Some reproductive characters of the fantail goldfish *Carassius auratus auratus* females from rearing ponds in Basrah, Southern Iraq.

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Abstract

This study was carried out to determine some reproductive characteristics of the fantail goldfish *Carassius auratus auratus* females (standard length 69-224 mm. and total weight 21.1- 255.35 g.) from rearing ponds in Basrah province, Southern Iraq. Standard length, total weight, gonad weight, absolute fecundity, relative fecundity, gonadosomatic index (GSI) and egg diameter were determined from October 2010 to April 2011 in 77 fantail goldfish females.

Results showed that the studied reproductive parameters increased gradually from October, to attain peak in March and decreased again thereafter. Absolute fecundity ranged between 2877- 357246 eggs, GSI 7.28-19.11 and egg diameter 298-1006 micron. Regression relationships between the various studied morphometric and reproductive parameters were calculated and the importance of these results to the culturists of this commercially important ornamental fish species was discussed.

Key words: Fantail goldfish, fecundity, Gonadosomatic index, egg diameter, Basrah.

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Introduction

The number of eggs found in fish ovary is named fecundity, which represent the egg laying capacity of a fish or the number of ripe eggs produced by a fish in one spawning season (Alam and Pathak, 2010). It is an important aspect to estimate commercial potential of fish stock, life history, fish farming and actual

management of the fishery (Chapman, 2000; Alam and Pathak, 2010).

Fecundity is species specific and varies from one species to another (Manikandavelu *et al.*, 2009). Considerable variation in the fecundity of fish species depends upon the length, weight, age and ecological conditions of the habitat including climatic factors of the locality. In a single population, the fecundity may also fluctuate considerably in relation to the availability of food in the natural and captive environment (Nikolsky, 1963). Egg size is one of the important parameters of egg and larval quality as it is positively correlated with both survival of eggs and fries and growth rate of larvae (Lo *et al.*, 2009; Serezly *et al.*, 2010).

Rearing of ornamental fish became a necessity not a luxury. Ornamental fishes are assuming importance in recent days as stress removers. Goldfish is standard ornamental fish enjoying constant support among ornamental fish lovers (Fossa, 2004; Manikandavelu *et al.*, 2009). It is an exotic fish species belongs to Family Cyprinidae, which first reared in china in 1000, introduced into Europe in 1611 and America in 1876 AD. Of the cyprinids cultured by man, goldfish remained most prominent and commonly used as ornamental and kept as expendable pet. Over the centuries goldfish has evolved into several varieties such as Ornada, Lion head, comet, Veiltail, Black moor and fantail, to mention a few (Smart, 2001; Balon, 2004; Ortega-Salas and Bustamente, 2006; Lawson and Alake, 2011).

In addition to its aesthetical characteristics goldfish acquired relatively recent interest as a biocontrol agent for mosquitoes in shallow ponds and pools because of its strong larvivorous nature of feeding (Chandra *et al.*, 2008; Gupta and Banerjee, 2009).

Very little work has been done on the biology of this species including reproduction, in southern Iraq mostly on the feral strain (C. *auratus gobelio*) in natural waters (Saoud, 2006; Ali, 2008; Al-Shami, 2008; Al-Noor, 2010). Therefore, this study is aiming at assessing the fecundity, gonadosomatic index and egg size of the ornamental goldfish *Carassius auratus auratus* females from culture ponds in Basrah, southern Iraq.

Materials and methods

Seventy six fantail goldfish *C. auratus auratus* females were collected from October 2010 to April 2011 from a private ornamental fish farm located near Al-Saraji creek , about 4 km southern Basrah city center ($30°$ 28'18" N $47°$51'32" E). Fish farm consisted of 7 small earthen ponds (6 x 4 x 1.5 m) lined with polyethylene sheets and covered with protecting netting to avoid the predatory birds. Ponds supplied with water through a branch of Al-Sarraji creek that connected to Shatt Al- Arab River. Four of the 7 ponds were devoted to goldfish breeding and culture and the others were used mainly for live bearing poecilid fishes (guppy, molly and swordtail). Goldfish were administered two meals a day (4-5 % of total weight of fish) of commercial feed (~ 30% crude protein) with occasional complementary meals of live brine shrimp *Artemia salina* and whole shrimp meal especially during periods of availability, in addition to the natural food that penetrate with river's water.

Specimens brought to the laboratory at the department of Fisheries and Marine Resources, College of Agriculture, University of Basrah. Total weight (TW, g.) and the standard length (SL, mm.) of fishes measured, fishes dissected and their ovaries removed and weighed.

The spawning period were estimated from the development of gonads (using Gonado-Somatic Index; GSI) and variation in egg diameters of samples (Lagler, 1966).

GSI calculated as follows:

$$GSI \% = (GW / TW) \times 100;$$

Where GW and TW are gonad weight and total weight of fish in grams, respectively (Lagler, 1966; Bagenal, 1978).

Absolute fecundity, AF, studied by the gravimetric method (Bagenal, 1978) as follows; subsamples of fresh eggs of 1 or 2 g according to the size of the eggs were taken from the front, middle and back parts of the ovaries. Eggs from each subsample were separated and counted. The number of the sub-samples multiplied up to the weight of the ovary. Relative fecundity (RF) obtained from the equation:

$$RF = AF / TW$$

The diameters of various eggs size from 3 different parts of each ovary were measured with object micrometer. Because eggs are not perfectly circular in their shape, several diameters were measured

for each single egg and average calculated. Sexual maturity was checked macroscopically according to the presence of "yoked eggs" in the gonads which characterized by increasing of yolk vesicles which fill the entire cytoplasm except beneath the chorion. The nuclear envelope begins to degenerate and the nucleus migrates peripherally at the final maturation stage (Nikolsky, 1963).

In addition, statistical relationships between standard length (SL), body weight (TW), gonad weight (GW), absolute fecundity (AF), relative fecundity (RF) and egg diameter (Ed) calculated using the formula (Nikolsky, 1969):

$$Y = a X^b$$

Correlation coefficients calculated for the above relationships also. Statistical analyses performed using Microsoft Excel 2003.

Results

The results of the present study indicate a gradual and steady increase in GSI values from October (7.28) onward until it reach its peak (19.11) during March and declined in April (Figure 1).
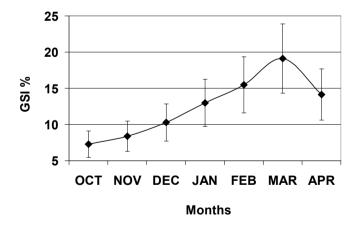

Figure 1. Monthly variations in gonadosomatic index, GSI (± S.D.) of fantail goldfish *Carassius auratus auratus* females during the study period.

This demonstrates clearly that March represents the beginning of the spawning season of this species in ponds in Basrah.

Lowest and highest fecundity values recorded in fish of average standard length 69 ± 3.3 and 224 ± 6.1 mm. and average weight of 21.1 ± 1.8 and 255.38 ± 10.9 g., respectively (Table 1). A significant positive relationship was noticed between gonad weight and fecundity(r =0.996, table 2). Relative fecundity followed the same trend as the absolute fecundity and increased steadily with gonad

Table 1. Some morphometric and reproductive parameters of fantail goldfish *Carassius auratus auratus* females.

SL	TW	GW	GSI	AF	RF	Ed
69	21.10	1.71	8.10	2877	136.35	311
77	24.72	2.16	8.74	8918	360.76	422
95	39.61	3.82	9.64	14886	375.81	469
120	51.09	5.32	10.41	20540	402.04	488
141	69.91	7.47	10.69	29779	425.96	556
160	98.17	10.88	11.08	49338	502.58	617
172	117.91	15.52	13.16	89790	761.51	669
188	141.28	21.29	15.07	164336	1163.19	744
197	205.22	31.75	15.47	252468	1230.23	882
211	228.7	39.01	17.06	301090	1316.59	918
224	255.38	46.89	18.36	357246	1398.88	978
Mean 150.36	113.92	16.89	12.55	117388	733.99	641.27
S.D. 54.156	68.89	12.98	3.00	110106.9	400.1	179.03

SL: Fish standard length, mm; TW: Fish total weight, gm: GW: Gonad weight, gm.; GSI: Gonadosomatic index, %; AF: Absolute fecundity; RF; Relative fecundity, Ed: Egg diameter, micron.

weight and absolute fecundity. This seems reasonable because of the strong correlation between the relative fecundity and the last two variables (r = 0.958 and 0.962, respectively; table 2).

Egg sizes in females of *C. auratus auratus* that tested in the current work were averaged in diameter between 298-1006 μ (Table 3). Egg diameters increased steadily from October to March then decreased.

In the current study, the power formula was the best representative of these relationships because it offers better fit of data (Table 2). Correlation coefficient values were also very high and significant for all these relationships, which could be evidence

Table 2. The statistical relationships between various morphometric and reproductive parameters of fantail goldfish *Carassius auratus auratus* females.

Relationship		Value of 'a'	Value of 'b'	Value of 'r'	Significance of 'r' at 5% and 1% levels
Ordinate	Abscissa				
SL	AF	0.0004	3.7608	0.884	Highly significant
TW	AF	18.251	1.7859	0.983	=
RF	AF	0.0593	2.136	0.962	=
GW	AF	2095.9	1.3669	0.996	=
GW	RF	146.01	0.605	0.958	=
SL	GW	0.00001	2.7521	0.909	=
TW	GW	0.0308	1.3087	0.991	=
SL	Ed	9.213	0.847	0.972	=
TW	Ed	101.45	0.4036	0.987	=
GW	Ed	296.57	0.3086	0.966	=
AF	Ed	52.734	0.2285	0.954	=

SL: Fish standard length, mm; TW: Fish total weight, gm; GW: Gonad weight, gm; AF: Absolute fecundity; RF; Relative fecundity, Ed: Egg diameter, micron.

Table 3. Average egg diameters (micron) in fantail goldfish *Carassius auratus auratus* females during the study period.

Month	Min.	Max.	Mean	S.D.
OCT	298	312	302	4.895
NOV	381	482	424	37.549
DEC	552	664	618	36.988
JAN	670	781	710	51.333
FEB	798	886	812	53.048
MAR	891	1006	989	39.895
APR	598	722	634	43.683

on the suitability of this kind of formulae. The strongest calculated correlation coefficient (r = 0.996) was between absolute fecundity (AF) and gonad weight (GW) and the weakest one (r = 0.884) was between absolute fecundity (AF) and standard length (SL), although they all were highly significant in the statistical analysis (P<0.01).

Discussion

Spawning of goldfish could be accomplished throughout the year by stocking the breeders under controlled temperature and photoperiod conditions (Gillet *et al.*, 1978; Kestemont *et al.*, 1991). Gonadosomatic index, GSI, used to represent the development of fish gonads relative to the total body and changes in GSI values are ascribe generally to the variations in gonad weight during the course of its seasonal development (Bagenal, 1978). The GSI is widely used by the biologists to indicate the maturity and periodicity of spawning and predicting the breeding season of the fish (Alam and Pathak, 2010). The results demonstrated in figure (1) about variation of GSI values during study months are compatible with those reported by other authors (Ortega-Salas and Bustamente, 2006; Sasi, 2008; Alam and Pathak, 2010; Al-Noor, 2010).

Variation in the fecundity among fishes of the same and different species is very common (Nikolsky, 1963). This could be governed by various factors such as size, age and condition of the fish (Ortega-Salas and Bustamente, 2006). It also depends upon the availability of space and food for fish in addition to many other physical and

chemical characteristics of the aquatic environment (Nikolsky, 1969). This agrees with results of the present study about absolute and relative fecundity (Table 1) and their relationship with gonad weight (Table 2). Al-Shami (2008) and Al-Noor (2010) obtained relatively higher values of fecundity for the crucian carp *C. auratus* from Garmat Ali River and Al-Hammar marsh, northern Basrah, respectively. Also, Ortega-Salas and Bustamente (2006) recorded lower fecundities during the course of their study on the initial sexual maturity and fecundity of the goldfish *Carassius auratus* under semicontrolled conditions This could reflect the different reproductive strategies between fishes of the same as well as different species under natural and culture environments. Investigations have shown that fecundity increased as fish length, weight, age and gonad weight increased (Ortega-Salas and Bustamente, 2006; Al- Shami, 2008; Sasi, 2008; Alam and Pathak, 2010; Al-Noor, 2010). Fecundity is affected by age, size, species, feeding of fish, season and environmental conditions. It is also different between stocks of the same species and does not remain constant from year to year (Nikolsky, 1969; Bone and Moore, 2008).

One of the most important parameters used to determinate the reproductive potential of fish is the variation of egg diameter in fish ovaries. Egg diameter may be related to the amount of food that females can metabolize (Nikolsky, 1963). Fish egg size may be governed by multiple genetic, physiological and nutritional factors. The larger egg size could result in better survival of larvae and fries, which are the most critical stages in fish life history, and this eventually, may be reflects on the success of the complete reproductive process (Blaxter, 1988; Smart, 2001; Bone and Moore, 2008; Lo *et al.*, 2009). The figures presented in table (3) about egg diameters that obtained in the current study agree and compare positively with those recorded in other cyprinids and fish species (Al-Shami, 2008; Sasi, 2008; Al-Noor, 2010). The larger egg sizes that encountered in the current study may be related to the superior care and nutrition of fish in culture ponds in comparison with fish that live in natural environments. This could reflect favorably on many reproductive parameters including egg size (Kestemont *et al.*, 1991; Halver and hardy, 2002; Kinsey *et al.*, 2007; Serezli *et al.*, 2010).

Statistical relationships of fish reproductive parameters are so important for understanding the general and seasonal trends of these parameters. It also could explain many phenomena that would be otherwise hardly understood which may be crucial for assessment and management of fish populations in nature and captivity (Cochrane, 2009). Fish length and weight are normally related to the various reproductive parameters like fecundity, GSI and egg size. Workers suggest many formulae to describe these relationships, namely logarithmic, exponential, and linear among others (Nikolsky, 1969, Bagenal, 1978, Sasi, 2008). The results of the present study, as shown in table 2, about the statistical relationships between the different measured parameters coincides well with several previous works on goldfish and other cyprinid species under culture and natural conditions (Ortega-Salas and Bustamente, 2006; Al- Shami, 2008; Sasi, 2008; Alam and Pathak, 2010; Al-Noor, 2010).

In conclusion, results indicate clearly that larger fish (~ 200 mm. SL) are better spawners in term of fecundity and fish size. Culturists have to give ultimate care to their fish broodstocks especially the nutritional aspects to insure the better conditions for growth and development. They also have to decrease physiological and environmental stress as well as avoiding health problems to provide safe and supportive medium for reproduction. Larger spawners give better results in productivity of fish population due to their heavier gonads that produce more eggs per fish (Ortega-Salas and Bustamente, 2006). The higher rate of larval survival could participate substantially in the success of reproduction process (Lo *et al.*, 2009). Therefore, it is recommended to use larger females of this variety (i.e. fantail) in breeding activities rather than smaller ones with the continuous monitoring of fish maturity especially during peak months of February and March.

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بعض الخصائص التكاثرية لإناث السمك الذهبي مروحي الذيل *Carassius auratus auratus* من برك الإكثار في البصرة جنوب العراق

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الخلاصة

أجريت الدراسة لتحديد بعض الخصائص التكاثرية لإناث السمك الذهبي مروحي الذيل *Carassius auratus auratus* (بطول قياسي 69–224 ملم ووزن كلي 21.1–255.35) من بعض برك الإكثار في البصرة. حدد الطول القياسي (ملم) والوزن الكلي للأسماك (غم) ووزن المناسل (غم) والخصوبة المطلقة (بيضة) والنسبية (بيضة/غم) والدالة المنسلية GSI وأقطار البيض(ميكرون) خلال الفترة بين تشرين الأول (أكتوبر) 2010 و نيسان (أبريل) 2011 في 77 أنثى.

أظهرت النتائج إن الخصائص التكاثرية المدروسة قد ارتفعت تدريجيا من تشرين الثاني (أكتوبر) وبلغت قيم الذروة خلال آذار (مارس) ثم انخفضت بعد ذلك. وقد تراوحت الخصوبة المطلقة بين 2877–357246 بيضة والدالة المنسلية بين 7.28– 19.11 وقطر البيضة بين 298–1006 ميكرون. كما حسبت علاقات الانحدار الخطي الإحصائية بين مختلف الصفات المظهرية والتكاثرية المدروسة لتكون هذه النتائج في متناول مربي هذا النوع من أسماك الزينة ذي المردود الاقتصادي.