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# Some Biological Characteristics of Ten Fish Species in a Tropical Man-made Lake, Taabo Reservoir, West Africa.

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**Abstract**

We studied some biological aspects of ten fish species from the Taabo Lake in Ivory Coast (West Africa). These fishes were the most targeted by the artisanal fisheries with about 77% of the captures. Fish populations were sampled during five surveys. Fish size, sex ratio, length-weight relationships and condition factor were analyzed. Standard lengths indicated a wide range for the ten species and the highest sizes recorded in this study were lower than those observed in other aquatic systems of West Africa. Sex ratios differed between species and showed significant variation from the expected ratio of 1:1 for seven species. Males were more abundant in four species (*Distichodus rostratus*, *Tilapia zillii*, *Pellonula leonensis* and *Schilbe mandibularis*) whereas females predominated in three species (*Chrysichthys nigrodigitatus*, *Synodontis schall* and *S. punctifer*). The values of the parameter "b" in length-weight relationships ranged from 2.702 to 3.267 and the ten fish species presented an allometric growth. The condition factor showed a wide range for all the studied species.

***Keywords:*** Size; Sex ratio; Length-weight relationships; Condition factor; Freshwater fishes; Taabo Reservoir; West Africa

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## 1. Introduction

Taabo Lake was built on Bandama River (one of the four main rivers of Ivory Coast) in 1979. Fishing activities are developed in this lake since its inception. Catches had dropped significantly from 433 tons in 1979 to 70 tons in 2006. The known fish fauna of this lake is 50 species but fisheries based on 10 major species which account for about 77% of the total catch. These species were: Chrysichthys nigrodigitatus, Distichodus rostratus, Oreochromis niloticus, Tilapia zillii, Labeo coubie, Pellonula leonensis, Heterotis niloticus, Synodontis schall, Synodontis punctifer and Schilbe mandibularis [1].

Fishing affects fish communities through changes in total biomass, species composition and size structures [2, 3, 4, 5]. The main direct effect of fisheries is obviously to reduce the abundance of target species. It affects mainly the larger species that become rare in the catches and landings [6, 7]. High fishing mortalities among large fish can have negative consequences on the recovery of stocks. The response of species to the effects of fishing depends on their biological characteristics [8]. Moreover, it is well known that habitat change induced by the creation of the lake can affect the biology and ecology of fish species [9].

The aim of the present work is to provide informations dealing with some biological characteristics of the ten species mentioned above in Taabo Reservoir. These characteristics include: size range, sex ratio, length-weight relationships and condition factor. The results of the study permit to fill a gap on these species biology and can also be used as inputs for fisheries management in this reservoir.

## 2. Material and methods

### *2.1. Study area*

The study was carried out on Taabo hydroelectric reservoir (06°20'N-06°40'N and 5°W-5°30'W). Taabo Lake has a main channel total length of 16 km and an area of 69 km2 at the average operating level of the dam (124 m). At this level, average water volume is around 625 106 m3. It encompasses a catchments area about 58700 km2 and a mean annual flow of about 128.7 m3 s-1 [10]. Macrophytes were very abundant in this artificial lake (Figure 1).

### *2.2. Data collection*

Fish populations were sampled during five surveys: July, October and December in 2006, and March and June in 2007. Data were collected through experimental fishing using gill nets which were usually set during the afternoon at about 16:00 h and lifted the following morning at about 07:00 h. Fish specimens were identified according to [11]. Five sampling stations were retained in Taabo Reservoir: one site in the riverine zone, another site in the transitional zone and three sites in the lacustrine zone. More sampling sites were retained in the lacustrine zone because of its relative extensive area.

For all individuals caught, the standard length (L) was measured to the nearest millimeter and the total weight (W) was recorded to the nearest gram. Sexes of fishes were separated by examining the gonads.

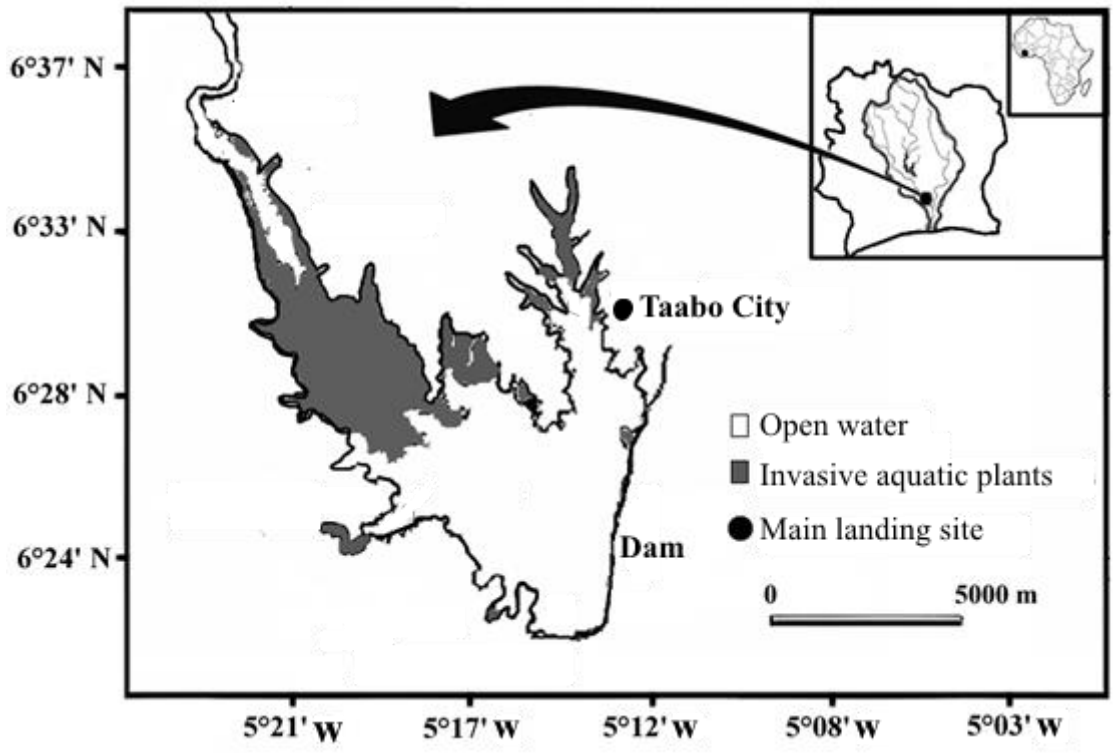


**Figure 1**: Map of Taabo Reservoir.

### *2.3. Data analysis*

For each species, the size range and the average of standard length were determined. The highest standard length observed in this study was compared to the highest standard length recorded in other hydrosystems of West Africa. Sex ratio of each fish population was determined as number of females for one male. We used the Chi-square test to assess if the sex ratio (male:female) differed significantly from the expected 1:1.

The length-weight relationship was established for each species following [12] formula:

$$W = a*L^b \quad (1)$$

Parameters "a" and "b" were obtained by linearization of the previous equation through logarithmic transformation as following:

$$logW = loga + b*logL \quad (2)$$

Where: W = the weight of fish in gram (g), L = the standard length of fish in centimeter (cm), a = exponent describing the rate of change of weight with length (= the intercept of the regression line on the Y axis), b = the slope of the regression line also designed as allometric coefficient. The linear regression was computed using the least square method. The parameter "b" of the length-weight relationship was compared with the theoretical value 3 using the Student's 't' test [13] to assess whether these species exhibit isometric (b=3) or allometric (b≠3) growth.

The condition factor (CF) of fishes was estimated from the relationship:

$$CF = 100*W/L^b \quad (3)$$

Where: W = weight of the fish in g, L = the standard length of the fish in cm and "b" = the value obtained from the length-weight equation relationship.

## 3. Results

### *3.1. Fish size*

Average, minimum and maximum of standard length of the ten fish species sampled in Taabo Reservoir are given in table 1. Differences between minimum and maximum showed a wide size range of captured fishes. The highest standard lengths recorded in this study were lower than those observed in other hydrosystems of West Africa.

**Table 1**: Size range (standard length) in ten fish species from Taabo Reservoir; N: sample size, SD: standard deviation, (*): references from [11]

| | Standard length characteristics in Taabo Lake | | | | Highest size recorded in West Africa* |
|---|---|---|---|---|---|
| Fish species | N | Min (mm) | Max (mm) | Average ± SD (mm) | (Standard length in mm) |
| *Chrysichthys nigrodigitatus* | 537 | 50 | 385 | 145.46 ± 38.02 | 473 |
| *Distichodus rostratus* | 396 | 47 | 530 | 158.16 ± 72.88 | 625 |
| *Tilapia zillii* | 183 | 39 | 197 | 98.61 ± 25.42 | 210 |
| *Oreochromis niloticus* | 125 | 43 | 308 | 128.52 ± 64.92 | 395 |
| *Labeocoubie* | 180 | 91 | 430 | 193.19 ± 62.29 | 750 |
| *Pellonula leonensis* | 500 | 23 | 56 | 36.68 ± 5.26 | 86.9 |
| *Synodontis schall* | 144 | 88 | 170 | 134.94 ± 14.78 | 370 |
| *Synodontis punctifer* | 143 | 83 | 202 | 133.47 ± 24.10 | 192 |
| *Heterotis niloticus* | 199 | 89 | 675 | 169.47 ± 86.05 | 980 |
| *Schilbe mandibularis* | 222 | 60 | 270 | 132.70 ± 33.07 | 300 |

### *3.2. Sex ratio in fish populations*

Sex ratio differed among fish species. For seven of the ten species, the sex ratio showed significant variation from the expected ratio of 1:1 (Chi-square test, $p < 0.05$). Males were more abundant in four species: *Distichodus rostratus*, *Tilapia zillii*, *Pellonula leonensis* and *Schilbe mandibularis.* Whereas females predominated in three species: *Chrysichthys nigrodigitatus*, *Synodontis schall* and *S. punctifer* (Table 2).

**Table 2:** Sex ratio in populations of ten fish species from Taabo Reservoir; $\chi^2$: chi-square value, s: significant difference at $p = 0.05$, ns: no significant difference at $p = 0.05$

| Fish species | Males | Females | Sex ratio (male:female) | $\chi^2$ | Difference with the ratio (1:1) |
|---|---|---|---|---|---|
| *Chrysichthys nigrodigitatus* | 62 | 152 | 1:2.44 | 37.85 | s |
| *Distichodus rostratus* | 78 | 22 | 1:0.28 | 31.36 | s |
| *Oreochromis niloticus* | 26 | 21 | 1:0.81 | 0.53 | ns |
| *Tilapia zillii* | 46 | 15 | 1:0.32 | 15.75 | s |
| *Labeo coubie* | 23 | 17 | 1:0.74 | 0.90 | ns |
| *Pellonula leonensis* | 113 | 77 | 1:0.68 | 6.82 | s |
| *Heterotis niloticus* | 5 | 7 | 1:1.41 | 0.33 | ns |
| *Synodontis schall* | 15 | 30 | 1:2.00 | 5.00 | s |
| *Synodontis punctifer* | 25 | 48 | 1:1.92 | 7.25 | s |
| *Schilbe mandibularis* | 29 | 7 | 1:0.24 | 13.44 | s |

### *3.3. Length-weight relationships (LWR)*

The values of the exponent *"b"* of LWR ranged from 2.702 (*Chrysichthys nigrodigitatus*) to 3.267 (*Pellonula leonensis*). None of the studied fishes presented an isometric growth (i.e. $b \neq 3$). For seven species, *"b"* was significantly lower than 3.0 (Student test, $p < 0.05$), indicating a negative allometric growth. These seven species were: *Chrysichthys nigrodigitatus*, *Tilapia zillii*, *Labeo coubie*, *Synodontis schall*, *Synodontis punctifer*, *Heterotis niloticus* and *Schilbe mandibularis*. In contrast, the three other species presented a positive allometric growth with an exponent *"b"* significantly higher than 3 (Table 3).

**Table 3**: Parameters of the length-weight relationships for ten fish species from Taabo Reservoir; N: sample size, b: the exponent of LWR, *a*: the intercept of the regression line on the Y axis, $R^2$: determination coefficient, A+: positive allometric growth, A-: negative allometric growth.

| Fish species | N | *b* | *a* | $R^2$ | *t* value of the Student test | Growth |
|---|---|---|---|---|---|---|
| *Chrysichthys nigrodigitatus* | 537 | 2.702 | 0.258 | 0.946 | 60.955 | A- |
| *Distichodus rostratus* | 396 | 3.071 | 0.173 | 0.983 | 6.634 | A+ |
| *Tilapia zillii* | 183 | 2.972 | 0.271 | 0.968 | 3.755 | A- |
| *Oreochromis niloticus* | 125 | 3.115 | 0.219 | 0.990 | 6.080 | A+ |
| *Labeo coubie* | 180 | 2.966 | 0.211 | 0.980 | 3.593 | A- |
| *Pellonula leonensis* | 500 | 3.267 | 0.139 | 0.917 | 155.217 | A+ |
| *Synodontis schall* | 144 | 2.734 | 0.259 | 0.819 | 56.990 | A- |
| *Synodontis punctifer* | 143 | 2.867 | 0.221 | 0.930 | 18.109 | A- |
| *Heterotis niloticus* | 199 | 2.930 | 0.170 | 0.985 | 10.666 | A- |
| *Schilbe mandibularis* | 222 | 2.785 | 0.179 | 0.943 | 120.611 | A- |

### *3.4. Fish condition factor (CF)*

Elementary statistics on fish CF are given in table 4. The highest average of CF was recorded with *Tilapia zillii* (CF = 5.01 ± 0.70) while the lowest was obtained with *Pellonula leonensis* (CF = 1.08 ± 0.16). For both species, CF indicated a wide range.

**Table 4**: Condition factor in ten fish species from Taabo Reservoir; N: sample size, SD: standard deviation.

| Fish species | N | Min | Max | Average ± SD |
|---|---|---|---|---|
| *Chrysichthys nigrodigitatus* | 537 | 1.72 | 8.52 | 4.48 ± 0.77 |
| *Distichodus rostratus* | 396 | 0.43 | 5.92 | 1.78 ± 0.32 |
| *Tilapia zillii* | 183 | 3.43 | 7.99 | 5.01 ± 0.70 |
| *Oreochromis niloticus* | 125 | 1.83 | 5.75 | 3.07 ± 0.53 |
| *Labeo coubie* | 180 | 1.64 | 5.08 | 2.80 ± 0.35 |
| *Pellonula leonensis* | 500 | 0.69 | 2.37 | 1.08 ± 0.16 |
| *Synodontis schall* | 144 | 3.16 | 6.67 | 4.52 ± 0.66 |
| *Synodontis punctifer* | 143 | 1.71 | 4.40 | 3.13 ± 0.44 |
| *Heterotis niloticus* | 199 | 0.93 | 2.29 | 1.69 ± 0.20 |
| *Schilbe mandibularis* | 222 | 1.17 | 4.02 | 1.93 ± 0.36 |

## 4. Discussions

Our results revealed wide fish sizes for the studied species in Taabo Lake; and the highest standard lengths recorded were lower than those observed in other hydrosystems of West Africa. This situation could be due to overfishing or unfavorable environmental conditions in the studied lake [3, 9]. Different sex ratios were recorded in this study. According to [14], the sex ratio in fish populations can vary annually, by metabolic changes under the influence of hormones, leading to unbalanced ratios. Besides, different mortality, growth, spatial segregation, and/or behavior for males and females during the life cycle could determine a change in the sex ratio and the predominance of one sex (reviewed by [15]). Therefore, the different proportions of sexes in the sampled populations could be the result of diverse factors. Indeed, uneven distribution of males and females could be due to difference between catchability of sexes [16, 17]. Knowledge on length-weight relationships of fish helps in predicting potential yield and determination of size at capture for obtaining optimum yield, as these parameters are directly related to weight of the fish. The relationship is also useful in differentiating populations as variations occur in populations of different localities [12, 18]. According to [19] the values of the exponent 'b' usually remain between 2.5 and 4.0 and in majority of the cases the value was not equal to '3'. Our results coincide with the interval of 2.5 – 4.0 ('b' ranged from 2.702 to 3.267 for the studied species). The values of condition factor indicated a wide variation. In fish, the condition factor reflects, through its variations, information on the physiological state of the fish in relation to its welfare. From a nutritional point of view, higher values are due to accumulation of fat and gonadal development [12]. According to [20], the range 2.9-4.8 is the recommended condition factor as suitable for matured fresh water fish. Ours results showed that the averages of CF range from 1.08 to 5.01.

## 5. Conclusion

The ten fish species studied in the Taabo Reservoir had a wide range of standard lengths and also wide range of condition factor. For seven species, the sex ratios showed significant variation from the expected ratio of 1:1. The values of the exponent "b" of LWR ranged from 2.702 to 3.267 and the ten fish species presented an allometric growth. These results may be useful for future studies.

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