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Observations on biological properties of the cyprinid fish, *Carasobarbus sublimus* in the Al-Diwaniya River, Middle Euphrates, Iraq

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Abstract: *Length frequency distribution, length-weight relationship, age, growth, gonado-somatic index (GSI) and food habit of the cyprinid fish, Carasobarbus sublimus (Coad & Najafpour, 1997) from the Al-Diwaniya River, Middle Euphrates, Iraq were investigated for the first time. Fish were collected by gill nets and electeofishig during July-September 2017. Fish lengths of 20 to 25 cm dominated the population. Total length–weight relationship was found to be* $W= 0.009L^{3.153}$*, growth pattern is isometric (P>0.05). The mean relative condition factor was 0.99. The mean lengths estimated at ages 1 to 4 year were found to be 8.5, 14.6, 18.3 and 21.7 cm respectively. The von Bertalanffy growth equation was* $L_t = 29.4(1-e^{-0.331(t+0.039)})$*. The overall values of GSI for females and males were 9.7 and 1.6%, respectively. C. sublimus was omnivorous fed on algae (31.0%), aquatic insects (29.8%), macrophytes (27.8%) and snails (11.5%).*

Key Words: *Carasobarbus sublimus, growth, food habit, Al-Diwaniya River, Iraq*

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I. Introduction

The himri barbal, *Carasobarbus sublimus* (Coad & Najafpour, 1997) belong to Cyprinidae family which is regarded as one of the most widespread fish families in the world with 376 genera and some 3148 species (Eschmeyer and Fong, 2018). *C. sublimus* was first described and reported by Coad and Najafpour in 1997 from Khuzestan waters, southwestern Iran. Coad and Najafpour (1997) and Esmaeil *et al.* (2006) have rectified the species by comparing it with *C. kosswigi* and *C. luteus* on the basis of their morphology in Iran, while, Mohamed *et al.* (2017) described and compared C. sublimus obtained from the Shatt Al-Arab River for the first time in Iraq with *C. luteus* in Iraqi waters. During the ichthyofauna survey for the Al-Diwania River, middle of Iraq during October 2016 to September 2017, a number of cyprinid fish, *C. sublimus* individuals were caught for the first time from south the Daghghara barrier on this river (Mohamed and Al-Jubouri, 2018). Now, two species of himri were recorded in the Iraqi waters which are *C. luteus* and *C. sublimus* (Mohamed *et al*., 2017; Mohamed and Al- Jubouri, 2018).

The age, growth, food habit and reproduction of the *C. luteus* have been investigated in several studies at different localities in Iraq, Turkey and Iran (Ahmed, 1982; Barak and Mohamed, 1982, 1983; Al-Rubayee, 1989; Epler *et al.*, 2001; Al-Rudaini *et al.*, 2002; Ozdilek *et al.*, 2004; Al Hazzaa, 2005; Mohamed *et al*., 2006; Gökçek and Akyurt, 2008; Mohamed *et al.*, 2010; Al- Amari *et al*., 2012; Al-Ashi, 2013; Baboli *et al.*, 2013; Baboli and Sayahi, 2014; Mohamed, 2014; Bilici *et al*., 2017), but no work has been published on the biology of *C. sublimus* in the coexistence regions.

Therefore, the present study aims to describe some biological characteristics of *C. sublimus*, such as occurrence, lengths distribution, length-weight relationship, relative condition factor, growth rates, food habit and reproduction in the Al-Diwaniya River, Middle Euphrates, Iraq.

II. Materials and Methods

The study area is located in the AL-Diwaniya River, Al-Qadidiyah Province in the Middle Euphrates, Iraq (Fig. 1). AL-Diwaniya River is an extension of the Al-Hilla River which is a branch of Euphrates River at Al-Hindyah Barrier, in the middle of Iraq. It is 123 km long, 25-30m wide and 3-5m depth. The river flows through the AL-Diwaniya city, then narrows in the districts of Sideer and Al-Hamzah and continues to flow until it fades in the district of Al-Rumaythah, Al-Muthanna Province. The predominant vegetations on the both banks of this locality were reed, *Phragmites australis* and cattail, *Typha domingensis*, whereas hornwort, Ceratophyllum demersum was dominant in the deeper areas.

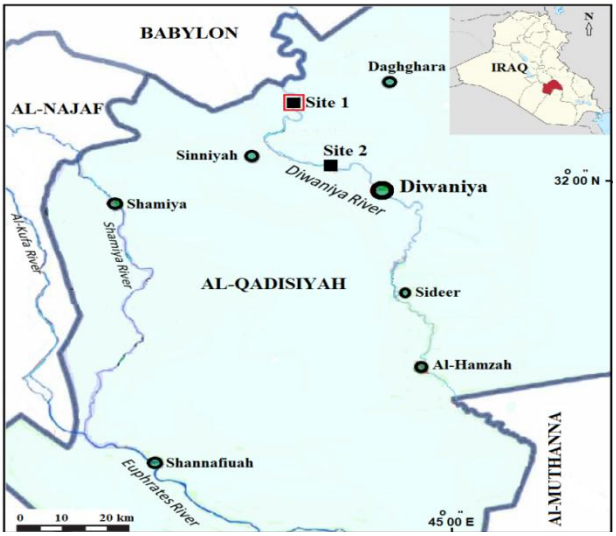

Fig. 1. Map of Al-Qadisiyah Province showing the collection site of C. sublimus in Al-Diwaniya River

The water temperature of the river varied from 10.2°C in March to 32.8°C in August, dissolved oxygen fluctuated from 5.0mg/l in August to 9.6mg/l cm in February, salinity values ranged from 0.55‰ in April to 0.79‰ in October (Mohamed and Al-Jubouri, 2017).

Fish were captured by gill nets (25m long with 20x20, 30x30 and 50x50 mm mesh sizes) and electro-fishing equipment (provides 150-300V) during the period from July to September 2017. Fish were immediately preserved in ice box till arrive the Al-Qasim Green University.

In the laboratory, total length and weight were measured for each fish to the nearest 0.1cm, and 0.01g, respectively. Four to six scales were extracted from the left side of each fish between the lateral line and the dorsal fin base and stored in labeled envelopes. Scales were cleaned with warm water and placed between two glass slides (Schneider et al., 2000).

The commonly used length-weight relationship $W= a L^b$ was applied (Le Cren, 1951), where W is the weight (g), L is the total length (cm), and a and b are constants. The hypothesis of isometric growth (Ricker, 1975) was tested with Student's t-test. The relative condition factor (K_n) was determined using the following formula: $K_n= W'/W$ (Le Cren, 1951), where W'= the observed weight and W= the calculated weight. All the calculations were done by using Microsoft Office Excel 2010.

Scale reading was carried out using Projectina microscope, 20X. From the magnified image of the scale, total scale radius and the distance between the focus and their respective annuli were measured. The relationship between the length of fish on capture (L) and the radius of scale (S) was calculated from the equation: L= a + b S (Bagenal and Tesch, 1978), where a is the intercept (the correction factor) and b is the slope of the regression line. For back calculation following equation was applied: $L_n= a + S_n /S (L-a)$ (Bagenal and Tesch, 1978), where L_n is the length of the fish at age 'n', a is the correction factor, S_n is the radius of the annulus 'n', S the scale radius and L is the length at the time of capture. Annual growth increment in centimeters was calculated for each fish collected for each year of its life using back-calculated mean length-at-age data.

The von Bertalanffy equation was used to describe growth of the species: $L_t= L_\infty (1– e^{-K(t-t_0)})$, where L_t is the fish length at age t, L_∞ is the asymptotic fish length, K is the growth coefficient and t_0 is the theoretical age when the fish was at zero length. The von Bertalanffy growth curve was fitted to the back calculated mean length at age of the species by means of Beverton and Holt method (Ricker, 1975). Growth performance index (Φ) was calculated using the equation $\Phi=\log k+2\log L\infty$ (Pauly, 1983).

The gonado-somatic index (GSI) for each sex was calculated using the equation (De Silva, 1973):

GSI= Weight of gonad / Total body weight × 100

Two analytical methods were adopted, i.e., points and frequency of occurrence (Hyslop, 1980) to analyze stomach contents. The importance of food item was determined by combined the two methods to calculate the index of relative importance (IRI%) of Stergion (1988) as follows:

IRI= O% × P% and IRI %= IRI / ΣIRI * 100

Statistical analyses were carried out with SPSS 13 software package and a significance level of 0.05 was adopted.

III. Results

Length frequency distribution

The length-frequency distribution of 50 individuals of *C. sublimus* which ranged from 13 to 25 cm is presented in Figure 3. The length groups from 20 to 21 cm were prevailing and formed 30.8%, followed by the length group of 17 cm, comprising 13.5% of the total catch. The fish at length groups 20 to 25 cm formed 61.6% of the total catch.

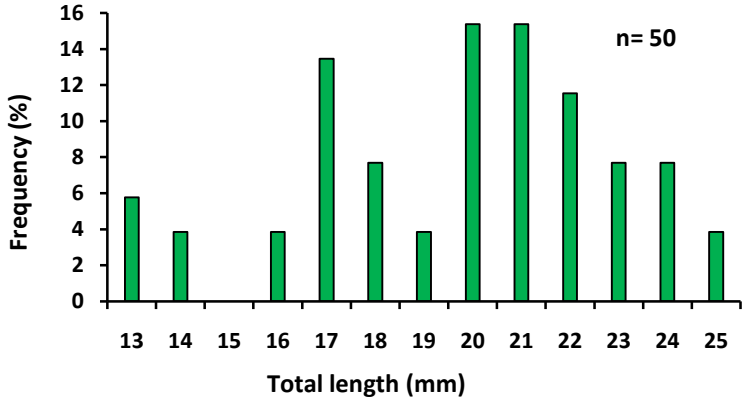

Fig. 2. The overall length frequency of *C. sublimus* from Al-Diwaniya River

The length-weight relationship of *C. sublimus* from Al-Diwaniya River based on 50 specimens ranging from 13 cm and 25 cm in total length and between 31 to 251 g in weight was studied. The scatter diagram between length and weight indicated a exponential relationship. Length-weight relationship was $W= 0.009L^{3.153}$. The coefficient of correlation was found to be 0.968, which indicated a high degree of positive correlation between the two parameters. In terms of growth type, *C. sublimus* showed isometric growth ($t= 1.87$, $P<0.05$).

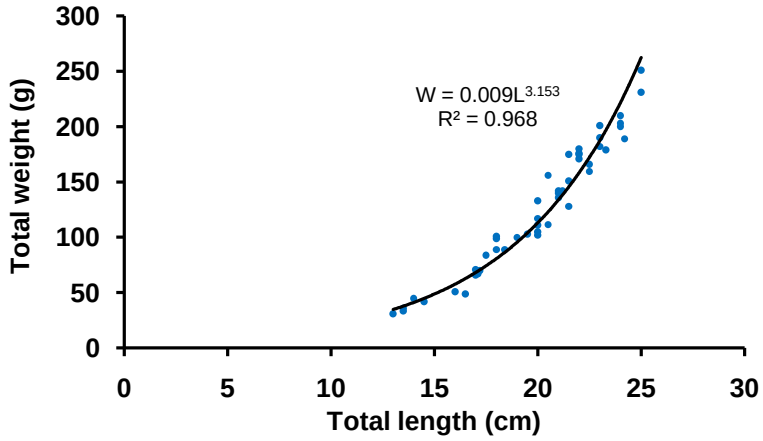

Fig. 3. The length-weight relationships of *C. sublimus* from Al-Diwaniya River

The means relative condition factor (K_n) for fish length groups from 13 to 25 cm were given in Table 1. The lowest mean value was 0.82 for length group 15-16 cm and the highest value was 1.05 for length group 13-14 cm. The overall mean value of the relative condition factor for the species was 0.99.

Age and Growth

The estimated age from scales ranged from 1 to 4 years, with most specimens in age two. The scatter diagram denotes the straight - line relationship between fish length (L) and scale radius (S). The relationship was expressed as: L =1.333+1.245S. The linear agreement of the relationship was supported by high coefficient correlation (r=0.966).

Table . 1. The relative condition factor (Kn) of *C. sublimus* from Al-Diwaniya River

Fish range (cm)	Mean length (cm)	No. of fish	Mean K_n
13-14	13.7	5	1.05
15-16	16.3	2	0.82
17-18	17.5	10	1.04
19-20	19.9	9	0.99
21-22	21.6	14	1.03
23-24	23.6	8	0.98
25	25	2	1.01

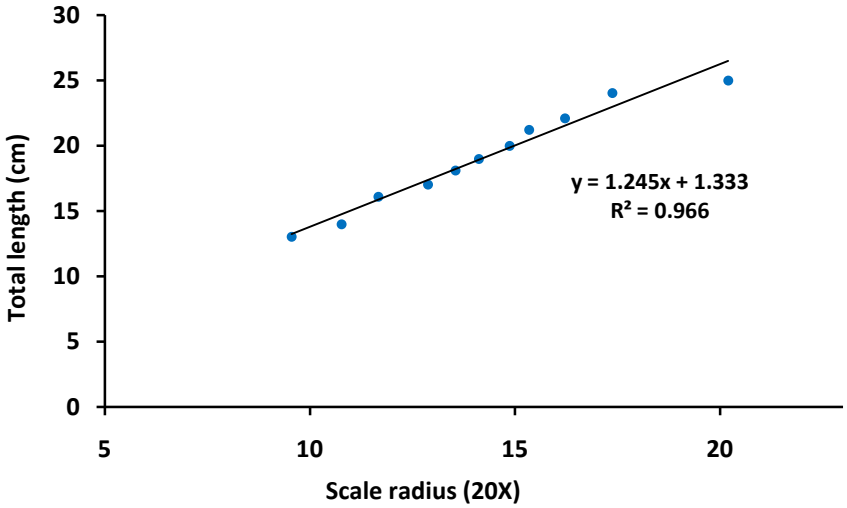

Fig. 4. The relationship between fish length (L) and scale radius of *C. sublimus*

Table 1 illustrates the mean length of *C. sublimus* at each annulus as determined by back calculation of lengths from the fish of different ages. The mean lengths so estimated at ages 1 to 4 year were found to be 8.5, 14.6, 18.3 and 21.7 cm respectively. Occurrence of rapid growth in length was found during the first year of life, followed by a period of slow growth rate in the rest of life. The percentage annual increment varied from 39.2% during the first year of life to 15.7% during the 4th year of life (Table 2).

Table 2. Mean observed and back-calculated total lengths of *C. sublimes*

Age	Number of fish	Length at age (cm)				Observed length (cm)
		1	2	3	4	
1	3	8.1				12.5
2	4	8.3	14.1			16.6
3	25	8.6	14.7	18.4		19.6
4	10	8.5	14.3	18.2	21.7	23.5
Mean length (cm)		8.5	14.6	18.3	21.7	
Annual increment (cm)		8.5	6.1	3.8	3.4	
% Growth increment		39.2	27.9	17.3	15.7	

The von Bertalanffy growth model was fitted to the age/length data of *C. sublimus*, which can be expressed as: $L_t = 29.4(1\text{-}e^{-0.331(t+0.039)})$. The growth performance index (ø) of *C. sublimus* was computed as 2.16.

Gonado-somatic index (GSI)

Figure 6 illustrated the variations in the values of the gonado-somatic index (GSI) for both sexes of *C. sublimus* with fish length. The peaks of the GSI were 13.7% for females and 4.0 for males corresponding with lengths 20 and 19 cm, respectively. The overall values of GSI for both sexes were 9.7 and 1.6%, respectively.

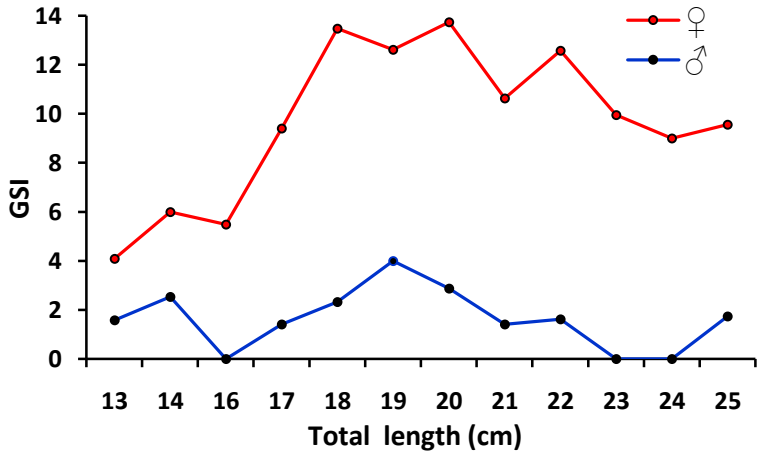

Fig. 6. Variations in the GSI of *C. sublimus* with fish lengths in the Al-Diwania River

Food habits

The results of analysis of stomach contents of 50 specimens of *C. sublimus* using the fullness method indicated that 98% of fish were loaded stomach. The diet items in terms of percentage composition by points showed that algae contributed the highest proportion (40.0%) of the total food ingested, followed by macrophytes (35.2%), snails (15.2%), and aquatic insects (9.7%). Further analysis in terms of frequency of occurrence method revealed that the food habit of *C. sublimes* comprised mainly of macrophytes (97.9%), algae (95.8%), snails (93.8%) and aquatic insects (79.2%). However, the index of relative importance (IRI) indicated that the food items of *C. sublimus* (Fig. 4) primarily comprised from algae (31.0%), aquatic insects (29.8%), macrophytes (27.8%) and snails (11.5%).

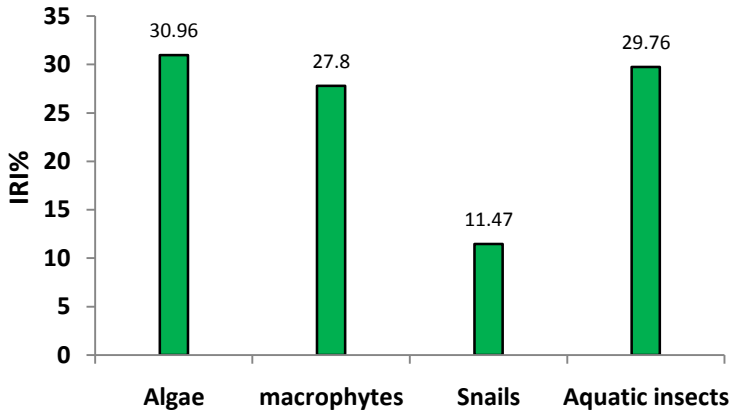

Fig. 5. The relative importance index (IRI%) of food items in the diet of *C. sublimus*

IV. Discussion

Despite the *C. sublimus* was first described and reported by Coad and Najafpour in 1997 from Khuzestan waters, southwestern Iran, and later Mohamed *et al*. (2017) whom described and compared *C. sublimus* obtained from the Shatt Al-Arab River for the first time in Iraq with *C. luteus* in Iraqi waters, no biological studies have been existed about this species. Therefore, we will compare the biological properties of *C. sublimus* with those who intended the *C. luteus* in various waters.

The length distribution of the *C. sublimus* population in AL-Diwaniya River was 13.0 to 25.0 cm and the fish at length group 20.0 - 21.0 cm was prevailing and constituted 30.8% of the total catch. The size of *C. sublimus* was larger than the range of the total length of *C. sublimus* obtained from other waters. Mohamed *et al.* (2017) reported a range of 11.9–17.0 cm TL for specimens of *C. sublimus* obtained from the Shatt Al-Arab River. However, the biggest specimen of *C. sublimus* from Khuzestan waters in Iran was 11.5 cm SL (Coad and Najafpour, 1997). Al-Amari *et al.* (2012) mentioned that the length of *C. luteus* in AL-Hila River was 5.5-30.3 cm, while Al-Jubouri and Mohamed (2018) found that the length size of *C. luteus* in AL-Diwaniya River was 13.0-30.0 cm, whereas in Al-Huwazah marsh, the total length of *C. luteus* ranged from 3.0 to 35.0 cm (Mohamed, 2014). In Iran, the length distribution of *C. sublimus* varied between 11.8-25.2 cm in Karoon River

(Biria *et al*., 2014), 7.5 to 29.0 cm in Karkheh River (Baboli and Sayahi, 2014) and 11.8 to 36.2 cm in Hoor Al-azim wetland (Eydizadeh *et al*., 2014).

The length-weight relationship is useful tool for fisheries research because they allow the conversion of growth in length equation assessment model, estimate of biomass from the length observation and the condition of the fish, and is useful for between regions comparison of life histories of certain species (Moutopoulos and Stegious, 2000). The slop value in the weight-length model for *C. sublimus* showed isometric growth, indicating the proportional increments of weights to lengths (Ricker, 1975). This result is comparable with the growth of *C. luteus* as reported by some authors, such as, Al Hazzaa (2005), Salman *et al.* (2007), Gökçek and Akyurt (2008), Amari *et al.* (2012), Biria *et al.* (2014) Eydizadeh *et al.* (2014) and Mohamed (2014). Species, geographic location and associated environmental conditions, such as seasonality, stomach fullness, disease and parasite loads can affect length-weight relationship (Bagenal and Tesch, 1978).

The condition of fish in a population determines its potential to provide benefits for fisheries in addition to producing data key to preservation of ecosystems with healthy biodiversity (Froese, 2006). The overall relative condition factors (K_n) of *C. sublimus* population in the study region was 0.99 which is similar to the findings of other studies on *C. luteus* in some Iraqi waters, such as of Al-Huwaza marsh, K_n= 1.00 (Mohamed, 2014) and Al-Diwaniya River, K_n= 0.95 for males and 0.96 for females (Al-Jubouri and Mohamed, 2018).

The value of $L\infty$ of *C. sublimus* determined in the present study was lesser than that recorded for *C. luteus* species in the same river, 35.0 cm (Al-Jubouri and Mohamed, 2018), and those noticed in other Iraqi waters, such as in Tharthar lake, 38.0 cm (Ahmed, 1982); in Euphrates River, 32.0 cm (Mohamed *et al*., 2006); in Swab River, 35.0 cm (Mohamed *et al.,* 2010); in Al-Huwazah marsh, 37.0 cm (Mohamed, 2014). It has been reported that there must be some differences between growth characteristics among species and localities (Nikolsky, 1963).

Analysis of stomach contents during this study indicated that *C. sublimus* was omnivorous, fed on a variety of food categories including algae, aquatic insects, macrophytes and snails, but tend to has 58.8% plant sources compared with 41.2% for the animal sources. Various authors studied the food habit of *C. luteus* in different parts of water bodies and reported its omnivorous (Al-Rudainy, 1989; Wahab, 2006; Salman *et al.*, 2007; Pazira and Vatandost, 2008; Amari *et al.*, 2012; Baboli *et al.*, 2013; Mohamed *et al.*, 2015). In contrast, other authors have been reported that *C. luteus* was herbivores species (Barak and Mohamed, 1982; Mohamed *et al.*, 2008; Lazem, 2009; Wahab, 2013; Mohamed, 2014; Al-Kaabi *et al*., 2017; Al-Jubouri and Mohamed, 2018). Mohamed and Hussain (2012) pointed out that *C. luteus* have the ability to alter their food habit according to food resources available in the environment.

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