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Reproductive Characteristics of *Leuciscus vorax* (Heckel, 1843) from Al-Huwaiza Marshes Southern Iraq

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Abstract A total of 114 (76 female and 38 male) specimens of Shelig *Leuciscus vorax* were monthly collected from Al-Huwaiza marsh southern Iraq from November 2016 to October 2017. The samples were caught utilizing gill net and electrofishing. The highest values of gonadosomatic index (GSI) were found in February (18.35 and 5.33 for female and male respectively). Only mature individuals of *L. vorax* female were used to estimate absolute-relative fecundity and measure eggs diameters of very ripe gonads. Absolute fecundity ranged from 77612 eggs at 56 cm in total length (1672 g) body weight to 378391 eggs 79.5 cm in total length and (5001 g) boy weight. Highly significant differences relationships were observed among to total length, body weight and reproductive parameters. The relative condition factor differs from 0.85±0.11 in October to 1.37±0.09 in June. The results showed one spawning peak on reproductive strategy of represented species, which is preceding other species of fish to enables the small fish of *L. vorax* feeding on larvae and other small fish species in assemblage.

Keywords *Leuciscus vorax*; Reproductive characteristics; Huwaiza marsh; Southern Iraq

Background

The *Leuciscus vorax* is highly commercial native cyprinid species inhabit Euphrates–Tigers Rivers, and is the only representative of this genus in the Tigris and Euphrates Basin (Coad, 2010; Oymak et al., 2011).

The reproduction is an important stage in life of organism in order to preserve the survival and continuity of the species. Understanding of reproductive strategies of fishes and the evaluation of fecundity are indispensable themes in the investigation of the biology furthermore assemblage dynamics of fish species (Hunter et al., 1992). The study of reproduction biology have a high benefits in fishes resource management and develop laws that regulate their properly investment, although our fish stocks are constantly deteriorating due to several factors: overfishing, pollution, lack of water discharges, fragmentation of environments and an increase in the number of exotic introduce species (Dudgeon et al., 2006).

Fecundity, usually refers to potential annual fecundity, its specific to species and can be defined; the number of ripe eggs that laying per female of fish during one spawning season (Murua et al., 2003), which differ from few eggs to millions in some species that spawn fish laying their eggs in open water on an annual basis. However; fecundity are inversely related with the amount of parental care among species in reproductive traits: Viviparous fishes have lower fecundity than ovoviviparous fishes, which in turn have lower fecundity than oviparous fishes, and nest builders have lower fecundity than pelagic spawners (George, 1981).

Due to the lack of studies in southern Iraq on this economic species, this study was executed.

Several studies have been done on reproductive feature of *L. vorax* in Euphrates-Tigris Rivers Basin (Shafi and Jasim, 1982; Ali et al., 1986; Al-Dabical and Al-Daham, 1995; Epler et al., 2001; Szypuła et al., 2001; Al-Selah et al., 2010; Al-Tameemi et al., 2010; Oymak et al., 2011; Al-Saleh et al., 2012; Duman and Gül, 2013).

The aim of this study was to acquire insights on such Gonadosomatic index (GSI), Absolute fecundity, Relative fecundity and condition factor. The information obtained from this study could reinforce the knowledge of the reproductive biology of *L.vorax* collected from Al-Huwaiza marshes South of Iraq.

1 Materials and Methods

A total of 114 specimens (76 female and 38 male) were monthly collected from Al-Huwaiza marshes N31˚27′, E47˚39′ during the period from November 2016 to October 2017. Fishes were caught by gill net (47- 55mm mesh size), and electrofishing. Samples were brought to the laboratory, and total length was measured in centimeters to the nearest 0.1 cm, body weight to nearest 0.1 g, ovary weight to the nearest 0.1 g, ovary length to nearest 0.1 cm and egg diameter in micron (µ) of mature specimens. Fish identification was done due to Coad (2010).

1.1 Gonadosomatic Index (GSI)

Determined by tested the gonads of male and female twice in month and calculated according to Lagler (1966).

GSI%=GW/Body weight (g) *100

Where GW represented gonads weight (g).

Absolute fecundity was calculated using gravimetric methods (Bagenal, 1978). Ovary of ripe females were removed, subsamples of fresh ovary eggs were taken from the front, middle and from the back of ovaries and then counted. The total number of eggs per female was obtained which represented absolute fecundity. Relative fecundity calculated by the equation:

Relative fecundity=Absolute fecundity/ body weight (g)

Eggs diameter were measured of oocytes by objective micrometer (µ).

Morphometric and reproductive parameter relationships have been done using the formula of Nikolsky (1969).

$Y = ax^b$, i.e., Log Y= loga+blogx

The calculated weight was obtained from the weight –length relationship and we can express as:

$W^- = ax^b$

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

Relative condition factors (Kn) were estimated by applying the formula of Dar et al. (2012).

Kn= W/ W^-

Where W is the observed weight (g), W^- is the calculated weight (g).

Statistical analysis were performed by used SPSS software program ver. 20 to analysis the correlation coefficient.

2 Results

Gonadosomatic index (GSI) exhibited monthly changes along the time over the year. The GSI values take the gradual rise in the female from November 2016 as 1.94 to attain the peak 18.31 in February 2017, then started decrease to 1.87 after that continued to increase. In the males the lowest value 0.67 in April and continued rise to the highest to attain 5.33 in February 2017 then started to decrease again (Figure 1). Significant differences were detected in GSI values between females and males.

The ovaries of *L. vorax* occupy the entire body cavity before the spawning take place for several days. The two ovary lobes were often heterogeneous in size, length and weight. The lobe of the ovary has irregular shape; the middle portion was bigger than upper and lower section. The examined of ovaries shown that the shape, size and color variable in the different stages of maturity. When the eggs were very ripe take a yellowish color and easy to release from the ovary.
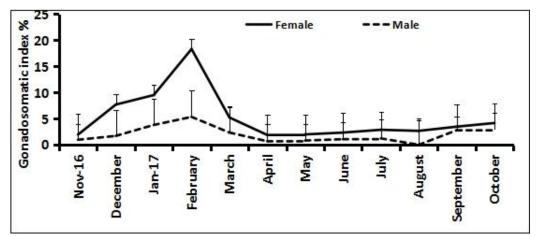
Figure 1 Monthly variations in gonadosomatic index (GSI) of *Leuciscus vorax* collected from Al-Huwaiza marshes south of Iraq during November 2016 to October 2017

Note: Error bars are standard deviation

The fecundity in fishes was rise due to increase in length, weight, status of fish, food available and environmental condition Table 1. The total length of sampled specimens ranged from 55 to 79 cm in total length. Absolute fecundity ranged from 77612 eggs at 56 cm total (1672 g body weight) to 378391 eggs 79.5 cm (5001 g). Relative fecundity ranged from 46.42 to 120.77. Ovary weight oscillated between 148.08 to 762 g. The ovary length varied from 23.20 to 38.50 cm. Eggs diameter were fluctuated from 1624 to 2015 μ for total length differ for 70.3 to 58.1 cm, respectively.

Table 1 Reproductive and morphometric features female of *Leuciscus vorax* fish collected from Al- Huwaiza marshes South of Iraq during November 2016 to October 2017

Total length (cm)		Body weight (g)	Ovary weight (g)	Ovary length (cm)	Absolute fecundity	Relative fecundity	Egg diameter(μ)
55.0		1618	189.00	24.00	95625	59.10	1628
55.3		1614	161.50	23.40	119510	74.05	1814
56.5		1672	200.00	26.00	77612	46.42	1786
58.1		1838	148.08	23.20	121435	66.07	2015
61.2		2325	192.20	26.20	183718	59.66	1655
62.2		2495	284.00	28.00	218748	87.67	1918
64.5		2319	423.00	27.50	280075	120.77	1695
65.5		2617	432.00	33.00	179098	68.44	1721
67.0		2796	566.00	32.00	291181	104.14	1700
67.0		2763	504.00	25.50	292917	106.01	1752
70.3		3129	490.00	33.00	294354	94.07	1624
79.5		5001	762.00	38.50	378391	75.66	1742
Mean	63.5	2515.58	362.65	28.36	211055.33	80.17	1604.17
S.D	7.11	932.66	196.29	4.75	96387.70	22.44	445.26

Strong positive significant correlation coefficient (r=0.91) (P<0.01) was showed between absolute fecundity and total length relationship (Table 2; Figure 2). The equation was to be liner and can addressed as:

Log AF=-2.3742+4.2492 log TL

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

The relationship between Absolute fecundity and body weight was revealed high positive significant correlations (r= 0.88) (P<0.01), the equation can be expressed as:

Log AF=0.5926+1.3866 log BW

Where AF= absolute fecundity and BW=body weight (g).

The relationship between Absolute fecundity and ovary weightshowed a highly positive significant correlation (r=0.87) (P<0.01) and can be expressed:

Log AF=3.287+0.7961 log OW

Where AF= absolute fecundity and OW= ovary weight (g).

Medium positive correlation coefficient (r= 0.698) (P<0.05) was found between relationship of absolute fecundity and ovary length (cm) and can be addressed as:

Log AF=2.045+2.2324 log OL

Where AF= absolute fecundity and OL= Ovary length.

Weak correlation coefficient (r=0.254) (P<0.05) was detected between the relationship of absolute fecundity and ova diameter (μ) and can be expressed as:

Log AF=11.803-2.0125 log OVD

Where AF= absolute fecundity and OVD= ova diameter

A strong positive correlation coefficient (r=0.987) (P<0.05) was discovered between the relationship of body weight and total lengthand the equation can be addressed as:

Log W=-1.9633 + 2.9666 log TL

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

Table 2 The relationship between reproductive and morphometric features of *Leuciscus vorax* female from Al-Huwaiza marshes south of Iraq during November 2016 to October 2017

Relationship		a	b	r
Y	X			
Absolute fecundity	Total length	-2.37	4.25	0.91[*]
Absolute fecundity	Body weight	0.59	1.39	0.88[*]
Absolute fecundity	Ovary weight	3.29	0.79	0.87*
Absolute fecundity	Ovary length	2.04	2.23	0.69
Absolute fecundity	Ovary diameter	11.8	-2.02	0.25
Body weight	Total length	-1.96	2.96	0.98[*]

Note: Abscissa (x); Y-intercept (a); Slope (b); correlation coefficient (r) [*=]Significant at level (0.01)

The relative condition factor mean values of *L. vorax* female ranged from 0.85±0.11 in October to 1.37±0.09 in June of mean total length 41±4.32 to 50.3±1.636 cm respectively. However; the means of weight varied from 631.3 ±268.40 to in October to 1719.7 ±56.002 g in June (Figure 3).

3 Discussion

Temperature is fundamental factor stimulating to acceleration the gonads maturity in fishes (Pankhurst and King, 2010). The results in the present work appear that maximum values of GSI for female and male occurred in February (Figure 1), Shafi and Jasim (1982) pointed that *L. vorax* spawning started in January at Habania lake, whereas Epler et al. (2001) reported that spawning started in February in Habania and Tharthar in Iraq, while Al-Saleh et al. (2012) stated that *A. vorax* spawning within February to March in the Euphrates River in Syria.

However; the spawning season in the North sector of Euphrates-Tigris Basin in Turkey from April to May and that combatable with the results of Oymak et al. (2011). Gonadosomatic index (GSI) is a good indicator to determine the spawning time in fishes, and common parameter widely used by the biologists to predict of spawning season of fish (Alam and Pathak, 2010). The variation in spawning time attributed to poikilotherms, due to variance of geographical laccolites which play an important role in spawning time (Wright and Trippel, 2009; Pankhurst and King, 2010). The results showed one spawning peak on reproductive strategy of represented species, which is preceding other species of fish to enables the small fish of *L. vorax* feeding on larvae and other small fish species in assemblage.
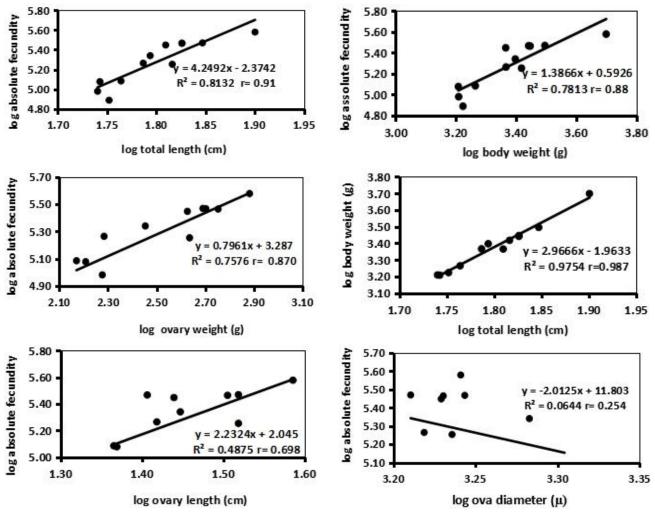

Figure 2 The relationship between absolute fecundity and total length, body weight, ovary weight, ovary length, ova diameter and body weight and total length of *Leuciscus vorax* female during November 2016 to October from Al-Huwaiza marshes
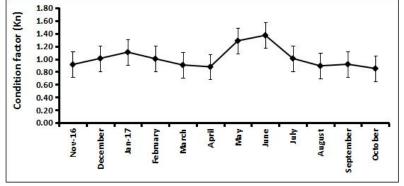

Figure 3 Monthly variations in condition factor of *Leuciscus vorax* female from Al-Huwaiza marshes during November 2016 to October 2017

Variations in fecundity among the same and different species are common phenomenon and differ from year to other Najim et al. (2012). Many factors could be influenced fecundity; length, weight, age, food abundance, environmental factors and fish status (Lambert et al., 2003; Kamler, 2005). However, there is compatible with our finding in the present work in general trends and with the previous studies on represented species (Al-Selah et al., 2010; Oymak et al., 2011; Al-Selah et al., 2012; Duman and Gul, 2013). Although the variance in absolute and relative fecundity between individuals of the same population in the year, appeardivers reproductive strategy for different species and stocks, which has been attributed to relation of influential factors to modify potential fecundity (Yoneda and Wright, 2004; Thorsen et al., 2006).

Statistical analysis in the present work exhibit highly significant correlation between reproductive and morphometric parameters. Table 2 showed that fecundity is highly related with length, weight and ovary weight at P<0.01 except of egg diameter included a weak correlation (Figure 2), and could be influenced by food abundances, environmental conditions, spawning strategy and reproductive pattern (Lambert, 2008). Our present study revealed match with previous studies in the general directions on present species and other species of cyprinid (Al-Saleh et al., 2010; Oymak et al., 2011; Al-Saleh et al., 2012; Al-Noor and Abdullah, 2015).

The results shown agree in related eggs diameters (1.624-2.015 mm) with Shafi and Jasim (1982) in Habanya and Tharthar lakes, when they recorded 1.6-1.7 mm and with Al-Selah et al. (2010) in the middle sector of Euphrates River in Syria when they found eggs diameters between 1.6-2.0 mm, our observation in eggs diameters differed from the results of Al-Saleh et al. (2012) who's found eggs diameters ranged between 1.56-1.92 mm, but disagree with Duman and Gul (2013) in mean of eggs diameters was 1.021 mm in April, this could be due to localities variation, environmental factors, food availability, fish size (Bagenal, 1978). Eggs size is important parameter to success the reproductive cycle of species that strongly associated with maximum size of the species (genetic), physiology, food available and environmental conditions. Caloric value of oocyte yolk which is largely associated of content water, lipids and protein that enables the larvae to pass the critical stage in their life history (Kamler, 2005). Yolked oocyte diameter is largely governed by the natural size of species attained, environmental conditions, reproductive strategy, spawning pattern and parental care (Lambert et al., 2003).

Elative condition factors is a common parameter used to measured fish status. Covariance in relative condition factor associated with ovary development, feeding intensity, age, physiological of fish and with increasing the weight Mat Isa et al. (2010). The condition factors somewhat vary from place to another and from time overall the year (Froese, 2006).

Our observations in relative condition factor of *L. vorax* female compatible with Shafi and Jasim (1982) in Habbaniyah and Tharthar lakes in Iraq and study of Oymak et al. (2011) in Ataturk Dam lake in Turkey, while higher than Al-Saleh et al. (2012) was (kn=0.71) in the middle reaches of Euphrates River in Syria and Duman and Gul (2013) (Kn=0.865) in Karakaya reservoir in Euphrates River, Turkey.

Values of relative condition factor started to increase gradually from November 2016 to attain the higher in January 2017 (Figure 3), due to gonads development and declined from February to April, it could be to the spawning, then values raised from May to July, this rising attributed to feeding, moreover, the variations in relative condition factor influenced by gonad development, nutritional conditions, water temperature (Doddamani et al., 2001; Froese, 2006; Oymak et al., 2011; Al-Saleh et al., 2012; Duman and Gul, 2013).

4 Conclusion

The results shown that there is one peak in the reproductive strategy of *L. vorax* in Huwaiza marsh, which has been lying-in early before other species (Hashim et al., 1984; Kahkesh et al., 2010; Mortezavizadeh et al., 2010; Najim et al., 2012; Al-Noor and Abdullah, 2015; Mohamed et al., 2017), that inhabits in the same habitat to enable the new generation of small fish for represented species to feeding on larvae and other small fish species (Hussain and Ali, 2006; Hussain et al., 2009; Mohamed et al., 2015) The results revealed high fecundity of investigated species, therefore few number of mature female capable of maintenance existences the species.

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