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Comparison of the zoo technical performances of *Oreochromis niloticus* between the traditional and the new floating cages breeding methods

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1 SUMMARY

The overpopulation of fingerlings in piscicultural breeding of *Oreochromis niloticus* (*O. niloticus)* constitutes a major constraint to the productivity of rural pisciculture in Congo. Several solutions have been proposed for this problem, one being use of pond with floating cages. The present study was initiated to compare the traditional method and the use of ponds with floating cages on the zoo technical performances of *O. niloticus*. The study was undertaken at the Piscicultural Station of the State of Djoumouna. Two ponds were used for each method. The two methods were compared based on the following variables: (i) the growth of fish, (ii) production of fingerlings and (iii) the productivity of the ponds. The results showed that the traditional method better performances than the method of pond with the floating cages: in particular the final average weight (105.5±7.3g) against 90 ±2.8g) and the individual weight gain (21.5±6.3g against 16.5± 07g) for the two methods respectively. The total biomass was significantly higher in traditional breeding method (7.3±0.2kg against 5.6±0.1kg) with better commercial fish yield (3.5±1t/ha/yr against 2.7±1t/ha/yr). On the other hand, the use of ponds with floating cages produced more fingerlings thus assuring sufficient quantity for the future breeding cycles. This study indicates that the traditional method reduces overpopulation of the fingerlings in ponds in Congo.

2 INTRODUCTION

Oreochromis niloticus is a fish adapted well to pisciculture. Commonly referred to as the African magic fish, occupies the first rank of fish in African pisciculture, due to its numerous positive attributes (Deceuninck, 1988). These attributes include its hardiness and tolerance to certain adverse parameters of the medium e.g. weak dissolved oxygen rates (Kestemont & al. 1989), turbidity and diseases; its fast growth (Kestemont & al. 1989), easy reproduction in ponds and basins; its polyester diet; and its good taste that is well appreciated by consumers (Melard, 1986).

However, in spite of its undeniable qualities, this fish has two major defects which are its precocity and its high frequency of laying (Arrignon, 1993). Indeed, *O niloticus* in breeding can reproduce starting room the age of two to three months, with a weight of 30-50g (Lazard et al. 1990). Moreover, the laying by the same female can occur at intervals of 30 to 40 days (Arrignon, 1993) when the temperatures of water lie between 25 and 28°C (Ngokaka, 1983; Kestemont & al., 1989). The precocity and the high frequency of laying constitute a major problem in the breeding of *O. niloticus* (Legendre & Jalabert, 1988; Arrignon,, 1993) because it leads to early overpopulation of the ponds whose immediate visible consequence is the dwarfism of the subjects (Legendre & Jalabert, 1988; Baroiller & Jalabert 1990; Arrignon, 1993).

Nowadays, several methods have been proposed for addressing the overpopulation constraint. However only two methods are feasible for application in rural set up. These are the temporary mixture of fish of different ages and method whereby pond are associated with floating cages. The temporary mixture of fish of different ages is by far the most widely used method of breeding in pisciculture in rural and peri-urban areas.

The method of pond association with floating cages is largely used in West Africa (Lazard, 1980, Franqueville & Lazard, 1991). It consists of sowing the pond according to its capacity with fingerlings. After three months of breeding, an intervention is undertaken by an intermediate draining of the pond at the conclusion of which the fish in breeding are separated from the possible recruits. The breeding is then renewed in the same pond until final draining by leaving in freedom fish in breeding and locking up the recruits in the cages according to the capacity (Anonymous 1993; Parrel & Lazard, 1990).

In view of the need to find sustainable solutions to the overpopulation of ponds by *Oreochromis niloticus* with the overall objective of improving the commercial fish yields and to ensure fingerlings independence of small piscicultures in rural and peri-urban area, we evaluated the two methods mentioned above.

The objective of this study was to compare the two methods with respect to variables like the growth of fish, the production of fingerlings, the total biomass and the productivity of ponds.

3 MATERIALS AND METHODS

3.1 Animals and experiment set up. The study was carried out at the Piscicultural Station of Djoumouna (Republic of Congo). Four ponds named T01, T02, T11 and T12 arranged as shown in figure 1 were used. The ponds T01 and T02 represented the method of breeding known as the temporary mixture of the ages or traditional method whereas T11 and T12 represented the method of breeding whereby the ponds are associated with floating cages. Each pond had a surface of 50m². The cycle of breeding was divided into two principal phases. During the first phase of three months duration, all the ponds were treated in the same manner with regard to fish feeding. The density of loading was two *Oreochromis niloticus* per square meter to which we added an extra 10% to cover mortalities that may occur during handling in particular during loading and at the time of fishing of the control.

At the end of this phase, only the ponds T11 and T12 we are emptied of their fish. The adult fish were separated from the recruits and those we are introduced into two floating cages C1 and C2 both of the same dimension (0.75m3) according to their capacity whereas the adult fish were released back to freedom in the pond.

The second phase of two months duration began by of loading from the floating cages and continued until the final draining of the ponds and the cages.

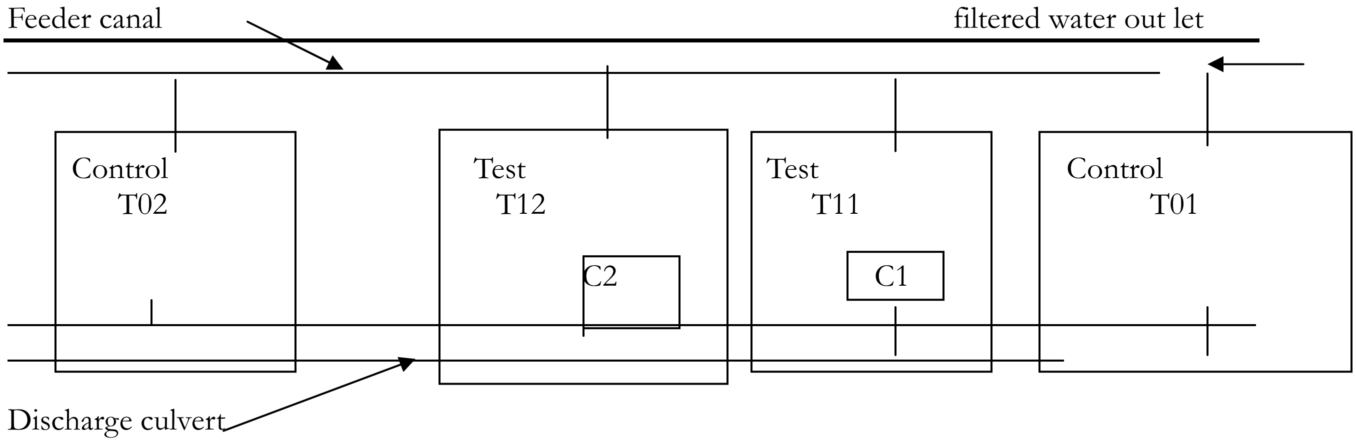

Figure 1: Arrangement of fish (*Orechromis niloticus*) breeding experiment in Congo (2nd phase). C1: Cage for observation in T11; C2: Cage for observation in T12

3.2 Measured variables: The experiment lasted five months; the two methods were assessed on the variables growth, production of fingerlings, total biomass and the total output.

3.3 Data analyses: The results were subjected to one way Analysis of Variance. The means were compared with the F test of Snedecor. Two averages were statistically different when $P<0.05$.

4 RESULTS

The data collected on the growth, the production of fingerlings and the productivity of the ponds are respectively presented in tables 1, 2 and 3.

4.1 Growth of fish during breeding: Table 1 shows that the ponds were sown with fingerlings of 27g average weight and mean density of 2.20 fish per m². After 5 months of breeding, there was a significant difference ($P<0.05$) in favour of the ponds T0 (traditional method) on the final average weight, the individual weight gain and the nutritive quotient. The first phase exhibited the strongest growth rate per individual per day (0.6 ± 0.14g/d) in the ponds T0 (traditional method) and less (0.5 ± 0.02g/d) in ponds T1 (floating cages). During the second phase, the growth rates per day were statistically equal. However, the final average weights of fish in the ponds T0 we are higher than those of fish in ponds T1.

4.2 The production of fingerlings: Table 2 shows that during the production cycle, the fish in breeding multiplied in all the ponds except for the cages. This production of fingerlings was significantly higher in the ponds T1 (floating cages) than in the others ($P<0.05$). On the other hand, the average weight of fingerlings was higher in these last ponds ($P<0.05$). With regard to biomass and yield of fingerlings, the highest values were noted in ponds T0 (traditional method) and the lowest in ponds T1. However, these two variables revealed no significant differences between the treatments.

Table 1: Weight gain and growth of fish (*Oreochromis niloticus*) during two phases of breeding in Congo.

Parameters of breeding	Pond T0 (traditional method)	Pond T1 (floating cages)
1st phase (3 months)		
Density (p/m²)	2.20	2.20
p.m.i (g)	27	27
p.m.f. (g)	84±14. 1^{a}	73.5±2.1^{b}
g.p.i. (g/d)	57±14.1^{a}	46.5±2.1^{b}
c.j.i. (g/d)	0.6±0.14^{a}	0.5±0.02^{b}
Qn	6.9±1.5^{a}	15.15±1.9^{b}
2nd phase (2 months)		
Density (p/m²)	2.2	2.2
p.m.i. (g)	84±14.1^{a}	73.5±2.1^{b}
p.m.f. (g)	105.5±7.3^{a}	90± 2.8^{b}
g.p.i. (g)	21.5± 6.3^{a}	16.5±0.7^{b}
c.j.i. (g/d)	0.3±0.1^{a}	0.29±0.1^{a}
Qn	10.2±0. 2^{a}	12.2±6.3^{b}

Legend: d: day ; **p/m²** : number of fish/ m² ; **pmi** : initial average weight ; **p.m.f.** : Final average weight ; **Qn** : nutritive quotient . The duration of the breeding was 5 months and the density of 2,2 p/m² in the ponds.. For the same variable and on the same column, two averages which are not followed by the same letter are statistically different (P<0.05). T0 is the average of T01 + T02; T1 is the average of T11 + T12.

Table 2: Comparison of the production of fingerlings of *Oreochromis niloticus* by the tradiiotnal and floating cages methods in Congo.

Method	Number	p.m.(g)	Biomass (kg)	Output (t/ha/yr)
T0 (traditional method)	298,5±13,4^{a}	10,2±3,7^{a}	3,05±0,35^{a}	1,49±0,16^{a}
T1 (floating cages)	523± 164^{b}	5,62± 1,4^{b}	2,87± 0,11^{b}	1,32±0,08^{b}

Legend: p.m. (g) - middle weight in grams.
For the same variable and on the same column, two averages which are not followed by the same letter are statistically different (P<0.05). T0 is the average of T01 + T02; T1 is the average of T11 + T12 p.m

4.3 Evaluation of productivity

4.3.1 Commercial fish yield: Data in table 3 shows that the commercial fish yields of the ponds T0 (traditional method) significantly exceed (P<0.05) those of the ponds T1 (floating cages) (3.5±1 against 2.7±1 t/ha / year).

4.3.2 The biomass and the nutritive quotient: The table highest total biomass (7.3±0.2kg) was observed in the ponds T0 (table 3). This also corresponds to a higher live weight in the ponds T0 which is also associated with better conversion of food in the ponds T0 (10.2±0.2 against 12±6.3).

Table 3: Total production of fish (*Oreochromis niloticus*) in different methods in Congo.

Ponds	Yield of commercial fish (kg)	Total Biomass (kg)	The nutritive quotient	Output (t/ha/yr
T0 (traditional method)	4.1±0.1[a]	7.3±0.2[a]	10.2±0.2[a]	3.5±1[a]
T1 (floating cages)	2.8±0[b]	5.6±0.1[b]	12±6.3[b]	2.7±1[b]

T0 is the average of the ponds T01 and T02 representing the ponds of the method of temporary breeding with mixture of ages (traditional method) T1 is the average of the ponds T11 and T12 - method of breeding on ponds with floating cages.

5 DISCUSSION

5.1 Growth of fish in breeding: Generally, the final average weights of fish in ponds T0 (traditional methods) were higher than T1 (ponds with floating cages). This superiority of about 11 and 15g during phase 1 and 2 respectively is most likely due to the higher oxygen content dissolved in the water in ponds T0 and less in ponds T1. These results are in conformity with former work (Stage coach &Muir, 1999, Dzodzi, 2001, Baroiller & Jalabert, 1990). Indeed, it should be noted that a pond is an ecosystem in which the fish and many other micro-organisms develop of which the phytoplanktons, under optimal conditions, produces great quantities of oxygen.

One can suppose that there was more abundant development of the phytoplankton in the ponds T0 (traditional method) than in the ponds T1 (with floating cages). This assumption can be justified insofar as during the five months cycle, the ponds T0 were not disturbed contrary to the ponds T1 whose evolution was stopped during the lowering of the water level that occurred after three months at the time of loading of the cages. This interruption could have caused immediate consequences, e.g. fall in the production (not quantified) of the phytoplankton in the ponds T1 which could have led to a fall of the dissolved oxygen rate.

Oxygen is a crucial factor for the growth of fish (Mélard, 1986), (Ouattara & al., 2006). When oxygen decreases or is entirely missing, a deceleration of fish growth occurs (Mélard, 1986). This is what certainly occurred during the cycle of breeding in the ponds T1. Other assumptions could be evoked to explain the difference in weight of fish between the two treatments. Indeed, it is well-known that the growth of fish is influenced by other factors including food (quality and quantity) and environmental variables (Ouattara & al., 2006). In the method of breeding known as temporary mixture of the ages (traditional method) access to the polyester pond, natural food, with more space, could be other causes of differences that favour fish compared to floating cages method.

5.2 Production of fingerlings: The first fingerlings bands appeared in the ponds between the 27th and the 35day of breeding when the fish in breeding had hardly attained 45g. This appearance of fingerlings practically in a month after loading confirms the easy and early reproduction of in ponds (Ngokaka, 1983; Lazard & al., 1990). The more rapid production of fingerlings in the ponds with floating cages (T1) could be attributed to the fact that in these method the fingerlings are separated from adult fish, thus the adults benefit from better conditions and more resources (space, food, oxygen) which stimulated more reproduction. Though not statistically significant the lower biomass and yields of fingerlings in ponds T1 (floating cages) compared to ponds T01 could be due to weaker growth of fingerlings noted cages of the ponds T1.

5.3 Commercial fish yields: The difference between the two treatments in terms of fish yield was based on the final average weights of fish obtained in each observation. The method of mixing fish of various ages was superior but within expected range of (1.7 to 4.4 t/ha/yr (Kestmont & al., 1989)

5.4 The nutritive quotient: The nutritive quotients recorded in the two observations are all poor being too high. This result confirms the conclusions of other authors (Hand-barrow & al., 1970; Dzodzi, 2001) who obtained nutritive quotients of about 8 to 12 using the loss of corn and waste of flour-milling and affirm that the conversion rate of this food is almost always very high. However, when the results of the two observations are compared, it is noted that the nutritive quotient observed at the end of the cycle is better in the traditional method than in the method of ponds with floating cages.

It is well-known that the smaller the nutritive quotient is, the better quality the food is and the better the fish grow. It should be recalled that during the breeding cycle, fish in pods T0 and T1 were nourished with the same artificial rough protein food, composed of corn spent grain (80%) and corn (20%). On this basis, it is not obvious that the quality of artificial food is the source of the differences observed in the level of the nutritive quotients at the end of the experiment. The best nutritive quotient of the observations T0 (traditional method) could thus result from other causes amongst other things, natural food. Indeed, apart from artificial food, the fish maintained in the ponds (fingerlings + fish of breeding) also profited from an abundant natural food, which is not the case for fingerlings raised in the floating cages.

According to (Lauzanne, 1998; Dufour, 1994), the success of the transformation of food into fish flesh by *Oreochromis niloticus* is related amongst other things to its diet which is artificial. Its food thus is variable because these are the microphages filters that essentially consume the phytoplankton and the various micros refuse. When water movements occur in the ponds, the artificial food distributed to the top of the floating cages is not entirely consumed by fish. All that is not consumed is not transformed into fish flesh, but constitutes losses which influence the nutritive quotient negatively. Ultimately, the variability of the nutritive quotient was influenced by quality of the natural food consumed by fish and the losses that occurred at the time of the distribution of artificial food in the floating cages.

6 CONCLUSION

The results of this study have shown that temporary mixture of fish of different ages makes results into the largest commercial fish; the highest commercial fish yields the highest total biomass and better conversion of food into fish flesh. On the other hand, the method associating ponds with floating cages makes it results into the highest number of fingerlings for the next cycles of breeding. All things considered, our results show that *Oreochromis niloticus* reached the best zoo technical performances in the method whereby fish of varying ages are mixed in the ponds. We therefore recommend the traditional method for use in pisciculture in both rural and peri-urban areas.

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