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# STUDIES ON THE MASS PRODUCTION OF NILE TILAPIA, OREOCHROMIS NILOTICUS, FRY IN CONCRETE BASINS

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ABSTRACT

Three experimental trials were conducted with Nile Tilapia, *Oreochromis niloticus*, breeders to test the effects of females brood fish size, brood fish sex ratio and protein sources of brood fish feed on the mass production of fry in concrete basin. The combination of test variables that resulted in highest fry production was that of the use of breeders with weights of 80–130 g, the lower sex ratios of male to female (1:1 and 2:3) and the use of pelleted diet of animal and plant protein mixture (fish meal and soybean meal).

## INTRODUCTION

There is no doubt that, Tilapias are prime domesticated species for fish culture because of their high tolerance to adverse environmental conditions, their relatively fast growth on low protein diets and their little susceptibility to disease. Also they have a short generation time and breed in captivity. Most important of all, they enjoy wide acceptance as food fish because of their high palatability (Pullin and Lowe-Mc Connel, 1982).

For a fish culture activities in Egypt and many of the developing countries, the necessity of dependable supply of Nile Tilapia, *Oreochromis niloticus*, fry is quite obvious, yet

the problem of mass production remains. Therefore the development of Tilapia hatcheries was felt to be the key to expansion of the fish culture industry (Pullin and Lowe Mc Connel, 1982; Mires, 1982; Rafael and Garacia, 1983). Recently, some of the Egyptian fish hatcheries have relatively succeeded in this field, but still has to overcome the problem of the low fry production from *O.niloticus* spawns. Among the factors considered to be important in fry production are density of brood fish, brood fish sex ratio, brood fish nutrition, frequency of removing brood fish or fry from the brooding unit, type of brooding unit, water quality and rate of water exchange (Westers, 1979; Mires, 1982; David and Behrends, 1983; Santiago *et al.*, 1985 ). Thereby, the purposes of the present study were to evaluate the effects of females brood fish size, brood fish sex ratio and protein source of brood fish feed on the production of fry in concrete basins.

## MATERIAL AND METHODS

The study was conducted at Balteem Research Station, National Institute of Oceanography and Fisheries, Kafr El-Shiekh Governorate, Egypt, from June to October, 1992- about 124 days-in concrete basins. The basins were 8.0 m long x 3.0 m wide. Water level was maintained at approximately 0.6 m depth. Water temperature during the study ranged from 22 to 31 °C.

1.Evaluation of body size of breeders:

Two sizes of Nile Tilapia breeders, *Oreochromis niloticus*, were used in this trial. Males and females of the small size group averaged 92.5 and 86.2 g, respectively, while

in case of the big size group, the males and females averaged 145.1 and 131.5 g, respectively. The stocking density was 16 breeders per basin (14.4 $m^3$). Fish were supplementally fed at a rate of 1.5% of initial body weight/day throughout the study with a 28.9% protein pelleted ration (Diet A, Tables 1 and 2).

At 7–10 day intervals, fry produced in each basin were collected with a dip net and counted. Then the fry were transferred to different concrete ponds of 48 $m^2$ for a 18–21 days nursing period. At the end of the trial the mean weights of breeders, the total number of fry and advanced fry produced in each treatment were measured.

2. Evaluation of sex ratios of breeders:

Five sex ratios of breeders 1:1, 1:2, 1:3, 2:3 and 1:4 (male to female) were compared. Mean weights of the fish were 131.5 g (female) and 145.1 g (male). Stocking density was 16 breeders / basin. Brood fish were fed at a rate of 1.5% of initial body weight / day throughout the trial with a 28.93% protein pelleted ration, diet A (Table 1 and 2). After 124 days of spawning period, the total number of fry produced in each treatment was measured.

3. Evaluation of protein source of brood fish feed:

Three composition of pellets were compared:

a) The standard pellet (Diet A), containing 28.93% crude protein with the supplemental protein furnished by fish meal and soybean meal.

b) The fish meal pellet (Diet B), containing 29.23% crude protein with all the supplemental protein furnished by fish meal alone.

c) The soybean meal pellet (Diet C), containing 29.01%

crude protein with all the supplemental protein furnished by soybean meal alone.

The composition and chemical analysis of the pellets are reported in Table 1 and 2. Mean initial weights of the fish were 131.5 g (female) and 145.1 g (male). The stocking density was 16 breeders / basin. The feeding rate was 1.5% of biomass for the three tested pellets, twice a day at 09.00 h and 14.00 h, for 6 days a week. After 124 days, the mean weights of breeders, survival and the total number of fry produced in each treatment were measured.

In the three trials, analysis of variance and Duncan's multiple range test were used to detect differences in fry production and brood fish growth due to treatments effect.

## RESULT AND DISCUSSION

The results of this study indicate that, the reproduction of *O. niloticus* occurred in concrete basins but with moderate intensity as some of the fertilized eggs were broken at the basins bottom.

1. Evaluation of body size of breeders:

Table 3 shows a slight variability not only in the mean weight gains between breeders of different size but also in the fry and advanced fry produced by the females within the two size groups. Weight gains of breeders were higher in small size group than in big size group by 6.55% and 5.51% for females and males, respectively. It was also noted in the trial that, with the different in weights of breeders in small and big size groups, the drop in fry and advanced fry production in the big size breeders was 8.60% and 7.16%,

respectively. Also the highest total fry and advanced fry productions, expressed in terms of fry or advanced fry per female or per gram of female, were found in small size breeders.

Data from this trial agree with observations made by Siraj *et al.*, (1983): David and Behrends (1983) for *O. niloticus* breeders, that year class I females (averaged 46 g) have a greater fecundity (in terms of fry / g of female) than year class II females (averaged 185 g). However, the productivity of small size and big size females, expressed in fry / basin, revealed an insignificant differences ($P < 0.01$) because of the low weight of big size females (131.5 g) stocked. This result will be of value from the economical point of view and accordingly, the author suggest the use of breeders with weights of 80–130 g for fry production in concrete ponds or basins.

2. Evaluation of five sex ratios (male to female) of breeders:

In this trail, the results indicate that high fry production, expressed in terms of fry / female, can be obtained using low sex ratios (Table 4). The highest total fry production was found in the ratios 1:1 and 2:3, each characterized by lower sex ratio. But the slightly higher total fry production of the 1:1 ratio (12814 fry / basin) compared with 2:3 ratio (12159 fry / basin) was far from significant ($P<0.01$). While, there were significant difference between the fry production of the 1:1 and 2:3 sex ratio and the other sex ratios of breeders tested, 1:2 (8691 fry / basin), 1:3 (6034 fry / basin) and 1:4 (3851 fry / basin).

These results may be attributed to the effect of the "male pressure" ratio. In concrete basins under the high sex ratios conditions it sometimes happens that four or more females are ready to spawn at the same time, while there are only less numbers of males available, therefore, eggs of one or more of these females are not fertilized. Similar trends were observed by (i) Lovshin (1980) for *O. niloticus* females X *O. hornorum* males, a 1:2 (female to male) sex ratio gave significantly higher fry production than 2:1 or 1:1, and (ii) Rafael and Garcio (1983) for *O. niloticus* breeders, a 3:1 (female to male) sex ratio gave a higher yield fry production than 5:1

3. Evaluation of protein sources of brood fish feed:

Table 5 shows that, feeding of breeders with standard diet (A) with the supplemental protein furnished by fish meal and soybean meal gave significantly ($P < 0.01$) better growth, survival and fry production than pelleted diet (B), with all the supplemental protein furnished by fish meal alone, or pelleted diet (C), with all the supplemental protein furnished by soybean meal alone. It was noted also in this trail that, the group of breeders fed fish meal pellets alone possessed a significant higher growth in weight, better survival rate and slightly higher fry production than those fed soybean meal pellets alone (Table 5). These results may be attributed to one or more of the following factors: i) soybean meal contain indigestible polysaccharide (hemicellulose, cellulose and oligosaccharides) that reduce the available energy to Nile Tilapia and thus reduce growth and fry production; ii) fish meal contains a high percentage of fish oil and protein could be utiliz by Nile Tilapia as source of energy and thus enhance

growth and fry production; and iii) the digestive tract of Nile Tilapia is long, therefore the bacterial population of the Nile Tilapias gut is able to decompose part of the more complex carbohydrates of soybean meal and to derive energy from them. These assumptions were confirmed by many scientists, Viola and Arieli (1983) for the hybrids of *O.aureus*. and *O. niloticus* and Nour *et al.*, (1989) for common carp, *Cyprinus carpio*.

In conclusion, the combination of test variables that resulted in highest fry production for *O. niloticus* in this study was that of the use of breeders with weights of 80-130 g, the lower sex ratios (1:1 and 2:3), and the use of artificial pelleted diet contained animal and plant protein mixture, i.e. fish meal and soybean meal.

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Table (1): Composition (%) of the tests diets.

| Ingredients | Diets | | |
|---|---|---|---|
| | A | B | C |
| Fish meal | 15.0 | 30.0 | -- |
| Soybean meal | 22.0 | -- | 45.0 |
| Broken corn | 10.0 | 11.0 | 10.0 |
| Wheat milling by-product | 52.0 | 58.0 | 44.0 |
| Mineral mixture * | 0.7 | 0.7 | 0.7 |
| Vitamin Permix * | 0.3 | 0.3 | 0.3 |

* As described by New (1987).

Table (2): Chemical analysis of the tested diets.

| Diets | Dry Matter (%) | % on dry matter basis | | | | |
|---|---|---|---|---|---|---|
| | | Crude protein | Ether extract | Crude fiber | Ash | Nitrogen free extract |
| A | 87.12 | 28.93 | 2.90 | 2.56 | 11.51 | 54.10 |
| B | 91.80 | 29.23 | 4.42 | 1.31 | 11.81 | 53.23 |
| C | 90.75 | 29.01 | 3.29 | 3.40 | 7.04 | 57.28 |

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Table (3):Mean weight gain and fry production of O.niloticus with two size of breeders after 124 days spawning period in concrete basins (14.4 m3 each). Each mean is the average of 2 replicates.

| Brood fish sizes | | Small fish | Big fish |
|---|---|---|---|
| Average initial weight(g): | female | 86.2±0.84 | 131.5±1.12 |
| | :male | 92.5±0.67 | 145.1±1.06 |
| Average final weight(g) | :female | 211.4±1.23 | 249.0±1.63 |
| | :male | 220.8±1.15 | 266.7±1.96 |
| Average daily gain | :female | 1.01 | 0.95 |
| (g fish/day ) | :male | 1.03 | 0.98 |
| Male to Female sex ratio | | 1:3 | 1:3 |
| Brood fish /basin | | 16 | 16 |
| Total number of newly hatched larvae/basin | | 6553±513 | 6034±625 |
| Number of newly hatched larvae/female | | 546.08±164 | 502.83±193 |
| Number of newly hatched larvae/g female | | 3.67±0.18 | 2.64±0.09 |
| Rearing period (days) | | 18-21 | 18-21 |
| Number of advanced fry , 2-3 cm length /basin | | 5432±483 | 5069±721 |
| Number of advanced fry/female | | 452.67±113 | 422.42±132 |
| Number of advanced fry/g female* | | 3.04±0.14 | 2.22±0.11 |
| Fry survival (%) | | 82.89±6.2 | 84.01±8.9 |

* based on the average of initial and final female weight (David et al., 1983) .

Table (4): of breeders after 124 days spawning period in concrete basins (14.4 m3 each). Each mean is the average of 2 replicates .

| Item | Sex ratios | | | | |
|---|---|---|---|---|---|
| | 1:1 | 1:2 | 1:3 | 2:3 | 1:4 |
| Brood fish (male to female)/ basin | 8:8 | 6:11 | 4:12 | 6:10 | 3:12 |
| Total nummber of newly hatched larvae/basin.* | 12814a (±1107) | 8691b (±927) | 6034 c (±625) | 12159a (±938) | 3851d (±754) |
| Number of newly hatched larvae/female | 1601.75 | 790.09 | 502.83 | 1215.90 | 320.92 |
| Number of newly hatched larvae/m3 | 889.86 | 603.54 | 419.03 | 844.37 | 267.43 |

* Means with different superscripts are significantly different (P< 0.01 )

Table (5): Mean weight gain , survival and fry production of O.niloticus breeders fed with pelleted supplemental diets contaning different protein sources in concrete basins after 124 days; two replicates per treatments. *

| Protein source of food | | Diets | | |
|---|---|---|---|---|
| | | Standard (A) | Fish meal (B) | Soybean meal (C) |
| Average initial weight(g) | :female | 131.50±1.12 | 131.50±1.12 | 131.50±1.12 |
| | :male | 145.10±1.06 a | 145.10±1.06 b | 145.10±1.06 c |
| Average final weight(g) | :female | 249.00±1.63 | 221.30±3.49 | 208.46±4.17 |
| | :male | 266.70±1.96 A | 237.12±2.89 B | 216.86±4.05 C |
| Average daily gain (g fish/day ) | :female | 0.95 | 0.72 | 0.62 |
| | :male | 0.98 | 0.74 | 0.58 |
| Breeders survival (%) | | 100.00 | 96.87 | 90.62 |
| Number of newly hatched larvae/basin | | D 6034 (±625) | E 4316 (±786) | F 3819 (±954) |
| Number of newly hatched larvae/female | | 502.83 | 359.67 | 318.28 |
| Number of newly hatched larvae/m3 | | 419.03 | 299.72 | 265.21 |
| Number of newly hatched larvae/g female ** | | 2.64 | 2.04 | 1.87 |

* In the same raw , Means with different superscripts are significantly different (P < 0.01 ).

** Based on the average of initial and final female weights , (David et al., 1983).

# دراسات على الإنتاج المكثف ليرقات أسماك البلطى النيلى فى الأحواض الأسمنتيه

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تم أجراء هذه الدراسة فى محطة بحوث الاسماك ببلطيم- محافظة كفر الشيخ -والتابعة للمعهد القومى لعلوم البحار حيث أجريت خلال هذه الدراسة ثلاث تجارب على أمهات البلطى النيلى لدراسة تأثير حجم الأناث ونسبة الجنس (الذكور الى الأناث) ونوعية البروتينات الغذائية فى علائق الأمهات وذلك على الأنتاج المكثف ليرقات الأسماك تحت ظروف التفريخ فى أحواض أسمنتيه

ولقد أظهرت هذه الدراسة أنه يمكن تحقيق أعلى أنتاجية ممكنة من يرقات أسماك البلطى النيلى فى أحواض التفريخ الأسمنتيه تحت الظروف الاتية :

١- أستخدام أناث بلطى نيلى يتراوح وزن الوحدة منها بين ٨٠ - ١٣٠ جرام.

٢- أستخدام نسبه جنسية منخفضة سواء ١ :١ أو ٢ :٣ .

٣- أستخدام علائق صناعية لتغذية أمهات البلطى وذلك فى صورة حبيبات تحتوى على مصادر بروتينية حيوانية ونباتية معا مثل مسحوق السمك ومسحوق فول الصويا .

مع أستخدام معدل تغذية يومى ٥ر١ % من الوزن الكلى لأمهات البلطى فى الحوض.