

## REPRODUCTION PERFORMANCE OF *OREOCHROMIS NILOTICUS* THROUGH THREE SEASONS IN EARTHEN PONDS

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**Key words:** reproductive performance, relative fecundity, *Oreochromis niloticus*, water temperature, earthen pond.

### ABSTRACT

Reproductive performance of *Oreochromis niloticus* broodstock was examined in earthen ponds through three spawning seasons in Sedy Salm City, Kafer Al-Sheikh Governorate. 21 thousand females (65-150 g) and 10.5 thousand males (75-200 g) were randomly assigned to 10 ponds (750 m<sup>2</sup>) at a density of 600; 700 & 800 females and 300; 350 & 400 males per pond. Fish were exposed to different levels of water temperature ranging from 20.04 °C to 36.06 °C during the three spawning seasons.

*Oreochromis niloticus* began to lay eggs at water temperature 20.06 °C. Spawning percentage increased during April; May and June were 23.82; 30.05 and 20.61 % at water temperature 20.04; 26.26 and 34.75 °C in three seasons respectively. During May, 2000, 2001 & 2002 female gave high number of fries / m<sup>2</sup>/ day ; 7.85±1.73 ; 6.84±1.16 and 7.85±2.03 fries / m<sup>2</sup> /day, respectively. Also, high female relative fecundity were 1.25±0.41; 1.76±0.24 and 1.3±0.34 fries/g female body weight at three season, respectively. On the other hand, high fry production per spawn per female was 184.6±53.01; 149.26±31.87 and 143.26±25.37 fries / female, when water temperature was 20.04; 26.79 and 26.26 °C, respectively.

It is evident that the reproductive performance of *Oreochromis niloticus* could be maximized by holding broodstock under natural photoperiod in water temperature above 20°C, the optimal reproductive performance occurs through summer season during May. The optimal water temperature range was 28-31 °C and females with highest body weight started to spawn first and gave more total fries.

## INTRODUCTION

*Tilapia* species are very important either in natural or cultured our freshwater ecosystems. Economic importance of *Tilapia* is constantly increasing for their fast growth, disease resistance, different feeding habits and palatability (Dagzie, 1982). *Tilapias* are second to the carps in weight harvested from culture ponds (Lovshin, 1997). The Nile tilapia, *Oreochromis niloticus*, is the most widely cultured tilapia in the world because of its rapid growth, late age of sexual maturity and planktivorous feeding habits (Gonzalez, 1997).

In the Delta area of Egypt, spawning of *Tilapia* extends from April to November with a peak in early summer (El-Saby, 1951). *Tilapia* culture is hindered by reproductive characteristics of its main species. Excessive reproduction in culture ponds reduces the growth rate of adult fish, and reduces marketable production. The low fecundity of *Tilapia* can make the production of adequate numbers of fingerlings difficult. *Tilapia* can reproduce in concrete tanks (Badawy, 1993). Also, he reported that the number of eggs per spawn may differ among species and strains, but within species the larger the female the greater the number of fry produced.

Ovulation based on the life cycle was a reasonable means for predicting time of stripping. Hormonal induction of ovulation would seem to be a logical method for determination of egg collection; however, cichlids have responded poorly to gonadotropic therapy (Rana, 1988). On the other hand, the physiological characteristics of tilapia gametes provide an advantage in chromosome manipulation. Eggs retain high fertility for three to six hours post-immersion in water (Myers *et al.*, 1995) and sperm remain motile in water for several hours in contrast with most fishes (Yehekel and Avtalion, 1986).

Carrillo *et al.* (1993) reported that spawning time on Sea bass (*Dicentrarchus labrax*) could be advanced by using a month of long days in an otherwise constant short photoperiod.

Smith (1996) reported that reproductive success and fry survival of red tilapia with genetic components from *O. niloticus*, *O. aureus* and *O. mossambicus* to pure *O. niloticus*. No significant difference was found in reproductive performance and in fry survival during sex reversal between the red tilapia and Nile tilapia. Nile tilapia females yielded 2,701 fry and red females 2,718 fry per kilogram of body weight per 13- to 19-day spawning cycle. An

average of 80 % and 77% of the Nile and red tilapia fry, respectively, survived the 14- to 28-day sex reversal period.

Abd El-Nasser *et al.* (2001) reported that the manipulation of photoperiod and temperature as the main factors in gonadal regulation and spawning of *Clarias gariepinus* became one of the means to adjust the timing of spawning to offer eggs and fry when they are demanded by fish farms.

Devlin and Nagahama (2002) found that sex determination in fish is a very flexible process with respect to evolutionary patterns observed among genera and families, and within individuals is subject to modification by external factors. These influences can affect the fate of both somatic and germ cells within the primordial gonad, and include the action of genetic, environmental (e.g. temperature), behavioural and physiological factors.

Su *et al.* (2002) reported that the genetic correlations of reproductive traits with body weight in rainbow trout at ages prior to 252 days were not significantly different from zero, while those with body weight at ages from 252 to 364 days were significantly greater than zero and increased with increasing age. The range of estimated genetic correlations between reproductive traits and body weight at ages from 252 to 364 days were: for egg size, from  $0.18 \pm 0.08$  to  $0.29 \pm 0.06$ ; for egg number, from  $0.21 \pm 0.08$  to  $0.32 \pm 0.06$ ; for egg volume, from  $0.28 \pm 0.08$  to  $0.45 \pm 0.06$  and for post-spawning weight,  $0.25 \pm 0.11$  to  $0.61 \pm 0.08$  g. As a whole, the genetic correlations between reproductive traits and body weight during the first year were favorable, allowing positive genetic improvement in both body weight and reproductive traits.

The objective of this study was to evaluate the effects of water temperature, female brood fish age and brood fish weight on the production of fries in earthen ponds through three spawning seasons.

## **MATERIAL AND METHODS**

### **I- Breeding systems**

*Oreochromis niloticus* broodstock were collected from different fish farms surrounding the fish hatchery and transported to 10 earthen managed ponds (750 m<sup>2</sup>) with improved pond design and management in Sedy Salm City, Kafer Al-Sheikh Governorate. Fish stocked at a sex ratio of 1 male : 2 females. On the first season (year 2000) fish stock was 6000 females ( $150 \pm 11.79$  g) and 3000 males ( $200 \pm 20.41$

g). On the second season (year 2001) 7000 females ( $65 \pm 3.33$  g) and 3500 males ( $75 \pm 3.33$  g) and on the third season (year 2002) 8000 females ( $112.4 \pm 14.25$  g) and 4000 males ( $132.4 \pm 14.25$  g) were randomly assigned to 10 earthen ponds. The water depth was maintained at about 50 cm 10% of Water was changed every third day. The experiment lasted 6 months during the spawning season from March to September.

Fish were exposed to air temperature naturally from  $20.04$  °C to  $36.06$  °C in earthen ponds and fed on diets 25% protein twice daily at a rate of 2.5% body weight/day. 10 earthen ponds had the same ecological conditions of water were used : -

Oxygen (ppm)	Alkalinity mg (CaCO <sub>3</sub> ) / L	NH <sub>4</sub> mg / L
$10.56 \pm 1.54$	$365.5 \pm 18.5$	$0.075 \pm 0.006$

Female broodstock were checked for spawning after 14 day from stocking by using net mesh pore 1 mm at the edge of the pond in the morning. After about 21 days, fries are collected and are numbering in nursery net enclosures (hapas) ; usually made of plastic mosquito netting (mesh pore 1 mm). Hapas are very easy to manage; because fry cannot escape harvesting. Hapas sizes are from 1-2 m<sup>2</sup> with a depth of 1-2 m, suspended on concert pond.

Transfer the fish broodstock to the same pond. Relative fecundity were calculated in relation to total number of fries per gram body weight of females present in that pond and the spawning percent were calculated in relation to total number of fries in one spawn per total number of fries in season x100.

## II- Statistical analysis:

Statistical analysis was performed using the analysis of variance (ANOVA) and Duncan's Multiple Range Test (Duncan, 1955). SAS program was used for statistically analysis according to Snedecor (1971).

## RESULTS AND DISCUSSION

A suitable temperature and controlled photoperiod permit a reasonably close prediction of ovulation time. *Tilapia* do not respond well to hormonal induction to spawning but can be induced to spawn through manipulation of environmental variables (Shelton, 1989). Also, El-Naggar *et al.* (2000) reported that Nile tilapia (*Orochromis niloticus*) did not lay eggs when water temperature decreased below

19 °C. In our study, Nile tilapia (*Oreochromis niloticus*) begin to give fries at water temperature 20.04 °C (Tables 3 & 5). This agrees with Hughes and Behrends (1983) who observed that in spawning of *Oreochromis niloticus* minimum seed production was relatively at low temperatures 24 °C followed by a marked increase with a sudden rise in water temperatures, reaching a high of 31 °C.

The reproduction activity of *Tilapia* begins at 22°C, and the optimal temperature range is 25-29°C (Shmuel and Yoel, 1975). In the present work, the reproduction activity of Nile tilapia (*Oreochromis niloticus*) was maximum at the optimal temperature range 25.06 - 31.65 °C, female gave maximum number of fries per day were  $7.85 \pm 1.73$ ;  $6.84 \pm 1.16$  &  $7.85 \pm 2.03$  fries respectively, in May from the three season (years 2000, 2001 & 2002) as shown in Table 4. This agrees with Shaikh and Hafeez (1993) who revealed that long photoperiod-warm temperature accelerated gametogenic progress in the prespawning season. Short photoperiod-warm temperature had inhibitory or regression effect in most seasons. Warm temperature in the spawning season, stimulated spawning and low temperature inhibited it regardless of photoperiod. Low temperature in long and short photoperiod initiated gonadal recrudescence in both sexes on Cyprinid fish. *Cyprinion watsoni*.

El-Naggar *et al.* (2000) reported that spawning percentage for *Oreochromis niloticus* averaged 10 and 34% for natural photoperiod treatments when water temperature increased to 19-21°C. The most reproductive period coincided with a rise in water temperature from 22 to 27 °C.

In our study, spawning percentage increased during April, May and June (23.82 ; 30.85 & 20.61 %) more than other months (Table 5 and Fig 6) and the females gave the highest fries ( $184.6 \pm 53.01$ ;  $149.26 \pm 31.87$  &  $143.26 \pm 25.37$  fries / month) at average water temperature 20.04; 34.75 & 26.26 °C respectively, in the three season, as shown in Table 4 and Fig 5. This result agree with Shmuel and Yoel (1975) reported that spawning of *Oreochromis niloticus* and *Oreochromis aureus* begins at 22°C, and the optimal temperature range is 25-29°C. In this temperature range, spawning can be easily accomplished throughout the whole year. Similarly, soon after the females complete the incubation and nursing of the young fry they are ready for a new round of mating and highest production of fries in earthen ponds (pure and crossbred fry) during April and May in shallow ponds stocked with one male to every five females.

Size often plays an important role in reaching sexual maturity and reproductive success. Often the fastest growing individuals within a population will reach sexual maturity the earliest (Dunham, 1990). Sex determination in fish is a very flexible process with respect to evolutionary patterns observed among genera and families, and within individuals is subject to modification by external factors. These influences can affect the fate of both somatic and germ cells within the primordial gonad, and include the action of genetic, environmental (e.g. temperature), behavioural, and physiological factors (Devlin and Nagahama 2002).

In this study, it was observed that female body weight play an important role in the beginning of spawning. Females with highest body weight ( $150 \pm 11.79\text{g}$ ) gave highest fries number throught April. Seeds recovered during the first harvest through April ( $109.35 \pm 28.5$  total fries  $\times 10^3$ ) in the first season (year 2000) as shown in Tables 1 & 3 and Fig. 1. Females with low body weight ( $65 \pm 3.33\text{g}$ ) gave more total fries throught June. Seed production gradually increased through June ( $99.95 \pm 22.56$  fries  $\times 10^3$ ) in the second season (year 2001) as shown in Tables 1 & 3 and Fig. 2 when all females reached maximum seed production. This fourth spawning coincided with a rise in water temperatures, reaching  $34.75^\circ\text{C}$ . While, females with the intermediate body weight ( $112.4 \pm 14.25\text{g}$ ) gave more total fries throught May. Seeds were recovered during the first harvest ( $115.37 \pm 20.76$  fries  $\times 10^3$ ) in the third season (year 2002) as shown in Tables 1 & 3 and Fig. 3. This result agrees with Shmuel and Yoel (1975) who reported that spawning of *Tilapia* family and sexual maturity when the fish are 4-6 months old, and reach a body weight 50-100g. Although Abd El-Nasser and El-Ghobashy (2000) reported that the bigger sizes of *Clarias gariepinus* in the wild start to spawn first before the intermediate sizes then comes the turn of the smaller ones at the end of the spawning season.

Hughes and Behrends (1983) reported that the highest total seed production from *Oreochromis niloticus* differed with respect to age and mean weight of females. The highest total seed were found in treatments characterized by the lower stocking density (5/m<sup>2</sup>) and lower sex ratio (1:2), while low or intermediate levels of seed production were found for either the 1:2 or 1:3 sex ratio in combination with the 10/m<sup>2</sup> stocking density. Siraj *et al.* (1983) reported that low fecundity of female *Oreochromis niloticus* (44 g.) range of from as low as 580 eggs per clutch per year and females (280

g.) to as high as 1820 eggs per clutch per year. In our study, the highest relative fecundity increased with the decreased female body weight. Female with low body weight ( $80.71 \pm 16.06$  g) has more relative fecundity ( $1.76 \pm 0.24$  fries/g body weight) as shown in Tables 1 & 5 and Fig. 4. On the other hand, female with high body weight ( $150 \pm 11.79$ g) has small relative fecundity ( $1.25 \pm 0.41$  fries/g body weight) as shown in Tables 1 & 5 and Fig. 4. Also, females with intermediate body weight ( $112.4 \pm 14.25$ g) have intermediate relative fecundity ( $1.30 \pm 0.34$  fries/g body weight) as shown in Tables 1 & 5 and Fig. 4. This result agrees with Silvera (1978) who found that seed production of *Oreochromis niloticus* was reduced significantly when brood fish density reached 8 fish / m<sup>2</sup> at a total female weight of 526 g/m<sup>2</sup>. Also, Hussein and Farag (2002) found that relative fecundity to *Oreochromis niloticus* in hapa ranged from 2.29 to 3.62 fries / g female body weight through spawning season.

Huang and Gall (1990) stated that the genetic correlations between body weight and egg production traits in channel catfish, especially body weight at early stages of development. They found no genetic relationship of fry weight with female post-spawning weight. In our study, fries production per spawn were  $184.6 \pm 53.01$ ;  $149.26 \pm 31.87$  and  $143.26 \pm 25.37$  fries / female, when water temperature was 20.04; 26.79 and 26.26 °C, respectively as shown in Table 4 and Fig 5. That is to say, fries production per spawn per female did not vary among treatments for all levels of water temperature or the small change in number of females in the three seasons, but depend on female body weight, which may suggest that water temperature affects merely spawning frequency but not the volume of fries production per spawn. These results agree with Su *et al.* (1996) who reported that reproductive efficiency is another economically important trait, especially for trout breeders producing fertilized eggs or fingerlings. Consequently, the genetic correlations among body weight and reproductive traits have an important implication to the design of breeding programs to enhance the overall net value of a stock. El-Naggar *et al.* (2000) stated that egg production per spawn per female did not vary among treatments for all levels of crude protein, photoperiod and water temperature, which may suggest that photoperiod affects merely spawning frequency but not the volume of egg production per spawn.

Results show that the reproductive performance of *Oreochromis niloticus* could be maximized by holding broodstock

under natural photoperiod in water temperature above 20°C, the optimal reproductive performance occurs through summer season during April, May and June. The optimal water temperature range from 28 to 31 °C, females with the highest body weight started to spawn first and gave more total fries before the intermediate body weight and water temperature affected merely spawning frequency, but not the volume of fries production per spawn.

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**Table (1): Monthly average number and weight of females *Oreochromis niloticus* broodstock in earthen ponds through three spawning seasons.**

Year	2000		2001		2002	
Month	No. of fems	FAW	No. of fems	FAW	No. of fems	FAW
March			700.00 ±65.7a	65.00 ±3.33d		
April	600.00 ±47.14a	150.00 ±11.79f	669.14 ±33.73ab	80.71 ±16.06d		
May	568.00 ±120.74a	163.86 ±11.23e	665.11 ±33.32ab	121.89 ±6.47cd	805.00 ±15.81a	112.40 ±14.25e
June	600.00 ±47.14a	192.10 ±15.04d	670.00 ±46.13ab	142.20 ±12.59bcd	790.00 ±31.62a	151.80 ±13.70d
July	600.00 ±47.14a	216.25 ±11.49c	679.00 ±48.07a	177.30 ±13.00bc	805.00 ±89.64a	181.40 ±10.91c
August	600.00 ±47.14a	248.00 ±4.32b	634.25 ±44.02b	207.50 ±3.74b	767.00 ±84.33a	218.40 ±12.55b
September	600.00 ±40.82a	269.00 ±8.16a	635.20 ±12.76b	222.80 ±5.01a	800.00 ±115.47a	226.00 ±13.33a
F-value	0.41	184.26	2.90	8.81	0.43	75.33
P >	0.842ns	0.0001***	0.015*	0.0001***	0.79ns	0.0001***

Means with the same letter in the same column were not significantly different ( $P < 0.05$ )

FAW = Female average weight

**Table (2): Monthly average number and weight of males *Oreochromis niloticus* broodstock in earthen ponds through three spawning seasons.**

Year	2000				2001				2002			
	Month	No. of male	MAW	Day	No. of male	MAW	Day	No. of male	MAW	Day		
March					350.00 ±32.85a	75.00 ±3.33b	29.90 ±0.32 a					
Abril	300.00 ±23.57a	200.00 ±20.41f	29.10 ±1.66a	334.57 ±16.86ab	91.43 ±17.43b	28.40 ±3.37ab						
May	284.00 ±60.37a	213.86 ±11.23e	22.57 ±1.88b	332.56 ±16.66ab	134.33 ±7.53b	21.44 ±2.5c	402.50 ±7.91a	132.40 ±14.25e	18.80 ±3.08b			
June	300.00 ±23.57a	236.10 ±15.80d	21.00 ±2.00c	335.00 ±23.07ab	155.00 ±13.26b	25.20 ±6.83abc	395.00 ±15.81a	187.80 ±9.85d	20.70 ±0.48a			
July	300.00 ±23.57a	263.75 ±14.09c	19.13 ±1.85d	339.50 ±24.03a	194.00 ±16.00a	23.60 ±11.82bc	402.50 ±44.82a	219.40 ±8.73c	20.50 ±0.53ab			
August	300.00 ±23.57a	292.29 ±10b	21.43 ±0.8bc	317.13 ±22.01b	225.00 ±2.36b	22.75 ±4.59c	383.50 ±42.17a	246.40 ±11.13b	21.30 ±3.13a			
September	300.00 ±20.41a	319.00 ±8.16a	30.00 ±0.47a	317.60 ±6.38b	239.80 ±2.86b	21.60 ±0.52b	400.00 ±57.74a	256.00 ±6.67a	21.00 ±0.47a			
F-value	0.41	109.95	84.76	3.31	3.23	3.43	1.04	94.09	2.38			
P >	0.84ns	0.0001***	0.0001***	0.007**	0.008**	0.0054**	0.398ns	0.0001***	0.066ns			

Means with the same letter in the same column were not significantly different ( $P < 0.05$ )

MAW = Male average weight

Day = Harvest day

Table (3): Monthly average number of fries per spawn of *Oreochromis niloticus* broodstock in earthen ponds through three spawning seasons.

Year	2000			2001			2002		
	No.L	No.O	T.F.	No.L	No.O	T.F.	No.L	No.O	T.F.
Month									
March				44.60	6.00	53.60			
				±16.01b	±2.11d	±16.46c			
April	99.40	9.95	109.35	73.57	19.57	91.94			
	±28.61ab	±0.6cd	±28.50a	±11.69ab	±7.15b	±4.90a			
May	86.43	11.43	97.86	62.78	29.33	96.11	91.20	24.17	115.37
	±24.12ab	±3.09bcd	±25.26a	±23.24ab	±7.32a	±11.07a	±22.57a	±11.89a	±20.76a
June	53.10	8.30	61.40	79.05	20.90	99.95	49.15	16.40	65.55
	±19.16ab	±3.68d	±19.05bc	±19.90a	±8.91b	±22.56a	±16.46bc	±5.65b	±16.74b
July	40.63	11.75	52.38	64.14	7.50	71.64	64.85	30.10	94.95
	±15.4b	±4.16abc	±16.33c	±17.39ab	±3.54d	±14.63b	±22.79b	±10.75a	±27.95ab
August	63.86	14.14	78.00	36.63	13.13	49.75	44.50	28.20	72.70
	±25.64a	±3.84ab	±25.57b	±15.03b	±5.24c	±17.94c	±18.26c	±3.33a	±17.57ab
September	45.00	15.00	60.00	13.40	8.60	22.00	22.20	13.10	35.30
	±8.16b	±4.08a	±12.25bc	±5.56b	±2.46cd	±2.58d	±6.23d	±4.90b	±10.84b
F-value	2.14	5.24	10.90	1.98	22.03	40.05	19.63	8.43	2.216
P >	0.074ns	0.0005***	0.0001***	0.082ns	0.0001***	0.0001***	0.0001***	0.0001***	0.0823 ns

Means with the same letter in the same column were not significantly different ( $P < 0.05$ )

No.O = No. oversize\*1000

T.F. = Total fries\*1000

No.L = No. larvae\*1000

**Table (4): Monthly average number of fries per female *Oreochromis niloticus* broodstock in earthen ponds through three spawning seasons.**

Year	2000			2001			2002		
Month	F	FD	F.D.F.	F	FD	F.D.F.	F	FD	F.D.F.
March				76.70 ±24.63c	1.292 ±0.55 de	2.56 ±0.548 ef			
Abril	184.60 ±53.01 a	3.771 ±0.985 ab	5.50 ±2.29b	138.01 ±10.9a	3.144 ±0.702 bc	4.74 ±1.14cd			
May	176.99 ±35.61a	4.421 ±1.33 a	7.85 ±1.73a	144.91 ±19.16a	4.542 ±0.73 a	6.84 ±1.16a	143.26 ±25.37a	6.339 ±1.75 a	7.85 ±2.03a
June	103.38 ±34.27bc	2.950 ±0.96 bc	4.97 ±1.76bc	149.26 ±37.87a	4.170 ±1.23 b	6.26 ±1.88ab	83.17 ±21.57c	3.170 ±0.82 c	4.02 ±1.06c
July	87.11 ±25.56c	2.776 ±0.95 bc	4.60 ±1.48cd	104.99 ±17.53b	3.478 ±1.25 b	5.18 ±2.01bc	118.18 ±32.04b	4.636 ±1.37 b	5.76 ±1.55b
August	130.95 ±43.37b	3.584 ±1.07 ab	6.02 ±1.83bc	79.68 ±30.61c	2.331 ±1.01 cd	3.75 ±1.75de	94.58 ±19.01c	3.435 ±0.77 c	4.45 ±0.69c
September	101.22 ±25.83bc	2.009 ±0.42 c	3.39 ±0.89d	34.63 ±3.99d	1.017 ±0.10 e	1.60 ±0.16f	44.81 ±14.21d	1.676 ±0.49 d	2.13 ±0.65d
F-value	12.15	5.790	9.43	38.25	15.880	18.13	25.40	24.155	26.53
P >	0.0001***	0.0002***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***

Means with the same letter in the same column were not significantly different (P < 0.05)

F = fries/female\*1000

FD = fries/day\*1000

F.D.F = Fries/day/female

**Table (5): Monthly relative fecundity, average temperature and spawning percent of *Oreochromis niloticus* broodstock in earthen ponds through three spawning seasons.**

Year	2000				2001				2002			
	Month	T	SP	RF	T	SP	RF	T	SP	RF		
March					22.90	11.05	1.17					
April	20.04	23.82	1.25	26.79	18.96	1.76						
May	25.06	21.32	1.09	31.65	19.82	1.19	26.26	30.05	1.30			
June	27.51	13.38	0.55	34.75	20.61	1.06	28.83	17.08	0.55			
July	28.55	11.41	0.41	36.06	14.77	0.60	29.92	24.73	0.65			
August	26.06	16.99	0.53	32.92	10.26	0.38	27.31	18.94	0.44			
September	24.02	13.07	0.37	30.34	4.54	0.16	25.17	9.20	0.20			
F-value		11.14	26.36		40.09	72.55		24.02	48.53			
P >		0.0001***	0.0001***		0.0001***	0.0001***		0.0001***	0.0001***			

Means with the same letter in the same column were not significantly different ( $P < 0.05$ ) T = Temperature  
 RF = Relative fecundity (No. of fries/gram body weight) SP = Spawning Percent



Fig (1): Average monthly number of fry per spawn of *Oreochromis niloticus* broodstock in earthen ponds through spawning season 2000.

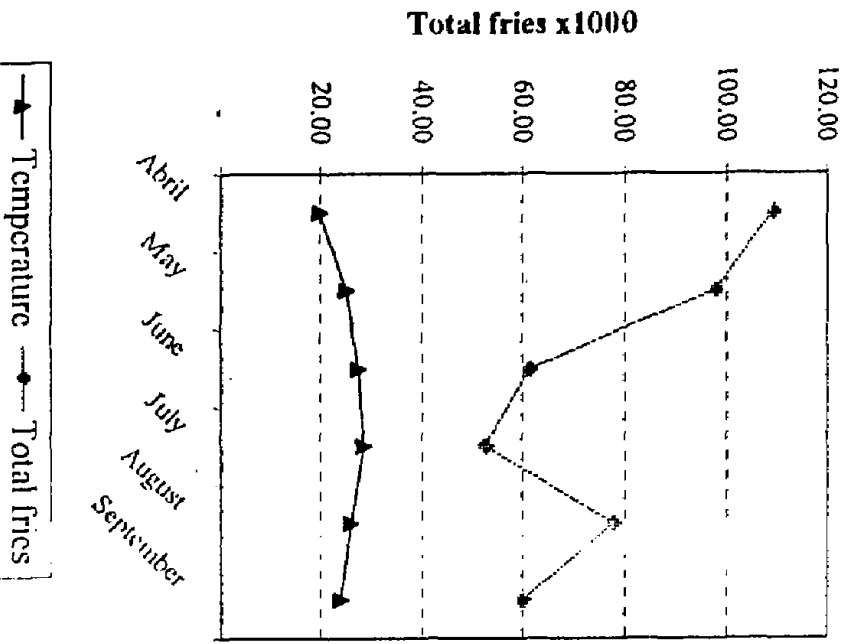
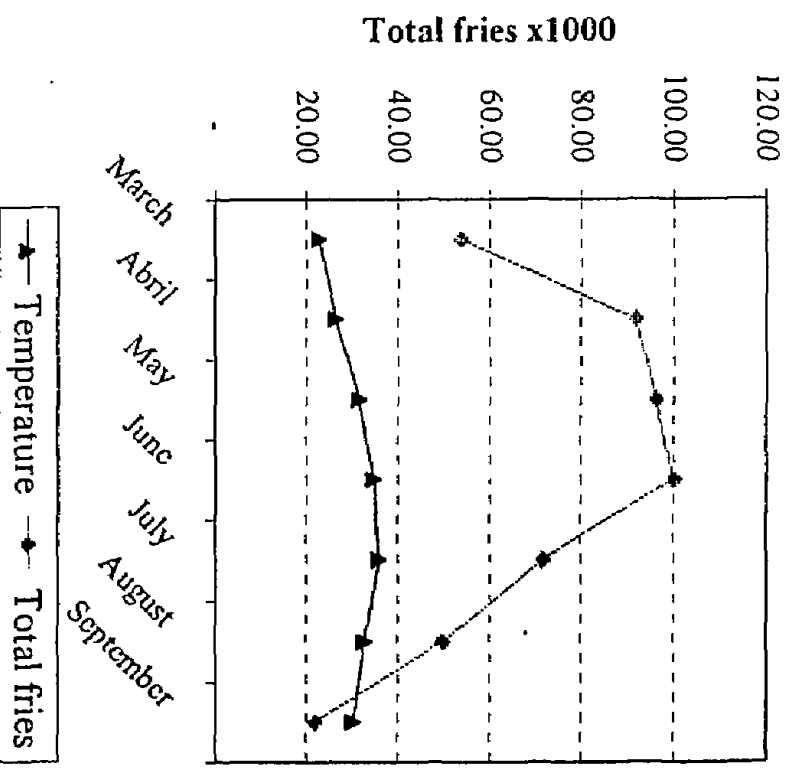
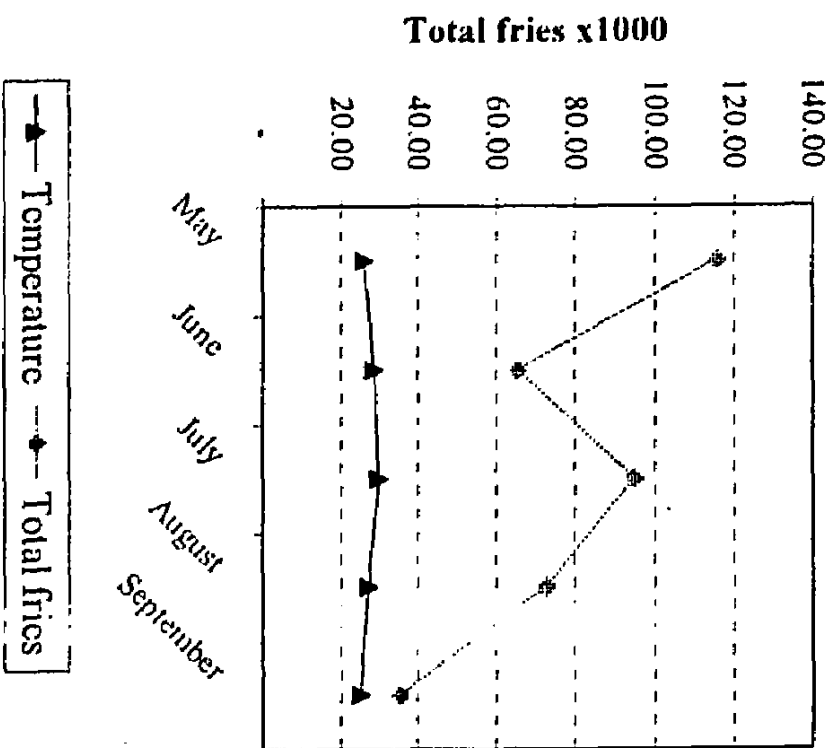


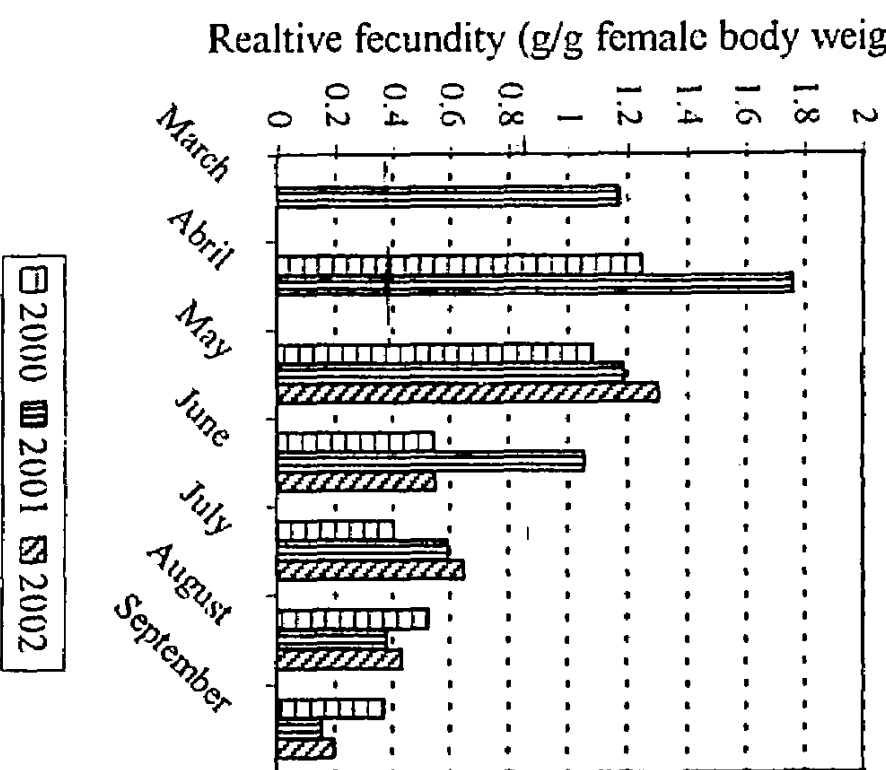
Fig (2): Average monthly number of fry per spawn of *Oreochromis niloticus* broodstock in earthen ponds through spawning season 2001.



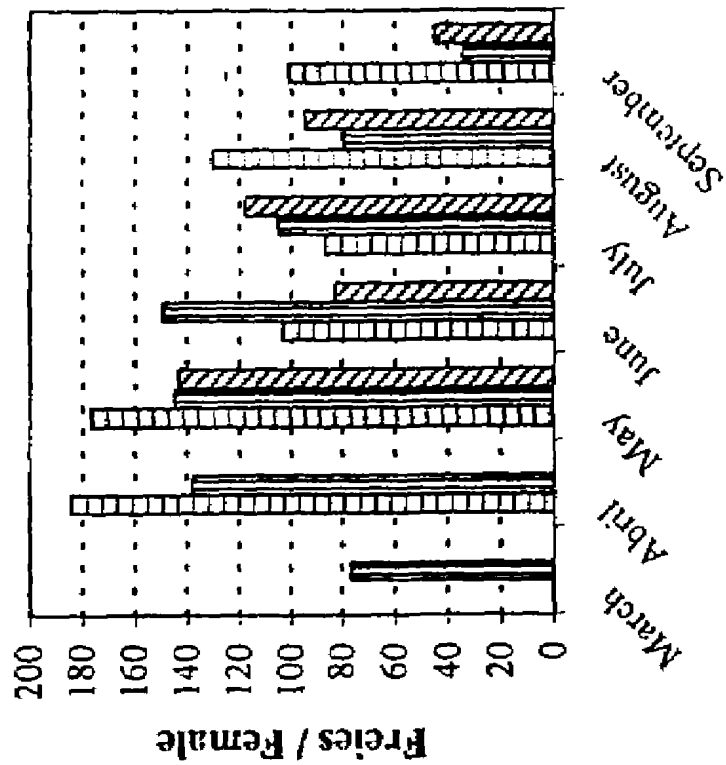
**Fig (3): Average monthly number of fry per spawn of *Oreochromis niloticus* broodstock in earthen ponds through spawning season 2003.**



**Fig (4): Monthly relative fecundity of *Oreochromis niloticus* broodstock in earthen ponds through spawning seasons.**



**fig (5): Average monthly number of fry per female of *Oreochromis niloticus* broodstock in earthen ponds through spawning seasons.**



**Fig (6): Monthly spawning percent of *Oreochromis niloticus* broodstock in earthen ponds through spawning seasons.**

