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Some Reproductive Parameters of *Synodontis schall* (Bloch and Schneider, 1801) from the River Nile, Egypt

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ABSTRACT

In the present study, some reproductive parameters including sex ratios, sexual maturity, gonadosomatic and gonad indices and fecundity of *S. schall* from the Nile, Egypt were estimated in relation to standard length, weight, age and months. Different patterns of variations were recorded in these parameters. The females and males of *S. schall* reached maturation at 28.2 and 29.4 cm, respectively. Gonadosomatic index recorded the higher value during the period from January to July for the females of *S. schall*. The highest value was recorded in March for the males of *S. schall*. Gonad index recorded higher values during all months. The number of eggs increased with increase in length. Fecundity exhibited variability with age, length and months in the same locality. Fecundity also showed variations with time and locality when compared with other studies. The largest number of *S. schall* in the current locality was 102600 which recorded in length of 36 cm during May for *S. schall*. The egg diameter increased from January to August. The largest diameter (1.44 cm) was recorded during June. The highest value was recorded during March for the females and during May and October for the males of *S. schall*. In conclusion, *S. schall* is a fecund fish with variations in time and localities. Also, variability of reproductive parameters with age, size, weight and gonad weight are evident.

Key words: Reproduction, sex ratios, fecundity, maturity, synodontis

INTRODUCTION

Catfishes support the commercial fisheries in Egypt. Catfishes of the genus *Synodontis* are small to medium sized fish belonging to the family Mockokidae. The genus contains only three species in Lake Nasser (*S. schall, S. serratus, S. frontosus*). After the High Dam constriction on the Nile at Aswan, Egypt, *S. schall* is more abundant in the Nile whereas *S. serratus* may be rarely recorded. However, such genus in Africa contains approximately 110 species (Poll, 1971) and hence have more species than any teleost genus in Africa other than *Barbus* and *Haplochromis* (Willoughby, 1979).

The reproductive biology of the Nile fish was the focus of Latif and Rashid (1979), Hashem (1981a), Abass (1982), Abu-Hakima (1987) and Zaher *et al.* (1991). Fecundity as one aspect of reproductive biology, is of interest for fishery scientists in concern with stock assessment based on egg production methods (Saville, 1964) and as a basic aspect of fish biology and population dynamics (Koslow *et al.*, 1995).

The size and age at sexual maturity and the sex ratio are fundamental biological parameters used in stock assessments and useful in management to calculate the reproductive potential of fish population (Wang *et al.*, 2003; Ghafari and Jamili, 2010). These parameters are also necessary parameters for age-and size-structured models, such as the spawner biomass per recruit model (Gabriel *et al.*, 1989), per recruit model (Foale and Day, 1997) egg and other size-or age-structured models (Derios *et al.*, 1985; Quinnll *et al.*, 1990).

Moreover, it is stated that the estimation of the reproductive parameters in terms of fecundity, egg size, size and length at sexual maturity, sex ratio and gonadosomatic index are basic steps in formulation of the life history theory. The goal of current life history theory is to predict how an organism's finite resources, time and energy, are allocated towards growth, maintenance and reproduction (Cody, 1966). The allocation of resources to reproduction is a compromise between the organism's immediate prospects of reproductive success against lifelong future prospects (Willbur, 1977).

Except for the study of Abass (1982) on *S. schall* and *S. serratus,* no detailed research has been done on the reproductive biology of these species in the Nile. Accordingly, the present study aimed at determination and estimation of some of the reproductive parameters of the *S. schall* from the main course of the Nile at Assiut, Egypt. These parameters included sex ratios, size and age at first maturity, maturity stages, gonadosomatic and gonad indices and fecundity relationships.

MATERIALS AND METHODS

Specimens collection: In the present study, 94 specimens of *S. schall* (18-41 cm in SL) were taken on a monthly basis between November 2001 and October 2002 from Assiut fish market catch collected from the River Nile, at Assiut, Egypt. Fish were weighed and measured in standard length to the nearest centimeter. Gonads were weighed to the nearest gram and ovaries were preserved in 10% formalin for later fecundity estimation.

Sex ratio: Sex ratio was determined on fish size and monthly bases. Sex ratio departure from the expected 1:1 ratio were tested by Chi-square test at 0.05 significance level. Association between length groups, months and sex distribution was also considered by Chi-square test at 0.05 level of significance.

Maturity stages: The maturity stages of ovaries and testes were identified and distinguished according to the following basis (Abass, 1982).

- **Stage I (immature):** Gonads are small, ovary is transparent. Eggs are small and cannot be detected by the naked eye. Testis is thread-like
- **Stage II (resting stage):** Gonads are still small and extend along ⅓-½ the length of the abdominal cavity. The ovary is still transparent and not thick. The eggs still cannot be distinguished with the naked eye. Testis is still without well-defined side lobes
- **Stage III (maturation):** The gonad begins to develop and extend along ¾ of the abdominal cavity length. Ovary is yellowish. Eggs are distinguished to naked eye. Testis starts to have side lobes
- **Stage IV (maturity):** Sexual products are clear. The gonads nearly extend along the whole length and reach their maximum weight. Ovaries are orange but the eggs still not extruded while the testis lobes are clear, finger-like and full of sperms

- **Stage V (reproduction):** Ovaries are voluminous with large viable eggs which could be seen through the thin ovarian wall. Testes are whitish in color with stout lobes which are distended with sperms
- **Stage VI (Spent):** The ovary is flassid, reddish blak in colour and much reduced in size, the testes are yellowish, white in colour, soft, empty and fleshy in its appearance

In the analysis, the maturity stages I and II were together considered as immature, stage III as maturing, while stage IV and V are considered as mature/ripe.

The gonadosomatic index (GSI) was predicted by the following formula (Khallaf, 1976):

$$GSI = GW \times 100/W$$

where, GW is the gonad weight in g and W is body weight in g.

The Gonad Index (GI) was predicted by the following formula (Scrimgeour and Eldon, 1989):

$$GI = GW \times 10^8/SL^3$$

Fecundity is the number of eggs per ovary of mature fish (Bagenal and Tesch, 1978), whereas relative fecundity is the number of egg per unit length or weight of fish. Three pieces per ovary were cut and weighed, then the eggs were counted and fecundity and relative fecundity were calculated. Egg diameter was measured to the nearest micron by an ocular micrometer fixed in the eye-piece of a light microscope.

RESULTS

Sex ratio: The sex ratio of *S. schall* of Assiut (Male: Female) was 1: 1.04 and did not depart from the expected 1:1 rate (Table 1-2). Also there was no association between sex distribution and months (Table 1, $p = 0.1866$, $\chi^2 = 14.91$) and length groups (Table 2, $p = 0.065$, $\chi^2 = 16.1$). Only within length group 32, the sex ratio 1: 0.26 departed significantly from the ratio 1:1 ($\chi^2 = 8.16$, $p<0.01$). Whereas the sex ratio of March (1: 5) was the only ratio that departed significantly from the ratio 1:1 ($\chi^2 = 5.34$, $p<0.05$). In spite of these findings, fishes were numerically insufficient to permit a reliable conclusion in some length groups and some months.

Size (Lm) and age (Tm) at first sexual maturity: The age and size-distributions of the mature and immature *S. schall* are given in Table 3 and 4. From such distributions, Lm (confidence limits) and Tm (confidence limits) of *S. schall* were estimated to be:

29.4 (29.1-29.7) and 3.1 (1.4-4.7) for males, respectively
28.2 (27.5-28.8) and 3.5 (3.1-4.6) for female, respectively
28.5 (28.2-28.9) and 3.3 (2.7-4.0) for combined sex, respectively

Maturity stages: The distribution of maturity stage categories (i.e., I+II, III, IV+V) showed variations among length groups in both males and females. The maturity increases with increase of fish size (Table 5). On other hand, all maturity stages categories of females were represented in June-July period. I+II + III category was related along the period of study which means a long period of spawning (Table 6). These females findings were different from those of males (Table 6).

Table 1: Sex ratio of S. *schall* in different length groups from the Nile at Assiut, Egypt

Length	Male	Female	Sex ratio (M : F)	Female sex ratio
18	1	2	1: 2	66.67
20	4	6	1: 1.5	60.00
22	6	3	1: 0.5	33.33
24	4	8	1: 2	66.67
26	10	12	1: 1.2	54.55
28	17	26	1: 1.5	60.47
30	25	23	1: 0.9	47.92
32	19	5	1: 03	20.83
34	2	2	1: 1	50.00
36	2	7	1. 3.5	77.78

Table 2: Seasonal variations in sex ratio of *S. schall* from the Nile at Assiut, Egypt

	Female			Male			Comb.		
Age group	No.	Mature	Mature (%)	No.	Mature	Mature (%)	No.	Mature	Mature (%)
I	1	0	0.0	2	0	0	3	0	0.0
II	11	3	27.3	13	0	0	24	3	12.5
III	45	26	57.5	50	15	30	95	41	43.2
IV	33	20	60.6	25	17	68	58	37	63.8
V	4	4	100.0	-	-	-	4	4	100.0

Table 3: Distribution of mature and immature individuals of *S. schall* from the Nile at Assiut, Egypt.among different age groups

Month	Male	Female	Sex ratio (M : F)	Female sex ratio
Nov.2000	11	15	1: 1.4	57.69
Dec.	5	5	1: 1	50.00
Jan.2001	2	2	1: 1	50.00
Feb.	11	7	1: 0.6	38.89
Mar.	2	10	1: 5	83.33
Apr.	5	4	1: 0.8	44.44
May	11	5	1: 0.5	31.25
June	9	11	1: 1.2	55.00
July	19	10	1: 0.5	34.48
Aug.	3	7	1: 2.3	70.00
Sept.	6	9	1: 1.5	60.00
Oct.	6	9	1: 1.5	60.00

Gonadosomatic (GSI) and gonad (GI) indices: The basic statistics of GSI and GI are shown in Table 7 and 8 for male and females of *S. schall*. The distribution of GSI and GI categories (Table 9-10) show variability among length groups. For females (n = 53), GSI (ungrouped data) was significantly correlated with SL (R = 0.87) and significantly slightly correlated with body weight (W) (-0.28), whereas GI (ungrouped data) exhibited significant correlation (R = 0.72) with SL and negative significant correlation with body weight (R = -0.32). GSI were strongly correlated were GI (R = 0.91). Gonad weight was significantly correlated with SL (R= 0.33) and insignificantly correlated with W (R= -0.08). For males (ungrouped data, N= 94), GW, GI were significantly correlated with SL (R = 0.39 and -0.3, respectively) and W (R = 0.23 and -0.21, respectively). GW were highly correlated with GI (R=0.89). The last categories with higher magnitudes of GSI and GI was represented by low or zero percent for females. Similar situation was recorded for males

Table 4: Distribution of mature and immature individuals of *S. schall* from the Nile at Assiut, Egypt.among different length groups

	Female			Male			Comb.		
Length group	No.	Mature	Mature (%)	No.	Mature	Mature (%)	No.	Mature	Mature (%)
18	2	0	0.0	1	0	0.0	3	0	0
20	6	1	16.7	4	0	0.0	10	1	10
22	3	1	33.3	6	0	0.0	9	1	11
24	8	5	62.5	4	1	25.0	12	6	50
26	12	8	66.7	10	3	33.3	22	11	50
28	26	20	76.9	17	6	35.3	43	26	60
30	23	21	91.3	25	10	40.0	48	31	65
32	5	5	100.0	19	12	63.0	24	17	71
34	2	2	100.0	2	2	100.0	4	4	100
36	7	7	100.0	2	2	100.0	9	9	100

Table 5: Length groups variation of different maturity stages of males and females of of *S. schall* from the Nile at Assiut, Egypt

		Male maturity stage				Female maturity stage		
Length group	No.	I+II	III	IV+V	No.	I+II	III	IV+V
18	1	100.0	0.0	0.0	2	100.0	0.0	0.0
20	4	100.0	0.0	0.0	7	85.7	0.0	14.3
22	6	100.0	0.0	0.0	2	50.0	0.0	50.0
24	4	100.0	0.0	0.0	8	62.5	12.5	25.0
26	10	90.0	0.0	10.0	12	41.7	50.0	8.3
28	17	58.8	10.5	41.2	26	46.2	38.5	15.4
30	25	60.0	8.0	32.0	23	47.8	43.5	8.7
32	19	42.1	10.5	47.4	5	0.0	60.0	40.0
34	2	0.0	0.0	100.0	2	0.0	50.0	50.0
36	2	50.0	0.0	50.0	5	0.0	60.0	40.0
38					2	0.0	0.0	100.0
40								

Table 6: Monthly variations of different maturity stages of males and females of *S. schall* from the Nile at Assiut, Egypt

		Male maturity stage				Female maturity stage		
Month	No.	I+II	III	IV+V	No.	I+II	III	IV+V
Nov.2000	11	81.8	18.2	0.0	15	60.0	40.0	0.0
Dec.	5	100.0	0.0	0.0	5	40.0	60.0	0.0
Jan.2001	2	100.0	0.0	0.0	2	50.0	50.0	0.0
Feb.	11	100.0	0.0	0.0	7	21.9	71.4	6.7
Mar.	2	50.0	50.0	0.0	10	0.0	60.0	40.0
Apr.	5	0.0	0.0	100.0	4	0.0	0.0	100.0
May	11	0.0	0.0	100.0	5	0.0	0.0	100.0
June	9	33.3	0.0	66.7	11	36.4	27.3	36.4
July	19	94.7	5.3	0.0	10	50.0	10.0	40.0
Aug.	3	33.3	0.0	66.7	7	14.3	85.7	0.0
Sept.	6	100.0	0.0	0.0	9	88.9	11.1	0.0
Oct.	6	66.7	33.3	0.0	9	88.9	11.1	0.0

especially for GSI. In addition to these findings, GSI and GI exhibited monthly variations with regards to their values and categories distribution (Table 11-12).

Table 7: Gonadosomatic index and gonad index of males and females in different length groups of *S. schall* from the Nile, at Assiut, Egypt

		Males			Females	
		GSI	GI		GSI	GI
SL	No.	X±SD (Min-Max)	X±SD (Min-Max)	No.	X±SD (Min-Max)	X±SD (Min-Max)
20	1	0.5	8.6	2	1.6±2.0 (0.2-3.0)	40.3±50.8 (4.4-76.3)
22	4	0.4±0.3 (0.2-0.9)	8.8±6.9 (3.7-18.9)	7	1.1±0.8 (0.3-2.8)	21.3±11.7 (6.6-45.1)
24	6	0.4±0.3 (0.1-0.9)	7.9±6.0 (2.8-17.8)	2	7.9±10.9 (0.2-15.6)	133.5±183.1 (4.1-263)
26	4	0.3±0.3 (0.1-0.7)	7.8±6.5 (2.5-16.4)	8	1.7±2.3 (0.2-6.2)	39.0±55.0 (4.0-155.5)
28	10	0.5±0.3 (0.1-0.9)	9.1±6.2 (2.3-20.5)	12	0.8±0.4 (0.4-2.0)	16.3±9.4 (8.2-42.4)
30	17	0.6±0.5 (0.2-2.0)	14.6±11.3 (4.1-43.8)	26	1.3±1.3 (0.3-5.7)	27.7±31.8 (7.4-118.5)
32	25	0.6±0.4 (0.1-1.6)	12.5±8.0 (3.0-31.5)	23	1.9±3.2 (0.2-13.5)	38.0±77.0 (8.5-338.0)
34	19	0.6±0.3 (0.2-1.1)	12.0±5.1 (4.0-19.1)	5	2.5±1.3 (0.9-4.0)	54.1±34.8 (15.0-101.7)
36	2	1.0±0.1 (0.9-1.0)	16.8±1.4 (15.9-17.8)	2	9.4±12.2 (0.8-18.0)	211±277.8 (14.1-407)
38	2	0.4±0.1 (0.3-0.5)	7.6±2.5 (5.8-9.3)	5	4.6±4.3 (0.5-10.3)	77.8±67.1 (9.1-173.7)
40				2	2.6±0.9 (1.9-3.2.0)	59.6±22.4 (43.8-75.4)

Table 8: Monthly variation with gonadosomatic index and gonad index of males and females of *S. schall* from the Nile, at Assiut, Egypt

		Females				Males		
Month	No.	S.L	GSI	GI	No.	S.L	GSI	GI
Nov.2000	15	21-32	0.8±0.3 (0.4-1.3)	3.6±2.1 (1.2-7.8)	11	26-32	0.6±0.1 (0.3-0.7)	3.1±2.2 (0.9-0.7.4)
Dec.	5	30-34	0.7±0.1(0.6-0.8)	3.1±0.9 (1.8-4.2)	5	29-32	0.3±0.1 (0.2-0.5)	1.1±0.5 (0.5-1.9)
Jan.2001	2	31-32	1±0.58 (0.6-1.4)	2.2±0.5 (1.8-2.6)	2	30-31	0.22±0.1 (0.2-0.24)	0.74±0.2 (0.6-0.9)
Feb.	7	26-30	1.9±1.0 (0.7-3.2)	3.5±2.2 (1.1-7.3)	11	27-35	0.3±0.1 (0.2-0.6)	1.1±0.5 (0.5-1.9)
Mar.	10	29-41	3.7±2.2 (1.9-5.1)	5.6±4.6 (0.9-8.7)	2	28-31	0.7±0.2 (0.6-0.9)	1.9±0.3 (1.7-2.1)
Apr.	4	29-34	0.4±0.2 (0.2-0.6)	3.4±1.7 (1.9-5.8)	5	27-32	1.3±0.4 (0.9-2)	2.6±3.1 (1.3-4.1)
May	5	31-38	1.1±1.1 (0.4-3)	4.5±1.6 (2.6-6.7)	11	27-33	1±0.3 (0.6-1.6)	3.6±1.6 (1.7-6.8)
June	11	23-33	3.2±4.6 (0.2-4.9)	5.1±3.2 (1.5-7.8)	9	23-34	0.7±0.4 (0.1-1.1)	2.9±1.6 (0.5-5.1)
July	10	19-28	1.3±1.2 (0.5-4.3)	5.1±6.1 (1.4-9.2)	19	19-31	0.4±0.3 (0.1-1)	2.3±1.6 (0.5-4.2)
Aug.	7	28-38	0.7±0.2 (0.4-1)	4.6±4.0 (2.1-8.2)	3	31-35	0.5±0.1 (0.5-0.8)	1.2±0.5 (0.8-1.7)
Sept.	9	21-32	0.8±0.8 (0.2-2.8)	3.1±2.3 (0.6-8.1)	6	27-32	0.4±0.2 (0.2-0.7)	2.7±2.4 (0.7-7.4)
Oct.	9	26-38	1.0±1.1 (0.4+4)	3.2±2.11 (1.0-7.1)	6	21-30	0.5±0.2(0.3+0.8)	3.6±2.4 (1.4-7.7)

Table 9: Percentages of males of *S. schall* from the Nile, at Assiut, Egypt, distributed according to each length groups in combination with three main categories of GSI and GI

		GSI			GI		
Length group	No.	>0.7	0.7-1.3	<1.3	>15.9	15.9-29.5	<29.5
18	1	100.0	0.0	0.0	100.0	0.0	0.0
20	4	75.0	25.0	0.0	75.0	25.0	0.0
22	6	83.3	16.7	0.0	83.3	16.7	0.0
24	4	75.0	25.0	0.0	75.0	25.0	0.0
26	10	60.0	40.0	10.0	60.0	40.0	10.0
28	17	76.5	11.8	11.8	76.5	11.8	11.8
30	25	60.0	36.0	4.0	68.0	28.0	4.0
32	19	57.9	42.1	0.0	68.4	31.6	0.0
34	2	0.0	100.0	0.0	0.0	100.0	0.0
36	2	100.0	0.0	0.0	100.0	0.0	0.0

Table 10: Percentages of females of *S. schall* from the Nile, at Assiut, Egypt, distributed according to each length groups in combination with three main categories of GSI and GI

Length group	No.	GSI >6.2	GSI 6.2-12.2	GSI <12.2	GSI >138.4	GSI 138.4-272.8	GSI <272.8
20	2	100.0	0.0	0.0	100.0	0.0	0.0
22	7	100.0	0.0	0.0	100.0	0.0	0.0
24	2	50.0	50.0	0.0	50.0	50.0	0.0
26	8	87.5	12.5	0.0	87.5	12.5	0.0
28	12	100.0	0.0	0.0	100.0	0.0	0.0
30	26	100.0	0.0	0.0	100.0	0.0	0.0
32	23	91.3	4.3	4.3	91.3	0.0	8.7
34	5	100.0	0.0	0.0	100.0	0.0	0.0
36	2	50.0	0.0	50.0	50.0	0.0	50.0
38	5	100.0	0.0	0.0	100.0	0.0	0.0
40	2	100.0	0.0	0.0	100.0	0.0	0.0

Table 11: Percentages of males of *S. schall* from the Nile, at Assiut, Egypt, distributed according to each length groups in combination with three main categories of GSI and GI

Month	No.	S.L	GSI >6.2	GSI 6.2-12.2	GSI <12.2	GI >138.4	GI 138.4-272.8	GI <272.8
Nov.2000	15	21-32	100.0	0.0	0.0	100.0	0.0	0.0
Dec.	5	30-34	100.0	0.0	0.0	100.0	0.0	0.0
Jan.2001	2	31-32	100.0	0.0	0.0	100.0	0.0	0.0
Feb.	7	26-30	100.0	0.0	0.0	100.0	0.0	0.0
Mar.	10	29-41	50.0	30.0	20.0	100.0	0.0	0.0
Apr.	4	29-34	100.0	0.0	0.0	100.0	0.0	0.0
May	5	31-38	100.0	0.0	0.0	100.0	0.0	8.7
June	11	23-33	81.8	18.2	0.0	90.9	0.0	9.1
July	10	19-28	100.0	0.0	0.0	100.0	0.0	0.0
Aug.	7	28-38	100.0	0.0	0.0	100.0	0.0	0.0
Sept.	9	21-32	100.0	0.0	0.0	100.0	0.0	0.0
Oct.	9	26-38	100.0	0.0	0.0	100.0	0.0	0.0

Fecundity: Basic statistics of Egg Diameters (ED) of mature *S. schall* females and the corresponding GSI and GI are given in Table 13. No significant variability in egg diameter mean with increase of fish size (R = 0.089) for ungrouped data, n= 53); ED was significantly correlated with GW (R = 1.0). Monthly variations in ED were evident with corresponding variability in GSI and GI. (Table 14).

Fecundity (F) and Relative Fecundity with Respect to Length (RFSL), were significantly correlated with SL for grouped data (R = 0.9 and 0.98, respectively) Fecundity, also showed significant association with W for grouped (R =0.43) whereas the relative fecundity (RFW) exhibited no significant correlation (R = -0.28). SL-F, SL-RFSL, W-F and W-RFW relationships were estimated for the grouped data as follow:

$$F = 325.9\ SL\ 0.11\ (R^2 = 0.85)$$
$$RFSL = 26.4\ SL - 470.5\ (R^2 = 0.803)$$
$$F = 47.2\ W - 1394\ (R^2 = 0.88)\ \text{and}$$
$$RFW = -0.168\ W + 404.8\ (R^2 = 0.89)$$

Table 12: Percentages of males of *S. schall* from the Nile ,at Assiut,Egypt, distributed according to each length groups in combination with three main categories of GSI and GI

			GSI			GI		
Month	No.	S.L	>0.7	0.7-1.3	<1.3	>15.9	15.9-29.5	<29.5
Nov.2000	11	26-32	63.6	36.4	0.0	100.0	0.0	0.0
Dec.	5	29-32	100.0	0.0	0.0	100.0	0.0	0.0
Jan.2001	2	30-31	100.0	0.0	0.0	100.0	0.0	0.0
Feb.	11	27-35	100.0	0.0	0.0	100.0	0.0	0.0
Mar.	2	28-31	0.0	100.0	0.0	100.0	0.0	0.0
Apr.	5	27-32	0.0	20.0	80.0	100.0	0.0	0.0
May	11	27-33	9.1	72.7	18.2	100.0	0.0	0.0
June	9	23-34	33.3	66.7	0.0	100.0	0.0	0.0
July	19	19-31	84.2	15.8	0.0	84.2	5.3	10.5
Aug.	3	31-35	100.0	0.0	0.0	100.0	0.0	0.0
Sept.	6	27-32	83.3	16.7	0.0	100.0	0.0	0.0
Oct.	6	21-30	83.3	16.7	0.0	100.0	0.0	0.0

Table 13: Egg diameter, GSI and GI in different length groups of females of *S. schall* from the Nile, at Assiut, Egypt

		X±SD (Min-Max)		
Length groups	No.	Egg diameter	GSI	GI
22	1	1463	2.8	2.6
24	1	1364	15.6	14.5
26	3	1297±214 (1057-1465)	3.9±2.8 (0.77-6.2)	27.3±20.6 (3.5-41)
28	6	1110±296 (946-1443)	1.1±0.4 (0.7-1.98)	5.7±2.2 (2.9-8.9)
30	14	1079±244 (740-1398)	1.9±1.6 (0.56-5.7)	5.8±4.6 (1.9-18.2)
32	14	1080±265 (735-1474)	2.4±3.9 (0.6-13.5)	5.2±7.3 (0.9-24.7)
34	5	1189±266 (743-1396)	2.5±1.3 (0.9-4)	4.2±2 (2-6.7)
36	2	1250±36 (1224-1275)	9.4±12 (0.77-18)	8.7±11 (1.1-16.4)
38	5	1168±259 (739-1373)	4.5±4.3 (0.5-10.4)	6.3±6.7 (0.38-14.3)
40	2	1254±19 (1241-1268)	2.6±1 (2-3.2)	1.1±0.2 (0.9-1.3)

Table. 14: Monthly average with egg diameter of females of *S. schall* from the Nile, at Assiut, Egypt

		X±SD (Min-Max)		
Month	No.	Egg diameter	GSI	GI
Nov.2000	6	747±6 (740-758)	0.9±0.2 (0.6-1.1)	4.3±2.2 (2-7.9)
Dec.	4	846±111 (743-985)	1±0.3 (0.6-1.4)	3.6±2.5 (1.2-6.8)
Jan.2001	2	1029±22 (1013-1045)	0.7±0.2 (0.6-0.9)	1.9±0.4 (1.6-2.2)
Feb.	5	1114±59 (1057-1179)	0.8±0.01 (0.7-0.8)	3.5±0.5 (3-4.2)
Mar.	10	1247±53 (1151-1345)	1.7±1 (0.6-3.3)	3±2 (0.9-7.3)
Apr.	4	1321±26 (1283-1343)	4.1±1.1 (3.3-5.7)	9.3±6.3 (4-18.2)
May	5	1347±70 (1224-1398)	11.8±4 (8.1-18)	17.6±4.8 (13 -25)
Jun.	5	1438±37 (1396-1474)	1.9±1.8 (0.6-4.6)	10.1±15 (1.5-37)
Jul.	4	1389±50 (1359-1463)	6.7±6.2 (2-15.6)	16.7±17 (2.6-41)
Aug.	6	1034±213 (735-1268)	1.4±1.5 (0.5-4.3)	3.1±4.4 (0.38-12)
Sept.	1	739	1	2.4
Oct.	1	739	2.8	2.9

Table 15: Fecundity variation with length groups of *S. schall* from the Nile, at Assiut, Egypt

		X±SD (Min-Max)	
Length groups	No.	F	RFSL
22	1	2928	133
24	1	16640	724
26	3	8058±5534 (2016-12879)	317±222 (77-515)
28	6	2716±1390 (1440-5208)	98±50 (51-186)
30	14	6085±5543 (1887-17600)	206±187 (65-587)
32	14	9819±16944 (1650-61000)	315±547 (53-1968)
34	5	11076±7360 (2940-21600)	330±218 (86-635)
36	2	53082±70029 (3564-102600)	1475±1945 (99-2850)
38	5	22456±19972 (2400-52800)	598±540 (63-1427)
40	2	27000±14029 (17080-36920)	664±335 (427-900)

Table 16: Fecundity variation with weight groups of *S. schall*. From the Nile, at Assiut, Egypt

		X±SD (Min-Max)	
Weight	No.	F	RFW
250	2	9784±9696 (2928-16640)	49±45 (17-81)
450	16	4075±3516 (1440-12879)	9.9±9.6 (3.6-33)
650	23	6932±7908 (1650-34100)	11.2±11.6 (3-50)
850	5	18604±22050 (2240-61000)	23.8±28 (3-82)
1050	4	46627±48565 (15680-102600)	44±45 (16-98)
1250	1	6300±5515 (2400-10200)	5.5±4.7 (2.3-8.7)
1450	1	17080	11.8
1650	1	36920	22.9

Table 17: The relationship between the months and absolute and relative fecundities of *S. schall*, from the Nile, at Assiut. Egypt

		X.+SD (Man-Max)		
Month	No.	Fecundity	R.Fec.SL	RFW
Nov.2001	6	2772.5±707.7 (2065-3904)	95.9±25 (66.6-130.0)	5.7±1.4 (3.7-7.2)
Dec.	4	3399.5±546 (2914-3900)	107.8±22.1 (86.5-128.1)	6.1±2.3 (4.0-8.5)
Jan.2002	2	2457.0±1141 (1650-3264)	77.6±34.5 (53.2-102.0)	3.8±0.8 (3.2-4.4)
Feb.	5	2163.0±384 (1560-2520)	77.1±11.8 (57.5-90.0)	4.6±0.5 (3.7-5.1)
Mar.	10	10076.0±10634 (1891-36920)	280.9±257.2 (65.2-900.5)	10.4±6.7 (3.4-22.9)
Apr.	4	16586.0±3860 (13144-21600)	524.9±102 (424.2-635.3)	23.2±5.6 (18.7-31.4)
May	5	56340±28727 (31200-102600)	1633.0±803 (821.0-2850)	66.3±23.8(39.0-97.7)
Jun.	5	5301.0±4645 (1440-11340)	179.9±155.9 (51.4-356.9)	10.9±10.4 (3.6-26.5)
Jul.	4	9413.7±6428.5 (2928-16640)	389.0±279.6 (133-723.5)	74.4±71.5 (11.0-172)
Aug.	6	5325.0±4830.7 (1920-12740)	164.5±156.5 (61.9-439.3)	7.0±7.3 (2.2-21.2)
Sept.	1	3965	123.9	6.3
Oct.	1	15680	412.6	15.7

Fecundity and relative fecundity show variability among length groups (Table 15), weight groups (Table 16) and months (Table 17). The fecundity, absolute and relative, increased with age group increase (Table 18).

Table 18: Relationship between age reproductive and some characters of *S. schall* from the Nile, at Assiut, Egypt

		X±S.D (Min -Max)			
Age	No.	F	R.F.SL	RFW	ED
II	2	9784±9696 (2928-16640)	428±417 (133-723)	127±64 (81-172)	1414±70 (1364-1463)
III	27	6211±7554 (1440-36920)	202± 209 (51-900)	10±9 (3-33)	11242±44 (740-1465)
IV	20	18188±2638 (1920-102600)	534±750 (62-2850)	22±28 (3-98)	1137±254 (735-1474)
V	4	14870±12174 (2400-31200)	391± 320 (63-821)	16±16 (2-39)	1120±273 (739-1373)

DISCUSSION

Sex ratio should be a consideration when choosing a species of fresh water fishes for culture and reproduction. The sex ratio designated as the percentage of males and females, is generally dealt with in the study of reproduction for knowing the sexual behaviour of the fish understudy during different months of the year (Shenouda *et al*., 1994). The ideal value of sex ratio is 1:1 (Hashem, 1973, 1981b). It may vary according to the year of capture (Latif and Shenouda, 1973), the season (Shenouda, 1985; Downs and White, 1997), the type of gears, the month (Hashem, 1973; Nural-Amin *et al*., 2005; Laleye, 2006) and length group (Dulcic and Kraljevic, 1996; Dulcic *et al*., 2003). In general, male may prevail in some populations (Mckenzie, 1964; Latif and Khallaf, 1974; Downs and White, 1997; Hashem, 1973) or females in other ones (Bishai and Abu-Gideiri, 1965; El-Maghraby *et al*., 1973; Hashem, 1973, 1981b; Rao and Sharma, 1984; Ghorab *et al*., 1986; Shenouda *et al*., 1994; Dulcic and Kraljevic, 1996; Dulcic *et al*., 2003; Nural-Amin *et al*., 2005; Ilkyaz *et al*., 2006).

Some Synodontis populations from two different Egyptian localities, the Nile at Assiut (present work) and a lacustrine one, Lake Nasser (Abass, 1982) show variability in sex ratio to a certain degree. For Synodontis populations of Assiut and Lake Nasser, there were no significant association between sex distribution and both length groups and months. The overall sex ratios were 1:1.04, 1:1.06 and 1:1.02 for *S. schall* of Assiut and Lake Nasser and *S. serratus* from Lake Nasser respectively with no departure from the ratio 1:1. Lake Nasser populations showed no departure from the expected value (1:1) through length groups and months. In *S. schall* and *S. nigrtia* from the Quene River, Bènin, males were observed numerically dominant than females ($p<0.05$) (Laleye, 2006). These authors also stated that according to the months, the sex ratio is in favor of the males for *S. schall* (ranged from 1: 0.9 to 1: 1.5 (M: F)) and in June, July, December, January and February for *S. nigrita* where the females were slightly dominant numerically (sex ratio ranged from 1:0.2 to 1:2.5). In Assiut populations of *S. schall* there was no association between sex and both size groups and months except for departure of expected sex ratio (1:1) in length group 32 (1:0.26) and March (1:5). Similarly, no association between sex and length groups and months in Lake Nasser populations of *S. schall* and S. serratus ($p<0.05$) with no departure of sex ratio 1:1 (for *S. schall* ranged from 1: 0.71 to 1: 2.5 in size groups and 1:0.72 to 1:1.47 in months; for *S. serratus* ranged from 1:0.72 to 1:3 in size groups and 1:0.89 to 1:1.11 in months). These findings reflected the observed differences in sex ratio patterns within and between fisheries; such situation can be interpreted in terms of differential maturation rates in addition to the other factors discussed previously. In spite of variability of sex ratio, the balanced sex ratios (1:1) are thought to evolve by a process known as frequency-dependent selection of the minority sex (Conover and Van Voorhees, 1990). These authors reported that increases in the proportion of the minority sex occurred in subsequent generations until a balanced sex ratio was established, thus confirming a central premise underlying the theory of sex ratio evolution.

The assessment of fecundity is the corner stone of the reproductive biology since it is not a stable character due to changes in environmental conditions and species specific factors (Nikolsky, 1963; Khallaf and Authman, 1991; Shenouda *et al*., 1995; Naeem *et al*., 2005). Sometimes, there are variability in fecundity for the same species in the some fisheries and in different years (Latif and Shenouda, 1973).

S. schall is a fecund fish, as observed from the high number of ova in the ripe ovaries (Halim and Gumaa, 1989). These authors also added that never the less, great variations in the timing of its spawning season were reported from one locality to the other. Identical breeding seasons for *S. schall* from the White Nile were reported by Nawar (1957) and Ponedelko and Schutov (1964). However, Guma'a (1979) referred to an earlier time for the same species from southern Sudan (June-July), and Bishai and Abu Gideiri (1965) reported the breeding season to be July to October in the Nile around Khartoum. Willoughby (1979) recorded August as the month with peak breeding activity in Lake Kainji with some ripe females appearing from May to November. The breeding seasons of *S . schall* in Lake Nasser was recoded in the April-September with two peaks in July and August for males and May-September with peak in July for females (Abass, 1982). In the present work, the breeding season was recoded in July-August for both sex in the Nile as Assiut, Egypt (Table 6).

Size at maturity (Lm) of *S. schall* show variability among sex and localities. Albert (1982) obtained Lm of 15.5 cm for this species. Halim and Gumaa (1989) observed different values of Lm of 14 and 15cm SL for males and females of *S. schall*, respectively in white Nile (Sudan) corresponding to an age of I. In Lake Kainji, males and females of the same species were found to mature at Lm of 10.4 and 11.8 cm respectively which corresponding to an age of maturity (Tm) of II. Lock (1982) reported Lm of 19.5 and 20 cm for males and females respectively for Lake Turkana. In the Kpong Head pond (Ghana), Lm was 26.6 cm for females *S. schall*. In Lake Nasser, Lm of that species was calculated by the authors based on Abass (1982) data to be 33.1, 31.4 and 32 for males, females and combined sex, respectively. In the Nile at Assiut, Egypt (present work), Lm was 29.4, 28.2 and 28.6 for males, females and combined sex, respectively. Such variability in Lm may be affected by several physical and biological factors in time and fisheries in addition to the fishing efforts and these may account for the discrepancies observed between the aforementioned findings. The influence of varying environmental conditions on maturity and reproductive traits have been postulated by Lae (1997), Leveque (1997), Duponchelle *et al.* (1998), Panfili *et al.* (2004), Laleye *et al.* (2006) and Shinkafi *et al.* (2011).

In spite of their description to some reproductive characteristics of *S. schall*, Nawar (1958), Ponedelko and Schutov (1964), Bishai and Abu Gideiri (1965), Rizkalla (1970), Guma'a (1979) and Willoughby (1979) did not describe fecundity in mathematical terms in relation to different morphological and anatomical features. However, Abass (1982), Halim and Gumaa, (1989), Laleye *et al.* (2006) and present authors described the relationship between fecundity or relative fecundity and fish size and weight by significant mathematical formulae which may be a power function or linear regression (Table 19). Halim and Gumaa (1989) described the fecundity-Age (A) relationship of *S. schall* by the following equation:

$$F = 5560A^{1.64}$$

Based on Abass (1982) data, such relationship was derived by the authors to be:

$$F = 376.1\ A^{2.8287}\ (R^2 = 0.951)$$

Table 19: Comparisons of fecundity and relative fecundity length and weight equation of *S. schall* with different authors

Locality	Equation	
Present work (2007)	$F = 1.87\ SL^{2.356}$	(R^2=0.754)
	$F = 4.1\ W^{1.14}$	(R^2=0.1769)
	$RF\ SL = 1.87\ SL^{1.356}$	(R^2=0.0263)
	$RFW = 39.61\ W^{-0.215}$	(R^2=0.0066)
Halime and Guma'a (1989)	$F = 15.62\ SL^{2.37}$	(R^2=0.73)
	$F = 193\ W^{0.84}$	(R^2=0.78)
Abass (1982)	$F = 0.00309\ SL^{6.5805}$	
	$F = -19586.6\ W+52.48$	
	$RF\ SL = 127.24\ SL-3542$	
	$RFW = 0.3953\ W^{0.3953}$	
Laleye` *et al.* (2006)	$F = 1.978\ TL^{2.817}$	(R^2=0.717)
	$F = 18.53\ W^{1.425}$	(R^2=0.809)

Table 20: The relationship between average fecundity with length groups of *S. schall* with different authors

	Assiut Present work			White Nile Halime and Guma`a (1989)		Lake Nasser Abass (1982)		Khartoum Nawar (1959)*		
Length	N	Mean	range	N	Mean	N	Mean	N	Mean	range
16					22824					
18					17144					
20					19093					
22	1	2928			25293					
24	1	16640			13658					
26	3	8058	2016-12879		38901					
28	6	2716	1440-5208		68526	1	5639			
30	14	6085	1887-17600		63012	1	7200			
32	14	9819	1650-61000		65648	5	10490			
34	5	11076	2940-21600			8	19540	3	19512	18700-20000
36	2	53082	3564-102600			2	36554	7	26319	11284-60960
38	5	22456	2400-52800			1	59572	14	31785	7340-58720
40	2	27000	17080-36920			1	68458	21	43815	10680-134140
42						1	75593			
44						1	83880	4	68103	19000-138360
46								4	56463	34590-88000
Total	53			45		21		53		

*Fishes are distributed among current length groups

In the present study, fecundity showed fluctuations among age groups since within each group, there was high variability (Table 18). The increase of fecundity with respect to length, weight or age of a fish may be a linear or a curvilinear trend (Shenouda *et al.*, 1995). Khallaf and Authman (1991) and Shenouda *et al.* (1994) described fecundity-length and/or fecundity-weight as a linear relationship for some Nile fish species. Sarker *et al.* (2002), Azadi and Mamun (2004) and Lawson (2011) referred to a significant increased fecundity of fish with the increase in size, weight and gonad weight as well.

Based on the studies of Nawar (1959), Abass (1982) and Halim and Gumaa (1989), Table 19-20 exhibits the degree of variability in the absolute fecundity of *S. schall* of different localities and periods. *S. schall* of Assiut showed a low fecundity in average among length groups in spite of the high values (102600 egg/fish) reflected by fecundity range in such groups (Table 20), with great variability. Laleye *et al.* (2006) reported a low fecundity ranged from1841-15076 egg/fish in *S. schall* from the Ouèmè River, Buènin; fish observed with the highest fecundity had a length of 20.8 cm TL and weighed 859. The great variation in the number of egg produced by the individual of cretin species was demonstrated for a large number of other tropical fishes (Nawar, 1959; Nawar and Yoakim, 1962, 1963; Ponedelko and Schutov, 1964).

The number of egg per gram ovary weight of *S. schall* in the Nile at Assiut, Egypt was found to range between 480-720 (568.11±57.78, 53). For the same species from the white Nile at Khartoum, such number ranged between1211 and 5442 (Halim and Gumaa, 1989). Willoughby (1979) reported a range of 1300-2500 eggs for *S. schall* from Lake Kainji. Abass (1982) recorded a range of 5639-76169 for increase of age from III to VI. In comparison with a range of 1440-102600 egg (arange mean from II to IV was 9784 to 14870, respectively) for *S. schall* from Assiut, Egypt. Halim and Gumaa (1989) gave an average mean range of 17736 to 74743 for age range of I-IV.

Egg diameter of *S. schall* of the Nile at Assiut varied from one specimen to the other and even between eggs from the same ovary (Halim and Gumaa,1989). These authors reported a range of 0.6 mm to 0.9 mm from the white Nile in Khartoum, Nawar (1959) reported also arange of 0.712 to 1.870 mm for the same species at Khartoum. Gave a range of 1.15-1.20 mm for *S. schall* from Ivory Coast. Abass (1982) recorded a maximum egg diameter of 1.575 mm with egg diameter average ranged from 0.196 mm (28-35 cm) in January to 1.015 mm in July (28-44 cm) for the same species from Lake Nasser, Egypt. Laleye *et al.* (2006) reported a range of 0.5-1.00 mm for *S. schall* from the Ouèmè River, Buènin. In the present study, an egg diameter range of 0.735 mm (August) to 1.474 mm (June) was recorded.egg diameter average ranged between 0.747 mm (November) and 1.438 mm (June). Such variations in the egg diameters were similarly reported for other tropical fishes including other species of genus Synodontis (Abass,1982; Awachie and Ezenwaji, 1981; Laleye *et al.*, 2006).

Authors' contribution: IAAM suggested the point of research and provided substantial contribution to conception and design, significant contribution to data acquisition and statistical analysis, drafting the manuscript and critical review of article, approval of final revision. AAH collected and measured specimens, estimated reproductive parameters and drafted the manuscript.

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