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BIOLOGICAL STUDIES ON THE PRODUCTION OF COMMON CARP, CYPRINUS CARPIO

By

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Key Words: Gonadosomatic index, Oocyte diameter, Fecundity, *Cyprinus carpio* (Teleostei).

ABSTRACT

The present study investigates the biological parameters as gonadosomatic index (GSI), ova diameter and fecundity of common carp. Cyprinus carpio to detect the accuracy of the reproductive season and to know its duration. The present results indicated that the gonadosomatic index (GSI) increased gradually at the beginning of February and reached its maximum value in March to 9.48. In May, the gonadosomatic index slowly decreased and reached its minimum value in June to 0.987. The ova diameter Fluctuated in its percentage and three diameter groups of ova appeared during the period of prespawning. Cyprinus carpio have a short spawning season which is restricted between April and May. The highest mode appeared at ova diameter 1.0mm during the period of prespawning and spawning season. The absolute fecundity strongly correlated with length, weight and age. Also, the relative fecundity correlated with total length and gave a strong correlation. On the other hand, the relative fecundity weakly correlated with weight.

INTRODUCTION

The study of reproduction in fishes is essential for obtaining an accurate knowledge of breeding season either in natural fisheries or in fish farms. One of the most common fish species is *Cyprinus carpio* which is so far considered as one of the most important source of animal protein.Due to its adaptability for

culture in fish farms, increasing interest has been given to its propagation and productivity. Many items such as gonadosomatic index, ova diameter and fecundity are important to be linked with each other to evaluate the spawning potential and also to serve as basis for aquaculture management. Numerous studies were carried out on the biological parameters in many other teleosts (Nikolsky, 1963; Nawar and Yoakim, 1959; El-Maghraby *et al.* 1974; El-Sedfy, 1977; Dowidar *et al*, 1985; Zaki and El-Gharabawy, 1990; Assem, 1992 and 1995; Abdo, 1996 and Zaki *et al.* 1998).

The present study aims to evaluate some biological parameters such as gonadosomatic index, ova diameter and fecundity to detect accurately the reproductive season.of common carp. Also, the fundamental information about *Cyprinus carpio* is used as a basis for both fishery and aquaculture development. Depending on a basis of this information, further study will be done in future and the next paper will be concerned on the induction spawning of *Cyprinus carpio* using hormonal treatment.

MATERIALS AND METHODS

The samples of this work were collected from El-Serw fish farm during the prespawning and spawning periods (January-Jun 2001). This farm which is located in the North East of Egypt about 200Km far from Cairo, is considerd as an ideal fish farm.

The total fish length for nearest 0.1cm and fish weight to the nearest 0.1gm were determined. The sex was determined for each fish.

Gonadosomatic index (G.S.I):

After the fish was dissected to determine sex and maturity stage. The gonad was removed and weighed for the nearest 0.01gm. The gonadosomatic index (GSI) was calculated according to the following formula.

$$GSI = \frac{\text{weight of gonad (gm)}}{\text{gutted weight (gm)}} \times 100$$

The egg diameter:

The egg diameter was determined according to Yaron and Levavi-Zermonsky (1986). The eggs were counted and the ova diameter was measured by using standardized eyepiece micrometer.

Fecundity

The ripe ovaries of 55 fish were collected during the spawning period. A small part of the ovary was weighed for the nearest 0.01gm and placed in a Petri dish, where the small eggs and tissue were discarded, only ripe eggs (yolky eggs) were taken in consideration and counted under a stereomicroscope. Two terms of fecundity were applied according to (Nikolsky, 1963). The absolute fecundity: denoting the total number of ripe eggs in the ovary. Relative fecundity: denoting the total number of eggs per unit length or weight of fish. The average number of weighed known samples were counted and the total number of eggs were estimated according to the following equation:

$$\text{Fecundity} = \frac{\text{weight of gonad (gm)}}{\text{weight of sample (gm)}} \times \text{No. of eggs in sample.}$$

RESULTS

The present study is concerned with the study of biological parameters such as gonadosomatic index, ova diameters and fecundity in order to determine the accurate time of spawning and define its duration.

The gonadosomatic index (GSI):

The gonadosomatic index (GSI) of mature females of more than 34cm in lengths and 1670gm in weight are shown in table (1) and figure (1). The value of gonadosomatic index increased gradually reaching its maximum value in March to 9.48±0.766. In April and May (spawning season) it decreased slowly 8.25±0.61 and 5.43±0.698 respectively. In June, the value of gonadosomatic index sharply declined to its average minimum value, 0.987±0.238.

The ova diameter:

The ova diameters were examined in prespawning, spawning and postspawning period. Ova of small size were observed throughout the time of

Table (1): Monthly variation of gonadosomatic index value of female *Cyprinus carpio* during the period from (January-June 2001).

Months	No. of fish	G.S.I. of Female		
		Maximum	Minimum	Average ±SD
Jan. 2001	7	5.5	1.9	4.05 ± 1.31
Feb.	8	8.2	5.5	7.31 ± 1.03
Mar.	8	10.7	8.5	9.48 ± 0.766
April	7	8.9	7.5	8.25 ± 0.61
May	7	6.4	4.5	5.43 ± 0.098
Jun.	8	1.3	0.65	0.987 ± 0.238

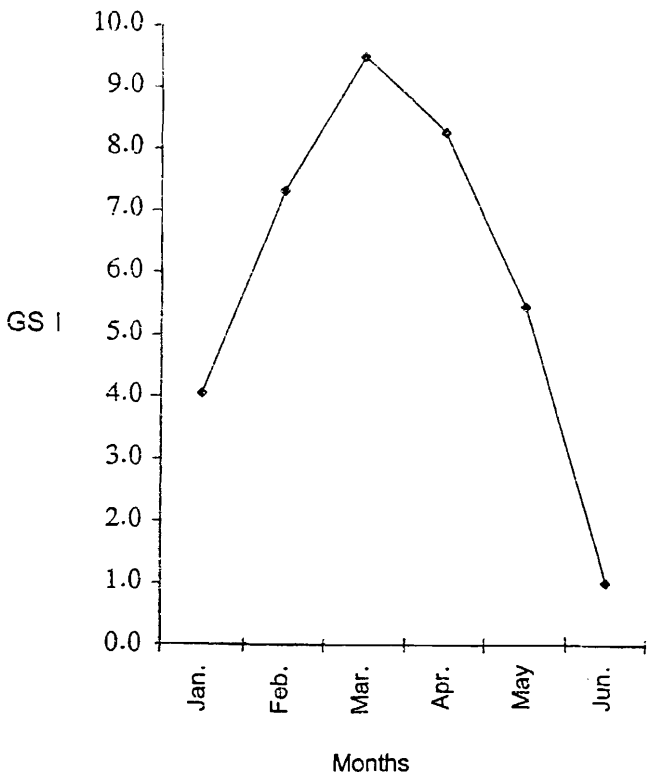

Fig. (1): Monthly variation of gonadosomatic index value of female Cyprinus carpio during the period from (January–June 2001)

examination, with the exception of the period of spawning (April & May), where ripe eggs were only observed in table (2). In January, the gonadosomatic index of two examined fishes were 4.10 and 3.65 respectively. The ova diameter in the first fish extended between 0.5-0.8mm, while in the second fish the ova diameters ranged from 0.5 to 0.7mm. The highest mode of ova diameter was located at ova diameter 0.6mm (table 2 and figure 2 a & b).

In February, the two examined fishes have higher gonadosomatic index 7.2 and 5.8 respectively. Few of ripe eggs reached its maximum capacity. The ova diameter of both fish extended between 0.5-1.0mm and the highest mode occurred at ova of diameter 0.7mm as shown in (table 2 , figure 3 a & b).

In March, three female fishes were examined. The gonadosomatic index reached its maximum value and recorded 10.25, 9.50 and 8.70 respectively. The ova diameter in the three fishes ranged between 0.8 - 1.0mm. The highest mode appeared at ova diameter of 1.0 mm as shown in (table 2, figure 4 a, b and c).

In April, the gonads of three female fishes were examined. At this period, slight decrease in the ovary weights was recorded. The gonadosomatic indices in examined fishes were 7.5, 8.5 and 8.0 respectively, as shown in table (2). The high mode appeared at ova diameter 1.0mm in the three fishes as shown in (table (2), figure 5 a, b & c).

In May, the gonadosomatic index of the three female fishes were 5.0, 5.8 and 4.2 respectively as in(table2). A high mode of ova diameter was observed at 1.0mm in the three fishes. However, the gonadosomatic index was slowly decreased.

In June, the ovaries were remarkably decreased in weight and the gonadosomatic index of two examined fishes were 1.30 and 0.87 respectively, as shown in table (2). The ova diameter decreased in its diameter and the highest mode was appeared at ova diameter of 0.1mm (figure 7 a & b).

Fecundity:

Relation between fecundity and total length:

The total number of ripe eggs (Fecundity) increased gradually with progressive lengths. The following equation was applied to represent the relationship between absolute fecundity and total length.

Table (2): Monthly variation in the frequency of egg diameters of *Cyprinus carpio* during pre-spawning, spawning

Months	G.S.I %	Total length "cm"	Gutt. weight "gm"	gg-diameters in (mm)									
				0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
23/1/2001	4.10	34.5	1670	5.0	-	-	-	30.0	50.0	8.5	6.5	-	-
	3.65	45.0	2750	7.0	-	-	-	26.0	52.5	14.5	-	-	-
15/2/2001	7.2	46.0	2850	1.5	-	-	-	5.5	28.0	36.5	20.0	6.5	2.0
	5.8	38.5	1890	2.0	-	-	-	3.0	28.5	38.5	22.0	5.0	1.0
17/3/2001	10.25	49.0	3500	1.5	-	-	-	-	-	-	2.0	16.5	80.0
	9.5	45.5	2900	1.0	-	-	-	-	-	-	3.0	15.0	81.0
	8.7	55.5	5200	0.5	-	-	-	-	-	-	2.5	12.0	85.0
21/4/2001	7.5	46.0	3200	-	-	-	-	-	-	-	-	3.0	97.0
	8.5	52.5	4500	-	-	-	-	-	-	-	-	2.0	98.0
	8.0	60.0	6200	-	-	-	-	-	-	-	-	5.0	95.0
15/5/2001	5.0	43.5	2500	-	-	-	-	-	-	-	-	1.0	72.0
	5.8	49.5	3800	-	-	-	-	-	-	-	-	-	81.0
	4.2	58.0	5500	-	-	-	-	-	-	-	-	-	77.0
2/6/2001	1.30	52.0	4500	97.5	2.5	-	-	-	-	-	-	-	-
	0.87	41.5	2400	98.5	1.5	-	-	-	-	-	-	-	-

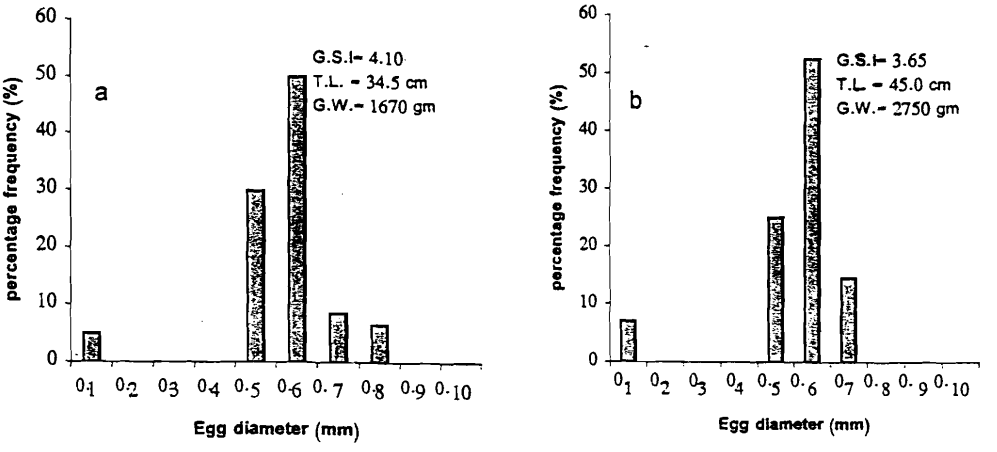

Fig. (2) Ferquency distribution of egg diameters in Cyprinus carpio in January

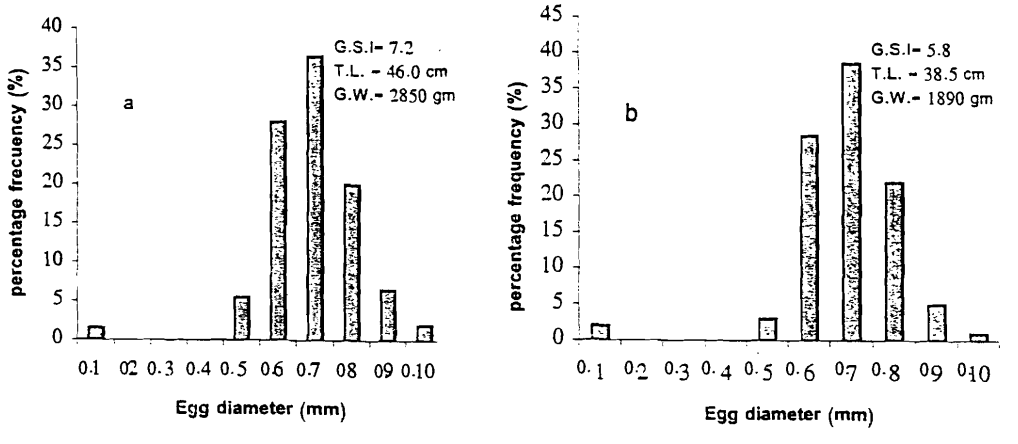

Fig. (3) Ferquency distribution of egg diameters in Cyprinus carpio in February

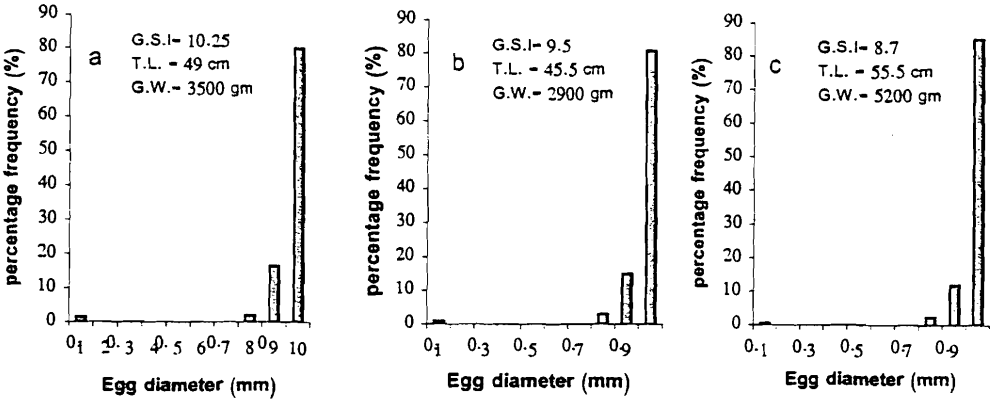

Fig. (4) Ferquency distribution of egg diameters in Cyprinus carpio in March

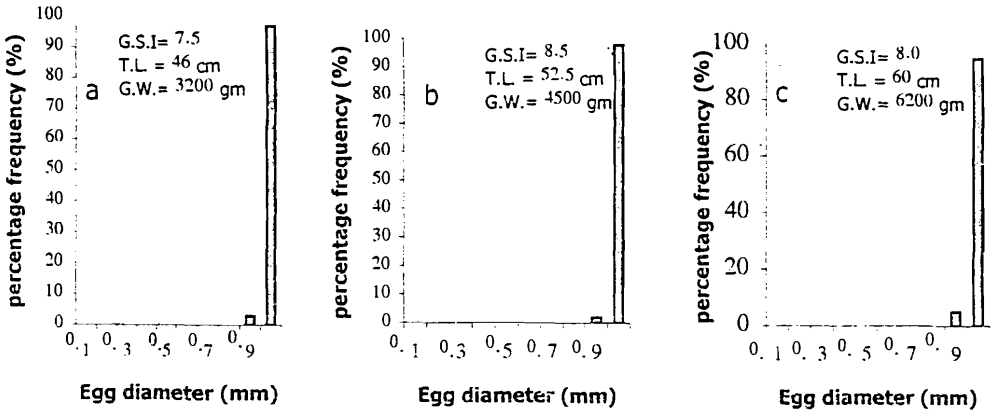

Fig. (5) Ferquency distribution of egg diameters in Cyprinus carpio in April

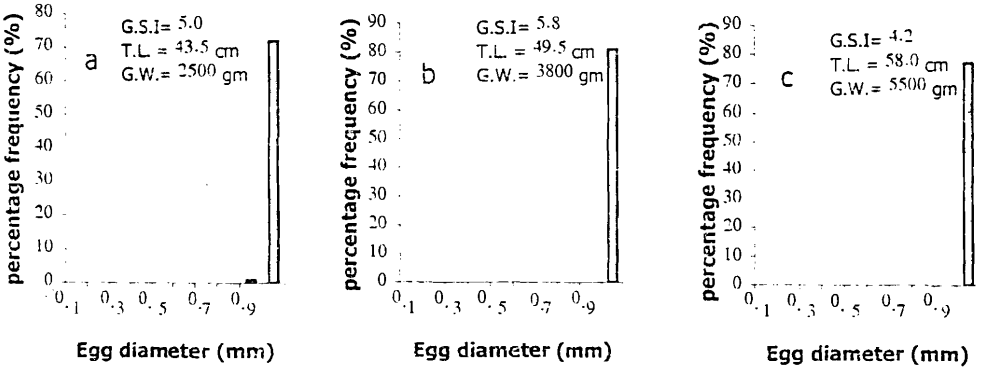

Fig. (6) Ferquency distribution of egg diameters in Cyprinus carpio in May

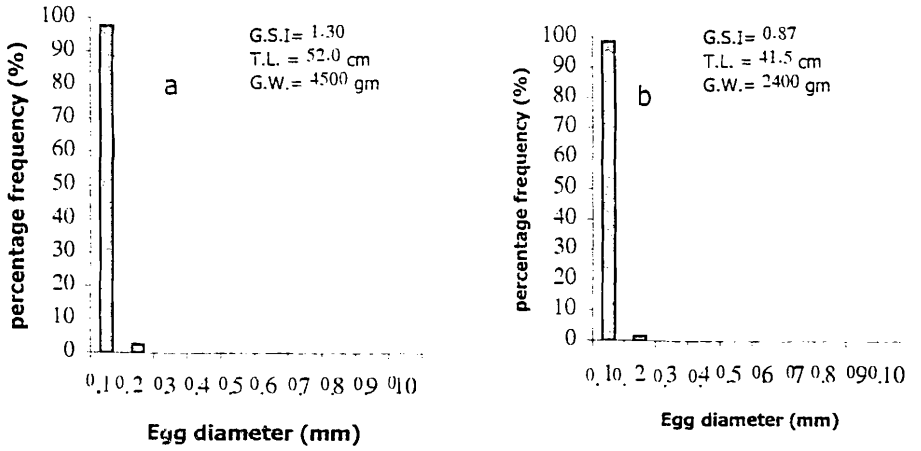

Fig. (7) Ferquency distribution of egg diameters in Cyprinus carpio in June

$$Fa=aL^b$$

Where Fa is the absolute fecundity, L is the total length in cm a and b are constants. Logarithmic transformation of above equation was applied.

$$\text{Log Fa} = \text{Log a} + b \text{ Log L}$$

The Log – Log transformation of the above equation yeilds a straight line and gave a strong correlation coefficient (r=0.993158). The formula representing this relationship is as follow :

$$\text{Log Fa} = 1.37423+2.67170 \text{ Log L.}$$

According to the equation, the absolute fecundity was strongly correlated with the total length of fish and exhibited high correlation coefficient as shown in table (3).

The observed and calculated absolute fecundity were related to each length group. The average of absolute fecundity varied from 320837 to 1309045 for fish lengths of 35-59cm respectively.

Relation between relative fecundity and total length:

The relationship between the relative fecundity and total length is represented by the following equation :

$$Fr = a L^b$$

Where Fr is relative fecundity per unit length, L is the total length in cm and a and b are constants. Log transformation of above equation was applied.

$$\text{Log Fr} = \text{Log a} + b \text{ Log L.}$$
$$\text{Log Fr} = 1.5724266 + 1.552329 \text{ Log L.}$$

The relative fecundity was strongly correlated with the total length of fish and exhibited high correlation coefficient(r= 0.958362299)as shown in table (4).

Table (3): Relation between absolute fecundity and total length of *Cyprinus carpio* during the period of spawning season

Total length group "cm"	No. of fish	Empirical absolute fecundity			Calculated absolute fecundity
		Minimum	Maximum	Average ± SD	
35	7	305128	332524	320837±11086.2	363378
38	7	338648	442127	379985±39528.6	399573
41	6	451622	528126	501617±34096.1	493639
44	7	573216	655228	613042±30021.2	590288
47	6	682877	786225	738949±34812.8	712173
50	6	816492	875268	846155±22887.6	835850
53	7	884782	952127	923856±21933.0	975735
56	5	978349	1252648	1098257±116642	1120016
59	4	1158492	1372357	1309045±87311	1269985

a= 1.374239546 b= 2.671701245 r = 0.99315841

Table (4): Relation between relative fecundity and total length of *Cyprinus carpio* during the period of spawning season.

Total length group "cm"	No. of fish	Empirical relative fecundity			Calculated relative fecundity
		Minimum	Maximum	Average±SD	
35	7	8683	9198	9009±187.6	9391.3
38	7	9127	11193	9931±778.5	10675.7
41	6	11234	12881	12123±640.3	12072.5
44	7	13299	14496	13859±417.2	13394.8
47	6	14845	16379	15650±532.3	14824.3
50	6	16595	17095	16798±236.2	16396.7
53	7	17015	17631	17308±210.0	17894.7
56	5	17718	20395	19205±1347	19437.0
59	4	19974	23198	22234±1306	20891.5

a= 1.57242664 b= 1.552329094 r= 0.958362299

Table (5): Relation between absolute fecundity and gutted weight of *Cyprinus carpio* during the period of spawning season

Gutted weight "gram"	No. of fish	Empirical absolute fecundity			Calculated absolute fecundity	Average of relative fecundity
		Minimum	Maximum	Average ± SD		
1500	12	305128	380577	336639±22884.2	360511	192±8.96
2000	11	423842	596988	512292±58937.5	476407	223±11.76
2500	6	613127	728492	658021±41967.9	574472	241±4.84
3000	4	72866	786228	755582±20613.2	721127	262±9.17
3500	4	816492	856426	834353±14892.1	825741	218±5.11
4000	4	864251	912692	884248±17957.4	945874	203±6.58
4500	7	916178	978349	943715±20891.6	1029532	200±3.25
5000	4	1124978	1252468	1171576±48406.5	1186237	207±10.14
5500	3	1350148	1372357	1359230± 9507.0	1223867	246±3.35

a= 2.064759561 b= 1.075206327 r=0.969023272

Table (6): Relation between the absolute fecundity and age of *Cyprinus carpio* during the period of spawning season

Year of life age group	No. of fish	Empirical absolute fecundity			Calculated fecundity
		Minimum	Maximum	Average ±SD	
II	5	305128	327577	316378±9861	301993
III	26	331422	751236	519846±135346.0	562092
IV	17	756498	985136	885302±66208	873457
V	7	1124978	1372357	1251998±108020	1229502

a= -3.275474176 b= 0.652647086 r= 0.996008911

Relation between absolute fecundity and gutted weight:

The minimum, maximum and average of absolute fecundity as well as calculated fecundity related to each total weight are shown in table (5). The relationship between the absolute fecundity and total weight is represented by the following equation:

$$Fa=a\ w^b$$

Where Fa is the absolute fecundity, w is the gutted weight of fish in gm., a and b are constants. Logarithmic transformation of above equation can be expressed as follow :

$$\text{Log Fa} = \text{Log a} + b\ \text{Log w.}$$
$$\text{Log Fa} = 2.0647595 + 1.07520632\ \text{Log w.}$$

The relationship between the absolute fecundity and gutted weight shows a strong correlation coefficient (r=0.96902327) to gutted weight ranging from 1500-5500gm.

Relation between relative fecundity and gutted weight:

The relative fecundity increased steadily, the highest value, 262 observed at 3000gm. At corresponding weight 3500gm, the relative fecundity was 218 as shown in table (5). The relationship between relative fecundity and total weight is represented by the following equation :

$$\text{Log Fr} = 0.3730811 + 1.3357922\ \text{Log wt}$$

Fr is relative fecundity per unit weight. The correlation coefficient between the relative fecundity and gutted weight shows a very weak correlation (r=0.28129507).

Relation between absolute fecundity and age:

The absolute fecundity increased with age, length and weight until the fish reached 5 years in age. At age two years, length interval was 34-35.4cm and the weight interval ranged from 1570 to 1683gm, the absolute fecundity was 316378. As the fish age became 3 years, the average of length was 41.72cm and their average weight were 2344.33gm, the absolute fecundity was 519846. At age four years, the average of length was 51.92 and their average weight reached 4265gm, the average of absolute fecundity was 885303. Finally, in age group five, the average of length reached 57.97cm and their average weight was 5473gm., the average of absolute fecundity of these fish was 1251998.

The relationship between the absolute fecundity and age of fish is represented by the following equation:

$$Fa = a\ A^b$$

Where Fa is the absolute fecundity the age. A is the age of fish (in years), a and b are constants. Log transformation of above equation can be expressed as follow:

$$\text{Log } Fa = \text{Log } a + b \text{ Log } A.$$
$$\text{Log } Fa = -3.2754741 + 0.6526470 \text{ Log } A$$

The absolute fecundity related to age exhibited a strong correlation coefficient (r=0.996008911) as shown in table (6).

DISCUSSION

In the present study, biological parameters such as gonadosomatic index, ova diameter and total number of eggs fecundity are discussed to detect an accurate time of spawning season as well as its duration. The gonadosomatic index increased gradually on 23rd of January and reached its maximum value in March, then it decreased gradually from April to May until it reached its minimum value in June. In agreement with the present results,Yaron and Levavi-Zermonsky (1986) studied on the *C. carpio*. they found that the gonadosomatic index (GSI) increased gradually from August to March and started to decrease during the spawning season from April to May. One peak of gonadosomatic index was detected for many other species; *Diplodus sargus* and *D. vulgaris* (El-Maghraby *et al.* 1982); *Clarias gariepinus* (Syn. *C. lazera*) (Zaki *et al.*, 1986); *Mugil capito* (Zaki and El-Gharabawy, 1990); *Mugil cephalus* (Mousa, 1994); *Oblada melanura* (Zaki *et al.* 1995) and *Sparus aurata* (El-Gamal, 1997).

The frequency distribution of ova diameter in *Cyprinus carpio* under the present study indicated that the ova diameter fluctuated in its percentage especially during the period of prespawning. A high mode appeared in the period of spawning season (April-May). Our results agree those reported by Yaron and Levavi-Zermonsky (1986) on the same species. The present finding indicated that the small ova diameter may be used as stock in the next spawning season and they will enter the next spawning season earlier than the other one.

The ova diameter distribution differ according to species, whether the fish is "synchronous" or "asynchronous". Nagahama (1983) stated that the synchronous ovary contains oocytes all the same stage of development, this type is found in teleost which spawn only once and have short spawning season. However the "asynchronous" ovary contains at all stages of development. The analysis of ova diameter distribution of *Mugil capito* obtained by Zaki and El-Gharabawy (1990) revealed the presence of series of peaked polygons of ova which have several modes. According to Nagaham (1983), *Cyprinus carpio* under study is "synchronous" and has a short spawning season from April to May. At this period, the gonadosomatic index gradually decreased and the ovary contains oocytes all at the same stage of development. Our results agree with those reported by Yaron and Levavi-Zermonsky (1986) on *Cyprinus carpio*.

In the present study, the total numbers of absolute fecundity varied even inside the same length group. In this respect, Hay *et al.* (1987) and Zaki *et al.* (1995) attributed the difference in number of ova for the same length group to the environmental factor as well as the number of spawning times for each individual fish. In the present study, the females were fed well in fish ponds approximately two months before the spawning season to give the best quality and quantity of eggs. Hay *et al.* (1987) studied *Clupea harengus pallasi* and stated that the feeding accelerated the rate of maturation and the fed fish spawned earlier than the unfed one. Our results on *Cyprinus carpio* indicated that absolute fecundity increase with the increase of length and weight of fish. The present finding agree with those reported by Ghorab *et al* (1986) in *Epinephalus chlorostigma*; Zaki and El-Gharabawy (1990) in *Mugil capito*; El-Mesiry (1993) in *Siganus revulatus*; Assem (1995) in *oblada melanura*, Abdo (1996) in *Dicentrarchus labrax* and Zaki *et al.* (1998) in *Sparus aurata*. The absolute fecundity in the present finding per unit body length was more expressive than the absolute fecundity per unit body weight of fish which agree with what reported by Assem (1992 and 1995) in *Oblada melanura*, *Solea vulgaris* and *Solea aegyptiaca* respectively and Zaki *et al.* (1998) in *Sparus aurata*. In the contrary to that Latif and Shenouda (1973) and Dowidar *et al.* (1985) found that the fecundities per unit body weight of *Saurida undosquamis* and *Clarias lazera* could be considered as more specific than the fecundity per unit body length.

In the present study, the absolute fecundity strongly correlated with the age of fish. Ghorab *et al.* (1986) studied the *Epinephalus chlorostigma* and attributed the decrease fecundity in old fish to senility. *Cyprinus carpio* under the present study reared in El.Serw fish farm until 5 years in age , the absolute fecundity has not dercreased as the fish became an old age .

It can be concluded that *Cyprinus carpio* is synchronous fish and has a short spawning season extended from April to May. The total number of ripe eggs increase as the fish increase in length, weight and age. We suggested that the good feeding before the spawning at least two months would give the best quality and quantity of eggs.

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