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# Reproductive Biology of the Blackchin Tilapia *Coptodon guineensis* in the Niamone-Kalounaye MPA, Casamance, Senegal

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**ABSTRACT**

The blackchin tilapia *Coptodon guineensis* is a highly prized fish species in Senegal. It is one of the most sought-after food species. The species is heavily caught by local fishermen in the Casamance estuary. This study was carried out in order to obtain basic scientific information on the reproductive parameters of the tilapia *Coptodon guineensis* in the Marine Protected Area of Niamone-Kalounayes. The individuals studied were sampled over a one-year period from June 2021 to May 2022 using a 250m long beach seine with a 25mm mesh size. Overall, a total of 338 individuals of *Coptodon guineensis* (195 males and 143 females) were sampled. Thus, the sex ratio obtained was in favor of males (1:0.7). The study shows a significant monthly change in the gonadosomatic index. The species has two breeding periods, a dry season in April, May and June with peak breeding in May and a second breeding period at the end of the rainy season in September and October. In the study area, males reach the size of first sexual maturity ($L_m50$) at a smaller size (11cm) compared to females (12cm). This study, considered the first of its kind in the area, is of crucial importance. The results will be used as a reference for a better management plan for the species in the MPA, but also to combat overfishing and fishing pressure that the species is suffering from in the area, especially in the Casamance estuary.

## INTRODUCTION

In Senegal, fishing is of crucial importance not only for the food security of local populations but also for the country’s economic development. Indeed, products from commercial fishing represent the primary source of foreign currency for the Senegalese economy. Despite its socio-economic importance, the fishing sector is threatened by the overexploitation of Senegal's fishery resources and the degradation of aquatic habitats.

To address this situation, the Senegalese government has initiated a vast project to conserve and restore aquatic ecosystems, especially along the coast. This initiative has enabled the authority to establish a vast marine area network in the coastal and estuarine areas of Senegal **(DAMCP, 2015)**. This establishment of protected marine areas network aims not only to preserve species diversity in the coastal zone but also to restore fish stocks and improve the conditions and means of existence of coastal populations **(DAMCP, 2015)**.

The Niamone-Kalounayes Marine Protected Area (NK-MPA) is one of the largest in Senegal, covering a surface area of 63,894 hectares. It is characterized above all by the presence of a large mangrove formation, to which must be added a fairly diverse ichthyofaunal community.

Surveys conducted in the area show a strong dominance of species belonging to the families Cichlidae and Mugilidae **(Diedhiou, 2019)**. Tilapia are therefore heavily exploited and constitute an important source of animal protein for local populations **(Diedhiou *et al*., 2022)**.

However, despite their socio-economic importance, the knowledge about the reproduction of these species and in particular of *Coptodon guineensis* in the NK-MPA is still poorly known. Thus, this study is the first to provide data on the reproductive biology of the species in the area. It is primarily intended to provide basic knowledge on reproductive parameters of the *Coptodon guineensis* tilapia, with a view to implementing local management measures for the species. Specifically, the study aimed to provide information on length-weight ratio, sex ratio, reproductive period and size at first sexual maturity of the species, and propose criteria for best management practices in the NK-MPA for sustainable fishing.

## MATERIALS AND METHODS

### Study area

Created by presidential decree (no. 2015-1724) on 4 November 2015, the Niamone-Kalounayes Marine Protected Area is located in the Casamance estuary of Senegal. It is a region characterized by a very extensive network of secondary watercourses commonly called "bolongs" and which are bordered on both sides by an important mangrove ecosystem that is characteristic of brackish intertropical wetlands (Fig. 1). The Casamance is a small coastal river with a vast estuarine zone. It is characterized by a salinity higher than that of sea water and a positive salinity gradient from downstream to upstream, as shown in the work of **Pritchard and Lauff (1967)**, **Saveniji and Pages (1992)** and **Mikhailov and Isupova (2008)**. The estuary is a drowned ria, where mudflats create a flat, marshy surface intersected by numerous anastomosing channels known as *bolongs*. These channels are influenced by tidal movements and are bordered by extensive mangrove formations. Due to its geographical position, the area experiences climatic variations that support a wide range of habitats, accommodating all life history stages of fish species. The region's climate is classified as tropical sub-Guinean, characterized by alternating dry and wet seasons. Temperatures show relatively low seasonal variations. The region is characterized by the succession of a cool season (November to March) influenced by boreal air masses, followed by a warm season generally beginning in May, with the arrival of warm southern air **(Diouf, 1996)**.

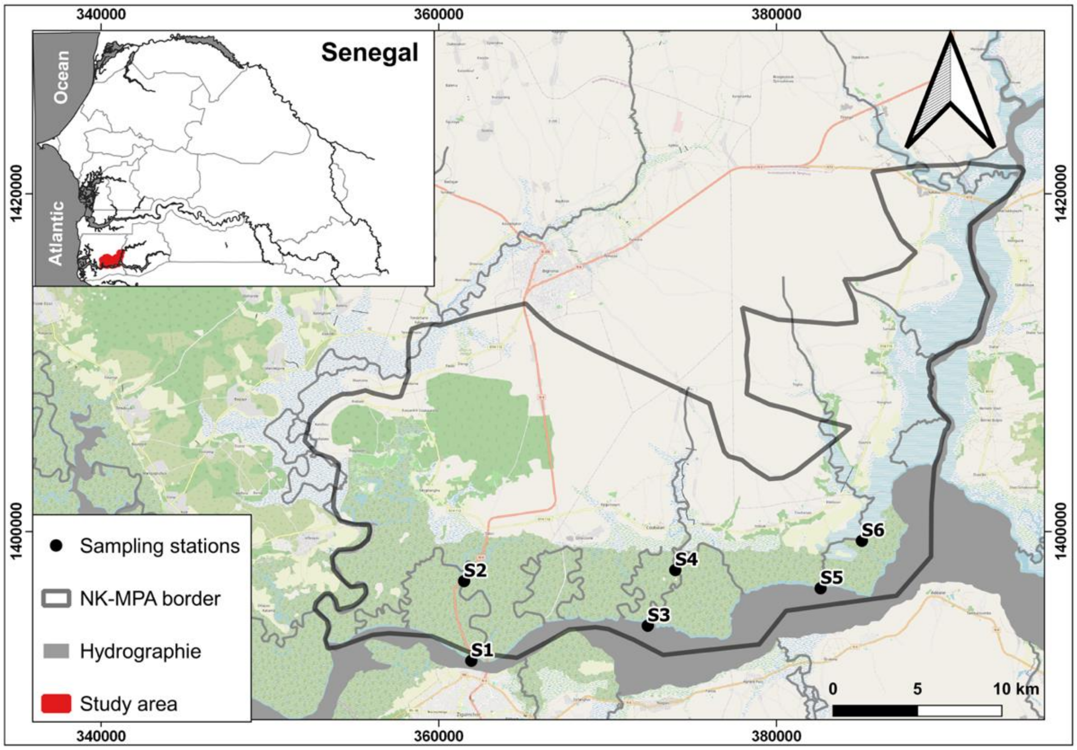


**Fig. 1.** Presentation of the NK-MPA in the Casamance estuary, Senegal, and the six sampling stations

## Data collection

The individuals captured in this study were sampled at six stations located in the protected marine area, including three stations in the mangrove bolongs and three other stations in the main bed of the Casamance River (Table 1). Fishing operations are carried out with 250m long beach seines and 25mm mesh. A total of 338 individuals of *C. guineensis* were caught between July 2021 and June 2022.

**Table 1.** Coordinates of the study stations

| Station | X | Y |
|---|---|---|
| S1 | 361932 | 1392357 |
| S2 | 361501 | 1397075 |
| S3 | 372382 | 1394432 |
| S4 | 374014 | 1397732 |
| S5 | 382619 | 1396650 |
| S6 | 385067 | 1399462 |

The individuals sampled at each station were measured (total length, TL, in cm) and then weighed (total weight, TW, and eviscerated weight, EVW, in g). The gonads were also weighed (gonad weights, GW, in g). Fish were measured with a 1mm precision ichthyometer and weighed using a 1g precision electronic scale. For each dissected individual, sex and stage of sexual maturity are determined by macroscopic observation of the male and female gonads according to the maturation scale defined by **Fontana (1969)** (Table 2). It gives a detailed description of the gonad based on the macroscopic appearance of the gonads: shape, color, vascularization, volume occupied by the abdominal cavity. At each station, the physicochemical parameters of the water including temperature, salinity, pH and dissolved oxygen were measured after each fishing run using a YSI probe (model 63).

**Table 2.** Description of the different stages of sexual maturity according to gender, as outlined in the work of **Fontana (1969)**

| Stage of maturity | State | Description |
|---|---|---|
| I | **Immature:** | **Immature:** Immature: The female gonads are small in size, color, usually light pink and invisible oocytes through the membrane. The male gonads are whitish or slightly translucid color, also very fine. |
| II | **Sexual rest:** | **Sexual rest:** Testicle and ovary are translucent, grey-red. Gonads increase in size. |
| III | **Ripening:** | **Ripening:** Firm gonads of color ranging from pale pink to light orange in females, some oocytes are sometimes visible through the ovary membrane. The male gonad is whitish firm, no fluid flows if an incision is made. |
| IV | **Advanced ripening:** | **Advanced ripening:** The gonad increases in volume, it is larger but less firm, usually orange. At this stage, the oocytes are clearly visible through the ovarian membrane which has a granular surface. In the male gonad, a whitish liquid appears after incision of the testicle. |
| V | **Ripe individual:** | **Mature individuals:** The ovary, large in size, occupies the entire abdominal cavity of the fish. It has a very thin membrane and the oocytes, large and clearly visible are expelled at the slightest pressure from the abdomen. In males, too, the testicles are very large and soft. At this stage, the semen flows with the slightest pressure on the abdomen. |
| VI | **Post-spawning:** | **Post-nesting:** The ovary of females appears flaccid and very vascularized. The oocytes are perfectly visible through the ovary membrane with a large hyaline space. In males, the testicles are also highly vascularized, but also very fine at the posterior part. |
| VII | **Spent:** | **Post-nesting:** Ovaries and testicles are completely flaccid and highly vascularized. At this stage, the gonads appear as an empty bag. |

## Reproductive biology

### *Sex ratio*

The sex ratio can be defined as the proportion of male or female individuals in the total population. It mainly provides an idea of the gender balance that can exist within a given population **(Kartas & Quignard, 1994)**. The sex ratio was calculated as follows:

$$SR = F/M$$

Where, SR is the sex ratio; F is the total number of female individuals; and M is the total number of male individuals. The monthly sex ratio was compared to the theoretical sex ratio (1:1) for both sexes using a chi-square test ($\chi 2$).

### *Gonadosomatic index (GSI)*

The monthly evolution of the gonadosomatic index (GSI) was evaluated for male and female individuals in order to define a sexual cycle of the species as well as its reproductive period. The gonadosomatic index was calculated using **Analbery**'s **(2004)** formula:

$$GSI = \frac{GW}{EVW} \times 100$$

Where, GW is the weight of the gonads expressed in grams, and EVW is the eviscerated weight expressed in grams. The analysis of variance (ANOVA) was used to compare GSI between sampling months for each sex.

### *Size at first sexual maturity ($L_m50$)*

The size at first sexual maturity ($L_m50$) was established for both sexes by considering the total length of individuals for each sex. It provides information on the sexual maturity of the species as a function of size. It also provides a good estimate of the $L_m50$, often used in fish stock valuation models following the equation of **White *et al.* (2022)**.

$$P\% = \frac{100}{1 + e^{-\alpha(TL - L_m 50)}}$$

Where, P% represents the percentage of sexual maturity of individuals in the population; α is the constant; TL is the total length of the fish; $L_m50$ is the length at which 50% of the individuals described have sexual maturity; and ∝ is the constant. The values obtained were compared between the two sexes according to the chi-square test ($\chi 2$).

***Length-weight relationship***

The relationship between length and total weight of individuals is a function of power. In this study, this relationship was calculated for both sexes combined and then for the male and female sexes to the following formula **(Le Cren, 1951)**:

$$TW = a \times TL^b$$

Where, TW represents the total weight of the individuals in grams; TL is the total length of the individuals in cm; a is a constant; and b is the allometric coefficient.

***Condition factor (CF)***

The condition factor (CF) highlights the influence of ecological factors (food, physical and chemical environment) and physiological factors (sexual development, state of emaciation) on individuals of a given population **(Kartas & Quignard, 1994)**. The condition factor, or coefficient of condition, was calculated for all individuals using the following formula:

$$CF = \frac{TW}{TL^3} \times 10^5$$

Where, CF represents the condition factor; TW is the total weight; TL is the total length. A comparison of the condition factor between sampling months was performed for both sexes combined using an analysis of variance (ANOVA).

***Size structure***

Size structure is the distribution of size frequencies within the population. Measurements of total length on individuals help establish the size structure and observe its evolution through time. Individuals were grouped by size classes within 1cm increments.

All statistical analyses were performed using R (version 4.3.1).

## RESULTS

### 1. Environmental parameters

The monthly variation of environmental parameters is shown in Fig. (2). Indeed, in the MPA, the temperature was more important between the months of March (30.4°C) and September (32.5°C). The temperature peak was recorded in April (43.1°C). However, there was a drop in temperature from December (24.6°C) to February (25.2°C).

Salinity varies considerably throughout the year. The highest values were recorded during the dry season, showing a salinity peak in April (42.1 psu) while it was lower in the rainy season, showing minimum values in September and October with salinity of 21.0 and 22.0 psu, respectively. The pH variation was relatively small over the months. The lowest pH values were recorded in October (6.4), November (6.6), December (6.8) and February (6.3). The pH peak was recorded in May (7.9). The highest concentration of dissolved oxygen was observed in February (6.9 mg/l) and the lowest in May (0.9 mg/l).

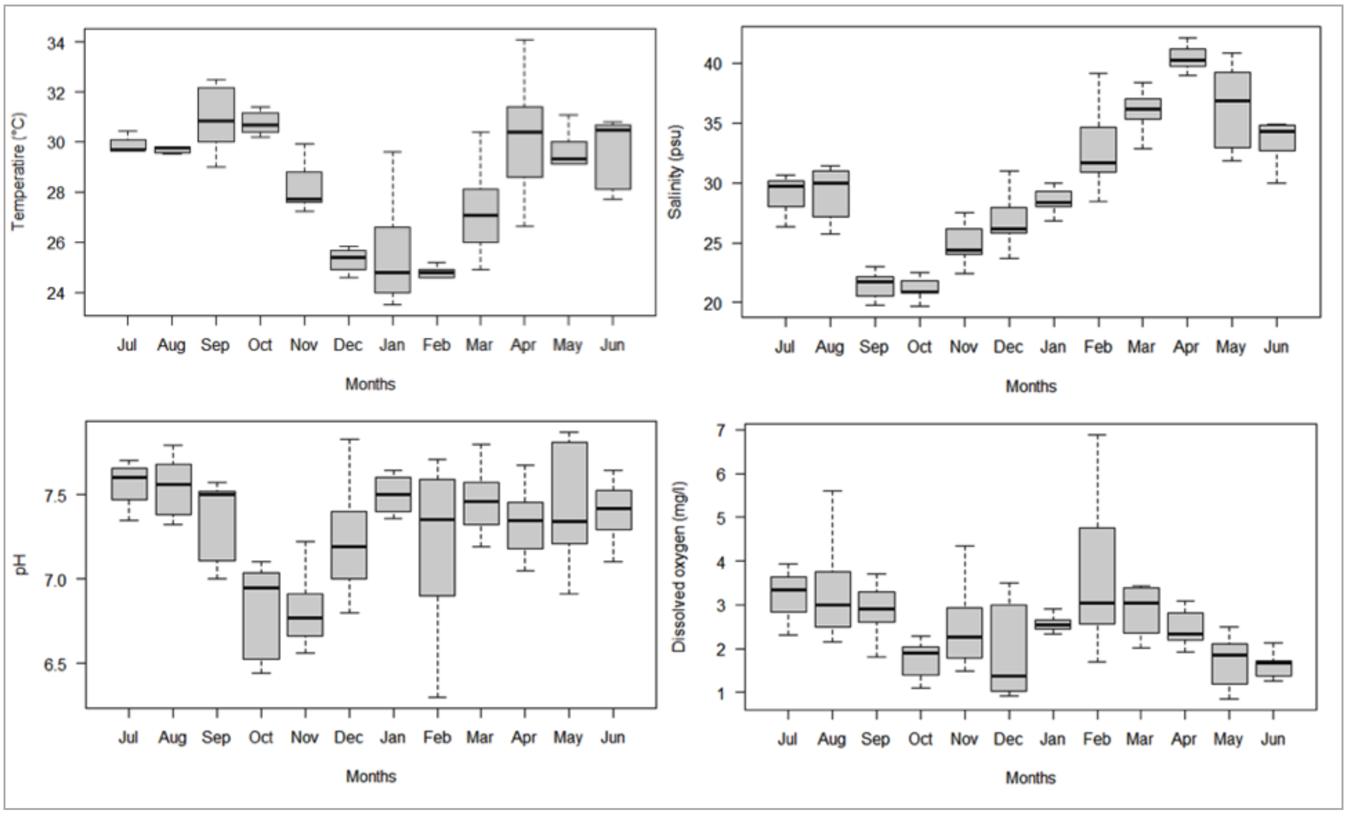


**Fig. 2.** Monthly change in environmental parameters in the NK-MPA during the study period

## 2. Sex-ratio

The results of this study were obtained on a sample of 338 individuals, including 195 (58%) male specimens and 143 female specimens (42%). The sex ratio was in favor of males (1:0.7) (Table 3). This sex ratio is significantly different from the theoretical sex ratio of 1:1 ($\chi 2 = 8.00$, $P< 0.05$). Significant monthly variations are observed in favor of males in January ($\chi2$ = 8.33, $P$< 0.05), May ($\chi2$ = 4.17, $P$< 0.05), June ($\chi2$ = 4.80, $P$< 0.05), and October ($\chi2$ = 11.11, $P$< 0.05).

### 3. Evolution of the monthly GSI and estimation of the reproductive period

In males, the highest mean GSI values were recorded in May, June, September and October, while in females, the highest GSI was recorded in May, June, July, September and October. The lowest values of the GSI were observed in October, November, December, January, February and March. However, in females, the lowest values were observed in August, November, December and February (Fig. 3). Regardless of sex, *C. guineensis* seems to have two different periods where the GSI is higher. The first occurs during the dry season (April, May and June) with a peak in May, and a second period occurs at the end of the rainy season between September and October. The occurrence of these two different periods (where the GSI is significantly higher than other periods of the year; ANOVA, $P$ < 0.05) could be interpreted as two different breeding periods for this species in the NK-MPA.

**Table 3.** Monthly sex ratio variation for tilapia *Coptodon guineensis* in the study area

| Month | N Females | % Females | N Males | % Males | Sex Ratio (M:F) | $\chi2$ | *P*-value |
|---|---|---|---|---|---|---|---|
| July | 12 | 8.3 | 13 | 7 | 1: 0.9 | 0.04 | 0.84 |
| August | 15 | 10 | 12 | 6.2 | 1: 1.3 | 0.33 | 0.56 |
| September | 12 | 8 | 13 | 7 | 1: 0.9 | 0.04 | 0.84 |
| October | 8 | 6 | 28 | 14.4 | 1: 0.3 | 11.11 | 0.0008** |
| November | 8 | 6 | 7 | 4 | 1: 1.1 | 0.06 | 0.79 |
| December | 8 | 6 | 16 | 8 | 1: 0.5 | 2.66 | 0.1 |
| January | 6 | 4.2 | 21 | 11 | 1: 0.3 | 8.33 | 0.003** |
| February | 17 | 12 | 9 | 5 | 1: 1.9 | 2.46 | 0.11 |
| March | 15 | 10.5 | 15 | 8 | 1: 1.0 | 0.00 | 1 |
| April | 24 | 17 | 20 | 10.3 | 1: 1.2 | 0.36 | 0.54 |
| May | 9 | 6 | 20 | 10.3 | 1: 0.5 | 4.17 | 0.04** |
| June | 9 | 6 | 21 | 11 | 1: 0.4 | 4.80 | 0.02** |
| Total | **143** | 100 | **195** | 100 | 1: 0.7 | 8.00 | 0.004** |

**$P$ < 0.05

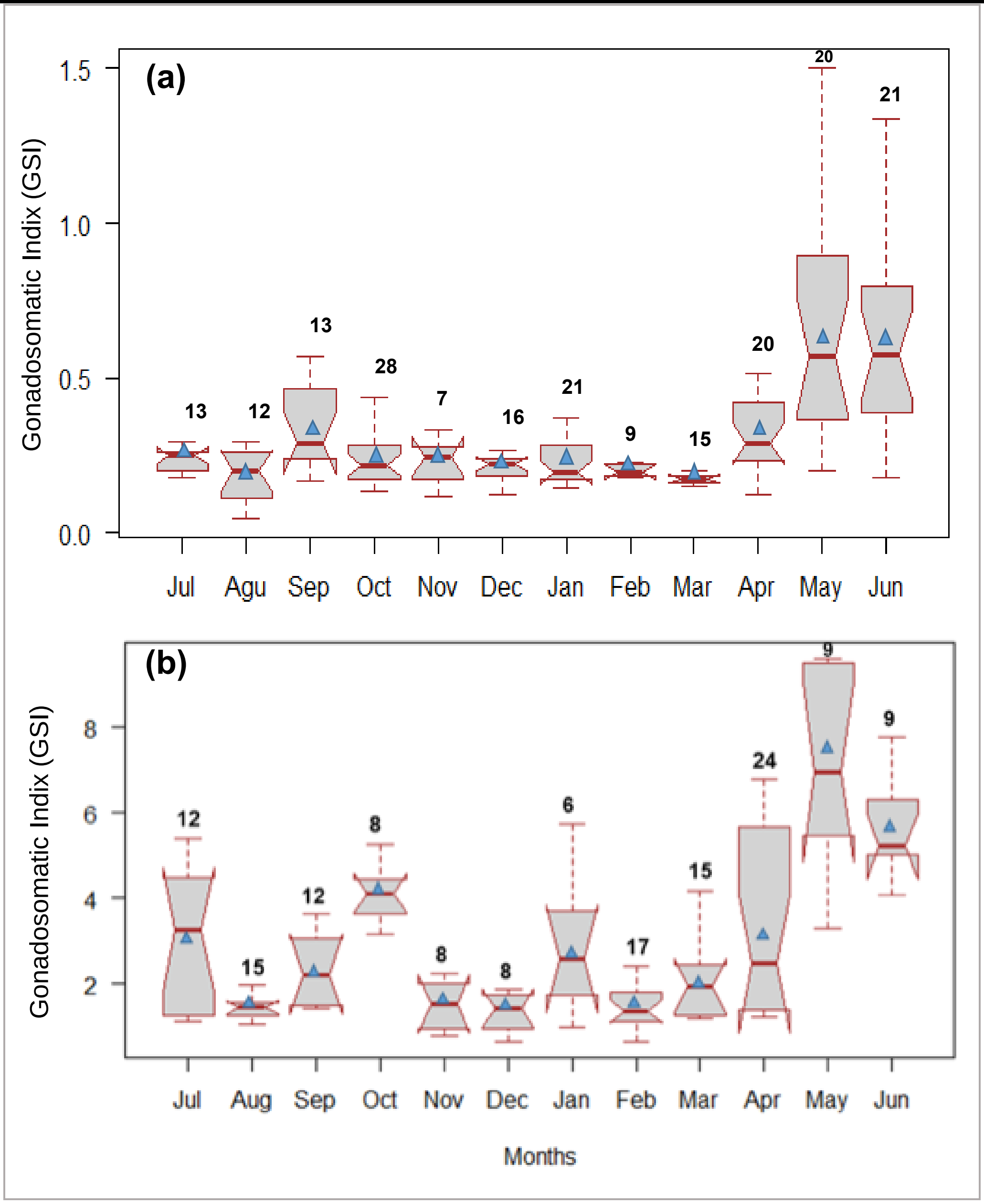


**Fig. 3.** Monthly evolution of the GSI of males (a) and females (b) of *Coptodon guineensis* in the NK-MPA (Senegal), between July 2021 and June 2022

## 4. Size at first sexual maturity ($L_m50$)

In the NK-MPA, size at first sexual maturity for *C. guineensis* was 11cm for males and 12cm for females (Fig. 4). There is no significant difference between the size of first sexual maturity in both sexes ($\chi2 = 0.04$; $P > 0.05$). Individuals from both sexes get to sexual maturity at 13cm.

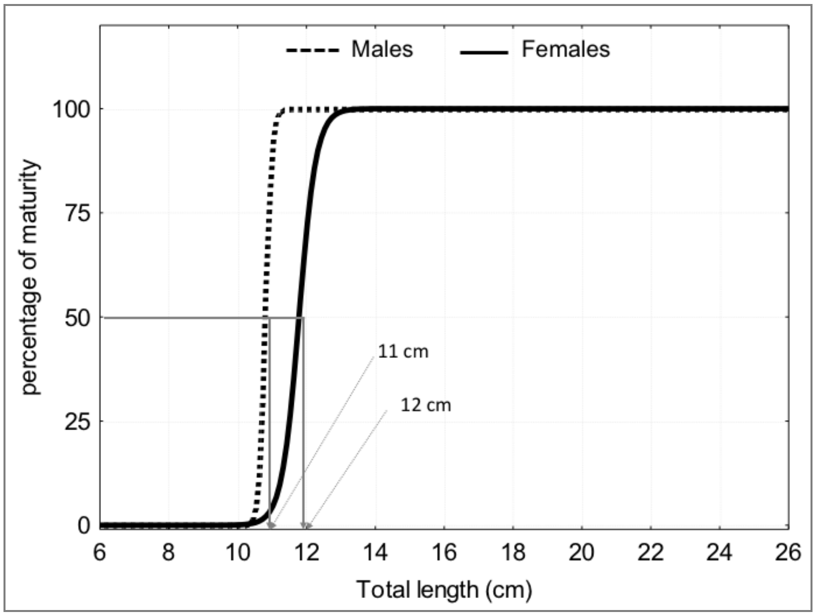


**Fig. 4.** Size determination curve at first sexual maturity ($L_m50$) for males and females of *Coptodon guineensis* in the Casamance Estuary (Senegal)

## 5. Stages of sexual maturity

The monthly recording of sexual maturity stages shows variable proportions depending on the sampling months (Fig. 5). In males, immature individuals (stages I and II) were encountered during all months at different percentages, except for May and June, where only mature individuals were recorded. Mature individuals (stages III, IV and V) were most present in April, May, June, September and October, with a peak in May (95%). For females, immature individuals (stages I, II) dominated in January, February, August, September, November, and December. Mature stages in females were recorded to be more abundant in March, April, May, and June, with a peak in June (100%). The maximum number of individuals in the spawning stage (V) was recorded in May and June for both sexes, with 45 and 43%, respectively, in males and 78% in females.

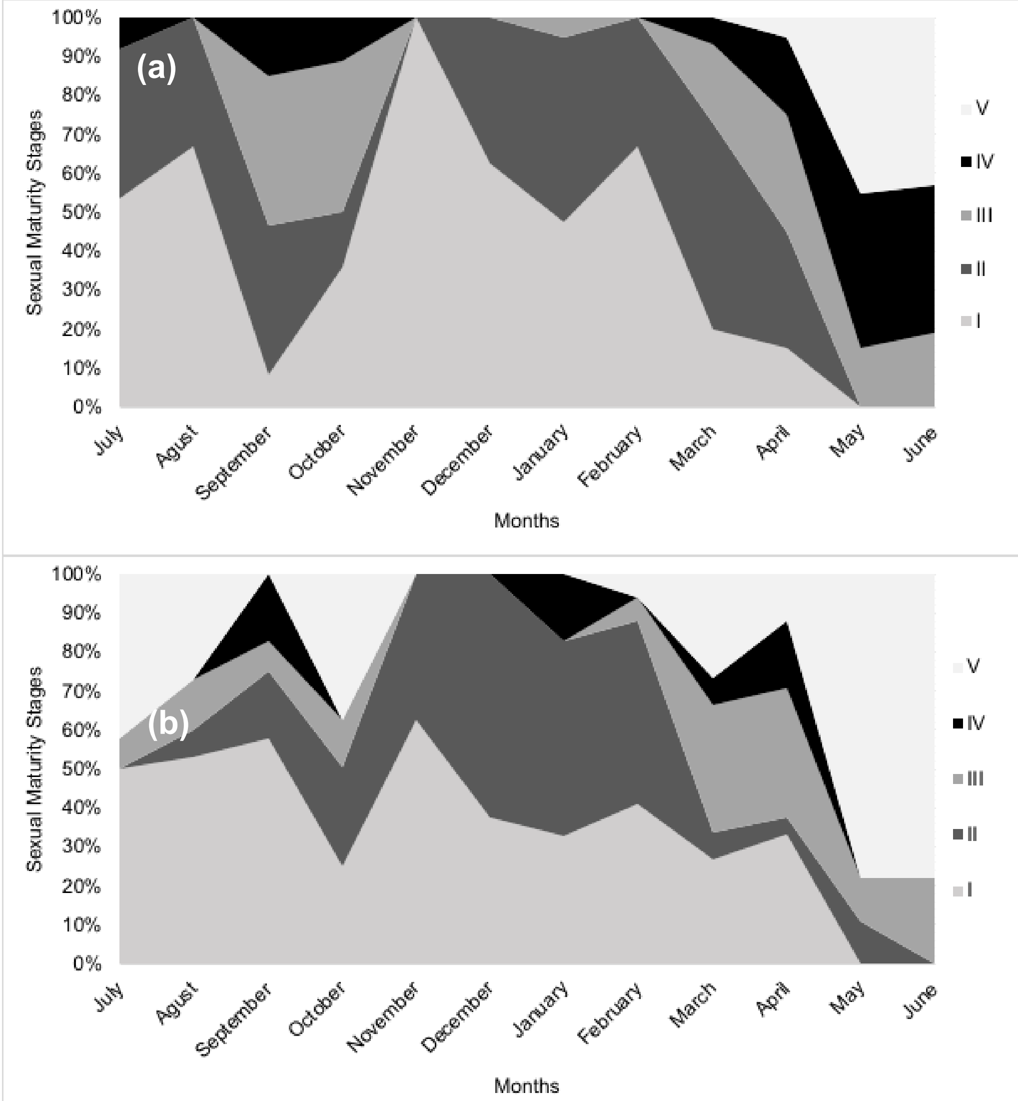


**Fig. 5.** Monthly evolution of the sexual maturity stages of males (a) and females (b) of *Coptodon guineensis* in the NK-MPA (Senegal), from July 2021 to June 2022

## 6. Length-weight relationship

In this population, the total lengths measured ranged from 10 to 28cm in males, with an average of 14.54cm ± 2.80, and from 10 to 24cm in females, with an average of 13.79cm ± 2.18. The total weight varied between 21.5 and 396.2g, with an average of 67.02 ± 52.88 for males, while for females, the total weight ranged from 22.2 to 278.6g, with an average of 58.87g ± 30.07 (Table 4). No significant difference was observed in the total loggers and total weight of males and females ($\chi 2$, $P$=0.57; $\chi 2$, $P$= 0.57).

Table (4) shows an allometric coefficient (b) of 2.79 for both sexes combined and 2.82 for male and female. Fig. (6) also shows a strong correlation ($r^2 \approx 1$) between the length and weight.

**Table 4.** Presentation of the size, weight and the length-weight parameters of tilapia *Coptodon guineensis* in MPA

| Sex | N | Length (cm) | | | Weight (g) | | | Parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Mean | Max | Min | Mean | Max | a | b | r2 |
| Males | 195 | 10 | 14.54 | 28 | 21.5 | 67.02 | 396.2 | 0.03 | 2.82 | 0.95 |
| Females | 143 | 10 | 13.79 | 24 | 22.2 | 58.87 | 278.6 | 0.03 | 2.82 | 0.92 |
| Combined sex | 338 | 10 | 14.22 | 28 | 21.5 | 63.99 | 396.2 | 0.03 | 2.79 | 0.92 |

N=total number of individuals; Min= minimum; Max= maximum; a= constant; b= allometry coefficient and $r^2$= determination coefficient

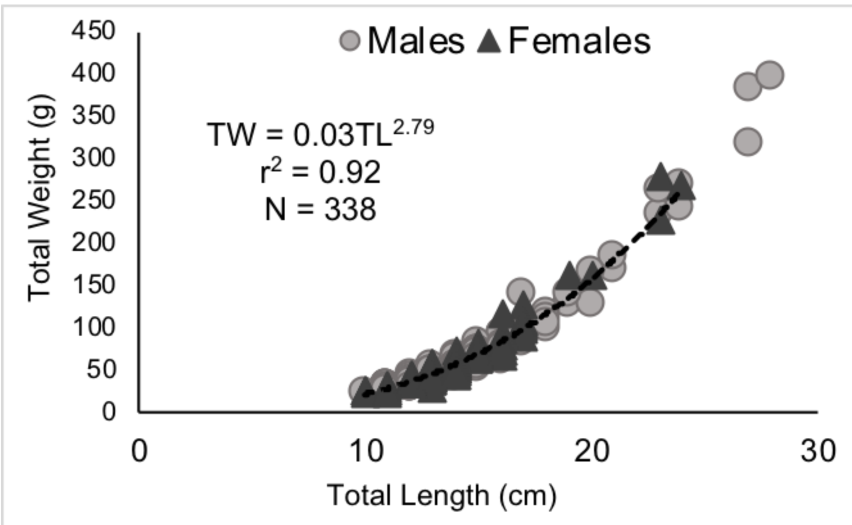


**Fig. 6.** Length-weight relationship of the tilapia *Coptodon guineensis* based on allometric model. TW= total weight, TL= total length $r^2$= correlation coefficient and N= number of fishes sampled

## 7. Monthly variation of the condition factor (CF)

The monthly variation of the condition factor (CF) is presented in Fig. (7). The mean value of the CF calculated for all 338 individuals is equal to 2.02 ± 0.17. The ANOVA test conducted shows a significant difference in the condition factor between months ($P< 0.05$). This difference can be translated into a decrease in the condition factor during the dry season and at the end of the rainy season, corresponding to the two moments were the gonadosomatic index is at the largest. The condition factor was higher in February and August.

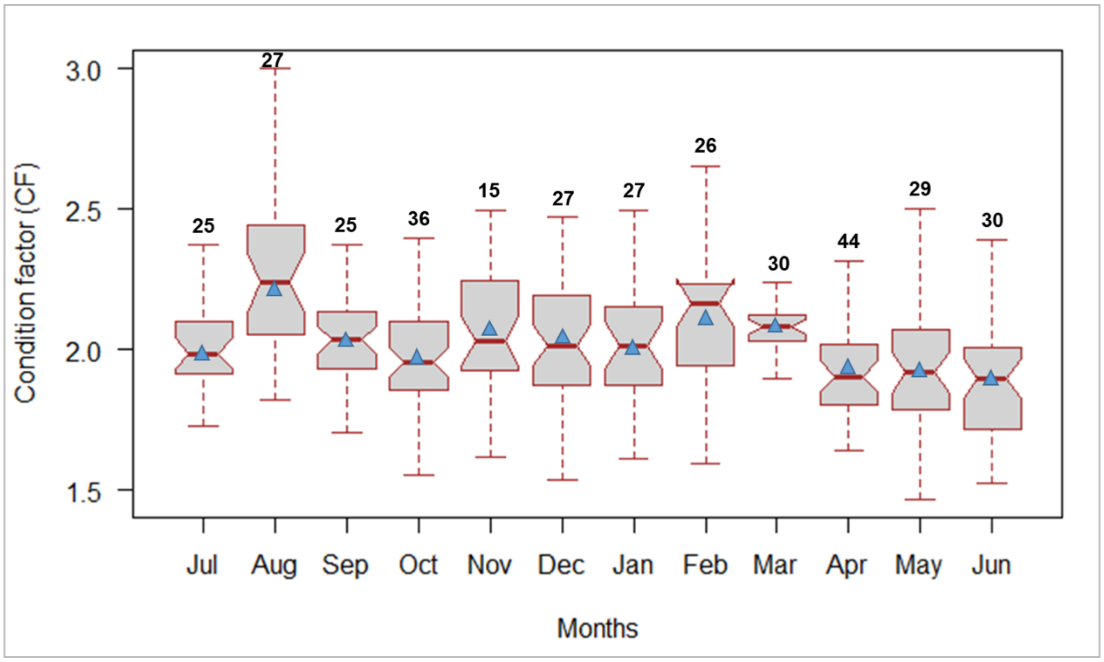


**Fig. 7.** Monthly variation in the condition factor of *C. guineensis* in the NK-MPA, from July 2021 to June 2022

## 8. Size structure

The majority of captures consisted of individuals with a total length between 10 and 18cm, both sizes included. The modal sizes are 13 and 14cm, and the mean total lengths are 14.54 ± 2.3 and 13.79 ± 2.2cm, respectively, for males and females (Fig. 8). The size frequency of female individuals was higher between 12 and 14cm.

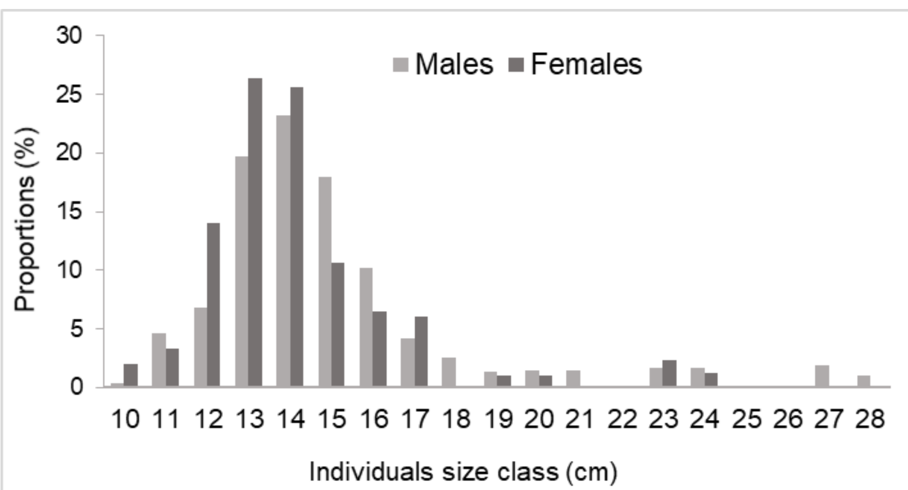


**Fig. 8.** Variation of the size structure of *Coptodon guineensis* in the NK-MPA, from July 2021 to June 2022

## DISCUSSION

The sex ratio shows a predominance of males in NK-MPA. However, the monthly change in gender ratio shows that in February, April, August and November there were more females than male, but this difference was not significant. These results corroborate those of **Fousseni *et al.* (2017)**, which indicate a male proportion in the Porto-Novo lagoon, Ahémé lake, Toho lake and coastal lagoon. Several hypotheses, including environmental factors, movement for feeding, reproduction, gregarious behavior, differential growth, and sex-related mortality **(Mellinger *et al.*, 2002)**, can explain this result. The dominance of male individuals is more pronounced during the peaks of the spawning period. This dominance may be related to parental care performed by males during spawning, but also to protection against invaders **(N'Goran *et al.*, 2022)**. **Schwanck (1987)** states that most male attacks on intruders in tilapia occur during spawning. However, the aggression of females generally increases when the fry is free-swimming and thus exceeds that of males. It should also be noted that male individuals tend to move away from the spawning area after the spawning peak, sometimes in areas that can serve as shelter and protection against predators but are inaccessible to fishers **(N'Goran *et al.*, 2022)**. Other reasons may also explain this predominance of male individuals in the catches not only migration for food **(Albaret & Legendre, 1985)** but also selectivity of fishing gear used **(Ameur *et al.*, 2003)**.

The monthly variation in gonadosomatic index (GSI) shows that *Coptodon guineensis* exhibits extended reproduction with two main periods: A more pronounced period from April to June during the dry season with a peak in May, and a second period from September to October; this period corresponds to the end of the rainy season.

These results are consistent with those of **Legendre and Ecoutin (1996)** in the Ebrié Lagoon, on the same species, showing reproduction spread throughout the year. According to **Lowe-McConnell (1982)**, most tilapia species exhibit continuous reproduction. However, in some cases, reproductive activity increases during periods of intense sunlight and/or precipitation. **Sanogo (1999)** postulated that in the Djoudj National Bird Park in Senegal and its surroundings, data on the GSI of *C. guineensis* are comparable in both sexes, and reproductive activity is permanent, occurring in two annual peaks. **Panfili *et al.* (2004)** illustrated the existance of an extended reproductive period from February to September in the Sine-Saloum and Gambia estuary. The study of **Legendre and Ecoutin (1996)** in Ivory Coast and that of **Pandaré *et al.* (1997)** in Casamance demonstrated that the reproduction of *C. guineensis* is continuous throughout the year. The slight differences observed between the reproductive periods of the aforementioned previous studies may be linked to habitat and seasonal conditions, more precisely to environmental factors which may potentially influence the species' reproductive parameters **(Tine *et al.*, 2007; Diouf *et al.*, 2009)**. As with most tilapia species, *Coptodon guineensis* also has a tolerance for variations in dissolved oxygen concentration of the marine **(Ouattara *et al.*, 2009)**. The highest temperatures were recorded during the period before the breeding peak of March, April and September. As evidenced by the work of **Philippart and Ruwet (1982)** in the Philippines, in the Niamone-Kalounayes MPA, monthly variations in water temperature and pH also show that the species tolerates changes in these parameters. One characteristic of cichlids is their ability to survive in high salinity conditions **(Panfili *et al.*, 2006; Chikou *et al.*, 2013)**. In the study area, salinity values were higher between the months of March and September corresponding to the breeding period of the species with a peak observed in March (38.38 psu) and April (42.13 psu).

Sexual maturity appears at a smaller size in males than in females. It was 11cm in males and 12cm in females. **Sanogo**'s **(1999)** work showed larger $L_m50$s in males for species caught by artisanal fishing. In natural environments, similar results were obtained by **Legendre *et al.* (1990)** in the Ebrié Lagoon in Ivory Coast, with $L_m50$s of 15.9 and 15.4cm, respectively, in females and males of *C. guineensis*. Thus, males reach sexual maturity more quickly than females. These results are also consistent with those of **Teugels and Thys (2003)** for the same species with smaller $L_m50$s; 6.9cm in males and 7.7cm in females. However, the results of **Fousseni *et al.* (2017)** in Lake Ahémé in southern Benin showed that females could reach sexual maturity at smaller sizes than males. Thereore, this parameter can vary from one environment to another, and its variation may be linked to environmental conditions. According to **Konan *et al.* (2021)**, the reduction in size at first sexual maturity would be due to increased fishing effort. This is indeed a strategy developed by species of this family to adapt to certain conditions. Fish subjected to these pressures may exhibit eco-physiological adaptations related to growth or reproduction, such as early maturity and dwarfism **(Legendre & Écoutin, 1989; Albaret, 1994)**. Several authors have shown that size at first sexual maturity varies depending on environmental conditions in Tilapias **(Lowe McConnell, 1982; Eyeson, 1983; Stewart, 1988; Legendre & Ecoutin, 1996)** or anthropogenic pressure such as overfishing **(Lae *et al.*, 1994)**. According to **Gueye *et al.* (2012)**, this value changes depending on ecosystems and decreases with the salinity of the environment. In the NK-MPA, several factors may explain the low $L_m50$ obtained for the studied species, notably the instability of environmental factors but especially the pressure related to fishing due to the importance of the species for the local population and its high economic value.

The results obtained provide the first data on the relationship between size and weight of tilapia *Coptodon guineensis* in the protected marine area of Niamone-Kalounayes. Thus, the values of the coefficient of determination vary between 2.79 in both sexes 2.82 for both males and females. **Froese**'s **(2006)** results indicate that the values of the allometric coefficient fall within the range of 2.5 to 3.5. Several authors have obtained similar allometric coefficients for *Coptodon guineensis.* **Tenda *et al.* (2020)** reported that studies conducted in three different ecosystems (Mvassa Lagoon, Lower Guinea, and the Republic of Congo) showed that all strictly lagoon species and lagoon species with continental affinity like *Coptodon guineensis* exhibited negative allometric growth during the rainy season and negative or isometric allometric growth during the dry season. **Écoutin and Albaret (2003)** deduced an allometric coefficient equals to 2.85 for *Coptodon guineensis* in the Ebrié Lagon in Ivory Coast. **Oribhabor and Ogbeibu (2009)** found an allometric coefficient b equals to 2.83 for *Coptodon guineensis* in the mangrove of the Niger Delta in southern Nigeria. According to **Fousseni *et al.* (2017)**, in the Porto-Novo Lagoon, *Coptodon guineensis* exhibits an isometric growth.

Growth factors can change depending on the environment, or food availability. Growth variations are largely explained by the species' adaptation capacities on one hand and the availability of food resources and physiological conditions of the fish on the other hand **(Fousseni *et al.*, 2017)**. In addition to these factors, there are strong seasonal fluctuations, such as salinity and temperature, which vary with the seasons in the MPA. The results show that individuals' weight is strongly correlated with length with correlation coefficients $r^2 > 0.90$, as evidenced by the work of **Tenda *et al.* (2020)** in Congo. This parameter can vary depending on stocks but also study areas **(Andrade & Campos, 2002)**. The positive and high values of the correlation coefficient show that for both sexes combined, growth in size leads to an increase in weight. **Écoutin and Albaret (2003)** obtained the same results for lagoon fishes in West Africa, as did **Mikembi *et al.* (2019)** for fishes in the Dzoumouna River in Congo.

The condition factor varied between 1.46 and 3.00, with an average of 2.02±0.17. These values are higher than those obtained by **Jawad *et al.* (2017)** for *Coptodon guineensis*, with a condition factor ranging between 0.26 and 1.84 in two lakes in southern Benin. The high condition factor values obtained for the population of *Coptodon guineensis* testify to favorable environment for the well-being of the species in the Niamone-Kalounayes MPA. This can be explained by the presence of high quality habitat, such as mature mangrove, which provide abundant food and shelters **(King, 2007)**. Furthermore, the monthly evolution of the condition factor shows higher coefficients during months of lower sexual activity. Indeed, these species increased their feeding during these periods to gain more weight and improve their physical condition. In fact, breeders regain their body mass through intensified feeding activity and find themselves in better physiological conditions **(Morton & Routledge, 2006)**. The beach seine used for capturing individuals allowed for a range of size variations, thus including juveniles and adults of *C. guineensis*. Size structure also provides information on the level of exploitation of the species **(Tenda *et al.*, 2020)**. The majority of captures consist of individuals with a total length between 10 and 18cm. The size structure shows a higher frequency of female individuals in catches after sexual maturity, which can be explained by a difference in activity rate between mature males and females following reproduction **(N'Goran *et al.*, 2002)**.

## CONCLUSION

Conducted between July 2021 and June 2022, this study provides foundational scientific data on the reproductive biology of tilapia (*Coptodon guineensis*) in the Casamance estuary. The research focused on key reproductive parameters, including sex ratio, gonadosomatic index, condition factor, reproductive period, and size at first sexual maturity. These findings serve as a reference for the improved management of the species in the region. The data will also inform the proposal of a minimum catch size (greater than 12cm) and the establishment of biological rest periods (from March to July and from August to November) to address overexploitation and the intense fishing pressure exerted by local fishers.

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