dikilitaş Reservoir (Köksal et al., 2003)	♂♂	2122	a= 0.00005	b= 3.0092	0.994
	♀♀	2298	a= 0.00002	b= 3.0797	0.995
Sera Lake (Erkebay, 2004)	♂♂	825	a= 0.000005	b= 3.4100	0.975
	♀♀	588	a= 0.00002	b= 3.0400	0.975
Demirköprü Dam Lake (Balık et al., 2005a)	♂♂	233	a= 0.00001	b= 3.2666	0.979
	♀♀	113	a= 0.00002	b= 3.0546	0.974
Apolyont Lake (Berber, 2005)	♂♂	843	a= 0.0002	b= 3.0251	0.948
	♀♀	573	a= 0.0003	b= 2.9551	0.939
İznik Lake (Berber, 2005)	♂♂	702	a= 0.0001	b= 3.1248	0.925
	♀♀	333	a= 0.0004	b= 2.8731	0.911
Manyas Lake (Berber, 2005)	♂♂	731	a= 0.0003	b= 2.9763	0.969
	♀♀	387	a= 0.0003	b= 2.9443	0.987
Hirfanlı Dam Lake (Benzer et al., 2017)	♂♂	130	a=0.0032	b= 2.8856	0.982
	♀♀	195	a= 0.0034	b= 2.9063	0.981
Mamasın Dam Lake (Büyükçapar et al., 2006)	♂♂	356	a=0.0528	b= 2.7228	0.837
	♀♀	196	a= 0.0601	b= 2.6209	0.862
Keban Dam Lake (Barım, 2007)	♂♂	149	a= 0.000086	b= 3.2438	0.974
	♀♀	170	a= 0.00037	b= 2.8591	0.952
Keban Dam Lake (Dartay and Ateşşahin, 2013)	♂♂	63	a= 0.2307	b= 3.018	0.973
	♀♀	27	a= 0.7396	b= 2.338	0.839
Alaşehir Lake (Deniz et al., 2013)	♂♂	87	a= 0.000009	b= 3.2349	0.97
	♀♀	70	a= 0.00007	b= 2.7698	0.97
Çıldır Lake (Deniz et al., 2013)	♂♂	46	a= 0.000003	b= 3.4355	
	♀♀	55	a= 0.00006	b= 2.7964	0.968

Eğirdir Lake (Deniz et al., 2013)	♂♂	86	a= 0.00003	b= 2.968	0.938
	♀♀	73	a= 0.00003	b= 2.958	0.933
Hirfanlı Dam Lake (Deniz et al., 2013)	♂♂	86	a=0.00001	b= 3.2066	0.963
	♀♀	79	a= 0.00007	b= 2.7791	0.939
Keban Dam Lake (Deniz et al., 2013)	♂♂	122	a= 0.000008	b= 3.2841	0.959
	♀♀	70	a= 0.0001	b= 2.7055	0.949
Porsuk Dam Lake (Deniz et al., 2013)	♂♂	99	a= 0.000005	b= 3.3820	0.913
	♀♀	87	a= 0.0003	b= 2.4158	0.863
Karpuzlu Irrigation Reservoir (Deniz et al., 2013)	♂♂	73	a= 0.000004	b= 3.439	0.978
	♀♀	89	a= 0.00005	b= 2.836	0.951
Aktaş Lake (Aksu and Kaya, 2017)	♂♂	81		b= 3.041	0.976
	♀♀	76		b= 2.954	0.962
Yenice Irrigation Reservoir (Berber et al., 2010)	♂♂	255	a= 0.00004	b= 2.9091	0.946
	♀♀	291	a= 0.00003	b= 2.9461	0.982
Dikilitaş Reservoir (Benzer and Benzer, 2015)	♂♂	155	a= 0.059	b= 2.75	0.99
	♀♀	105	a= 0.031	b= 2.97	0.99
Apolyont Lake (Benzer and Benzer, 2018)	♂♂	270	a= 0.03	b= 2.9479	0.979
	♀♀	270	a= 0.041	b= 2.775	0.983
Eğirdir Lake (Harlıoğlu and Harlıoğlu, 2005)	♂♂	38	a= 0.00167	b= 2.5185	0.959
	♀♀	38	a= 0.0081	b= 2.1166	0.906
İznik Lake (Harlıoğlu and Harlıoğlu, 2005)	♂♂	20	a= 0.00071	b= 2.7261	0.97
	♀♀	21	a= 0.00091	b= 2.6603	0.97
Hirfanlı Dam Lake (Harlıoğlu and Harlıoğlu, 2005)	♂♂	75	a= 0.000011	b= 3.6685	0.94
	♀♀	31	a= 0.0032	b= 2.2218	0.88
Gaga Lake (Yılmaz et al., 2011)	♂♂	131	a= 0.3484	b= 2.5513	0.87
	♀♀	129	a= 0.4348	b= 2.4902	0.9
Keban Dam Lake (Yüksel and Duman, 2012)	♂♂	2962	a= 0.027	b= 3.095	0.94
	♀♀	2412	a= 0.054	b= 2.719	0.925
Eğirdir Lake (Balık et al., 2005)	♂♂	2366	a=1.10^{-11}	b= 2.922	0.98
	♀♀	1264	a= 6.10^{-10}	b= 2.724	0.99
Mogan Lake (Benzer et al., 2015)	♂♂	98	a= 0.00095	b= 2.23	0.99
	♀♀	14	a= 0.0022	b= 2.01	0.99
İznik Lake (Aydın et al., 2015)	♂♂	1001	a= 0.000008	b= 3.011	0.987
	♀♀	896	a= 0.00003	b= 3.3016	0.987

3.4. Meat Yield

In crayfish, the economically valued part is mainly the meat in the abdominal area, but the amount of meat in the claws is also evaluated together in the total meat yield. Meat yield in caught crayfish has been calculated as claw meat yield (CMY), abdomen meat yield (AMY), and total meat yield (TMY) based on carapace sizes and monthly variations to reveal sexual and locality differences.

In the study conducted on 536 freshwater crayfish, ranging in TL from 70.4-197.76 mm and TW from 10.16-165.61 g, the TMY was calculated to have an average of 14.34%. The AMY, which was 10.84% based on TW, accounted for an average of 76.71% of the total meat quantity. The AMY was found to be 81.66% in female crayfish and 68.27% in male crayfish. The CMY was determined to be 25.10% in the entire population, 31.30% in males, and 18.33% in females. The TMY of the sexes with differences in weight in the abdominal and claw meat quantities were found to be different. However, the difference in TMY between sexes was not found to be statistically significant (p>0.05), while the difference in abdomen and claw meat quantities was found to be significant (Table 6).

Table 6. General meat yield characteristics of Kocahıdır Irrigation Reservoir crayfish.

Sex	*N*	*CL±SE (mm)*	*TW±SE(g)*	*TCMY±SE*	*AMY±SE*	*TMY±SE*
♀♀	204	59.24±0.471	43.6±0.981	2.48±0.086	11.38±0.244*	13.85±0.285
♂♂	332	63.43±0.562	58.84±1.545	4.13±0.19*	10.52±0.201	14.64±0.315*
♀♀♂♂	536	61.83±0.401	53.04±1.075	3.5±0.127	10.84±0.156	14.34±0.224

The total meat yield of crayfish varied between 13.19% and 17.16% depending on the size groups of crayfish ranging from 35-90 mm (CL). The lowest TMY was determined to be 13.19% in the 75.82 mm size group, while the highest was 17.16% in the 43.50 mm size group. The AMY was found to be the highest at 13.36% in the 43.50 mm size group and the lowest at 9.72% in the 75.82 mm size group, for the entire population. The AMY for females was calculated to be between 10.21% and 13.53%, and the CMY was between 1.83% and 2.74%. The AMY for males was found to be smaller than that of females at 8.34% to 13.26%, while in females, it was between 10.21% and 53.00%. However, the CMY was found to be larger in females, resulting in greater total meat quantities. The total claw meat yield of male crayfish ranged between 2.91% and 5.61%, and it was determined that the CMY increased with the increase in carapace size.

Table 7. Meat yield characteristics of crayfish by size groups.

Length	*Sex*	*N*	*CL*	*TW*	*TCMY (%)*	*AMY (%)*	*TMY (%)*
35-42	♂♂	5	38.31±0.747	16.5±3.298	4.01±0.489	10.65±1.188	14.66±1.093
43-50	♀♀	19	46.75±0.554	21.9±0.849	2.73±0.325	13.53±0.699	16.26±0.841
	♂♂	32	47.36±0.411	28.5±2.023	4.43±0.324	13.26±0.535	17.69±0.731
	♀♀♂♂	51	47.13±0.33	26.04±1.376	3.9±0.262	13.36±0.421	17.16±0.559
51-58	♀♀	62	54.23±0.308	33.56±0.678	2.27±0.15	12.04±0.452	14.32±0.519
	♂♂	55	54.26±0.35	35.51±0.822	2.91±0.17	10.52±0.476	13.430.578±
	♀♀♂♂	117	54.25±0.231	34.48±0.533	2.57±0.116	11.33±0.334	13.9±0.387
59-66	♀♀	96	62.17±0.229	48.1±0.707	2.5±0.13	10.75±0.36	13.25±0.431
	♂♂	109	61.59±0.217	48.53±0.717	3.04±0.198	10.39±0.348	13.43±0.472
	♀♀♂♂	205	61.86±0.158	48.33±0.504	2.79±0.122	10.56±0.25	13.35±0.321
67-74	♀♀	25	68.38±0.396	64.17±1.65	2.74±0.207	10.6±0.547	13.34±0.637
	♂♂	69	69.67±0.247	73.58±1.871	5.12±0.727	10.34±0.455	15.46±0.992
	♀♀♂♂	94	69.33±0.217	71.08±1.498	4.48±0.546	10.41±0.363	14.9±0.752
75-82	♀♀	2	78.39±0.515	88.52±1.49	1.83±0.195	10.21±0.093	12.04±0.102
	♂♂	53	76.7±0.249	94.31±2.429	5.61±0.332	9.7±0.497	15.31±0.722
	♀♀♂♂	55	76.76±0.244	94.1±2.345	5.47±0.334	9.72±0.479	15.19±0.701
83-90	♂♂	9	86.45±0.879	135.68±5.992	7.32±0.687	8.34±0.785	15.66±1.041

With respect to AMY, female crayfish showed significant differences from males in all size ranges ($p<0.05$). Males, on the other hand, had larger CMY in all size ranges. When evaluated in terms of TMY, statistically significant differences were found in males (Table 7).

The highest TMY values were determined as %17.78 in August 2015, while the lowest values were %8.79 in November 2015 for the crayfish in Kocahıdır Irrigation Reservoir. In female individuals, the highest total meat yield was %17.04 in July 2015, and the lowest value was %8.33 in February 2016. In male individuals, the highest total meat yield was %18.19 in August 2015, and the lowest value was %8.14 in November 2015.

The highest AMY was determined as %13.52 in August 2015, while the lowest was %6.75 in November 2015. In female individuals, the highest abdomen meat yield was %14.33 in May 2016, and the lowest value was %7.20 in February 2016. In male individuals, the highest abdomen meat yield was %13.29 in August 2015, and the lowest value was %5.80 in November 2015.

The highest CMY was determined as %4.77 in July 2015, while the lowest value was %2.04 in November 2015. In female individuals, the highest total claw meat yield was %3.09 in July 2015, and the lowest value was %1.13 in February 2016. In male individuals, the highest total claw meat yield was %5.58 in July 2015, and the lowest value was %2.34 in November 2015.

The TMY was observed to increase in parallel with the period when crayfish females incubate their eggs and the winter season ends for the entire population, and metabolic activities accelerate starting from the spring months. TMY gradually decreased during the winter period when mating and egg-laying activities took place (Table 8).

Table 8. Abdomen, claw, and total meat yield ratios by months for Kocahıdır Irrigation Reservoir crayfish.

Month	***Sex***	***N***	***CL***	***TW***	***TCMY***	***AMY***	***TMY***
07/2015	♀♀	26	56.05±1.605	37.72±2.973	3.09±0.239	13.95±0.541	17.04±0.642
	♂♂	54	64.25±1.643	61.43±4.14	5.58±0.266	11.83±0.368	17.41±0.422
	♀♀♂♂	80	61.58±1.294	53.73±3.199	4.77±0.235	12.52±0.322	17.29±0.352
08/2015	♀♀	29	59.82±1.39	44.5±2.77	3.07±0.148	13.94±0.454	17.01±0.44
	♂♂	53	65.53±1.378	64.25±3.748	4.9±0.267	13.29±0.417	18.19±0.504
	♀♀♂♂	82	63.51±1.057	57.26±2.805	4.26±0.204	13.52±0.314	17.78±0.364
09/2015	♀♀	25	62.96±1.352	52.87±3.249	1.82±0.183	9.66±0.498	11.48±0.525
	♂♂	18	60.56±1.793	48.3±3.61	3.11±0.451	11.07±0.776	14.18±1.016
	♀♀♂♂	43	61.96±1.089	50.96±2.416	2.36±0.235	10.25±0.443	12.61±0.555
10/2015	♀♀	27	60.17±0.935	46.17±1.844	2.65±0.252	10.51±0.592	13.17±0.781
	♂♂	20	60.2±2.067	52.34±5.239	2.94±0.341	7.68±0.712	10.61±1.028
	♀♀♂♂	47	60.18±1.017	48.79±2.476	2.77±0.204	9.31±0.496	12.08±0.647
11/2015	♀♀	20	60.87±1.003	47.34±2.537	1.73±0.108	7.74±0.583	9.47±0.616

	♂♂	21	65.59±1.841	66.36±7.388	2.34±0.419	5.8±0.315	8.14±0.488
	♀♀♂♂	41	63.29±1.114	57.08±4.211	2.04±0.224	6.75±0.357	8.79±0.4
12/2015	♀♀	19	61.3±1.429	47.53±3.776	2.83±0.248	9.74±0.817	12.57±0.972
	♂♂	35	60.61±1.944	51.29±4.592	5.57±1.448	10.49±0.595	16.06±1.824
	♀♀♂♂	54	60.85±1.348	49.97±3.245	4.61±0.955	10.23±0.479	14.83±1.25
01/2016	♀♀	15	63.38±1.095	45.63±2.198	3.03±0.522	9.95±0.679	12.99±0.974
	♂♂	22	65.54±2.18	67.37±6.354	2.97±0.418	8.9±0.936	11.87±1.098
	♀♀♂♂	37	64.67±1.367	58.55±4.234	3±0.322	9.33±0.62	13.32±0.759
02/2016	♀♀	9	55.52±2.152	39.47±3.713	1.13±0.083	7.2±0.358	8.33±0.358
	♂♂	21	60.37±1.815	50.6±4.657	2.98±0.428	8.29±0.614	11.27±0.879
	♀♀♂♂	30	58.91±1.464	47.26±3.537	2.42±0.337	7.96±0.449	10.38±0.668
03/2016	♀♀	3	49.97±1.058	27.81±2.782	1.46±0.199	13.09±0.7	14.56±0.896
	♂♂	21	61.47±2.613	54.42±6.752	3.17±0.464	8.67±0.782	11.84±1.009
	♀♀♂♂	24	60.03±2.416	51.09±6.176	2.95±0.422	9.22±0.751	12.18±0.905
04/2016	♀♀	8	55.55±1.28	36.09±2.929	2.59±0.448	13.72±0.711	16.31±0.703
	♂♂	21	67.32±2.17	72.19±7.841	3.52±0.449	9.58±0.608	13.1±0.599
	♀♀♂♂	29	64.07±1.908	62.23±6.457	3.27±0.353	10.72±0.59	13.99±0.542
05/2016	♀♀	3	57.87±5.429	43.86±13.288	2.16±0.293	14.33±0.813	16.49±1.071
	♂♂	26	61.04±1.37	47.65±4.017	3.55±0.323	11.97±0.528	15.52±0.634
	♀♀♂♂	29	60.71±1.297	47.26±3.777	3.41±0.301	12.21±0.496	15.62±0.577
06/2016	♀♀	20	54.7±0.966	33.13±1.475	2.13±0.23	14.12±0.281	16.25±0.323
	♂♂	20	66.25±2.011	63.23±5.175	4.45±0.442	12.12±0.438	16.57±0.539
	♀♀♂♂	40	60.38±1.428	48.18±3.586	3.29±0.294	13.12±0.303	16.41±0.311

From an economic perspective, just as ecological adaptation is important for crayfish, the quality and quantity of meat yield are equally important. Meat yield of crayfish is mostly calculated based on tail meat. However, in this study, the claw meat weight was also taken into account to determine the weights of abdomen, claw, and total meat. In Kocahıdır Irrigation Reservoir, CMY was found to be 3.74%, AMY was 11.43%, and TMY was 14.9% in individuals with an average total weight of 45.81 g. Despite the differences in the meat yield in their bodies, no gender differences were detected in total meat yield (Table 7). Among crayfish with a total length range of 70-199 mm, the lowest TMY was found to be 13.45% in the 110-119 mm size group, while the highest was 17.97% in the 80-89 mm size class. The abdomen meat yield of female crayfish ranged from 9.09% to 14.12%, while their CMY ranged from 1.97% to 3.55%. The AMY of males ranged from 5.17% to 12.25%, while their CMY ranged from 2.72% to 11.26%. The abdomen meat yield of males was found to be smaller than that of females. However, when compared by gender, total meat yield values were similar due to the higher total claw meat yield in male individuals (Table 7).

When the meat yield is examined monthly, the highest TMY is observed in July (18.89%), while the lowest is in November (9.03%). The values for AMY and CMY are similar, with the lowest values also observed in November (7.49-2.58%) and the highest in August (14.52-5.26%). The meat yield increases towards the end of winter and reaches its highest level in the summer months. This period continues from the end of winter, when female individuals incubate their eggs, to the end of the summer season, mostly in parallel with the decrease in water temperature and metabolic activities of the population (Table 8).

Studies conducted with *P. leptodactylus* in various locations have yielded different meat yields. Goddard (1988) determined that the meat yield of *P. leptodactylus* was 15.45%. Köksal (1988) reported that male individuals with a length of 80-145 mm had tail meat weights ranging from 3-12 g and claw meat weights ranging from 0.8-8.9 g, while female individuals with a length of 80-132 mm had abdomen meat weights ranging from 2-12 g and claw meat weights ranging from 0.63-6.00 g. Even though the weight of the claws of males is higher than that of females, no significant difference was found between the sexes in freshwater crayfishes with a total length of less than 10 cm. It was determined that the total amount of meat was almost equal in male and female freshwater crayfishes, with only males larger than 10 cm having a higher meat ratio than female individuals. In a study conducted to determine the meat yield of Eğirdir Lake crayfish, it was reported that the meat yield increased from 10-14% to 20% in crayfish with a length above 100 mm and to 26-27% in individuals with a length above 140-150 mm. It is suggested that increasing the legal catch size from 9 cm to 11 cm will further increase the yield (Yıldırım et al., 1997).

Various freshwater crayfish species from different water sources have been found to have varying meat yields. In this regard, commercially important species such as *Pacifastacus leniusculus* have been found to have meat yields ranging from 15-25%, *Cherax quadricarinatus* from 22%, *Pontastacus leptodactylus* from 15-23%, Cherax destructor from 25%, and *Procambarus clarkii* from 10-26% (Lee and Wickins, 1992).

Studies on commercially important freshwater crayfish individuals have determined different CMY, AMY, and TMY ratios (Table 9). In studies on *P. leptodactylus*, male individuals were found to have an average CMY of 5.23 g (2.89 g-9.77 g), an average AMY of 10.54 g (7.34 g-12.7 g), and an average TMY of 16.04 g (11.45 g-221.3 g). The average CMY for female individuals was calculated as 2.57 g (1.32 g-5.23 g), the average AMY was 12.66 g (8.97 g-15.83 g), and the average TMY was 15.8 g (11.66 g-19.87 g). In table 9, when the findings on meat yield related to *P. leptodactylus* are compared with individuals from Kocahıdır Irrigation Reservoir, it is seen that the average CMY for females and the average AMY for males are quite close. In terms of other findings, the meat yield values in our study area were lower than the averages for crayfish.

Table 9. Meat yield calculated for *P. leptodactylus* and other species in different localities.

Reference	***Species***	***CMY***		***AMY***		***TMY***	
		♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
Gürel (1998)	*P. leptodactylus*	7.2	3.31	11.18	14.22	18.33	17.49
Kalma (1998)	*P. leptodactylus*					21.3	19.05
Harlıoğlu (1999)	*P. leptodactylus*	6.24	3.02	10.43	11.7	16.67	14.72
Harlıoğlu (2000)	*P. leptodactylus*	3.38	2.59	8.07	11.15	11.45	13.74
	P. leniusculus	8.16	5.23	5.56	5.46	13.72	10.69
Erkebay (2004)	*P. leptodactylus*			11.75	13.64		
Hubenova et al. (2004)	*P. leptodactylus*	4.07-6.79	1.96-2.69	7.34-8.67	8.97-10.23	12.74-14.13	11.66-12.18
Berber (2005)	*P. leptodactylus*	3.92	2.78	11.94	14.58	15.86	17.36
Berber (2005)	*P. leptodactylus*	5.3	3.67	12.7	16.2	17.96	19.87
Berber (2005)	*P. leptodactylus*	4.26	3.33	11.1	14.79	15.35	18.12
Büyükçapar et al. (2006)	*P. leptodactylus*	5.28	2.76	9.55	10.15	14.83	12.76
Berber et al. (2010)	*P. leptodactylus*	5.39	3.49	12.49	15.83	17.87	19.27
Barım (2007)	*P. leptodactylus*	2.89	1.32	12.58	14.93	15.16	16.25
Yılmaz et al. (2011)	*P. leptodactylus*	9.77	5.08	9.88	10.6	19.7	15.68
Aksu and Kaya (2017)	*P. leptodactylus*	4.6	2.73	10.03	11.59	14.63	14.32
Dabrowski et al. (1966)	*O. limosus*					24.3	20.07
Lindqvist and Loekari (1975)	*A. astacus*					19.16	17.5
Rhodes and Holdich (1984)	*A. pallipes*			14.43	15.73	27.38	23.21
Huner et al. (1988)	*A. astacus*	8.4	4.8	13.14	15.3		
	P. clarkii	8.3	1.6	13.19	17.19		
McDonald et al. (1992)	*O. immunis*			18.14	19.8		
Wetzel (1993)	*O. virilis*			18.8	17.7		

Different studies have reported various meat yield values for the same or different species of freshwater crayfish at different times and localities, which can vary depending on the genetic structure of the species, ecological factors of their habitat, the time of harvest, and the methods used to determine meat yield. Some researchers have boiled freshwater crayfish individuals in water for a while before determining their meat yield (Lindqvist and Louekari, 1975; Köksal, 1988; Erkebay, 2004), while others have directly measured the yield (Rhodes and Holdich, 1984; Gu et al., 1994; Berber et al., 2020). It has been reported that the meat yield obtained from boiled individuals was 1-3% higher than that obtained from raw measurements (Yıldırım et al., 1997).

4. CONCLUSION

In conclusion, length-weight relationships, and meat yield of the narrow-clawed crayfish (*P. leptodactylus*) populations in Kocahıdır Irrigation Reservoir were determined. The results showed that the CL of the narrow-clawed crayfish ranged between 37 and 90 mm (39-79 mm for females and 37-90 mm for males), while the TW ranged from 10.10 to 165.61 g (11.13-90.01 g for females and 10.16-165.61 g for males). The ratio of individuals above the minimum legal-size limit of 100 mm was determined to be 80.70% for the crayfish population in

Kocahıdır Irrigation Reservoir. Regression analysis indicated that the TL-TW and CL-TW relationships for female narrow-clawed crayfish exhibited negative allometric growth, while males showed positive allometric growth in terms of the TL-TW relationship and isometric growth in terms of the CL-TW relationship. Isometric growth was observed in the whole population for both male and female individuals in terms of TL-TW and CL-TW characteristics. Female individuals with carapace lengths ranging from 43-82 mm had a chelae meat yield of 2.48%, an abdomen meat yield of 11.38%, and a total meat yield of 13.85%. Male narrow-clawed crayfish with carapace lengths ranging from 35 to 90 mm had a chelae shear meat yield of 4.13%, an abdomen meat yield of 10.52%, and a total meat yield of 14.64%. This study, which is the first research on the bio-ecological and morphometric reproductive characteristics of freshwater crayfish living in Kocahıdır Irrigation Reservoir, is very useful for monitoring temporal changes and planning efficient fishing strategies.

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6. CONFLICT OF INTERESTS

No conflict of interests.

7. REFERENCE

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