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Technical Management of Jawfish *Chrysichthys nigrodigitatus* Lacepède, 1803 Rearing in Lagoon Enclosures at the Layo Aquaculture Station (Côte d'Ivoire)

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Abstract | **Original Research Article**

A study was carried out from April 12 to June 10, 2024, at the Layo experimental station (Dabou) to evaluate the growth performance and survival of juvenile *Chrysichthys nigrodigitatus* in an enclosure. A total of 1,200 fish with an average initial weight of 38.93 ± 15.09 g and an initial length of 162.26 ± 17.52 mm were used for this experiment in an enclosure with a density of 6 individuals per m^3. The fish were fed at 10% of their biomass with Koudijs feed. One hundred fish, sampled at random each week, were weighed and measured individually. The results showed that the averages for temperature (29.26 ± 0.19°C), dissolved oxygen (6.20 ± 0.18 mg/l) and pH (6.97 ± 0.48) were in line with recommended standards for rearing this species. With regard to zootechnical performance, values of 91.60 ± 10.85 g, 214.7 ± 11.81 mm, 1.6 g/d and 100% were observed at the end of rearing, respectively for Average Weight, Average Length, ADG and Survival Rate. However, growth performance was exponential in weeks 1, 4 and 5. On the other hand, they slowed down in weeks 2 and 3. In short, it would be interesting to repeat this study in the non-rainy season to gain a better understanding of the factors influencing the growth of this species.

Keywords: *Chrysichthys nigrodigitatus*, Lagoon enclosure, Growth, Survival rate.

INTRODUCTION

Aquaculture remains the fastest-growing food production sector in the world [1]. However, in recent years, annual landings of this foodstuff supplied by the world's fisheries have stagnated or even declined, to around 90.3 million tonnes per year [2].

In Côte d'Ivoire, the yearbook of fisheries and aquaculture statistics puts average consumption per capita per year at 25.6 kg [3]. However, national fish production is struggling to reach 100,000 tonnes for a requirement of over 618,182 tonnes [4]. The shortfall is made up by frozen fish imports, which result in a significant outflow of foreign currency. To facilitate local self-sufficiency in fish, the Ivorian government has created research structures, including the Oceanological Research Center (ORC). One of the ORC's main missions is to identify and study local species with high aquaculture potential, in order to make them available to fish farmers. Among these species, the jawfish *Chrysichthys nigrodigitatus* is a good candidate for fish farming. Its flesh is highly prized by the population [5]. The species also has good resistance to handling and the ability to temporarily withstand low oxygen levels [6,7] adds that *C. nigrodigitatus* has good commercial value. According to [8], the breeding of this species is very well mastered in Côte d'Ivoire. However, it is currently encountering difficulties, notably a dependence on high-protein diets. Furthermore, the slow growth of this species could be linked to the breeding structure. Indeed, for most farmed fish species, bypass ponds, floating cages and happas are the most commonly used. So, what effect does the lagoon enclosure have on the growth and survival of *C. nigrodigitatus?*

The main objective of this work is to contribute to the improvement of rearing techniques for this species. Specifically, the aim will be assess the quality of the

rearing water and determine some of the fish's zootechnical parameters.

MATERIALS AND METHODS

Study area

The study took place at Layo aquaculture experimental station, from April 12 to June 10, 2024. This station is located on the north bank of the Ebrié Lagoon, around 40 km west of Abidjan on the Abidjan-Dabou axis (Figure 1).

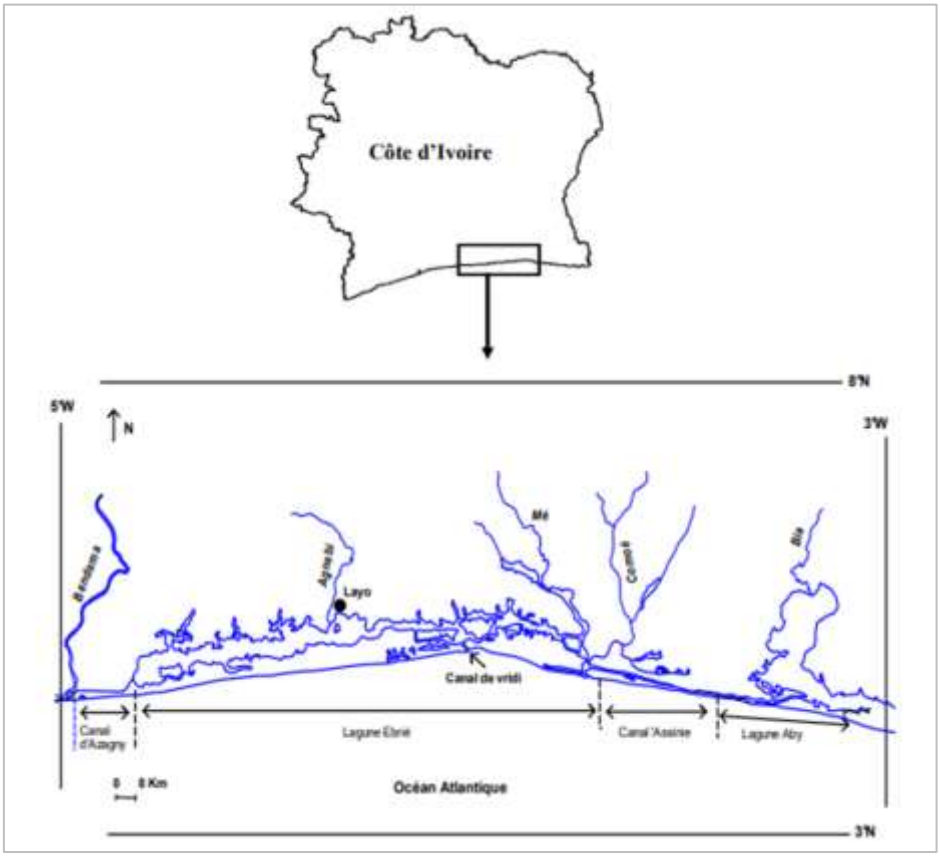

Figure 1: Geographical location of the Ebrié lagoon and location of the Layo Aquaculture Experimental Station (N'dri *et al.*, 2025)

Biological materials

The animal biological material consisted of 1,200 juveniles of the jawfish *C. nigrodigitatus* (Figure 2a). These juveniles were caught in the ponds of the Layo Experimental Station, with a average initial weight of 38.93 ± 15.09 g and an initial length of 162.26 ± 17.52 mm.

Koudijs feed (35% PB) with a diameter of 2 mm was used to feed the subjects (Figure 2b).

Chrysichthys nigrodigitatus juvenile (a) Experimental food (b)

Figure 2: Biological materials

Equipment

The technical equipment used consisted of :

- a Fisher Scientific precision digital scale accurate to 0.01 g with a maximum capacity of 600 g for weighing the daily ration ;
- a digital scale from brand Electronic kitchen scale with a precision of 1g and a maximum capacity of 10,000 g for weighing juveniles during sampling ;
- a 50 cm ichthyometer to measure fish size during sampling ;
- an HQ Series multi-parameter was used to determine the temperature, dissolved oxygen and pH of the rearing water ;
- a fishing seine (12 mm mesh, 35 m long and 9 m drop) to catch fish during sampling ;
- a landing net with 6 mm mesh handles for collecting juveniles during sampling ;
- buckets and other containers for transporting fish during sampling ;
- rubber bowls to serve the daily ration ;
- trays to carry the daily ration.

Breeding structure

Rearing took place in a rectangular enclosure set up in the Ebrié lagoon. It was 20 m long by 10 m wide, with a water depth of 1 m, providing a total volume of 200 m³. It was equipped with a 14 mm mesh seine net. The enclosure was supported by concrete stakes driven firmly into the sediment (Figure 3).

Figure 3 : Used lagoon enclosure

Methodology used Stocking

The fish used were caught in one of the Station's ponds. They were sorted to obtain a homogeneous size and stored in a 6 m^2 cage previously installed in the enclosure, for two weeks. The aim was to acclimatize them to their new environment. During this period, the fish were fed ad libitum three times a day (at 7:30 am, 11:30 am and 3:30 pm).

At the end of the conditioning phase, 1200 fish (6 subjects/m^3) were introduced into the pen to start rearing. To determine average starting weight and length, 100 fish were taken at random, weighed and measured individually.

Breeding

Subjects were fed at 10% of their biomass with a daily ration distributed manually at 08:00, 12:00 and 16:00. Weekly sampling was carried out to monitor fish zootechnical parameters. To this end, 100 fish were taken at random, weighed and measured individually using a precision scale (Electronic kitchen scale brand) and an ichthyometer. The ration was readjusted after each control fishery. At the end of the trial, all fish were weighed, measured individually and counted. In addition, temperature, pH and dissolved oxygen were measured once a week at using a multi-parameter. To do this, the device's probe was immersed directly in the water, then switched on. After stabilization, the values displayed were recorded.

Calculated zootechnical parameters

- Growth in weight and length

The average weight was estimated using the following formula :

Aw (g) = Sum of the weights of the individuals weighed / Total number of subjects weighed

The average length was calculated as follows :

Al (mm) = Sum of lengths of subjects weighed / Total number of subjects weighed

- Average daily gain (ADG)

It is calculated from the following relationship :

ADG (g/d) = (Average final weight - Average initial weight) / Rearing time

- Coefficient of variation (CV)

It is determined by the following formula :

CV (%) = (Standard deviation / Average) X 100

- for a CV of less than 2%, the population is said to be very homogeneous ;
- when the CV is between 2 and 30%, the population is said to be homogeneous ;
- if CV is greater than 30%, the population is said to be heterogeneous.

- Survival rate (SR)

SR (%) = (Number of fish remaining / Initial number of fish) X 100

Data processing and analysis

Descriptive statistics were used to analyze the data collected. Results were expressed as average ± standard deviation. Word software version 2016 was used for data entry. Excel version 2019 was used for data organization and graphing.

RESULTS

Physico-chemical parameters of farm water

All values recorded during rearing are shown in Table I. There was little variation in the temperatures obtained. The variation ranged from 29.13 ± 0.13°C to 29.40 ± 0.14°C, with an average of 29.26 ± 0.19°C. Dissolved oxygen levels also varied slightly overall. Calculated values ranged from 6 ± 0.12 mg/l to 6.3 ± 0.14 mg/l, with an average of 6.20 ± 0.18 mg/l. As far as pH is concerned, a relatively slow or constant evolution was observed. Values ranged from 6.86 ± 0.41 to 7.07 ± 0.67, with an average of 6.97 ± 0.48.

Table I: Water temperatures, dissolved oxygen and pH recorded during rearing

Week	Temperature (°C)	Dissolved oxygen (mg/l)	pH
Week 1	29.13 ± 0.13	6.00 ± 0.12	6.86 ± 0.41
Week 2	29.20 ± 0.14	6.15 ± 0.15	6.90 ± 0.45
Week 3	29.30 ± 0.15	6.20 ± 0.18	6.93 ± 0.49
Week 4	29.33 ± 0.12	6.25 ± 0.13	7.00 ± 0.53
Week 5	29.40 ± 0.14	6.30 ± 0.14	7.07 ± 0.67
Average	29.26 ± 0.19	6.20 ± 0.18	6.97 ± 0.48

Zootechnical performance

Weight growth

The variation in fish average weight is illustrated in Figure 4a. From 38.93 ± 15.09 g at the start of the experiment, the average weight of the subjects reached 91.6 ± 10.85 g. However, this weight growth went through three main phases. During the first week, a rapid increase in the average weight of the fish was observed. It rose from 38.93 ± 15.09 g to 55.40 ± 15.42 g. During weeks 2 and 3, however, weight growth slowed. It rose from 55.40 ± 15.42 g to 66.80 ± 10.31 g. From the end of week 3 to week 5 weight growth resumed its acceleration, rising from 66.80 ± 10.31 g to 91.60 ± 10.85 g.

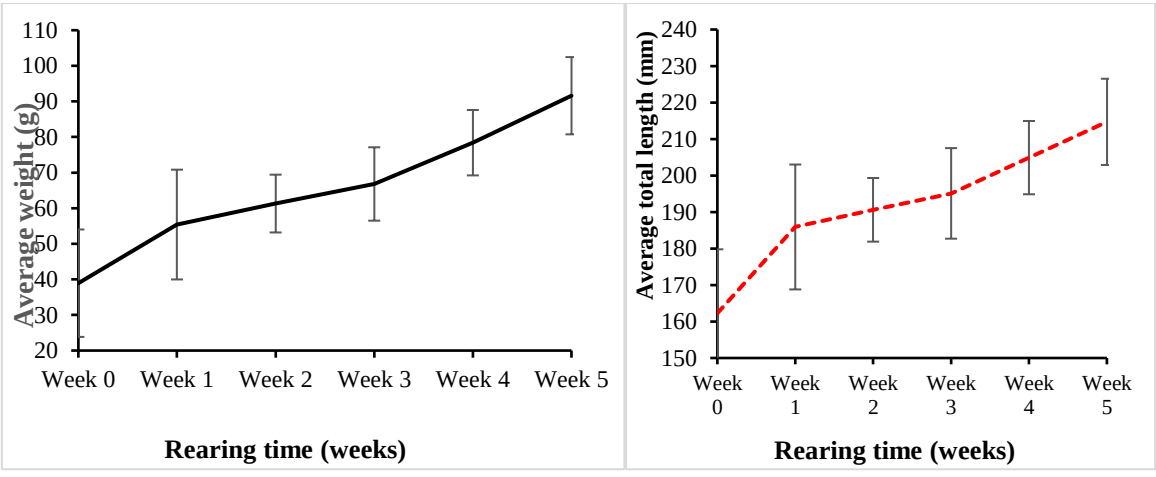

Figure 4: Growth in weight (a) and length (b) of reared fish as a function of age.

Growth in length

The curve representing individual length is shown in Figure 4b. The evolutionary profile of mean total length followed a similar trend to that of weight growth. Average total length grew rapidly and exponentially from week 1, from 162.26 ± 17.52 mm to 185.9 ± 17.11 mm. During weeks 2 and 3, length growth progressed at a more moderate pace than in the first week, from 185.9 ± 15.11 mm to 195.1 ± 12.41 mm. From the end of week 3, this growth resumed its rapid progression, reaching 214.7 ± 11.81 mm.

Average daily gain (ADG)

Body weight measurements revealed an overall Average Daily Gain of 1.6 g/d. The most degraded value of Average Daily Gain was observed at week one (2.35 g/d), followed by week five with a value of 1.88 g/d. The lowest value was observed in week three, with a value of 0.78 g/d.

Coefficient of variation (CV)

The calculated coefficients of variation (CV) for the average weight and average total length of Jawson *chrysichthys nigrodigitatus* were 11.84% for weight and 5.50% for average total length. In all cases, CV values ranged from 2 to 30%.

Survival rate (SR)

At the end of the experiment, calculation of the survival rate for juveniles in the experimental pen showed a remarkable survival rate of 100%.

DISCUSSION

During this study, the average values of physicochemical parameters (temperature, dissolved oxygen and pH) determined in the rearing structures remained relatively stable. Temperature was within the optimum range for rearing *Chrysichthys nigrodigitatus*, as described by [9]. According to these authors, a temperature between 27°C and 30°C favors optimal growth of *C. nigrodigitatus* juveniles. The dissolved oxygen concentration measured was 6.20 mg/l. This value is above the recommended value (5 mg/l) for aquaculture in general and for *C. nigrodigitatus* in particular. It therefore appears optimal for supporting healthy growth and reducing the risks associated with insufficient oxygen levels. According to [10], dissolved oxygen levels above 5 mg/L are essential to ensure efficient metabolism and minimize stress in fish. On the other hand, concentrations below this threshold can lead to a range of problems such as reduced growth, impaired general fish health and increased mortality rates. The pH measured was within the range recommended for optimal rearing *of Chrysichthys nigrodigitatus*. Our results corroborate those of [11] which showed that the most favorable pH levels for this species are between 6.5 and 7.5. Overall, these parameters did not negatively influence the growth and survival of *C. nigrodigitatus* juveniles.

With regard to the average weight of the fish, an overall upward trend was noted, indicating continuous weight gain over time. This result can be justified not only by the satisfactory quality of the feed distributed, but also by the fish's favorable living environment. Work by [12] has shown that adequate levels of protein in the diet lead to improved growth and significant weight gain in *Chrysichthys nigrodigitatus*. The increase in average fish weight is therefore a positive indicator of the effectiveness of rearing conditions and feeding practices. However, more detailed observation reveals notable variations in the growth curve. At week 1, the increase in average weight was particularly marked. This could be explained by the fact that the fish were well acclimatized and feeding efficiently. In contrast, during weeks 2 and 3, growth was slower. This could be linked to particularly difficult environmental conditions, notably the heavy rainfall observed during this period. This observation is supported by the work of [13] who have shown that fish tend to reduce their feeding activity and consumption during periods of rain. resumption of rapid growth during weeks 4 and 5 could be explained by the fact that fish began to express their full growth potential once environmental conditions had stabilized. Another reason could be that the fish made efficient use of the feed provided.

Fish size showed a similar trend to that of average weight. This could be explained by the fact that culture conditions and feed quality had an overall positive impact on fish growth. A recent study by [14] showed that there was a consistent increase in both weight and size of juvenile *Chrysichthys nigrodigitatus* when feed was of good quality, suggesting a direct correlation between these two growth parameters.

With regard to Average Daily Gain (ADG), the values observed are justified by the fact that the fish benefited from favorable rearing conditions. In fact, the culture conditions and feeding practices implemented would have been adequate to promote healthy and efficient juvenile growth. According to [14], the optimal ADG for *Chrysichthys nigrodigitatus* , depending on rearing conditions and diets, is generally between 1.5 and 2.5% of body weight per day.

The coefficients of variation (CV) for average weight and average total length were 11.84% and 5.50% respectively. This indicates that juvenile growth was generally homogeneous. This homogeneity may be linked to the slow growth typical of this species. This could contribute to better management and increased stability in rearing systems.

In terms of survival rate, a value of 100% was observed at the end of rearing. This result could be justified by a notable success in the management of rearing conditions. A complete survival rate is generally considered to be a key indicator of the quality of the practices implemented, whether in terms of environmental conditions, diets or management methods.

CONCLUSION

This study shows that *Chrysichthys nigrodigitatus* adapts well to pen culture. Good aquaculture practices have a positive influence on fish size, weight and survival rate. However, variations in average weight and size show an overall upward trend, with periods of slower growth. It would be important to maintain stable rearing conditions to optimize fish growth and survival.

Conflict of interest

The authors declare that they have no competing interests

Authors' contributions

KMN, YLA and MLF designed and carried out the study. KDK processed the experimental data. KMN and YNA prepared the draft manuscript. KY supervised the work. All authors critically reviewed the manuscript and approved the final version.

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