E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2020; 8(1): 92-98

www.fisheriesjournal.com
Received: 11-11-2019
Accepted: 15-12-2019

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Biological properties of *Luciobarbus xanthopterus* in the Al-Diwaniya River, middle of Iraq

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Abstract
Despite the importance of *Luciobarbus xanthopterus* as one of the most valuable and economic species in Iraq, no research on the biology of this species has been conducted in the Al-Diwaniya river. This study aimed to determine the growth, reproduction and food habit of *L. xanthopterus* in this river between November 2016 and October 2017. Samples were collected by different fishing gears. The calculated length-weight relationship for fish sizes 12.0 to 60.2 cm was $W = 0.008L^{3.093}$, with positive allometric growth. The highest value of the relative condition factor was in April and the lowest in May. Seven ages were identified from the scales and the mean lengths of these ages were 15.3, 26.3, 35.9, 42.8, 49.0, 54.7 and 57.1 cm, respectively. von Bertalanffy growth model was $L_t = 73\ [1\text{-e}^{-0.228\ (t-0.012)}]$. The overall male: female ratio (1:1.57) was biased in favour of females. Length at first maturity was 36 cm for males and 38 cm for females. The *GSI* of the species was at the highest level in March means that spawning activity is going to start after this month. There were significant correlations between water temperature and both feeding activity and intensity of the fish. The species is omnivorous, fed mainly on aquatic insects, macrophytes, detritus, crustacean, and diatoms. The results obtained can assist in fisheries management and conservation of the species in this river.

Keywords: *Luciobarbus xanthopterus,* growth, reproduction, food habit, Al-Diwaniya river

1. Introduction
Yellowfin barbell, *Luciobarbus xanthopterus* (Heckel, 1843), which is locally known as Kattan, belongs to the Cyprinidae family. This species formerly placed in the genus *Barbus* and recently became within the genus *Luciobarbus* [1]. *L. xanthopterus* is endemic to the Tigris-Euphrates basin. In Iraq, it is found in large rivers such as the Tigris, Euphrates, Little Zab, Great Zab, Diyala and Shatt al Arab River, lakes such as Habbaniyah, Tharthar, and Razzazah, reservoirs such as the Hindyah, Al-Qadisiyah, Dukan and Derbendikhan dams and the southern marshes [2]. Also, the species found in dams and reservoirs on Tigris-Euphrates rivers, Turkey [1, 3, 4], and in southern Iran such as Karkheh river and Hoor-al-Azim marsh [5, 6].
L. xanthopterus are endangered from most of the southern marshes, especially those that have been hit by drying processes, in addition to Habbaniyah lake and Haditha dam reservoir as a result of overfishing and mismanagement and from Razzazah lake due to high salinity [7]. The fish is one of the most valuable and economic species in Iraq, therefore it became a subject of artificial spawning and restocking, and many attempts were carried on to cultivated the species in earthen ponds [8, 9].
Several authors have been described growth of *L. xanthopterus* in different natural waters of Iraq such as in Tharthar lake [10], Habbaniyah lake [11], Tharthar, Razzazah and Habbaniyah lakes [12], Al-Qadisia dam lake [13], in artificial lake, west of Baghdad [14], Euphrates river, Al-Hindyah barrier [15], Euphrates river, Al-Musaib power station [16], Haditha dam lake [17]. Others have determined some properties of reproduction such as in artificial lake [18], Euphrates river, Al-Musaib [19]. Finally, some investigated the food habit of the species such as in Al-Hammar marsh [20], Tharthar, Razzazah and Habbaniyah lakes [12], Al-Hammar marsh [21], Al-Qadisia dam lake [22], Euphrates river, Al-Musaib [19], Tharthar arm, Tigris [23], Habbanyia lake and Himreen dam [7, 24]. Eskandari *et al.* [5] studied fecundity and feeding of the species in the Karkheh River and Hoor-al-Azim marsh in southern Iran.
No information is available on the biological characteristics of *L. xanthopterus* in the Al-Diwaniya river, the middle Euphrates river. The objective of this study was to provide information on the biology of the species including length frequency distribution, length

weight relationship, relative condition factors, age, growth rate, sex ratio, gonado-somatic index and food habit in Al-Diwaniya river. The results obtained in this study can assist in fisheries management, aquaculture, and conservation of the fish resources in this river.

2. Materials and Methods
2.1 Study area
The study area, AL-Diwaniya river, is the major water resource for the AL-Diwaniya City/Al-Qadisiyah Province, which flows through the city. It is an extension of the Al-Hilla river which is a branch of Euphrates river at Al-Hindyah barrier, in the middle of Iraq. Two sits of the study were selected within the part that extends from the Daghara barrier to Diwaniya city center (Fig. 1). It was reported that the water temperature varied from 10.2 to 32.8°C, dissolved oxygen 4.5–10.0 mg/L, salinity 0.53-0.81 and pH was between 6.5–8.9 [25].

2.2 Fish sampling
Samples were caught with seine net (3m long and 2.5m depth with a 20mm mesh size), gill nets (25m long with 20x20, 30x30 and 50x50mm mesh sizes) and cast net (9m diameter with 15x15mm mesh size), and by electrofishing equipment (provides 150-300V) between November 2016 and October 2017. Fish were immediately preserved in an icebox for subsequent analysis.

2.3 Biological aspects analysis
The total length (L) and weight (W) of the fish were measured to the nearest 1 mm and 0.1 g accuracy. The length-weight relationship was calculated using the formula of $W= aL^b$, and (a) and (b) are constants computed from the least square method. A significant difference of b from 3 was tested by Student's *t*-test. The relative condition factor (K_n) was calculated from the equation $K_n= W/W'$, where W= observed weight and W'= calculated weight [26].

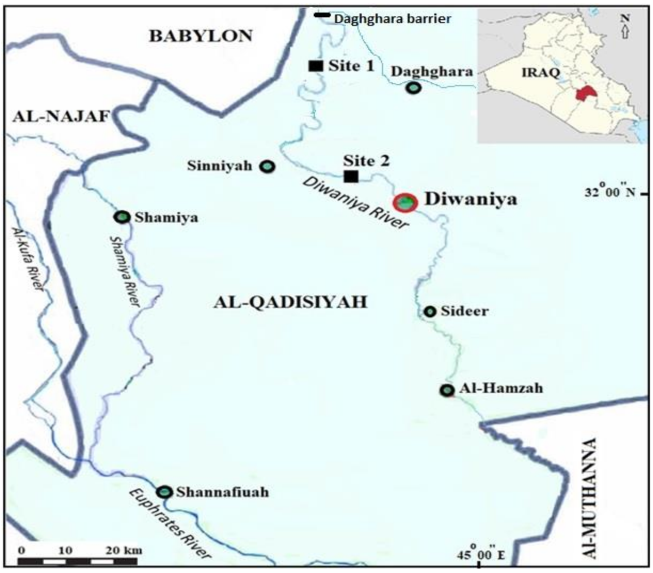

Fig 1: Map showing the study sites in Al-Diwaniya River

For age determination, scale samples were removed, cleaned and then mounted dry between two glass slides for measurement with Projecting microscope, 20X. The gut of each fish was detached and preserved in a specimen bottle containing 4% formaldehyde. Gonads were removed and weighed. Sex in mature specimens was easily determined with the naked eye, but the microscopic examination was used for differentiating sex in small individuals.

Length at age was back-calculated by means of the following formula: $L_n= a + S_n /S\ (L-a)$ [27], where L_n is the length of the fish at age 'n', a is the constant, S_n is the radius of the annulus 'n', S is the scale radius and L is the length at the time of capture. Growth was expressed in terms of the von Bertalanffy equation: $L_t= L_\infty (1-e^{-K (t-to)})$, where L_t is the total length of the fish at age t, L_∞ is the ultimate length an average fish could achieve, K is the growth constant which determines how fast the fish approach $L\infty$ and t_o is the hypothetical time at which the length of the fish is zero [28]. The index of growth performance (Φ) of the species was calculated with the equation of Pauly and Munro [29]: $\Phi=\log k+2\log L\infty$, where K and $L\infty$ are the von Bertalanffy parameters.

The sex ratio was tested by the Chi-square (χ^2) test to indicate whether there was a deviation from a 1:1 ratio. The gonado-somatic index (GSI) was estimated from the weight of gonad/bodyweight X 100 [30]. Size-at-maturity was considered as the smallest length at which 50% of the fish in the sample are matured.

The food items were identified as the least taxon possible and counted. The frequency of occurrence (O) and the points (P) methods [31] was used for analyzing the food items. The diet was determined using the index of relative importance (IRI) of Stergion [32]. The index combines the occurrence (O) and points (P):

$$IRI= O\% \times P\% \text{ and } IRI\%= IRI / \Sigma IRI * 100$$

Statistical analyses were performed with Microsoft Office Excel 2010 and a significance level of 0.05 was adopted.

3. Results
3.1 Relative abundance
L. xanthopterus found in all monthly samples and constituted 5.7% of the total fish catches in the study area by number. The monthly variations in the percentage of *L. xanthopterus* is illustrated in Figure 2. The abundance fluctuated from 0.6% in October to 9.1% in June.

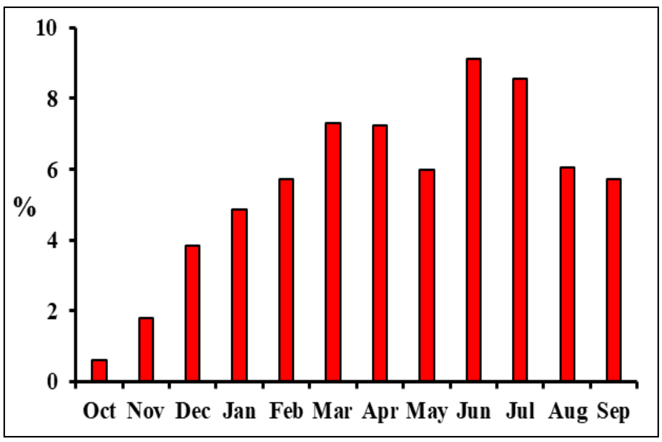

Fig 2: Monthly variation in the relative abundance of *L. xanthopterus*

3.2 Length frequency distribution
The total length of all individuals for *L. xanthopterus* (n= 682) collected in this study ranged from 11 to 60 cm (Fig. 2). Several modes can be recognized, but the highest one was 38 cm which constituted 10%, followed by length group 33cm formed 9% from the catch of the species. However,

specimens of the species between 25-44 cm were most abundant and formed 73% of the catch.

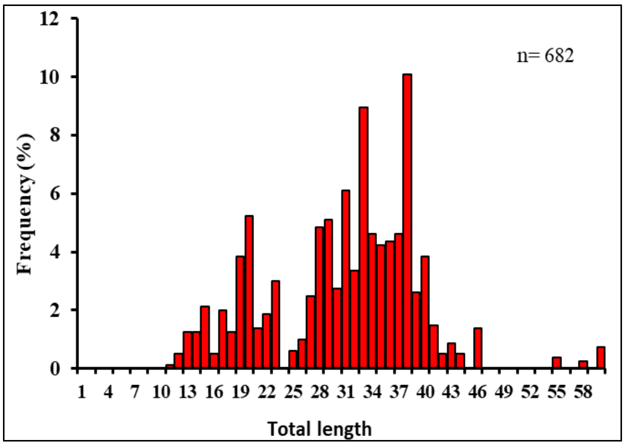

Fig 2: Length frequency distribution of *L. xanthopterus*

3.3 length-weight relationship and condition factor

The length-weight relationship was computed based on the data gathered from 522 of *L. xanthopterus* specimens ranging from 12.0 to 60.2 cm in total length and between 29 to 3472 g in weight (Fig. 3). These were found to be $W = 0.008L^{3.093}$, (r^2= 0.946). The value of 'b' for this species was significantly different from 3.0 (*t*-test= 2.87, P>0.05), indicating positive allometric growth.

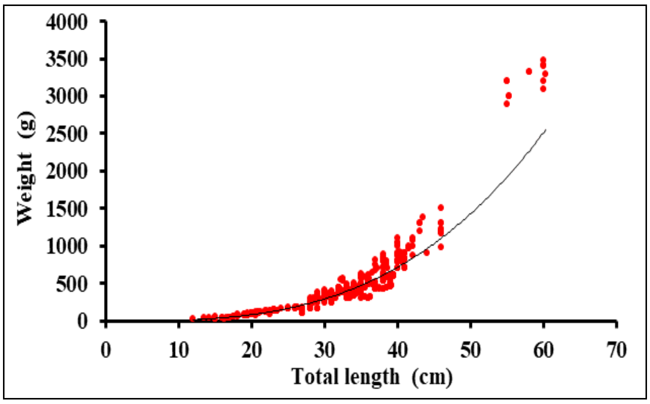

Fig 3: The length-weight relationships of *L. xanthopterus*

When analyzed the monthly variations in the relative condition factor (K_n) for fish length groups from 12.0 to 60.2 cm (Fig. 4), it can be seen that this value reached the highest level in April (1.05) and the lowest in May (0.78). Generally, the monthly trend K_n values were high at the beginning of spring (March-April) and low during May to July. The mean value of the relative condition factor in the overall sample was 0.92.

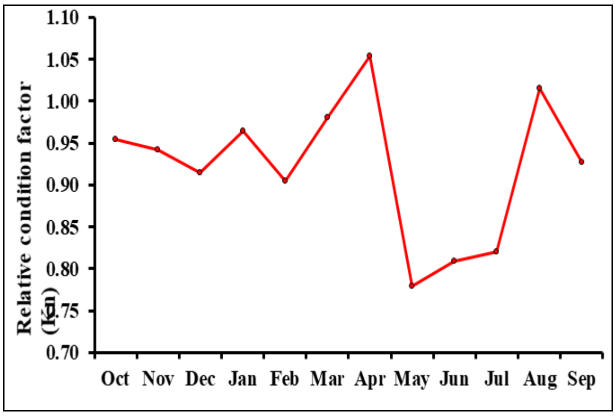

Fig 4: Monthly variation in relative condition factor (K_n) of *L. xanthopterus*

3.4 Age and growth

The age of *L. xanthopterus* caught from the river was between ages 1 and 7. The relationship between fish length (L) and scale radius (S) fitted to a linear model, L= 2.942+3.892*S* (Fig. 5), which reflects the high degree of correlation between these two parameters (*r* = 0.859). The mean back-calculated lengths of the pooled data at different ages were given in Table 1. The mean lengths of these seven ages were found to be 15.3, 26.3, 35.9, 42.8, 49.0, 54.7 and 57.1 cm, respectively. The occurrence of rapid growth in length was found during the first two years of life after which growth increment decreased gradually. The percentage of annual increment varied from 26.7% during the first year of life to 10.0% during the 7th year of life.

The von Bertalanffy growth equation was obtained by using back-calculated lengths of *L. xanthopterus* was L_t= 73 $[1-e^{-0.228\ (t-0.012)}]$ and the index of growth performance (Φ) was 3.012.

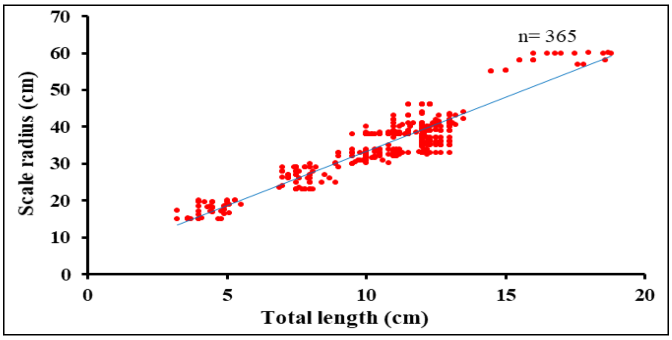

Fig 5: The linear relationship between total length and scale radius of *L. xanthopterus*

Table 1: Mean observed and back-calculated total lengths of *L. xanthopterus*

Age	No. of fish	Length at age (cm)							Observed length (cm)
		1	2	3	4	5	6	7	
1	38	15.1							16.0
2	64	16.0	26.6						27.3
3	103	14.5	25.9	36.0					36.1
4	81	15.9	26.6	35.7	42.9				43.0
5	6	14.4	27.1	35.7	42.3	49.0			49.2
6	4	15.3	26.6	36.0	42.7	48.9	55.2		56.6
7	6	14.3	26.9	35.9	42.3	49.1	54.4	57.1	58.7
Mean length (cm)		15.3	26.3	35.9	42.8	49.0	54.7	57.1	
Annual increment (cm)		15.3	11.1	9.5	7.0	6.2	5.7	2.4	
% Growth increment		26.7	19.4	16.7	12.2	10.8	10.0	4.2	

3.5 Reproduction

From a total number of 517 fish sampled, 201 males and 316 females were detected. The chi-squared test shows a significant departure from a 1:1 sex ratio. The overall male: female ratio (1:1.57) was biased in favour of females (χ^2= 25.58, P>0.05). Lengths at first maturity (L_{m50}) for males and females were 36 and 38 cm, respectively.

Gonad development was studied using the gonado-somatic index (*GSI*) values of samples. Monthly changes in *GSI* for all individuals are shown in Figure 6. It is observed that the highest values of *GSI* for males and females were 7.89 and 4.26, respectively in March, then declined gradually in April to lowest values in August. However, there is no significant difference in the values of *GSI* between males and females among the study months (t-test = 1.062, P < 0.05).

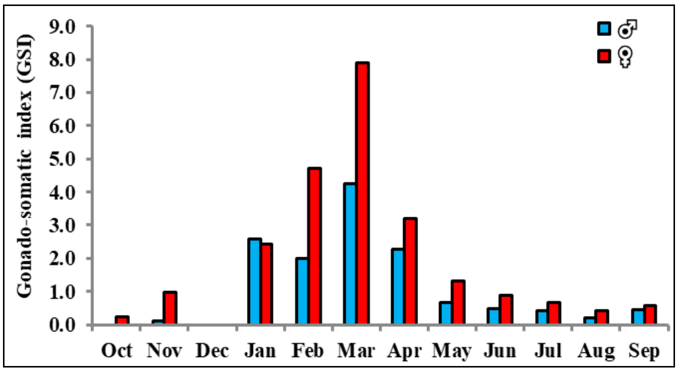

Fig 6: Monthly variations in the GSI of *L. xanthopterus*

Figure (7) illustrates monthly variations in the feeding activity and intensity of *L. xanthopterus* in the river. The feeding intensity varied from 5.0 points/fish in November to 15.6 points/fish in September, while the feeding activity of the species ranged from 30.3% in January to 90.0% in Jun. In general, the percentage of the stomach with food items was highest in March to August (spring and summer) and lowest in November to February (winter), there were significant correlations between water temperature and both feeding activity and intensity, r= 0.859 and 0.845, P < 0.05, respectively.

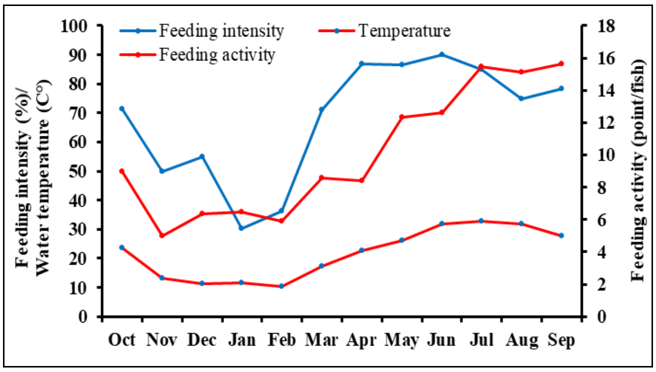

Fig 7: Monthly variations in water temperature (C°) and feeding intensity and activity of *L. xanthopterus*

3.6 Food habit

Based on the stomach content analysis of *L. xanthopterus*, there were five food groups; aquatic insects, detritus, crustacean, macrophytes, and diatoms (Fig. 8). Aquatic insects came first in terms of relative importance index (IRI%) and varied from 26.9% in September to 47.8% in January, followed by Macrophytes which altered from 9.7% in February to 26.8% in September. Detritus stand third among food items of the species and varied from 7.1% in January to 40.7% in February. Crustacea fluctuated from 9.7% in February to 27.1% in October. Finally, diatoms recorded the highest value (20.0%) in November. The overall food items of *L. xanthopterus* were aquatic insects (36.9%), macrophytes (20.0%), detritus (19.5%), crustacean (13.9%), and diatoms (9.6%).

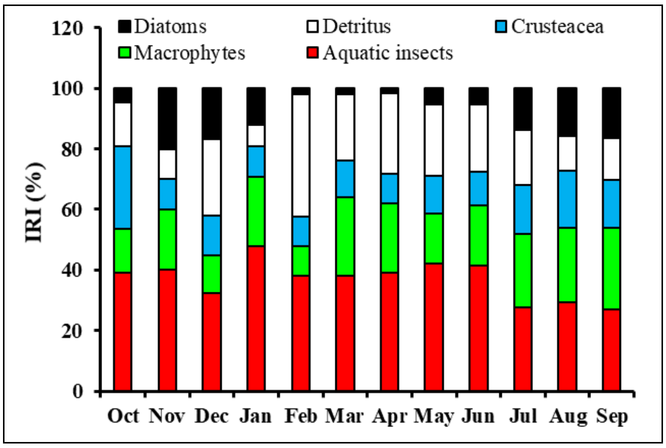

Fig 8: Monthly changes in *IRI*% of food items of *L. xanthopterus*

4. Discussion

L. xanthopterus comprised 5.7% of the fish assemblage in Al-Diwaniya river which was higher than the values reported for the species from some other Iraqi waters such as 0.02% of fish in Euphrates River between Al-Hindyah barrier and Kufa [33], 0.13% of fish population in Al-Huwaizah marsh [34], 0.02% of fish population in East Hammar marsh [35], 1.1% of fish in Al-Hilla river [36], 0.02% of fish population in Garmat Ali river [37], 2.5% of fish population in Tharthar lake [38], 1.2% of fish population in Euphrates river at Al-Hindyah barrier [39], 3.0% of fish population in Euphrates river near Al-Hindyah barrier [40] and 0.01% of fish population in Shatt Al-Arab river [41]. However, this percentage was lower than that documented from other waters such as 16.6% of fish in Al-Qadisia lake [9], 10.0% of fish in Euphrates River, Al-Mussaib [16] and 7.1% of fish population in Dukan dam lake [42].

The length range of *L. xanthopterus* in the present study, 11 to 60 cm was higher than the values reported for the species from some other Iraqi waters such as 21.5-42.0 cm in Al-Qadisia lake [13], 7.4-58.0 cm in Euphrates River, Al-Mussaib [16], 12.2-49.0 cm in Tharthar arm, Tigris [23], 6.5-42.5 cm in Haditha dam lake [17] and 15.0-45.0 cm in Habbanyia lake [7]. It was within the range of the total length of the species recorded from the Euphrates river near the Al-Hindia barrier [15]. However, Al-Rudainy *et al.* [43] reported the largest size of *L. xanthopterus* in Iraqi waters, had length 86 cm in the artificial lake. The difference in the length of fish ranges may be due to the different fishing methods used or to different environmental conditions, food supply, fish density, exploitation rate or competition with exotic species [44].

In this study, the exponent of the total length-weight relation showed that the growth is positive allometric. This type of growth implies the fish becomes relatively stouter or deeper-bodied as it increases in length and is indicated by a β > 3.0 [45]. Several authors have reported allometric growth for *L. xanthopterus* from various water bodies such as Al-Jerian [10] in Tharthar lake; Al-Rudainy *et al.* [15] in Euphrates river; Mohamed *et al.* [16] in Euphrates river, Al-Musaib; Salman [23] in Tharthar arm, Tigris river; Abbas and AL-Rudainy [17] in

Haditha dam lake and Wahab [38] in Tigris river, Tikrit. Whereas, Abu Alhana and Al-Rudainy [13] in Al-Qadisia dam lake and Al-Nasiri *et al.* [18] in the artificial lake have observed isometric growth for *L. xanthopterus* in these waters. The variations of (b) value observed in different regions result from a size range of fish, sex, sexual maturity, stomach fullness, health, season, and a major change in environment factors [46-48].

Condition factor represents the health status of fish which is the result of the interactions between biotic and abiotic factors and their effect on the physiological condition of the fish [49]. Generally, the monthly relative condition factor of *L. xanthopterus* showed a higher level during March-April as the growth of the gonads, but lower after the spawning period and improved steadily during summer months corresponded with the highest period of feedings. It may be concluded that the seasonal fluctuation in the relative condition factor of *L. xanthopterus* was influenced by the spawning cycle and feeding intensity of the fish. Sharma *et al.* [50] stated that the variations in the condition factor of fish primarily reflect its nourishment status and state of sexual maturity. The relative condition factor of *L. xanthopterus* population in present study was ranged from 0.81 to 1.01 which is within the findings of other studies, such as in Euphrates river, Al-Musiab, K_n= 0.91-1.35 for males and 0.86-1.12 for females [16], in Haditha dam lake, K_n= 1.25 [17] and in Tigris river, Tikrit, K_n= 0.64-1.50 [38]. In general, the seasonal fluctuation in the value of relative condition factor in fish has been mainly assigned to dependency on many factors such as feeding activity, gonad development, fish size and several other factors [51, 52].

Growth parameters for all analysed material given in this paper were compared with the results of other studies for *L. xanthopterus* (Table 2). The oldest specimens in the present the study was 7 years old. A similar age result was observed for the species in the Euphrates river, Al-Musaib [16]. The maximum age of *L. xanthopterus* recorded in Haditha dam lake was 10 years-old [13, 17]. On the other hand, the differences between growth rates can also be observed in various waters. The growth rate of the species in the present study was similar to that reported in the Euphrates river at Al-Musaib by Mohamed *et al.* [16], but it was higher than those stated by Abu Alhana and Al-Rudainy [13] and Abbas and AL-Rudainy [17] in Haditha dam lake. Furthermore, the growth of the species in an artificial lake was the highest one [14].

In present work, the value of ultimate growth of length (L∞) was closely similar to the value recorded by Mohamed *et al.* [16] in the Euphrates river at Al-Musaib but was different from those found by other authors (Table 2). The growth that an individual fish achieves depends on three constraints, the genetic constitution of the individual, the abiotic environment experienced by the fish will set constraints on growth and the biotic environment will determine the extent of the growth potential that the fish can achieve as defined by its genotype and the abiotic environment experienced [30].

Table 4: Growth comparison of *L. xanthopterus* in different ecosystems

Ecosystem	Mean total length at each age (cm)										*L∞*	Reference
	1	2	3	4	5	6	7	8	9	10		
Tharthar lake	-	-	-	-	-	-	-	-	-	-	130	[12]
Razzazah lake	-	-	-	-	-	-	-	-	-	-	130	=
Habbaniyah lake	-	-	-	-	-	-	-	-	-	-	95.5	=
Al-Qadisia (Haditha) lake	8.6	11.9	16.5	19.5	23.0	26.6	29.8	33.8	36.6	40.0	120	[13]
Artificial lake	16.0	27.0	40.0	46.0	54.0	63.0	67.0	70.0	72.0		87.1	[14]
Euphrates river, Al-Musaib	15.0	26.0	36.0	42.0	48.5	52.5	56.0	-	-	-	72.5	[16]
Haditha dam lake	10.9	16.9	21.0	24.4	26.7	28.8	32.0	34.4	36.4	38.1	68.9	[17]
Euphrates river, Al-Hindyh barrier	-	-	-	-	-	-	-	-	-	-	98.0	[15]
Al-Diwaniya river	15.3	26.3	35.9	42.8	49.0	54.7	57.1	-	-	-	73.0	Present study

Our observation showed that the overall sex ratio of *L. xanthopterus* was 1:1.57 which was significantly different from 1:1, indicating that females had more communion in the population. Similar results were observed for the species in Euphrates river, Al-Musaib, 1:1.34 [53] and in Tharthar arm, Tigris river, 1:1.3 [23]. It is well known that the sex ratio in most species is close to one, but it may vary depends on different factors like differences in mortality rates between sexes, spawning migration and differences in growth between sexes, selectivity of fishing gears and differences in sampling and different habitats [54].

Lengths at first maturity (L_{m50}) for males and females of *L. xanthopterus* were 36 and 38 cm, respectively. Al-Nasiri *et al.* [18] stated that females of the species attained the first maturity at 41 cm and males at 37 cm in the water system of Tigris-Euphrates marshes. Al-Rudainy *et al.* [19] reported that *L. xanthopterus* matures sexually when it reaches about 40.4 cm for females and 36.8 cm for males in the Euphrates river. Sexual maturity is a critical life stage and length at first maturity may be different in various populations [54]. It was noticed that the mean values of GSI of *L. xanthopterus* in the present study were at the highest level in March means that spawning activity is going to start after this month. A similar result was found for the species in the Euphrates river by Al-Rudainy *et al.* [19]. However, this period may change more or less year by year, depending on the ecological characteristics of the water system, such as the temperature of the water in which they live [56].

Seasonal trends in the feeding activity and intensity of *L. xanthopterus* were related positively with the water temperature of the river (r= 0.859 and 0.845, P< 0.05, respectively). Al-Rudainy *et al.* [43] found similar rhythms for both feedings of *L. xanthopterus* in the artificial lake. Temperature is an important factor that regulates the biological and chemical activities in the aquatic environment as well as the metabolism and growth of fish [44]. It is generally known that feeding activity of Cyprinids decreases with decreasing of the water temperature [57].

L. xanthopterus was found to be omnivorous food habit in this study, fed chiefly on aquatic insects, macrophytes, detritus, crustacean, and diatoms. Al-Rudainy *et al.* [43] stated that the food habit of the species was omnivorous with its tendency to plant origin in the artificial lake. Eskandari *et al.* [5] mentioned that the species was omnivorous with a tendency to animal origin in Hoor-al-Azim marsh, southern Iran. However, Al-Kanaani [20] found that the species was carnivorous consumed mollusca (38.6%), crustacean (26.9%) and aquatic insects (13.1%) in Al-Hammar marsh. Hussain *et al.* [58] stated that detritus (23.4%), aquatic insects (20.1%) and mollusca (14.1%) were the main food items of *L. xanthopterus* in Al-Hammar marsh. The unidentified digested food (animal origin) formed 31.8% of the species diet followed by mollusca 21.5%, aquatic insects 15.0%, detritus 12.6% and zooplankton 7.5% in Habbaniyah lake [7]. Also, other studies indicated that the food habit of the species was carnivorous [15, 22, 24,]. The ontogenetic change in the diet of fish may be due to an interaction of changes in external factors such as habitat, food supply and predation risk, and internal conditions like anatomical structures, behavior and physiological demands [59, 60].

In conclusion, it is found that the population of *L. xanthopterus* reflects the expected and previously observed features of condition factor, age, growing, reproduction and food habit in natural fish populations. Proper fishing techniques and following the fishing restrictions are necessary for the continuation of *L. xanthopterus* population in the river as an economic resource by activating the national law of fishing, exploiting and protecting aquatic resources.

5. References

1. Fricke R, Bilecenoğlu M, Sari HM. Annotated checklist of fish and lamprey species (Gnathostoma and Petromyzontomorphi) of Turkey, including a Red List of threatened and declining species. Stuttgarter Beiträge zur Naturkunde. 2007; 706:1-172.
2. Coad WB. Freshwater Fishes of Iraq. Pensoft Publishers, Sofia, Bulgaria, 2010, 274.
3. Kuru M, Yerli SV, Mangit F, Unlu E, Alp A. Fish biodiversity in inland waters of Turkey. Journal of Academic Documents for Fisheries and Aquaculture. 2014; 3:93-120.
4. Eskandari GH, Safeikhani H, Dehgahan S, Esmaeli F. Fecundity and Feeding of *Barbus xanthopterus* in Karkheh River and Hoor-al-Azim Marsh. Iranian Journal of fisheries Sciences. 2003; 12:21-42.
5. Esmaeili HR, Coad BW, Gholamifard A, Nazari N, Teimory A. Annotated checklist of the freshwater fishes of Iran. Zoosystematica Rossica. 2010; 19:361-386.
6. Al-Shamma'a AA, Al-Mashhadany AJ, Alasha'ab MH, Nasser EN. Natural feeding of fish from Habbanyia lake. 3- Kattan *Barbus* (*Luciobarbus*) *xanthopterus* (Heckel 1843). Iraqi Journal of Agriculture. 2009; 14(1):170-177.
7. Al-Mahdawi GJ, Al-Rudainy AJ, Al-Shamma'a AA, Rhig A, Mosa KM. Culture of Kattan, *Barbus xanthopterus* in earthen ponds. Basrah Journal of Agriculture Sciences. 1996; 9(2):63-66.
8. Al-Rudainy AJ, Al-Mahdawi GJ, Al-Shamma'a AA, Ruhaig AM, Abu Al-Hani AJ. Composite culture of kattan (*Barbus xanthopterus*) and common carp (*Cyprinus carpio*) in earthen ponds. Scientific Journal of the Iraqi Atomic Energy Commission. 2001; 3(2):59-64.
9. Al-Jerian AA. Age and Growth of two species, *Barbus sharpeyi* and *Barbus xanthopterus* in Al-Tharthar reservoir, MSc. Thesis. Coll. of Science, University of Baghdad, Iraq, 1974.
10. Bawazeer AA. Age and growth of *Barbus xanthopterus* (Heckel) and *Barbus luteus* (Heckel) in Habbaniya Lake. Marsh. Sciences. Univ. Baghdad, Iraq, 1981.
11. Polservic Consulting Engineers. Detailed report on the development of fisheries in Tharthar, Habbaniya and Razzazah lakes. Inland fish. Inst. Warsaw, Poland. Final report submitted to General State of fishes. Ministry of Agriculture, Iraq, 1984, 329.
12. Abu Alhana AJ, Al-Rudainy AJ. Age and growth of gattan *Barbus xanthopterus* (Heckel) in Al-Qadisia Dam Lake. Scientific Journal of the Iraqi Atomic Energy Commission. 2000; 2:124-132.
13. Al-Rudainy AJ. Ecology and stock assessment of three cyprinids species in man-made lake, west of Baghdad. PhD Thesis, College of Agriculture, University of Baghdad, Iraq, 2002.
14. Al-Rudainy AJ, Hassan HA, Ahmed SS, Saad SA, Hussain YS. Age and Growth of *Barbus xanthopterus* in Euphrates river near Al-Hindia barrier. Journal of Fisheries. 2002; 21:78-80.
15. Mohamed ARM, Alrudainy AJ, Abbas LM. Stock Assessment of Gattan *Barbus xanthopterus* in Euphrates River, North Al-Mussaib Power Station. Iraqi Journal Aquaculture. 2005; 10:25-42.
16. Abbas LM, AL-Rudainy AJ. Growth and mortality rates of Gattan, *Barbus xanthopterus* (Heckel) in Haditha dam lake. Iraqi Journal Aquaculture. 2007; 12:124-131.
17. Al-Nasiri KS, Al-Rudainy AJ, Jasim MA. Stock assessment of gattan *Barbus xanthopterus* in man-made lake, west of Baghdad. Iraqi Journal of Agriculture. 2004; 9(3):113-123.
18. Al-Rudainy AJ, Mohamed ARM, Abbas LM. Ecology and biology of *Barbus xanthopterus* (Heckel) in Euphrates river, middle of Iraq. Journal of Um-Salama for Sciences. 2006; 3(4):595-603.
19. Al-Kanaani SM. Diet overlap among the common carp *Cyprinus carpio* L. and three native species in Al-Hammar marshes, Southern Iraq. MSc. Thesis, College of Agriculture, University of Basrah, Iraq, 1989.
20. Al-Daham NK, Hussein SA, Al-Kanaani SM. Feeding habits of Kattan *Barbus xanthopterus* in Al Hammer Marsh. Basrah Journal of Agriculture Sciences. 1992; 5(2):149-157.
21. Al-Shamma'a AA, Mohamed MA, Al-Mashhadany AJ. Natural feeding of fish in Al-Qadisia dam reservoir. 2-Kattan *Barbus xanthopterus* and other *Barbus* species. Jordan Journal of Natural and Engineering Studies. 26(1):137-149.
22. Salman AH. Biodiversity of fish and biology of two species in Al-Tharthar arm, Tigris. PhD thesis. College of Science, University of Al-Mustansyria, Iraq, 1999, 2006.
23. Al-Shamma'a AA, Nashaat MR, Al-Janabi AF, Abd BK. Diet overlap of five *Barbus* species from Hemrin reservoir, Deyala-Iraq. Proceedings of the 3rd Scientific Conference of the College of Science, University of Baghdad, 2009, 1199-1207.
24. Mohamed ARM, Al-Jubouri MOA. Fish assemblage structure in Al-Diwaniya River, middle of Iraq. Asian Journal of Natural and Applied Sciences. 2017; 6(4):10-20.
25. Le Cren ED. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology. 1951; 20:201-219.
26. Bagenal TB, Tesch FW. Age and growth. In Methods for assessment of fish production in freshwater, Bagenal TB. (ed). IBP Handbook No. (3): Blackwell Scientific Publications, Oxford, 1978, 101-130.
27. Ricker WE. Computation and interpretation of biological

statistics of fish populations. Bulletin of the Fisheries Research Board of Canada. 1975; 191:382.
28. Pauly D, Munro JL. Once more on the comparison of growth in fish and invertebrates. ICLARM Fish byte, 1984; 2:21.
29. Wootton RJ. Growth: environmental effects. In Encyclopedia of fish physiology: from genome to environment, Farrell AP (ed). Elsevier Science Publishing Co. Inc, United States, 2011, 1629-1635.
30. Hyslop EJ. Stomach contents analysis -a review of method and their application. Journal of Fish Biology. 1980; 17:413-422.
31. Stergion KI. Feeding habits of the lessepsian migrant *Siganus luridus* in the Eastern Mediternian, its new environment. Journal of Fish Biology. 1988; 33:531-543.
32. Salman JM. Ecological study of possible pollution in the Euphrates River between Al-Hindyah barrier and Kufa, Iraq. PhD thesis. College of Science, University of Babylon, Iraq, 2006.
33. Mohamed ARM, Hussain NA, Al-Noor SS, Coad BW, Mutlak FM, Al-Sudani IM *et al.* Species composition, ecological indices and trophic pyramid of fish assemblage of the restored Al-Hawizeh Marsh, Southern Iraq. Ecohydrology & Hydrobiology. 2008; 8(2-4):375-384.
34. Hussain NA, Mohamed ARM, Al-Noor SS, Mutlak FM, Abed IM, Coad BW. Structure and ecological indices of fish assemblages in the recently restored Al-Hammar Marsh, Southern Iraq. Bio Risk. 2009; 3:173-186.
35. Al-Amari MJY. Study of some biological and ecological aspects of fish community in Al-Hilla River/Iraq. Iraq: College of Science, University of Babylon, 2011.
36. Mohamed ARM, Hussein SA, Lazem LF. Fish assemblage of Garmat Ali River, north of Basrah, Iraq. Basrah Journal of Agriculture Sciences. 2013; 26(1):150-166.
37. Wahab NK. Food habits and diet overlaps for some freshwater fish in Tharthar Arm, Tigris, Iraq. Basrah Journal of Agricultural Sciences. 2013; 26(2):182-197.
38. Khaddara MM. Ecological and biological study of fish community in Euphrates River/Middle of Iraq. MSc thesis, College of Science, University Babylon, Iraq, 2014.
39. Abbas LM, Abu-Elhine AJ, Radhy AG, Hassan AH. Evaluating the Fish Structure Community at Euphrates River near Al-Hindyah Barrier, Babylon Province/ Iraq. Journal Tikrit University For Agriculture Sciences. 2017; 17:28-29.
40. Mohamed ARM, Abood AN. Compositional change in fish assemblage structure in the Shatt Al-Arab River, Iraq Asian Journal of Applied Sciences. 2017; 5(5):944-958.
41. Sediq SO, Abbas LM. Fish Community Structural in Dukan Dam Lake, Northern Iraq. Iraqi Veterinary Medical Journal. 2013; 37(1):1-16.
42. Al-Rudainy AJ, Al-Nasiri SK, Hussain TS. Natural food of gattan *Barbus xanthopterus* in man-made lake, west of Baghdad. Marina Mesopotamica. 2004; 19(2):257-266.
43. Nikolsky GV. The Ecology of Fishes (Translated by L. Birkett). Academic Press. London, 1963, 352.
44. Riedel R, Caskey LM, Hurlbert SH. Length-weight relations and growth rates of dominant fishes of the Salton Sea: implications for predation by fish-eating birds. Lake and Reservoir Management. 2007; 23:528-535.
45. Isa MM, Rawi CS, Rosla R, Shah SAM, Shah ASR. Length-weight relationships of freshwater fish species in Kerian River Basin and Pedu Lake. Research Journal of Fisheries and Hydrobiology. 2010; 5(1):1-8.
46. Hamid MA, Mansor M, Nor SAM. Length-weight relationship and condition factor of fish populations in Temengor Reservoir: Indication of Environmental Health. Sains Malaysiana. 2015; 44(1):61-66.
47. Cuadrado JT, Lim DS, Alcontin RMS, Calang JL, Jumawan JC. Species composition and length-weight relationship of twelve fish species in the two lakes of Esperanza, Agusan del Sur, Philippines. Fish Taxa. 2019; 4(1):1-8.
48. De Giosa M, Czerniejewski P, Rybczyk A. Seasonal changes in condition factor and weight length relationship of invasive *Carassius gibelio* (Bloch, 1782) from Leszczynskie Lakeland, Poland. Advances in Zoology. 2014, 1-7.
49. Sharma NK, Singh R, Gupta M, Pandey NN, Tiwari VK, Akhtar MS. Length–weight relationships of four freshwater cyprinid species from a tributary of Ganga River Basin in North India. Journal of Applied Ichthyology. 2016; 32(3):497-498.
50. Doddamani M, Rameshaand TJ, Shanbhogue SL. Length-weight relationship and condition factor of *Stolephorus bataviensis* from Mangalore Area. Indian Journal of Fisheries. 2001; 48:329-332.
51. Simon KD, Bakar Y, Mazlan AG, Zaidi CC, Samat A, Arshad A et al. Aspects of the reproductive biology of two archer fishes *Toxotes chatareus* (Hamilton 1822) and *Toxotes jaculatrix* (Pallas 1767). Environmental Biology of Fishes. 2012; 93:491-503.
52. Al-Temimy LMA. Ecology, Biology and Assessment of Fishes Community in Euphrates River near Al-Mussaib Power Station. PhD Thesis. College of Agriculture, University of Basrah, Iraq, 2004.
53. Bartulovic V, Glamuzina B, Conides A, Dulcic J, Lucic D, Njire J et al. Age, growth, mortality and sex ratio of sand smelt, *Atherina boyeri*, Risso, 1810 (Pisces: Atherinidae) in the estuary of the Mala Neretva River (Middle-Eastern Adriatic, Croatia). Journal of Applied Ichthyology. 2004; 20:427-430.
54. Moyle PB, Cech JJ. Fishes: an introduction to Ichthyology. Pearson Prentice Hall, Upper Saddle River, New Jersey, 2004, 726.
55. Balik U, Özkök R, Çubuk H, Uysal R. Investigation of some biological characteristics of the silver crucian carp, *Carassius gibelio* (Bloch 1782) population in Lake Eğirdir. Turk. J. Zool., 2004; 28:19-28.
56. Penttinen OP, Holopainen IJ. Seasonal feeding activity and ontogenetic dietary shifts in crucian carp, *Carassius carassius*. Environmental Biology of Fishes, 1992; 33:215-221.
57. Hussain NA, Al-Sabonchi AA, Ali TS, Mahdi AA. Feeding relationship of eight species of family Cyprinidae in Basrah region. Iraqi Journal of Sciences. 1992; 33:241-254.
58. Persson A, Hansson LA. Diet shift in fish following competitive release. Canadian Journal of Fisheries and Aquatic Sciences. 1999; 56:70-78.
59. Specziár A, Erős T. Dietary variability in fishes: the roles of taxonomic, spatial, 2 temporal and ontogenetic factors. Hydrobiologia. 2014; 724:109-125.