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Population Structure, Weight-length Relationships, and Parasitism Associated with *Hepsetus Odoe* (Bloch, 1794) Caught in Lake Togbadji in Southwest Benin, West Africa

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Abstract *Hepsetus odoe* is a widespread fish species in tropical regions. It is usually found close to the banks of rivers where vegetation is very heavy. Like an alone species in the family Hepsetidae, *H. odoe* is supposed to be more abundant in the lagoons, backwaters, and lakes. Unfortunately, it does not meet this hypothesis in the lake Togbadji. The present study was designed to assess some biological factors that can explain the low abundance of *H. odoe* including the length-weight relationships and the diversity of parasite that can potentially affect it. From January to April 2024, length-weight relationships (LWR) were estimated for 87 fish caught from Lake Togbadji. The parasite collected were identified and their prevalence was assessed. The b value varied between 2.91 for males to 3.51 for females with a mean value equaling to 3.43 (3.16 – 3.57) for both sexes indicating a positive allometric growth and the condition factor (K) was 2.27 for females and 2.53 for males. A parasitological investigation revealed that 7 individuals of the nematode *Philometroides* sp. were infecting the fish gills. The prevalence is estimated at 3.44 % and the mean abundance is around 2.33 whereas the mean intensity is very low. Those results should be comforted with the mode of reproduction and the diet of this fish to understand more about its relatively low frequency of capture in the Lake.

Keywords: *Condition factor, Hepsetus odoe, Philometroides sp., positive allometric growth, prevalence*

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1. Introduction

The African pike, *Hepsetus odoe*, is a Characiforme that belongs to the family Hepsetidae, representing a predatory and piscivorous species distributed in the freshwater basins of Africa [1,2], bearing a striking resemblance to the European pike. One of the most striking features of this fish species is its dentition, with the lower jaw filled with two rows of sharp teeth while the upper jaw has only one [3]. Due to its role in the freshwater food chain, its role in the human diet, and the antimicrobial properties of its flesh, *H. odoe* is biologically and economically important [3,4]. *Hepsetus odoe* was considered the only species in the Hepsetidae family. Inland fish such as *H. odoe* are known to be a highly demanded, valuable, and important source of protein for humans and also contribute immensely to the country's gross domestic product (GDP) [5].

In Benin, *H. odoe* is widely exploited in continental water bodies, particularly lakes and lagoons. This is the case, for example, of Lake Togbadji in the catchment area of the River Mono. In this lake, *H. odoe* is heavily exploited by small-scale fishermen because of the quality of its flesh and its market value. Despite its great economic and dietary importance, no biological data is available on this fish species in Benin's water bodies. Coastal and inland waters, particularly oceans, lakes, and lagoons, are under increasing threat from human activities

such as industrial, agricultural, and domestic pollution, which can alter the quality of the environment and have biological, ecological, and societal implications [6]. Protecting aquatic ecosystems with a view to rational management of biodiversity is therefore becoming a major concern for scientists and natural resource managers.

Population dynamics are essential for understanding the functioning of aquatic ecosystems and managing exploited populations [7]. For example, the length-weight relationship is one of the most widely used basic units of biological information for estimating the weight corresponding to a given length [8]. It provides information on the growth pattern of fish [9,10], and combined with the identification of parasite diversity in fish, it effectively aids stock assessment [10,11]. Condition factors are also used as indicators of fish well-being and the health of fish populations in their habitats [12]. They provide information on the quality and suitability of the environment [13,14] and, as indices, they reflect an interaction between biotic and abiotic factors in the physiological conditions of fish [15].

Although numerous studies have been carried out on certain ecological and biological aspects of many fish species in the Mono River basin in Benin and in other basins such as the Ouémé basin, there is little scientific data on *H. odoe* in Benin, particularly in Lake Togbadji, an important body of water in the Mono basin. This study aims to provide the first basic data on the size structure and to determine the length-weight relationship and parasite diversity in *H. odoe* in Lake Togbadji. This could be used as an important tool for the real management process of this species in the lake.

2. Materials and Methods

Study environment

Lake Togbadji is located in southwest Benin, in the delta of the Mono River. It is a vast expanse of stagnant water with a surface area of around 91.509 km^2 and a depth ranging from 4 meters (during flood season) to 8 meters (during high water). It is located between latitude 6°44'36 North and longitude 1°42'9 East. Lake Togbadji is situated between Agbodranfo, Adrogbodji, Adjakomey, Bakpohoué, Kpolédji, Takon, and Togbadji villages. It is a natural water source shared by the communes of Dogbo and Lokossa in the Couffo and Mono departments, respectively. It is one of the largest lakes on the periphery of the alluvial valley of the Mono and Sazué basin, characterized by a degraded and complex hydrographic network. It is fed by run-off from several horizons.

Sampling

As part of this study, samples of H. odoe were collected each month from January to April 2023 from catches landed by artisanal fishermen using baited hooks and gillnets of various mesh sizes. After fish identification according to [16,17], morphometric measurements such as total length (L), standard length (SL) (to the nearest cm), and total weight (W) (to the nearest g) were taken from each *H. odoe* specimen. TL and SL were measured using an ichthyometer, while W was measured using an electronic Balance.

Size structure, weight-length relationship, and condition factor

The individuals sampled were grouped into size classes with intervals of 1 cm to estimate size-frequency distributions. The weight-length relationship was assessed using the equation: $W = aL^b$ from Le Cren [13] where W = weight (g), L = total length (cm), b = growth exponent, and a = constant. The value of b characterized the model of growth of the fish. Growth is considered to be isometric if $b = 3$ and allometric if $b \neq 3$ (positive if $b > 3$ and negative if $b < 3$). This value of b is between 2.5 and 3.5 and provides information about the dimensions of growth or an interpretation of the well-being of individuals to Bagenal et al., [8]. A logarithmic transformation was used to make the relationship linear: log W = log a + b log L. This form index reflects the species' nutritional state, trophic environmental conditions, and physiological state. The correlation r which explained the degree of association between length and weight, was calculated from the linear regression analysis: $R = r^2$.

The condition factor (K) of the fish specimens was estimated from the relationship: $K = 100\ W/\ L^b$ where K = condition factor, W = weight of fish (g), L = length of fish (cm).

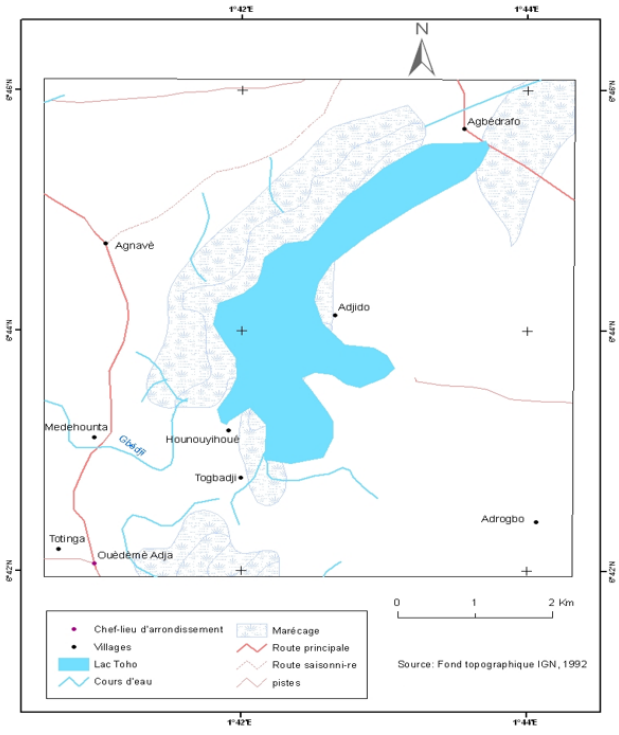


Figure 1. Map of Lake Togbadji

Parasite investigation and collection

An external body comprising smear of scrapings from the fins, skin, and gills of the fish was examined for ectoparasitic species. The endoparasites were examined from internal organs. The gastrointestinal tract was sectioned into successive portions such as the oesophagus, intestine, and rectum that were carefully (1) washed in a Petri dish with 0.1% sodium chloride solution and (2) rinsed with 0.1% sodium bicarbonate to enhance parasite search to [18,19]. Parasite identification was made using the

determination key of Paperna [18] and data presented in Moravec and Van As [20].

Statistical analysis

The *b* values were compared to 3 using Student's *t-test* [21]. Total length and total weight were compared separately between sexes using analysis of variance (ANOVA). Statistica 12.0 and Excel were used for statistical analysis. The coefficients of determination (r^2) obtained for each sex and the sexes combined were compared using analysis of covariance (ANCOVA). Analysis of covariance (ANCOVA) was chosen because these data do not have a normal distribution (Shapiro-Wilk test; $p < 0.05$) [22].

3. Results

Size structure

In Lake Togbadji, a total of 82 specimens of *H. odoe* were collected, 53 (64.63%) females and 29(35.37%) males. Total length ranged from 10.20 cm to 40.10 cm for females with an average of 24.16 ± 5.79 cm and from 8.40 cm to 34.90 cm for males with an average of 21.27 ± 4.90 cm. Total weight ranged from 59.00 g to 281.20 g for females with an average of 176.30 ± 45.34 g and from 65.50 g to 316.00 g for males with an average of 177.54 g ± 46.92. A significant difference in length ($t = 2.87$, df = 80, $p = 0.001$) and weight ($t = 2.25$, df = .80 $p = 0.0021$) was observed between males and females.

The results of the size distribution frequency obtained showed that the *H. odoe* population of Lake Togbadji has a bimodal size structure, revealing the presence of two groups of fish individuals (Figure 2). The first group of fish is constituted of individuals between 8.40 cm and 25.20 cm and the second group of individuals between 25.20 cm and 40.10 cm.

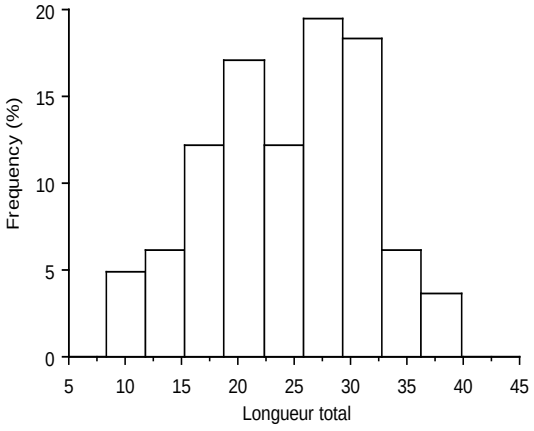


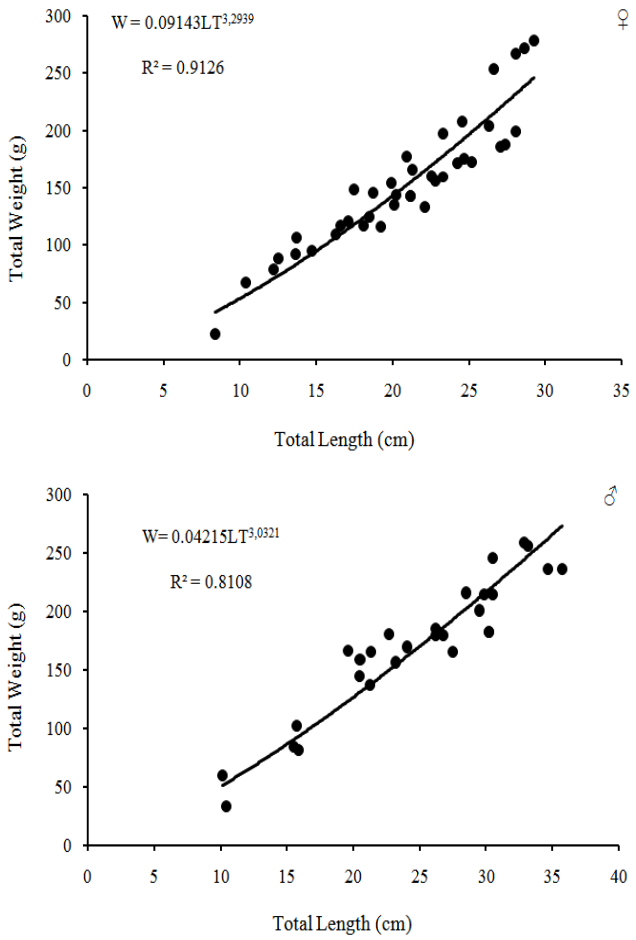
Figure 2. Size frequency distribution for *H. odoe* caught in Lake Togbadji. Total length (cm) was used.

Weight-length relationships

The weight-length relationship of 87 individuals of *H. odoe* from Lake Togbadji was examined. Figure 3 shows the regression plot of the relationship between the total length and weight of individuals of the species. The relationship between total length (L) and total weight (W) showed a highly significant positive correlation ($p = 0.001$) for both female and male individuals and both sexes combined (Table 1). This showed that the total weight of *H. odoe* individuals from Lake Togbadji increases as total length increases. The results of the analysis of covariance (ANCOVA) showed a significant difference ($p < 0.05$) in the coefficients of determination (r^2) between females and males. The coefficient *b* was significantly different from 3 (Student's *t* test: $p < 0.05$) for both females and males of *H. odoe* sampled in Lake Togbadji (Table 1). Values of *b* were greater than 3 ($b > 3$) indicating positive allometric growth in *H. odoe* individuals. This indicates better growth in weight than in length in both populations.

Table 1. Regression analysis of total weight on total length in the *H. odoe* population of Lake Togbadji. L: Total length W: Total weight, Values in brackets (CI) are the confidence intervals below and above 95% for the regression coefficients of *b*, r^2 = coefficient of determination, *a* and *b* = estimated parameters of the length-weight relationships

Sexes	Number	Mean TL (cm)	Mean TW (g)	*a*	*b* (CI)	r^2	Type of growing
♀	53	24,16 ± 5,79	176,30 ± 45,34	0,09	3,29 (3,09 – 3,31)	0,91	A+
♂	29	21,27 ± 4,90	177,54 g ± 46,92	0,04	3,03 (2,91 – 3,19)	0,81	A+
♂♀	82	24,27 ± 5,90	175,84 ± 37,12	0,05	3,43 (3,16 – 3,57)	0,89	A+



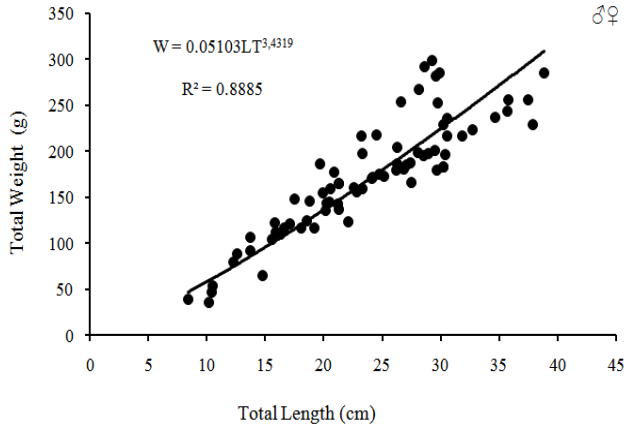


Figure 3. Length-weight relationship of *H. odoe* from Lake Togbadji

Condition factor

The condition factors (K) obtained were 2.27 for females and 2.53 for males. A significant difference was noted between the K values for males and females of *H. odoe* from Togbadji.

Numerical abundance of parasites of fish examined

Parasitological investigation in the present studies proved an incidence equaling 3.44% (3 out of 87 individuals). Only one ectoparasite species was identified and belonging to the genus *Philometroides* Yamaguti, 1935 (family: Philometridae, Baylis et Daubney, 1926). The mean abundance was 0.08 while the mean intensity was 2.33 during the survey, no female was infected whereas the infected fish length ranged from 20 to 25 mm.

Discussion

Stock assessment often refers to the part of the fish population that is exploitable in a fishery. Thus, a fish population is defined as a group of individuals of the same species or subspecies that are spatially, genetically, or demographically separated from other groups [23]. The distribution frequency results showed variation in the size structure of the *H. odoe* populations in Lake Togbadji. This shows that the samples included both young and adult specimens of *H. odoe*, which are therefore assumed to be representative of the *H. odoe* populations in Lake Togbadji, as confirmed by Stiassny et al. [16]

The length-weight relationship is an effective tool for rational exploitation and appropriate management of fish stock populations in aquatic environments. According to [24,25], this parameter is of significant importance in the study of growth, gonadal development, and welfare of fish populations. In aquatic environments, the length-weight relationship of fish species varies in time and space as a function of size, reproductive activities, or environmental conditions such as temperature, water quality, food quality and quantity, food availability, disease, and competition between fish individuals [8,26]. In the present study, the coefficients of determination (r^2) obtained for the *H. odoe* population of Lake Togbadji from the weight-length relationship showed that there was a high and significant correlation between total length and total weight for female and male individuals, as well as for individuals of both sexes combined. Positive allometric growth was observed in males, females, and both sexes. This shows that *H. odoe* individuals in Lake Togbadji grow more in mass than in length, regardless of sex. These results suggested that the water body presents better ecological and biological conditions and a good quality food resource for *H. odoe* populations. Many factors, such as morphology, sex, sexual stage, egg density and condition of the digestive tract, can cause weight variations in a fish [27].

The values of the allometric coefficient (*b*) obtained were well within the limits (2 and 4) indicated by [8] ; this shows that the model used for the analysis corresponds to the data, thus confirming the suitability and effectiveness of the model applied to the fish populations studied. The value of b obtained for female individuals was higher than that observed for male individuals of *H. odoe*. This difference in the *b* value observed between males and females of *H. odoe* is thought to be linked to the phenomenon of growth dimorphism, which allows females to have larger bodies to lay eggs and keep them longer. This difference may also be due to the tendency of certain larger species to put on more weight as they grow. In fact, during the breeding season, adult female *H. odoe* can be distinguished from males at first glance by the size of their abdomen, most of which is filled with oocytes. This variation in morphological characteristics between females and males of *H. odoe* during the reproductive period can strongly influence the size and weight of females, and consequently increase the value of the allometric coefficient (*b*). In addition, the high value of *b* observed in females is thought to be a function of their physiological state [28] and their numbers in the samples as a whole, since there are more females than males. The results obtained in the present study for *H. odoe* populations from Lake Togbadji are consistent with those of Adedokun et al. [29]. These authors reported positive allometric growth in *H. odoe* populations from Ogbomoso reservoir. The same observations were made by [30,31] in the Ado-Ekiti reservoir in Nigeria and [32] in Lake Eleyele Nigeria with a positive allometric value.

The condition factor, K, was used to assess the degree of welfare of *H. odoe* in Lake Togbadji in order to provide information on the quality and suitability of the environment [14]. According to [8,33], fish with higher K values (> 1) are in better condition than fish with lower K values (< 1). In the present study, the K values obtained in both females and males were greater than 1 (> 1). This indicates that *H. odoe* populations in Lake Togbadji were in good condition during the study period. These K values obtained were within the range (2.9 to 4.8) proposed by [8] for mature freshwater fish in Africa. The results obtained for the condition factor K for H. odoe populations in Lake Togbadji are similar (K > 1) to those obtained for the same species in the Epe River, Zambezi River, Ado Ekiti, Ogbomoso, Ogun Coastal Estuary and Eleiyele Reservoir [29,30,32,34], respectively.

The parasite prevalence associated with *H. odoe* in the present study was low. Irrespective of the sample size, Lekeufack Folefack and Fomena [35] have suggested that the absence of infection could account for the balanced population structure of H. odoe within the population. Although it was not equal to zero, the prevalence recorded in the present study was similar to those of Bayo [36] who observed no parasites on *H. odoe* individuals in the River Kwa, Calabar in Nigeria. The same authors found that fish such as *Mormyrus rume*, *Ethmalosa fimbriata*, and *Cynoglossus senegalensis* were not infected, unlike other species such as *Clarias*

gariepinus and *Chrisychthys nigrodigitatus*. This suggested either that *H. odoe* is insensitive to parasites or that there is a probable specificity between fish and parasite species. However, there exist studies mentioning important prevalence in *H. odoe*. In Ivory Coast, N'Douba et al. [37] examined three species of monogenic Ancerocephalidae including *Annulotrema hepsetidi*, and two new species *Annulotrema macropenis* n. sp. and *Annulotrema biaensis*. Similarly, [20,38] reported the nematode *Philometra* (syn: *Margolisianum*) *africanus* and the copepod *Lamproglena hepseti*, respectively on individuals of *H. odoe* from the waters of Botswana, and prevalence obtained by [20] was high (29%). Later in 2013, [35] identified three *Myxobolus* species (Myxosporidia) in *H. odoe* from the Sangé River in Cameroon. While Ojere et al. [39] mentioned the infestation of *H. odoe* by acanthocephalans and nematodes in Nigeria. Although it appears that the prevalence obtained in the present study is low compared to the 29% presented by [20], the prevalence in the other studies is frequently low. Also, the gills are the most infected organs in H. odoe. Even if the mean abundance and mean intensity have often not been reported, this could be because they represented parameters of little importance, either in terms of the problem of novel parasite description or because of the low values recorded for these ecological parameters.

4. Conclusion

This is the first study of *H. odoe* populations in Lake Togbadji in southern Benin. It provided information on the structure and some biological parameters of the species. The results show that the *H. odoe* population at Lake Togbadji has a positive allometric growth model with a bimodal size structure. The population as a whole is in relatively good condition in terms of the results obtained from the condition factor and parasite data. Efforts must therefore be made to maintain and support the environmental conditions of the lake for continued prosperity of this fish species in Lake Togbadji.

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Competing Interests

There are no competing interests.

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