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Observations on some reproductive features of *Carasobarbus luteus* (Heckel, 1843) from the Shatt Al-Arab River, Southern Iraq

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Abstract - The present study was conducted from December 2013 to November 2014 to investigate the reproductive features of Himri *Carasobarbus luteus* in the Northern reaches of Shatt Al-Arab river in Southern Iraq. The samples were collected using seine, gill, cast nets as well as electrofishing. A total of 351 specimens from himri were caught but only mature individuals were chosen to estimate the absolute and relative fecundity and egg diameters. The results of the present research revealed that the highest GSI values were recorded in male and female (4.63 and 11.99) during the April month. Absolute fecundity was increased with length, weight and gonads weight, and it was ranged as 2098 eggs for 131 mm total length and 35 g weight to 14147 eggs for 209 mm total length and 131 g weight. Relationship between length, weight and reproductive parameters were highly significant. A highest relative condition factor of females (1.24) was calculated in March 2014.

Keywords: *Carasobarbus luteus*, Electrofishing, Reproduction features and Shatt Al-Arab river.

Introduction

Fecundity represents the total number of advanced matured yolked oocytes per female that will be released during spawning season. It is specific species and affected by different factors such as length, weight, size, types of species, food availability and ecological factors (Nikolsky, 1963; Murua *et al*., 2003).

The success of reproduction depends on passing genes to the next generation, the capacity of new offspring to attain maturity and recruiting of new individual (Clutton-Brock, 1988; Caswell, 2001). Although, ecological and biological constraints have strongly influences the fecundity, factors as female size, absolute fecundity, eggs weight and pattern of spawning can limit production of the hydrated oocytes during spawning season (Lambert *et al.*, 2003; Lambert, 2008). The volume of body cavity that limits the reproduction potential at spawning season was reflected by the correlation between the number of eggs and fish size. Meanwhile, the potential fecundity was strongly related to body size (Wootton, 1999). Therefore, female size could explain 25-98 % of the variability in potential fecundity of different freshwater and marine fish species (Kamler, 2005).

Few studies on the biology of *C. luteus* were conducted in Iraq and investigated the reproduction cycle of the fish species (Bahatti and Al-Daham, 1978; Al-Daham and Bahatti, 1979; Ahmed *et al*., 1984; Elper *et al.*, 1996).

The present study was aimed to assess the fecundity, gonadosomatic and some relationships between morphometric and reproductive parameters of *C. luteus* in some natural freshwaters ecosystems of Southern Iraq.

Materials and Methods

A total of 351 specimens were caught monthly from December 2013 to November 2014. Sampling was conducted at three stations (Fig. 1). Station 1 was situated at the upper reaches of the Shatt Al-Arab river, north of Qurna (N 31° 01′ 42.24″, E 47° 26′ 0.96″); Al-Sweeb was the station 2 (N 30° 58′ 40.8″ E 47° 28′ 23.52″) and Al-Shafii was the station 3 (N 30° 51′ 20.16″ , E 47° 32′ 16.8″).

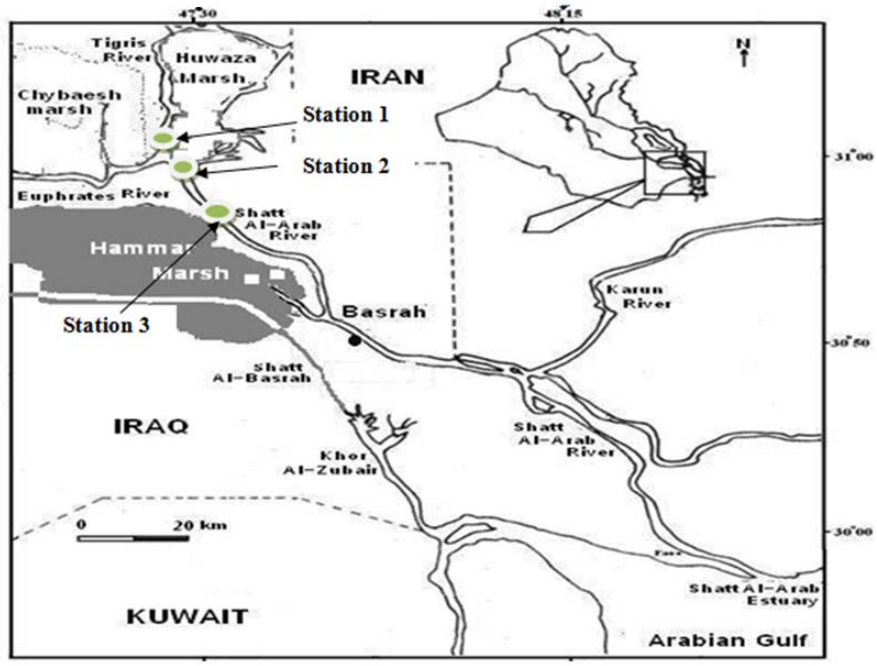

Figure 1. Map of sampling area.

Fishes were caught by means of seine, gill, cast nets and electrofishing. Different mesh size and length (18-30 mm and 80-120 m, respectively) of gill nets were used during the sampling period. Fish samples were kept in ice-box and transported to laboratory. Total length (TL) was measured to the nearest 1.0 mm, total weight (W) was measured to the nearest 0.1 g and gonads weight (GW) was measured to 0.01 g of mature individuals. Fish identification was done according to Coad (2010).

Gonadosomatic Index (GSI):

Spawning time was determined by monitoring the development of gonads (male and female) through calculation of gonadosomatic index (GSI) by following the formula suggested by Lagler (1966).

$$GSI\ \% = GW/W*100$$

Where, GW represents the gonads weight (g), while W was the body weight (g). Only fish with ripe gonads were chosen and placed in the Gilson's fluid (modified by Simpson, 1951).

Absolute (AF) and relative fecundity (RF):

Containers with tissue were agitated few times to release eggs from the tissue. Free eggs in fluid were washed with distilled water until water became clear, filtered through filter papers and dried (Bagenal, 1966). Number of eggs (using dissecting microscope) and weight of three replicate of sub-samples were measured to nearest 0.01 g.

AF=Mean number of egg in subsamples/weight of subsample*weight whole eggs

Number of eggs per gram (Relative fecundity) of fish body was estimated as in the equation proposed by Bagenal (1978).

$$RF=AF/Weight$$

Statistical relationships of morphometric and reproductive parameters have been extracted by applying the formula given by Nikolsky (1969).

$$Y= a\ x^b \quad i.e., Log\ Y=loga+ blogx$$

This equation represented the best application of the relations between the morphometric and biological parameters. From the weight-length relationship, the calculated weight was derived for each length groups as to the following:

$$W^{\wedge}= a\ X^b$$

Where W^ is the calculated weight (g), X is the total length, "a" and "b" are constants.

The relative condition factors (Kn) were calculated by using the formula of Le Cren (1951).

$$Kn = W/W^{\wedge}$$

Where, W is observed weight and W^ is calculated weight.

Average diameters of eggs were measured in two dimensions of each Oocyte using objective micrometer (micron). Statistical analysis was conducted to determine the correlation coefficient which was performed using statistical software SPSS (version, 17).

Results

Male gonadosomatic index (GSI) was increased gradually from December 2013 (2.22) to its peak in April 2014 (4.63), and then declined towards September 2014 to 0.78. Whereas 2.17 in December, the highest GSI value for female (11.99) was recorded in April 2014 and then declined to 0.14 in September (Fig. 2). Significant differences ($P<0.05$) in GSI values were found between females and males (Sig.=0.012, F= 7.436).

Morphometric and reproductive parameters of female *C. luteus* fish *viz*., total length (TL), absolute fecundity (AF), fish weight (W), gonad weight (GW), relative fecundity (RF) and fish egg diameter (Egg D) collected from Shatt Al-Arab river was studied during the study period from December 2013 to November 2014 and the findings were presented in Table (1).

The results of Table (1) showed that the fecundity was increased with length, weight and gonad weight of the fish. The fecundity was ranged from 2098-14147 eggs per female for average total length 131 ± 10.50 to 209 ± 9.99 mm and average weight 35 ± 15.73 t0 131 ± 6.50 g (Table 1). Values of the reproduction indicators were fluctuated evidently during the period of study which was ranging from 9.06 µ to 13.87 µ, 42.94 µ to 107.99 µ and 607 µ to 912 µ for gondosomatic index, relative fecundity and egg diameter respectively (Table 1). Monthly variations in gonadosomatic index (GSI) of *C. luteus* collected from Shatt Al-Arab river was studied in this present research during December 2013 to November 2014 and the results were given in Figure (2).

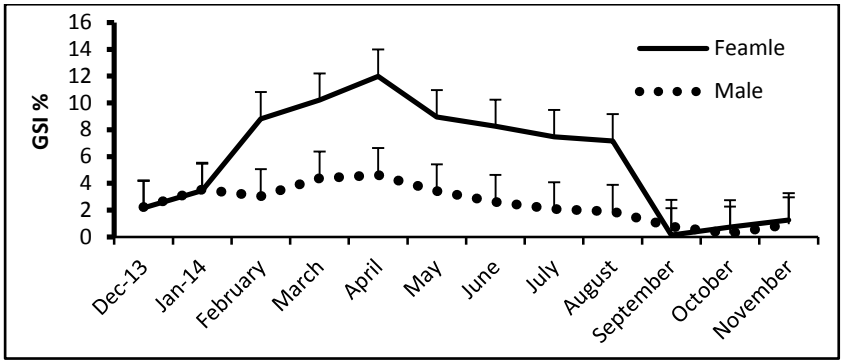

Figure 2. Monthly variations in gonadosomatic index (GSI) of *C. luteus*, collected from Shatt Al-Arab river during December 2013 to November 2014.

Table 1. Morphometric and reproductive parameters of female *C. luteus* fish total length (TL), absolute fecundity (AF), fish weight (W), gonad weight (GW), relative fecundity (RF), fish egg diameter (Egg D) collected from Shatt Al-Arab river during the period from December 2013 to November 2014.

TL (mm)	W (g)	GW (g)	AF	RF	Egg D (µ)
131	35	4.81	2098	59.94	607
137	39	5.42	2431	62.34	790
152	68	6.16	3018	44.38	811
156	73	7.19	3113	42.94	819
159	76	7.61	3638	47.87	710
162	82	8.19	5016	60.92	834
176	89	10.62	7876	89.00	933
181	94	12.29	8061	85.76	874
187	106	13.65	8360	78.87	840
190	119	13.55	8419	70.75	891
197	123	14.31	11552	93.92	895
209	131	15.37	14147	107.99	912
Mean 170	86.19	9.93	6477	70.46	826
S.D 24.12	30.72	3.80	3877.62	20.94	92.16

The Figure (2) showed a highly positive significant correlation coefficient (r) (r=0.98) which was calculated between absolute fecundity and total length (Table 2), and the relationship can be expressed as:

Log AF = - 5.937 + 4.3458 log TL

Where, AF = absolute fecundity and TL = total length (mm).

The correlation coefficient (r) between absolute fecundity and gonads weight was strong positive (r=0.98). The relationship can be expressed as:

Log AF= 2.2483+ 1.5392 log GW

Where GW=gonad weight (g).

A highly strong positive correlation coefficient (r) (r=0.97) was found between weight and total length. The relationship can be expressed as:

Log W= - 4.3615 + 2.8157 log TL

Where W= weight (g) and TL = total length (mm).

Strong positive correlation coefficient (r) was found to be (r=0.92) between absolute fecundity and weight. The relationship can be expressed as:

Log AF= 1.0584+ 1.4048 log W

Where W= weight (g).

Moderate positive correlation coefficient (r) was found to be 0.78 (r=0.78) and it was observed between absolute fecundity and egg diameter. The relationship can be expressed as:

Log AF= - 8.4225+4.1712 log egg D

Where, egg D = egg diameter.

The range and mean of total length and weight, and values of relative condition factor (Kn) of female of *C. luteus* collected from Shatt Al-Arab river was studied during the period from December 2013 to November 2014 and the results were furnished in Table (3).

The Table (3) showed that the minimum relative condition factor (0.73 ± 0.0611) was calculated in December 2013. Whereas, the maximum value was measured in March 2014 (1.24 ± 0.0680). The recorded minimum and maximum mean values of total length were 148 mm in July 2014 and 186.50 mm in August 2014 respectively. However, the lowest mean of weight (47.00 ± 19.08 g) was observed in March 2014 and the highest (95.00 ± 43.53 g) was recorded in August 2014.

Table 2. The relationship between some of morphometric and reproductive parameters of *C. luteus* females collected from Shatt Al-Arab river during the period from December 2013 to November 2014. (Abscissa (x); Y-intercept (a); slope (b); correlation coefficient (r); other symbols as in Table (1); *= significant at 1 % level).

Relationship		A	b	R
Y	X			
Absolute fecundity	Total length	-5.93	4.34	0.98*
Absolute fecundity	Weight	1.05	1.40	0.919*
Absolute fecundity	Gonads weight	2.24	1.53	0.98*
Absolute fecundity	Egg diameter	-0.8420	4.17	0.78*
Weight	Total length	-4.36	2.81	0.97*

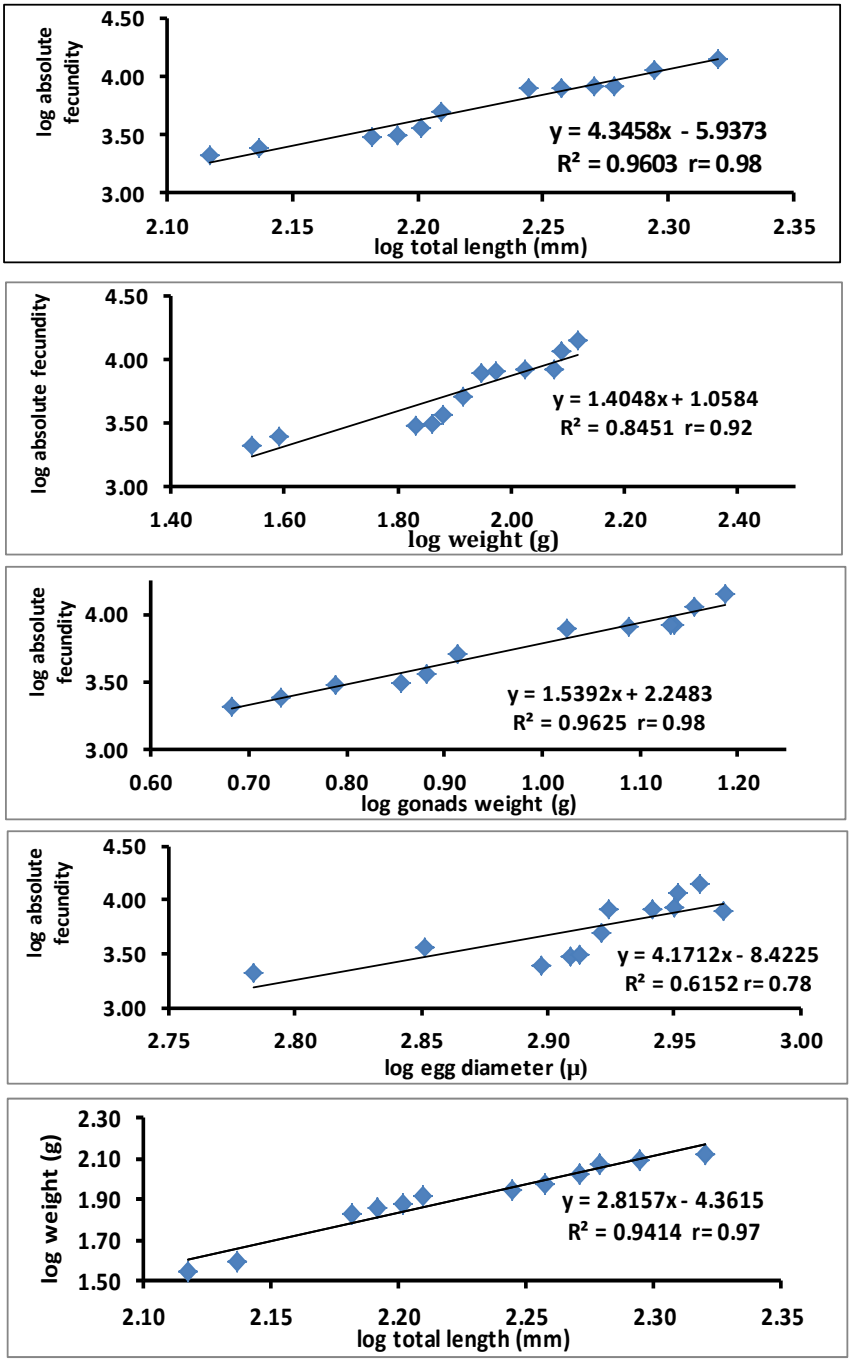

Figure 3. Relationship between absolute fecundity (AF) and total length, weight, gonads weight, egg diameter, weight and total length of *C. luteus* collected from Shatt Al-Arab river during the period from December 2013 to November 2014.

Table 3. Range and mean of total length and weight, and values of relative condition factor (Kn) of female *C. luteus* collected from Shatt Al-Arab river during the period from December 2013 to November 2014.

Month	Fish No.	Total length(mm)		Weight (g)		Kn
		Range	Mean	Range	Mean	
Dec. 2013	6	134-186	164.60 ± 19.40	31-79	62.40 ± 19.14	0.73 ± 0.0611
Jan. 2014	5	144-190	168.40 ± 12.44	52-94	75.80 ± 15.05	1.04 ± 0.0816
Feb. 2014	7	129-215	167.50 ± 35.52	29-82	61.75 ± 23.04	1.16 ± 0.2539
Mar.2014	8	139-165	150.60 ± 19.58	33-66	47.00 ± 19.08	1.24 ± 0.0680
Apr.2014	6	127-209	167.00 ± 27.96	25-125	67.33 ± 33.73	0.94 ± 0.0801
May 2014	5	136-203	169.83 ± 30.41	37-136	78.00 ± 40.48	0.90 ± 0.0625
June 2014	8	110-176	154.00 ± 20.73	19-87	56.71 ± 20.34	0.95 ± 0.0447
July 2014	9	115-176	148.00 ± 23.03	19-78	47.40 ± 22.14	1.00 ± 1.6307
Aug. 2014	7	160-229	186.50 ± 24.46	53-176	95.00 ± 43.53	0.99 ± 0.0937
Sep. 2014	6	136-180	157.80 ± 22.09	27-68	50.20 ± 18.17	1.09 ± 0.1290
Oct. 2014	11	163-189	171.33 ± 9.39	55-94	69.00 ± 14.21	0.88 ± 0.0844
Nov. 2014	10	99-204	158.50 ± 44.17	12-111	62.75 ± 40.97	0.95 ± 0.0548

Discussion

Gonadosomatic index and fecundity of fish species are fundamental parameters for stock assessment of commercial fishes, culture and fishery management (Rahimibashar *et al.*, 2012). Occurrence of several length groups at different maturity stages proved that the spawning take place at the shallow banks of the river that sheltered dense submerged vegetation which were used by the fish to lie their eggs, feeding, nursery and protection from predators. Gonadosomatic index was a valuable factor used by scientists to determine the development of the gonad relative to total weight of fish body and forecasting time of spawning. The results of the present study showed that the GSI values attain its peak in April 2014 (Fig. 2) for females which was in accordance with pervious works of Bhatti and Al-Daham (1978); Ahmed *et al.* (1984); Al-Hazzaa (2005) and Baboli *et al.* (2013). However, our results of the present research showed that the male maturation was observed in the April month which was highly differed from the results of previous investigations. Al-Daham and Bhatti (1979) found that the spawning period of *C. luteus* was observed between May and July in the lower reaches of Euphrates river. Whereas, Epler *et al.* (1996) reported that the spawning of this species was noticed between June to July in some Iraqi freshwater lakes. This could be due to the variation in habitat and spatial distribution of *C. luteus* population (Baboli *et al.*, 2013).

The Figure (3) showed that the fecundity was increased with increasing length, weight and gonad weight which was concured with other studies (Nikolsky, 1963; Ahmed *et al.*, 1984; Al-Hazzaa, 2005; Najim *et al.*, 2012). The variation in fecundity among the fish of the same species was a common phenomenon and fluctuates from years to another (Nikoliky, 1963). High fecundity refers to high mortality, so the number of eggs released in the breeding season depends on reproductive strategy and spawning patterns.

Fishes live in open water could produce higher number of eggs when compared with those in built nests as well as in Ovovivi-parus or Vivi-parus species which are characterized by large size and more parental care (Murua *et al*., 2003).

In the present study, all reproductive parameters have a significant relations at 0.01 level (Table 2). A high and moderate level of correlations were found between morphometric and reproductive parameters which were influenced by total length, weight, condition factor, food availability, environment, biomass and spawning method (Nikolsky, 1963). The present investigation revealed a compatible trend of statistical relation between the length and weight of fish with previous reports on the *C. luteus* and other species from the same family (Ahmed *et al*., 1984; Al Hazzaa, 2005; Al Mukhtar *et al*., 2006; Najim *et al*., 2012). Egg size play an important role for enabling fish larva to pass the critical period during their feeding on the yolk sac. Therefore, eggs size participate in success of the reproductive strategy of species (Lo *et al.*, 2009; Serezly, 2010).

Relative condition factor refers to the healthy, fitness and feeding intensity which could be increased with the increasing weight of fish. Fluctuation in condition factor in fish population could be attributed to their reproductive cycle, feeding, physiochemical factors, age and physiological status (Kalita and Jayabalabn, 1979; Narejo *et al*., 2002).

The results of the present investigation showed that the maximum value of relative condition factor of *C. luteus* female was attended in March 2014 due to gonad development (Table 3). Although, the values of condition factors are in consistence with the results given by Baboli *et al.* (2013). However, distinction in timing of peak value might be the result of geographical and environmental differences. Also, the decline in relative condition factors during April 2014 enhanced the results of GSI and lead to spawning at the same month (Ahmed *et al*., 1984). It could be concluded that there was one peak of spawning for this high food value species, and the shallow submerged vegetation areas of river banks represent a reproduction ground and the presence of all age stages at sampling sites confirm this conclusion.

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ملاحظات لبعض الصفات التكاثرية للحمري (Heckel,1843) *Carasobarbus luteus* من شط العرب، جنوب العراق

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المستخلص - أُجريت الدراسة للمدة من كانون الأول 2013 إلى تشرين الثاني 2014 لمعرفة بعض الصفات التكاثرية للحمري *Carasobarbus luteus* في المقتربات الشمالية لشط العرب. جمعت العينات بوساطة شباك الكرفة والنصب والسلية والصيد الكهربائي. صيدَ 351 نموذجاً وإختيرت الأفراد الناضجة فقط لتقدير الخصوبة المطلقة والنسبية واقطار البيوض. أوضحت النتائج بأن أعلى القيم لدليل دالة المناسل GSI (4.63 و 11.99) للذكور والأناث في نيسان، وتزداد الخصوبة المطلقة بزيادة الطول والوزن ووزن المناسل وتراوحت من 2098 بيضة لطول كلى 131 مليمتر ووزن 35 غم إلى 14147 لطول كلي 209 مليمتر ووزن 131 غم. كانت العلاقات بين الطول والوزن ومقاييس التكاثر الأخرى ذات معنوية عالية. سجلت أعلى قيمة لمعامل الحالة النسبي Kn (1.24) في آذار 2014.