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Some Biological Aspects of Four Fish Species in East Hammar Marsh, Iraq

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Abstract After inundation of the East Hammar marsh in April 2003, little information is available on the biological characteristics of commercial fish species inhabiting the marsh. Therefore, this study described some biological aspects of *Planiliza abu, Carassius auratus, Leuciscus vorax* and *Tenualosa ilisha* in the marsh from January 2009 to May 2010. Fish were caught by means of five types of fishing gears. The most dominant length groups observed were those of 6 to 13cm for *P. abu*, 11 to 21 cm for *C. auratus*, 17 to 38 cm for *L. vorax* and 8 to 11 cm for *T. ilisha*. Length-weight relationship of *P. abu* $W= 0.0143L^{2.934}$, *C. auratus* $W= 0.0135L^{3.085}$, *L. vorax* $W= 0.006L^{3.085}$ and *T. ilisha* was $W= 0.0082L^{3.006}$. The maximum age estimates were 4, 6, 8 and 5 years for the four species, respectively. The estimated von Bertalanffy growth constants were: $L\infty = 23.3$ cm, $K = 0.43$, *P. abu*; $L\infty = 41.5$ cm, $K = 0.26$, *C. auratus*; $L\infty = 65.0$ cm, $K = 0.21$, *L. vorax*; $L\infty = 57.0$ cm, $K = 0.33$, *T. ilisha*. The overall sex ratio was significantly different from 1:1 in favor of females for *P. abu* and *L. vorax*, and was insignificant for *T. Ilisha*, whereas, unbalanced in favour of females (1:14.8) in *C. auratus*. The monthly changes in GSI of *P. abu, C. auratus* and *T. ilisha* suggest that these species have protracted spawning periods, while *L. vorax* has a short spawning season.

Keywords Age and growth, reproduction, East Hammar marsh, Iraq

Introduction

East Hammar marsh is an extensive area of wetlands. It is located at the upper corner formed by the meeting of the Euphrates and Shatt Al-Arab Rivers and extends west to the oilfields of West Qurna. The Shatt Al-Arab flows southwards along the eastern edge of the marsh. After inundation in April 2003, the marsh received water mainly from the Shatt Al-Arab River. Therefore, it is a tidal marsh affected by semidiurnal tide from Arabian Gulf, so differs from other Iraqi marshes by the regular occurrence of marine fish species, in addition to pure freshwater species both native and alien [1]. According to a recent study, the fish assemblage of East Hammar marsh consists of 39 species belonging to 19 families, 11 of them were native, nine alien and 19 marine species [2].

The freshwater mullet or Khishni, *Planiliza abu*, is a mugilid that is endemic and widely distributed in the Tigris-Euphrates River basins [3] and crucian carp, *Carassius auratus* is a cyprinid exotic fish to Iraqi which was recorded for the first time by [4]. The freshwater fish *Leuciscus vorax*, is a native cyprinid which is found along the Euphrates and Tigris Rivers in Turkey, Syria and Iraq [3, 5-6], while hilsa shad, *Tenualosa ilisha*, belongs to the family clupeidae, locally known as 'sbour' in Iraq and other Arabian Gulf countries. Its geographical distribution extends from Shatt Al-Arab River, along the coasts of Iran, Pakistan, India, Bangladesh, and Burma to South Vietnam [7]. Mohamed A.R.M. & Qasim, A.M.H. [8] found that *T. ilisha* fishery contributed 90% of the total marine landings in Iraq during 1965-1973, decreased to 52.9% in 1991-1994, then to 30.7 % in 2000-2006 and to 18.9% in 2007-2011.

Some studies about age, growth and reproduction of the species under the present study have been done in the studied marsh before the draining of the marsh in the end of the last century [9-12]. After inundation the marsh in April 2003, published research papers dealt mostly with the fish species composition, such as [1-2, 13], but unfortunately few studies were detected dealing with the biological aspects of fish [14-15].

The objective of the present work is to determine length frequency distribution, length-weight relationship, age, growth and reproductive of four fish species *P. abu, C. auratus*, *L. vorax* and *T. ilisha* in the East Hammar marsh following six years of inundation.

Materials and methods

Samples were collected from three sites in the East Hammar marsh (Fig 1); Harer site, Salal site and Burkah site from January 2009 to May 2010. Fish were caught by means of different types of fishing gears; seine net (120m long with 25 and 100 mm mesh sizes), trammel net (150 m long with 30 and 40 mm mesh sizes), fixed and drifted gill nets (50 to 100 m long with 25 to100 mm mesh sizes), cast nets (6 to 9 m diameter with 25 and 40 mm mesh sizes) and electro-fishing by generator engines (provides 300-400V and 10A).

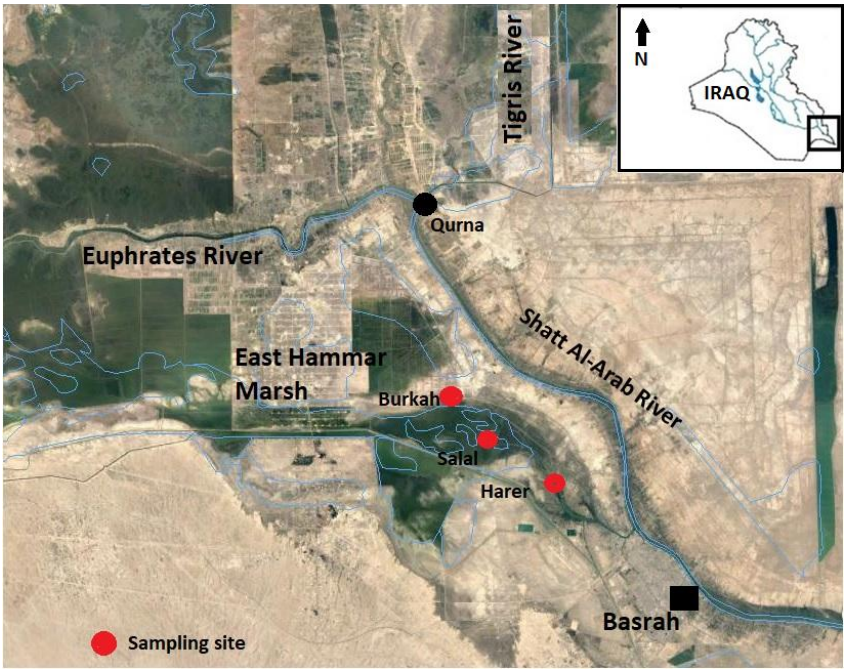

Figure 1: Map showing the location of sampling sites in East Hammar marsh

Total length (TL, cm) was measured to the largest possible number of fish in the field to construct the length frequency distribution for each species. Subsamples were collected from each species for the biological study. The samples obtained were measured to the nearest 0.1 cm total length (TL) on a measuring board and weighted to the nearest 0.1 g using electronic balance. The commonly used length-weight relationship $W = a\ L^b$ was applied [16], where W is the weight (g), L is the total length (cm), and a and b are constants. The allometric index value (b) obtained was compared to the expected value by using a t-test for allometry. All the calculations were done by using Microsoft Office Excel 2007.

For age determination, scales were used for ageing of *P. abu, C. auratus* and *L. vorax*, while opercula were adopted for aging of *T. ilisha.* Scales were removed from the left side of each fish between the lateral line and the dorsal fin base, cleaned in warm water and mounted dry between two slides for age determination by Projectina microscope (Type 4014 BK-2), 10X. From the magnified image of the scale, total scale radius and the distance between the focus and their respective annuli were measured [17]. The operculum of each fish was removed by scalpel, thoroughly cleaned with boiling water and examined under the dissecting microscope over a black background using reflected light. Annuli on opercula were considered to be the narrow transparent bands adjacent to the wide opaque bands [18].

The relationship between the length of fish at capture (L) and the radius of scale or operculum (S) was calculated from the equation: $L = a + bS$ [19], where a is the intercept (the correction factor) and b is the slope of the regression line. Therefore it was possible to back-calculate length-at-age using the equation: $L_n = a + S_n/S\ (L-a)$ described in [19]. 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 theoretical growth in length was analyzed by means of the von Bertalanffy equation: $L_t = L_\infty(1 - e^{-K\,(t-to)})$, where L_t is the fish length at age t, L_∞ is the asymptotic fish length, K is the growth coefficient and t_o 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 each species by means of Beverton and Holt method [16].

Each fish was sexed by macroscopic examination of the gonads, which were removed and weighed (g). The overall sex ratio was determined. A Chi-squared test was used to examine the homogeneity of the sex ratio. The spawning period was determined by means of the monthly changes in the gonadosomatic index (GSI) as follows [20]: GSI= Gonad weight / Total body weight × 100.

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

Results

A total of 47 fish species belonging to 35 genera and 20 families were collected from the marsh, including 24 freshwater and 23 marine species. *P. abu* and *C. auratus* were the most abundant species in the East Hammar marsh represented by 14.8 and 13.1% of the total catch, respectively, while *T. ilisha* and *L. vorax* comprised 6.1 and 3.7%, respectively.

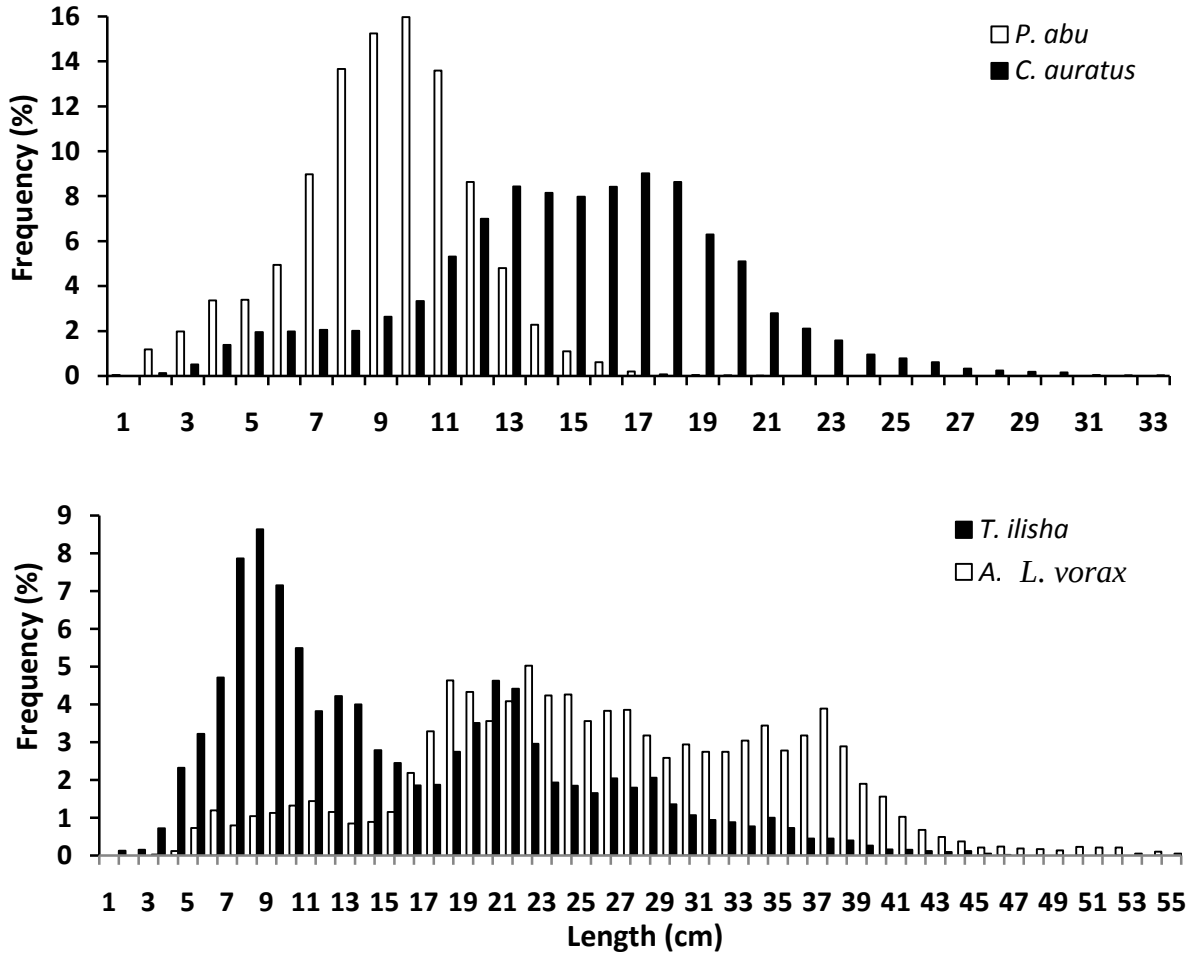

Figure 2: The overall length frequency distribution of the study species in East Hammar marsh

Length frequency distributions

The length-frequency data for each species were pooled from different sampling sites and subsequently grouped with one cm class intervals for analysis (Fig 2). A total of 23131 *P. abu*, 20331 *C. auratus*, 5751 *L. vorax* and 9533 *T. ilisha* were caught. Lengths of *P. abu* ranged from 1.4 to 21.3 cm, and the most dominant length groups observed were those of 6.0 to 13 cm representing 85.8% of the total number. Sizes of *C. auratus* ranged from 2.3 to 34.5 cm, and the length groups (11.0 to 21.0 cm) were prevailing formed 74.4%. Length range of *L. vorax* includes sizes from 3.7 to 55.6 cm, with fish of 17.0-38.0 cm dominating the catch forming 78.1% of the species catch. Lengths of *T. ilisha* from 2.3 to 47.7 cm were represented in the samples, and the dominant length groups were 8.0 to 11 cm (29.2%).

Length-weight relationships

The length–weight relationships for the four fish species are illustrated in Figure 3. Length-weight relationship of *P. abu* $W= 0.0143L^{2.934}$, *C. auratus* $W= 0.0135L^{3.085}$, *L. vorax* $W= 0.006L^{3.085}$ and *T. ilisha* was $W= 0.0082L^{3.006}$. In terms of growth type, *P. abu*, *C. auratus* and *L. vorax* showed allometric growth (t= 6.98, 7.07 and 6.42, respectively, P<0.05). An isometric growth was observed for *T. ilisha* (t= 0.73, P>0.05). All length–weight relationships were highly significant (P< 0.001), with r^2 values being >0.98.

Age and growth

The maximum age estimates determined from scales or opercula were 4, 6, 8 and 5 years for *P. abu, C. auratus, L. vorax* and *T. ilisha*, respectively. Linear relationships have been observed between total fish length and scale or operculum radius for all species, which reflects the high degree of correlation between these two parameters (r^2 = 0.937 to 0.986). The values of the correction factor (the intercept) were 1.6, 2.2, 1.1 and 3.9 for *P. abu, C. auratus, L. vorax* and *T. ilisha*, respectively.

Table 1 represents the average lengths of four species at each annulus as determined by back calculation of lengths from the species of different ages. The maximum annual increments are found to occur in first year of life for all species. The percentage annual increment varied from

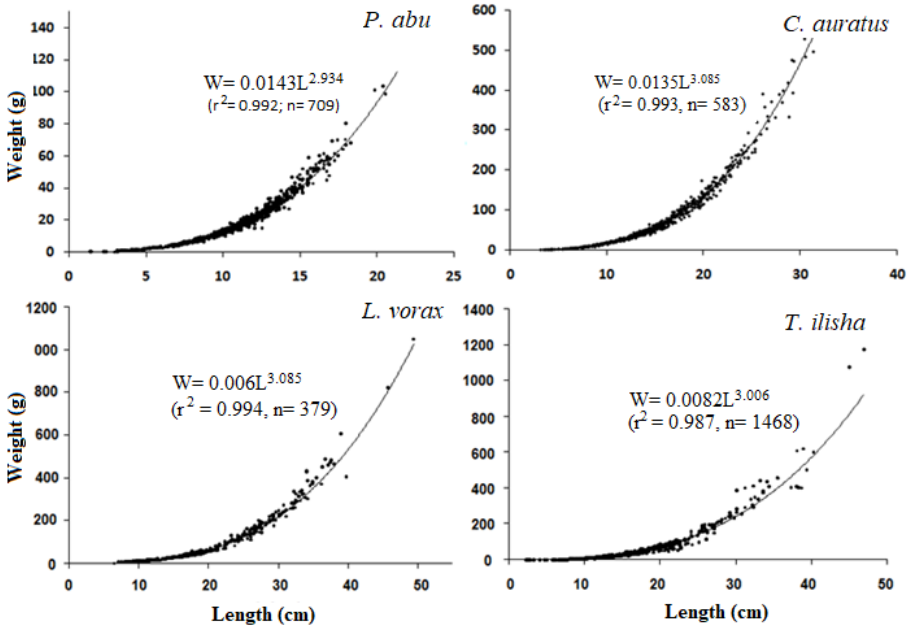

Figure 3: The length-weight relationships of the study species in East Hammar marsh

53.4% for *P. abu* to 30.7% for *L. vorax* (Table 1). The estimated von Bertalanffy growth constants were: $L\infty$ = 23.3 cm, K = 0.43, t_0 = -0.361, *P. abu*; $L\infty$ = 41.5 cm, K = 0.26, t_0 = -0.142, *C. auratus*; $L\infty$ = 65.0 cm, K = 0.21, t_0 = -0.244, *L. vorax*; $L\infty$ = 57.0 cm, K = 0.33, t_0 = -0.03, *T. ilisha*.

Table 1: Summary of back calculated length (cm), standard error (±SD) and the annual increment (%) of the study species.

Species	No. of fish		Mean length (cm) at age							
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
P. abu	66	Length	10.6	14.7	17.8	19.8				
		±SD	0.031	0.044	0.090	-				
		%	53.4	20.8	16.0	9.8				
C. auratus	99	Length	11.0	17.5	23.1	27.4	30.4	33.2		
		±SD	0.042	0.040	0.015	0.085	0.057	-		
		%	33.0	19.7	16.9	12. 9	9.0	8.5		
L. vorax	109	Length	16.4	24.5	31.2	37.4	42.5	47.2	50.8	53.5
		±SD	0.038	0.131	0.104	0.159	0.098	0.148	0.134	-
		%	30.7	15.2	12.6	11.6	9.4	8.8	6.7	5.1
T. ilisha	95	Length	17.4	27.1	35.5	41.3	46.1			
		±SD	0.132	0.179	0.156	0.100	-			
		%	35.4	23.4	18.2	12.6	10.5			

Sex ratio and gonado-somatic index (GSI)

The overall sex ratio (males: females) of *P. abu* was 1:1.45 (399/579), which significantly differed from the expected 1:1 (X^2 = 33.1, p<0.001). The ratio between the sexes of *C auratus* proved to be extremely unbalanced; 74 male specimens (6.31%) were observed, as against 1098 females (93.69%); the sex ratio was therefore 1:14.8 (X^2 = 894.7, p<0.001). There were 33 males (38.24%) and 333 females (61.76%) for *L. vorax*, the sex ratio (1:1.62) deviated significantly from 1:1 (X^2 = 42.1, p<0.001). The ratio of males to females of *T. ilisha* was 1:0.85 (246/209), the difference was not statistically significant (X^2 = 3.0, p<0.05).

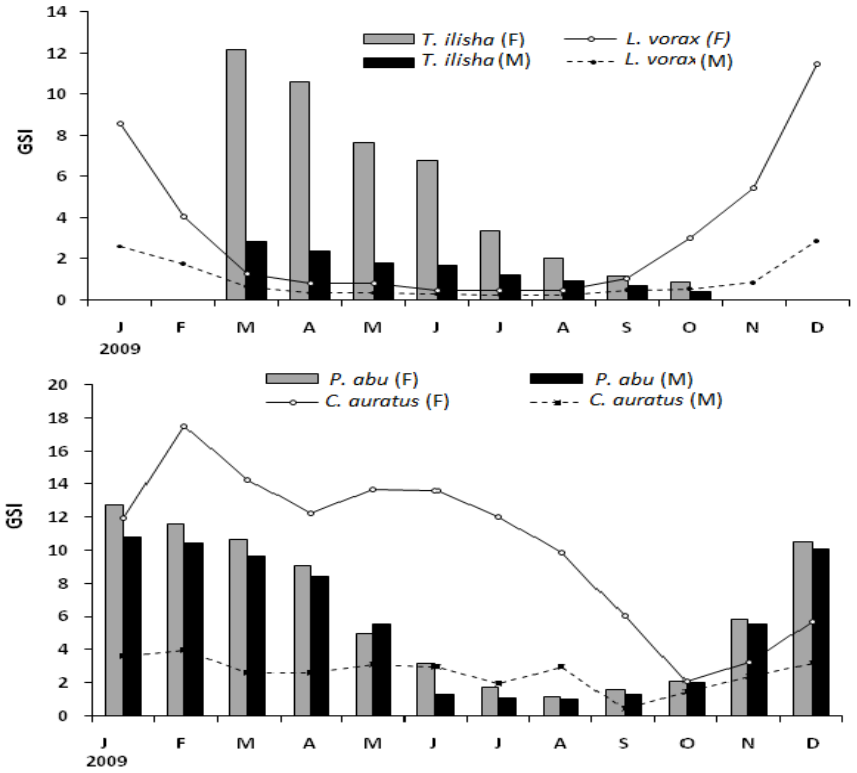

Figure 4: Monthly variations in GSI of the study species in East Hammar marsh

The monthly variations in the gonado-somatic index (*GSI*) values for all species are shown in Figure 4. The highest value of *GSI* for females of *P. abu* was 12.77% in January, gradually decreased thereafter to the lowest value of 1.19% in August. A similar pattern was found for males, with peak at 10.82% in January and the lowest at 0.99% in August. A gradual increase in the *GSI* of *C. auratus* for both sexes was recorded in December through January, while the maximum values were 17.48% for females and 3.91% for males recorded in February. The minimum values were observed in September for males and October for females. The highest

values of *GSI* for both sexes of *L. vorax* were observed in January, 8.55% for females and 2.17% for males. The lowest values of *GSI* were found in July for both sexes. Unlike other fish species, the mature specimens of *T. ilisha* were available only for eight months, March to October. Therefore, the *GSI* of females showed peak in March (12.17%), then gradually declined to its lowest value (0.89%) in October. The pattern of changes in *GSI* of males was almost similar to that of females.

Discussion

The results revealed that the length ranges of *P. abu*, *C. auratus* and *L. vorax* in the present study were almost similar to those recorded for these species in the southern marshes after inundation [21, 22, 15], except *T. ilisha*. The length range of *T. ilisha* was wider than those reported previously in East Hammar marsh after inundation in 2003. [13] found that the length range of this species in the marsh ranged from 3 to 13 cm, and a length of 6 cm dominated the catch during 2005-2006 and the species exploited the marsh for nursery and feeding activities. During the last years the structure of fish assemblage of the marsh has been altered due to impact of marine waters progress from Arabian Gulf as a result of the low waters flow into the Shatt Al-Arab River from the Tigris and Euphrates Rivers [2], and the diversion of the Karun River, away from the Shatt Al-Arab River [23] pushing adult individuals of *T. ilisha* and other marine species to enter East Hammar marsh for spawning, after it has been exploited by the species for nursery and feeding activities.

The values obtained for the weight–length relationship showed that *P. abu*, *C. auratus* and *L. vorax* were allometric in their growth, while *T. ilisha* was positively isometric. Several authors have reported both isometric and allometric growth for different fish species from various water bodies. The values of slope coefficient (*b*) for *P. abu* varied from 2.08 to 2.870 in Atatürk Dam Lake, Turkey [24], from 2.662 to 3.190 in southern marshes, Iraq [25] and 3.269 in Tigris River, Iraq [26]. For *C. auratus*, the *b* value was reported to be 2.89 in Euphrates River, Iraq by [27], 3.062 in Lake Trasimeno, Italy by [28], 2.987 in East Hammar marsh, Iraq by [15] and 3.092 in Tigris River, Iraq by [26]. For *L. vorax*, the *b* value was 3·060 in Habbaniyah Lake, Iraq [29], 2.430 for males and 2.905 for females in Atatürk Dam Lake, Turkey [5], 3.130 in Euphrates River, Syria [6], 2.971 in Karakaya Reservoir, Turkey [30], 3.03 in the Shadegan Wetland, Iran [31] and 2.986 in Tigris River, Iraq [26]. The value *b* for *T. ilisha* was reported to be 2.961 for Hooghly estuary, 2.880 for River Meghna, 2.534 and 2.957 for Indus River, 2.968 for Khuzestan Province and 3.268 for Shatt Al-Arab Estuary [32-35, 8]. These variations could be attributed to differences in size range of fish, degree of stomach fullness, sex, age, health, major change in environment factors and stage of maturity [16, 19, 36].

Asymptotic length ($L\infty$) of *P. abu* was comparable to those in other Iraqi waters, 23.8 cm in Tharthar Lake [37] and 23.2 cm in East Hammar marsh [25], although is lower than the value (24.6 cm) recorded for the species in Atatürk Lake, Turkey [24]. The value of $L\infty$ of *C. auratus* was better than that recorded for the species in the same marsh (32.6 cm) during 2005-2006 [15] and similar to that recorded for the species (43.0 cm) in Trasimeno Lake, Italia [28]. $L\infty$ value of *L. vorax* determined in the present study was lower than that of Habbaniyah Lake, 91.0 cm [29], in Tharthar Lake, 145.5 cm [38], in Atatürk Dam Lake, 158.4-218.5 cm [5] and 92.7 cm in Karakaya Reservoir [30]. $L\infty$ of *T. ilisha* in the study marsh was slightly lower than those recorded for the species in the Iraqi marine waters, 60.5cm [39] and 61.5cm [8], and better than those recorded in the Iranian waters, 43.3 cm [40] and 42.7 cm [35] and Indian waters, 47.8 cm [41]. It has been reported that there must be some differences between growth characteristics among localities as a result of diversity and availability of dietary items, hydrographical and climatic conditions [42, 43].

The overall sex ratio was significantly different from 1:1 in favour of females for *P. abu* and *L. vorax,* whereas, insignificant for *T. Ilisha.* Similar results were observed for *P. abu* by [10] in Al-Hammar marsh, [44] in the Tigris River, Turkey, [45] in the Khozestan Province, Iran, [46] in the Orontes River, Turkey. The overall sex ratio in *C. auratus* was unbalanced in favor of females and the species was characterized by a protandric hermaphroditism. The predominance of females and hermaphroditism are common in *C. auratus* populations and confirmed by the relevant literature [47, 48, 28, 49, 50]. [5, 30] observed the dominance of males to females of *L. vorax* in the Atatürk Dam Lake and the Karakaya Reservoir, Turkey. Overall sex ratio of *T. ilisha* in the present study was slightly in the favour of males, being 1:0.85. This situation was similar to that reported for *T.*

ilisha in Shatt Al-Arab River, 1:0.92 [51] and in Pakistan waters, 1.1:1 [34], but it was different from that reported by some investigators from Kuwaiti waters, 1:2.4 [52] and Iraqi marine waters, 1:1.24 [8]. Although the sex ratio in most of the species was close to one, this may vary from species to species, differing from one population to another of the same species, and may vary year after year in the same population [42].

The spawning season was deduced from the monthly peak values of the *GSI* of the female species. The drop in the values of the *GSI* was associated with the release of eggs as a result of spawning. The monthly changes in *GSI* of *P. abu*, *C. auratus* and *T. ilisha* suggest that these species have protracted spawning periods, while *L. vorax* has a short spawning period. The spawning period of *P. abu* in the present study extended from January to May. [53] found that the spawning of *P. abu* in Tuz-Chi tributary, north Iraq occurred from March to May and in the Khozestan Province, Iran extended from February to June [45]. Meanwhile, spawning season of *P. abu* from the Atatürk Dam Lake occurred in May [54] and from the Orontes River, Turkey in April to August [46]. Analyses of the *GSI* showed that the reproductive period of *C. auratus* in present study extends over an ample time period, from March until September. Similar result was observed for this species by [15] in the same study area. [28] mentioned that spawning of *C. auratus* in Lake Trasimeno, Italy occurred from March to June and suggested that it is multiple spawned. The monthly changes in *GSI* of *L. vorax* in the present study concluded that the spawning season was short and took place in January. Similar finding was observed for this species by [29] in Habbaniya Lake. Meanwhile, spawning season of *L. vorax* started in April and last until May in Atatürk Dam Lake, Turkey [5]. The spawning season of *T. ilisha* in the study marsh started in March and extended to September. [55] noted a long spawning season with two peaks for spawning in Shatt Al-Arab River, the first was during March-May and the second was from July to August, while [51] mentioned that the spawning season of *T. ilisha* in the same river was extended from March to October. [34] reported that the spawning season in *T. ilisha* was from May to October in Pakistan waters. Spawning periods of fish vary with respect to their species; the ecological characteristics of fish are determined by such ecological differences as stagnant or running water, as well as altitude, temperature and quality of food [42].

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