

Reproductive Properties of *Capoeta umbla* (Heckel, 1843) Living in Lake Hazar (Elazığ, Turkey)

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Abstract

This study was aimed to investigate the reproductive properties of *Capoeta umbla* (Heckel, 1843) population in Lake Hazar (38° 29' N; 39° 24' E) between February 2009 and November 2009. A total of 364 *C. umbla* (Heckel, 1843) samples (127 males and 237 females) were caught from Lake Hazar; the age composition of the specimens ranged between I and X age groups during the research. The first maturation was determined to be at age group II (23.31 cm in total length) for males and at age group III (25.61 cm in total length) for females. The highest mean GSI values were estimated in April for both sexes. Egg diameter values ranged from 0.70 to 2.00 mm, and the highest mean value was found in May (1.708 mm). Spawning period was determined between April-June. Fecundity values ranged from 1860 (Lt=24.70 cm and W=132 g) to 15624 (Lt=39.30 cm and W=448 g). The relationships between the total length (L)-fecundity (F), fish weight (W)-fecundity (F) of *C. umbla* were found as $F_{TL} = 26.516 \cdot TL^{1.648}$ (N = 128, r = 0.66) and $F_W = 212.71 \cdot W^{0.6418}$ (N = 128, r = 0.65), respectively.

Key Words: Lake Hazar, *Capoeta umbla*, GSI, Maturation age, Egg diameter, Fecundity

1. Introduction

Determination of the reproductive characteristics of fish populations is a very important topic of fisheries biology. The reproductive characteristics of fishes change according to physical, chemical, biological and hydrographic conditions of habitat and fish species.

Capoeta genus is distributed in southern China, northern India, Turkmenistan, Lake Aral, the Middle East and Anatolia (Türkmen et al., 2002). *C. umbla*, Transcaucasian barb, widely inhabits

Euphrates-Tigris river systems and it is of the most economical value among the five fish species (*Alburnus heckeli*, *Capoeta capoeta umbla*, *Orthrias angorea eregliensis*, *Cyprinus carpio* ve *Kosswigichthys asquamatus* (Şen, 1995)) living in the Lake Hazar (Şen and Aydın, 2000; Geldiay and Balık, 2007).

A large number of studies have been carried out about this species (Ekingen and Sarıyüpoğlu, 1981; Şen and Özdemir, 1986; Ekingen and Polat,

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1987; Şen, 1988; Girgin et al., 1997; Şeker et al., 1998; Öztürk et al., 2000; Şen and Aydın, 2000; Türkmen et al., 2000; Canpolat and Çalta, 2001 and 2003; Demirok and Ünlü, 2001; Şen et al., 2001 and 2002; Aydın and Şen 2002; Türkmen et al., 2002; Köprücü and Özdemir, 2003; Özekinci et al. 2003; Yılmaz et al., 2003; Bayır et al., 2007; Güneş, 2007; Aras et al., 2009).

Although the reproduction properties of this fish were previously studied by some authors (Yüksel, 2002; Yüce and Şen, 2003), they have been done nearly 10 years ago. It is possible that reproduction of fish might be influenced due to change of physico-chemical properties of lake water as a result of establishing of recreational facilities and fish restaurants and increasing population in the residential areas such as Sivrice and Gezin towns around the lake. So the present study was aimed to find out the changes, if any, of reproduction properties of *C. umbla* in Lake Hazar.

2. Materials and Methods

Area Description

Lake Hazar located at 25 km south of Elazığ (coordinated 38° 29' N and 39° 24' E) is a tectonic lake and its surface area is about 86 km² and altitude of 1248 m. The average length of Lake Hazar is about 20 km and its width 4.5 km and its shape roughly like a rectangle (Fig 1) (Anonymous, 1995). Lake Hazar has brackish and alkaline water (NaCl = 728.6 mg/l; Na₂CO₃ = 726.10 mg/l). Besides, the lake has the characteristics of hard water (CaCO₃ = 628 mg/L) and high pH value (8.8) (Cici, 1995).



Figure 1: The map of Lake Hazar and study area

Fish Samples

Fish samples were monthly caught from Lake Hazar (Elazığ) between February 2009 and November 2009. Trammel nets and gillnets with different mesh sizes ranging from 20 to 120 mm were used for catching of fish samples.

Methods

In this study, a total of 364 *C. umbla* was examined. The total lengths (TL) of all fish were measured to the nearest ± 1 mm. The body weights (W) and gonad weights were recorded with an electronic balance at the nearest 0.01 g. Sexes of fish were determined by opening their abdomens. The otolith of the each fish sample was taken out and their ages were determined from these otoliths (Ekingen and Polat, 1987; Öztürk et al., 2000; Aydın and Şen, 2002).

GSI = [Gonad weight / (Body weight – Gonad weight)] * 100 formula for determination of the spawning period and CF = [(Body weight – Gonad weight) / Fish length³] * 100 formula for determination of the condition factor were used (Avşar, 2005).

The age and the length at which 50 % of fish matured were considered to be age and length at first maturity for both sexes (Avşar, 2005). In order to determine first sexual maturation length, a logistic curve equation was used (King, 1995): $P = 1/(1+\exp[-r(L-L_m)])$ here, P, proportion of mature individuals; r, slope of curve; L, total length, and L_m, mean length at maturity length or mean length of individuals where 50% of population is reproduced.

The number of eggs was estimated by gravimetrically (Bagenal and Braum, 1978), and intra-ovarian egg diameter was measured by using an ocular micrometer with a scale of 0.01 mm. The relationships between fecundity (F)-total length (TL) and fecundity-weight (W) were determined by using the formulas $F=a*TL^b$ and $F=a*W^b$, respectively (Avşar, 2005). The significance of differences between measured and calculated fecundity groups were interpreted by using “t-test”. Data were statistically analysed by using Microsoft Office Excel 2003 and SPSS 12.00 package programmes and interpreted according to Fowler and Cohen (1992).

3. Results and Discussion

Age and Sex Distribution

A total of 364 *C. umbla* (Heckel, 1843) samples (127 males and 237 females) were caught from Lake Hazar during the research. Age composition varied from I to X, and they were composed of 34.91% males, 65.09% females (Table 1). The overall sex ratio was 0.54:1.00 (males/females), differing significantly from the theoretical 1:1 value ($X^2=16,621 > X^2_{(1, 0.05)}=3,84$). Males were abundant until age group I, while beginning from age group II female were more abundant than males. Similar findings were reported by Girgin et al. (1997); Şen and Aydın (2000); Türkmen et al. (2002); Yüksel (2002); Yılmaz et al. (2003) and Güneş (2007).

Maturity Age and Length (TL)

The first maturation ages were determined to be at age group II for males and at age group III for females. First maturity lengths were also estimated at 23.31 cm for males and at 25.61 cm for females (Fig 2). Generally, the results of this study have showed a great accordance with other studies (Table 3). According to Lagler et al. (1977) and Çelikkale (1991), species diversity, length, physiological status of fish, temperature, the amount of

food, food quality and other features of the water affect the first maturity age. Nikolsky (1963), also reported that, in fish, in terms of first maturation age, there is wide variation and it may be changed even between different populations of the same species according to regions and years.

Condition Factor (CF)

The CF values of *C. umbla* population in Lake Hazar varied between 0.47-2.43 for males and 0.47-1.80 for females throughout the year. The lowest mean CF values were found in April for both sexes (for males 0.78 ± 0.02 and for females 0.83 ± 0.04). CF was decreased with increasing age. The differences between sexes were not statistically significant ($p > 0.05$) according to age groups (Table 2). An inverse relationship developed between the amounts of reproductive cells created in gonads with food reserves stored in the muscles. Generally, CF values decrease, when GSI values of individuals increase (Avşar, 2005). Parallel to these explanations, in April, GSI values were found to be the highest and CF values were to be the lowest. CF values have changed according to age, stress, food state and reproduction activities (Korkut et al., 2007). Differences between this study and other studies may be caused due to these reasons.

Table 1

Age composition and sex distribution of *C. umbla* population inhabiting Lake Hazar

Age	Male		Female		Male + Female		M:F Ratio	X^2
	N	%	N	%	N	%		
I	11	3.03	7	1.92	18	4.96	1.57:1.00	0.444
II	22	6.05	24	6.59	46	12.63	0.92:1.00	0.044
III	39	10.73	52	14.29	91	25	0.75:1.00	0.929
IV	24	6.59	65	17.87	89	24.45	0.37:1.00	9.444
V	9	2.48	38	10.44	47	12.92	0.24:1.00	8.946
VI	10	2.75	23	6.31	33	9.06	0.43:1.00	2.560
VII	7	1.92	16	4.39	23	6.32	0.44:1.00	1.761
VIII	4	1.09	5	1.37	9	2.47	0.80:1.00	0.056
IX	-	-	3	0.82	3	0.82	-	
X	1	0.27	4	1.09	5	1.37	0.25:1.00	
Total	127	34.91	237	65.09	364	100	0.54:1.00	16.621

Table 2

Distribution of condition factor values of *C. umbla* populations inhabiting Lake Hazar according to age and sex groups

Age groups	Male		Female		t-test	Male + Female	
	N	$\bar{x} \pm S.e.*$ (Min-Max)	N	$\bar{x} \pm S.e.*$ (Min-Max)		N	$\bar{x} \pm S.e.*$ (Min-Max)
I	11	1.64±0.11 ^c (1.23-2.43)	7	1.47±0.08 ^b (1.14-1.80)	p>0.05	18	1.57±0.07 ^b (1.14-2.43)
II	22	0.85±0.02 ^{ab} (0.69-1.17)	24	0.91±0.02 ^a (0.71-1.15)	p>0.05	46	0.88±0.01 ^a (0.69-1.15)
III	39	0.90±0.02 ^b (0.63-1.23)	52	0.90±0.01 ^a (0.66-1.32)	p>0.05	91	0.90±0.01 ^a (0.63-1.32)
IV	24	0.87±0.03 ^b (0.47-1.15)	65	0.89±0.01 ^a (0.63-1.16)	p>0.05	89	0.89±0.01 ^a (0.63-1.16)
V	9	0.80±0.07 ^{ab} (0.53-1.27)	38	0.84±0.02 ^a (0.47-1.17)	p>0.05	47	0.84±0.02 ^a (0.47-1.27)
VI	10	0.77±0.06 ^{ab} (0.49-1.13)	23	0.83±0.01 ^a (0.71-1.07)	p>0.05	33	0.82±0.02 ^a (0.49-1.13)
VII	7	0.75±0.05 ^{ab} (0.58-0.99)	16	0.84±0.02 ^a (0.62-0.95)	p>0.05	23	0.81±0.02 ^a (0.58-0.99)
VIII	4	0.68±0.05 ^a (0.58-0.80)	5	0.84±0.03 ^a (0.76-1.04)	p>0.05	9	0.77±0.04 ^a (0.58-0.97)
IX	-	-	3	0.87±0.09 ^a (0.73-1.04)	-	3	0.87±0.09 ^a (0.73-1.04)
X	1	0.95	4	0.81±0.04 ^a (0.67-0.86)	-	5	0.84±0.04 ^a (0.67-0.95)

*Same letters in the same column are not statistically important (p>0.05).

Table 3

The reported first maturity age, spawning period and average condition factor values for various *C. umbla* populations in Turkey

Researchers	Regions	First maturity age	Spawning period	CF	
		♂-♀		♂	♀
Solak et al. (1993)	Euphrates-Tigris Riv. Sys.	2-3	-	-	-
Girgin et al. (1997)	Karakaya Dam Lake	-	-	0.94-1.40	0.90-1.62
Şen and Aydın (2000)	Hazar Lake	-	-	0.54-1.40	0.63-1.44
Türkmen et al. (2002)	Karasu River	2-4	May-July	-	-
Yüksel (2002)	Hazar Lake	1-2	April-June	0.51-1.07	0.53-1.37
Yılmaz et al. (2003)	Fırat River	2-3	-	0.83-1.15	0.85-1.12
Yüce and Şen (2003)	Hazar Lake	2-3	May-July	-	-
Bayır et al. (2007)	Hınıs Stream	-	May-June	-	-
Güneş (2007)	Tuzla Stream	3-4	March-June	0.87-1.74	0.85-1.78
	Tercan Dam Lake	2-3	March-June	0.85-1.74	0.77-1.53
Present study	Lake Hazar	2-3	April-June	0.78-1.24	0.83-1.06

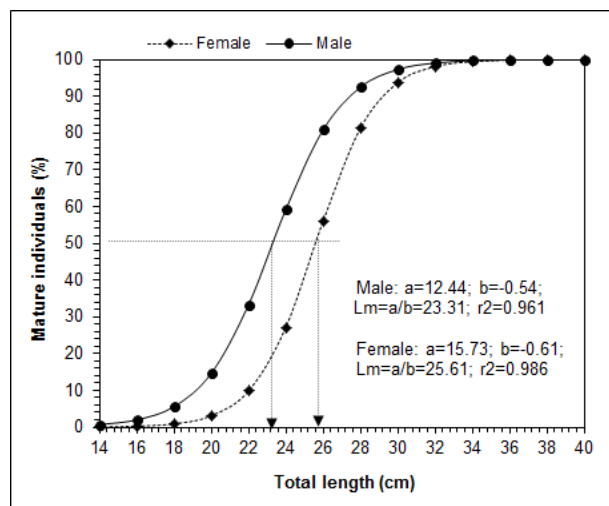


Figure 2: First maturity length of *C. umbla* population inhabiting Lake Hazar

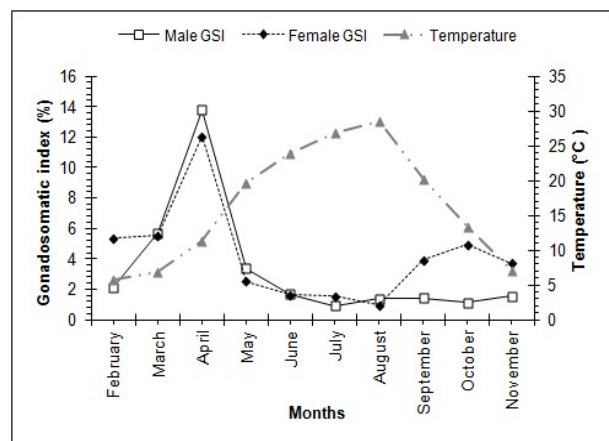


Figure 3: Changes of GSI values of *C. umbla* populations inhabiting Lake Hazar according to sexes and months and temperature values

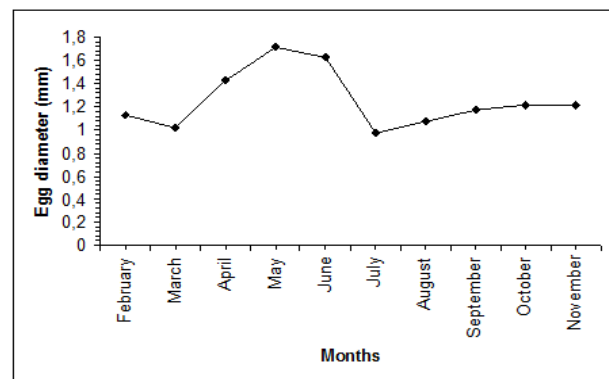


Figure 4: Changes of egg diameter values *C. umbla* populations inhabiting Lake Hazar according to months

Gonadosomatic Indeks (GSI)

The GSI values reached a maximum in April ($13.79 \pm 0.78\%$ in males, $12.02 \pm 1.38\%$ in females, 11.3°C) and declined rapidly thereafter (Fig 3). The GSI values ranged from 0.11% to 23.80% for males and from 0.07% to 20.56% for females. The average monthly water temperature values were determined between 5.8 - 28.6°C during the study period.

Egg Diameter

Egg diameter and fecundity of 128 female individuals that were captured in Lake Hazar were individually measured. The highest mean egg diameter value was determined in May (1.70 ± 0.04 mm). The lowest and the highest egg diameters were measured in February-March (0.70 mm) and in May (2.00 mm), respectively (Fig 4). The differences in egg diameters between months were not statistically significant ($p > 0.05$) except for April, May and June. Egg diameter values were reported as 0.90 - 1.70 mm by Şen (1988); as 0.93 - 2.45 μm by Türkmen et al. (2002); as 0.80 - 2.00 mm by Yüce and Şen (2003). Egg diameter can change according to fish species and size. The individuals living in different environments of the same species can also spawn different-sized eggs (Bircan and Polat, 1995).

Spawning Season

The GSI and egg diameter values are important for the determination of the spawning season. Therefore, the determination of the spawning season for *C. umbla* population in Lake Hazar was based on the GSI and egg diameter. It can be said that spawning period of *C. umbla* in Lake Hazar is between April-June due to the highest GSI values that were estimated in April, it declined until June (Fig 3) and the highest egg diameter value was determined in May (Fig 4). This finding showed similarities with earlier studies in the same region (Table 3).

A comparison of the first maturity age, spawning period and mean condition factor values of this study with some previous works is given in Table 3.

Fecundity

During the study, average weight and average total length of 128 females that were used for fecundity

determination were identified as 244.87 ± 10.90 g and 29.33 ± 0.49 cm. The fecundity values ranged from 1860 to 15624. According to age groups, the mean fecundity values were changed between 5569 and 10894. The highest number of eggs per 1

g weight was estimated in age II group as 42.36 egg/g weight and the lowest number of eggs per 1 g weight was estimated in age X group as 14.41 egg/g weight (Table 4).

Table 4

Length, weight, fecundity and egg diameter values of *C. umbla* individuals that fecundity measured

Age groups	N	TL (cm)	W (g)	F*	F/cm	F/g	Egg diameter (mm)
II	15	23.74 ± 0.32	131.46 ± 5.09	5569.69 ± 830.27^a	234.61	42.36	1.23 ± 0.06
III	26	26.09 ± 0.97	180.14 ± 23.47	5748.93 ± 408.63^a	220.35	31.91	1.24 ± 0.04
IV	32	28.70 ± 0.68	228.52 ± 15.43	7022.44 ± 480.97^{ab}	244.68	30.73	1.21 ± 0.04
V	21	31.71 ± 1.15	270.22 ± 18.83	8039.57 ± 628.02^{abc}	253.53	29.75	1.26 ± 0.06
VI	12	33.15 ± 1.50	333.00 ± 29.47	10229.21 ± 653.41^{bc}	308.57	30.71	1.14 ± 0.05
VII	11	33.86 ± 1.36	350.09 ± 30.55	9135.87 ± 1150.54^{bc}	269.81	26.09	1.22 ± 0.09
VIII	5	34.82 ± 1.08	383.40 ± 38.42	10894.80 ± 1581.69^c	312.88	28.41	1.12 ± 0.08
IX	2	37.36 ± 3.10	478.33 ± 84.79	10046.06 ± 413.26^{bc}	268.89	21.00	1.20 ± 0.07
X	4	44.65 ± 1.54	736.25 ± 60.17	10610.00 ± 511.95^c	237.62	14.41	1.32 ± 0.05
Mean		29.33 ± 0.49	244.87 ± 10.90	8588.50 ± 691.73	261.21	30.12	1.21 ± 0.02

*Same letters in the same column are not statistically important ($p > 0.05$).

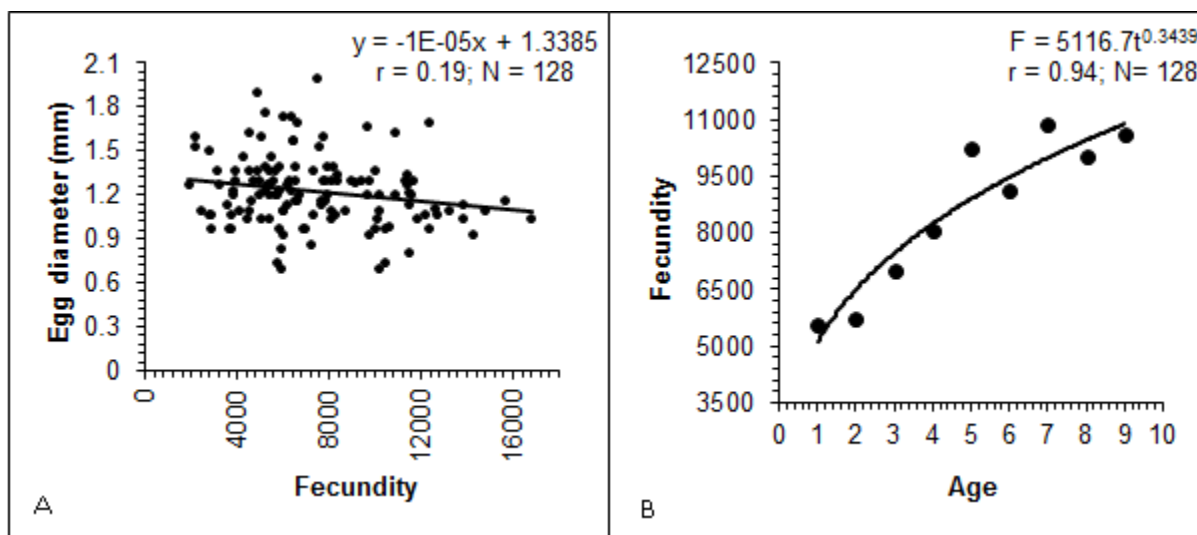


Figure 5: Egg diameter-fecundity (A) and Fish age-fecundity (B) relation of *C. umbla* population inhabiting Lake Hazar

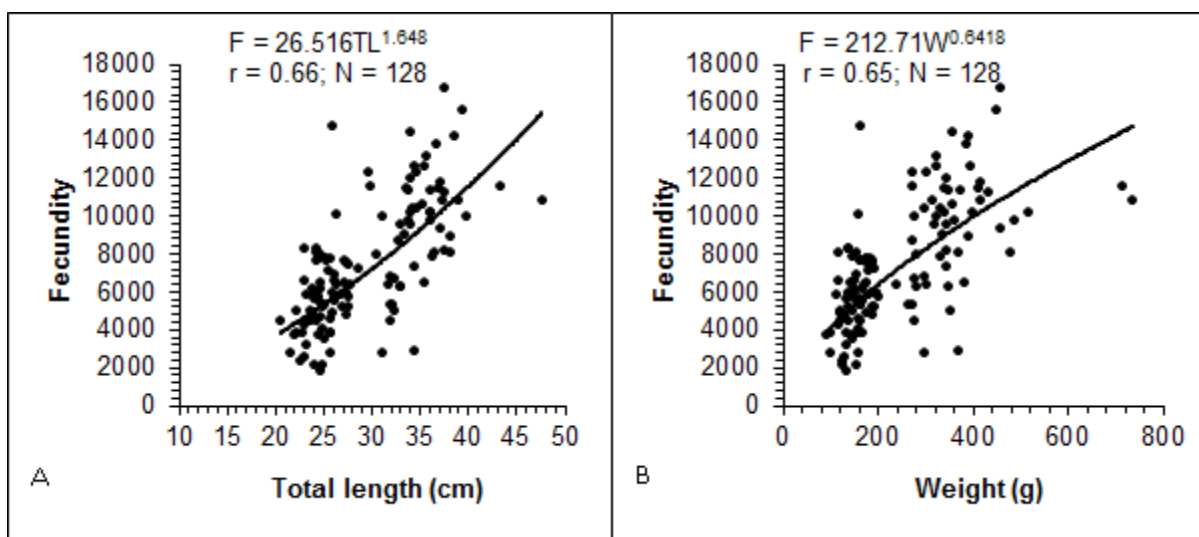


Figure 6: Total length-fecundity (A) and fish weight-fecundity (B) relation of *C. umbla* population inhabiting Lake Hazar

The correlation between egg diameter-fecundity was found negative and very weak ($r = 0.19$) (Fowler and Cohen, 1992), and also egg number decreased depending on increase in egg diameter (Fig 5A). The regression equation between fish age (t)-fecundity (F) were calculated as $F_t = 5116.7 \cdot t^{0.3439}$ ($r = 0.94$), and parallel to fish age increasing, egg number were increased (Fig 5B).

The regression equation between fish length (TL)-fecundity (F) was calculated as $F_{TL} = 26.516 \cdot TL^{1.648}$ ($r = 0.66$) (Fig 6A). The differences between measured fecundity values with calculated fecundity values by using fish length-fecundity equation ($F_{TL} = 26.516 \cdot TL^{1.648}$) were not statistically significant ($t = 1.785$; $df = 127$; $p > 0.05$). The regression equation between fish weight (W)-fecundity (F) was calculated as $F_W = 212.71 \cdot W^{0.6418}$ ($r = 0.65$) (Fig 6B). The differences between measured fecundity values with calculated fecundity values by using fish weight-fecundity equation ($F_W = 212.71 \cdot W^{0.6418}$) were not statistically significant ($t = 1.796$; $df = 127$; $p > 0.05$).

Fecundity-age, fish length-fecundity and fish weight-fecundity relationships were reported as; $r =$

0.64, $r = 0.74$, $r = 0.95$ by Yüce and Şen (2003). Türkmen et al. (2002), determined fecundity values as 3754-35859; relationship fish length-fecundity $r = 0.75$; relationship fish weight-fecundity as $r = 0.79$ and relationship fecundity-age $r = 0.61$. Fecundity is affected by age, size, fish species, feeding of fish, season and environmental conditions (Nikolsky, 1980). Differences between this study and other studies can be caused because of these reasons.

4. Conclusion

In conclusion, for sustainable fisheries of *C. umbla* population in habiting Lake Hazar, individuals under 23 cm should not be caught and also fisheries activities must be forbidden between April-June for *C. umbla*.

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