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Specific richness, size classes and growth parameters of the main fish species in the upper Mouhoun River basin in Burkina Faso

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Abstract
In Burkina Faso, fisheries management based on compliance with the fishing gears being authorized by the legislations is inadequate. In this context, it is necessary to find other tools to assess the catch sizes of the species and the quality of the living environment of the fish. For this purpose, a sampling was carried out in three fishing sites in order to study the richness, the size class, the weight-length relationship of captured species and the condition factor of the dominant species during the rainy and dry seasons. The results showed that the three fishing sites were found to be species abundant ones with 43 species divided into 31 genera belonging to 18 families. The dominant species were: *Oreochromis niloticus, Sarotherodon galilaeus, Heterotis niloticus, Auchenoglanis occidentalis* and *Synodontis schall*. In Bama, the catch sizes of *O. niloticus* ranged from 7.5 to 25 cm while in Balla it varied from 12.5 to 32.5 cm. The size of *S. galilaeus* ranged from 7.5 to 22.5 cm, 12.5 to 30 cm and 15 to 25 cm in Bama, Balla and Samendeni, respectively. Values of the constant b of the weight-length relationship revealed that 50% of the species had negative allometric growth, 20% had isometric growth and 30% had positive allometric growth. This showed that some species are exploited below the size of their first maturity in some sites, which might compromise their long-term survival.

Keywords: Fisheries, size class, weight-length relationship, condition factor, Burkina Faso

1. Introduction

In West Africa as elsewhere, human activities have been affecting strongly the fish communities [1]. These include the construction of dams, the use of chemicals in agriculture, the destruction of forests, and the discharge of domestic and industrial waste into watercourses. On one hand, these activities contribute to the reduction of fish habitats and on the other hand the qualitative degradation of their living environment.

In addition to these threats, certain forms of fishing such as overexploitation and the use of prohibited gears have direct impacts on fish diversity and growth. Lévêque and Paugy [2] stated that growth metabolically covers the proportion of energy used to increase the body weight and length. This growth parameter is widely used in fisheries ecology as an indicator of fish habitat quality [3]. The assessment of this fish growth requires the use of approaches such as the method of the size class structure, the marking on bone pieces, the weight-length relationship and the condition factor. The growth process of fish is conditioned by the external environment (e.g., seasonal shrinkage of water bodies), the fish confinement and the scarcity of food resources [4, 5]. It is in this context that knowledge on the biology of fish growth becomes an essential tool for assessing the quality of the living environment and the level of fish exploitation. Thus, this would help to better manage the exploited stocks [6]. In this regard, studies on fish growth using the above-mentioned parameters have been conducted in Burkina Faso [7, 8, 5].

With regard to the upper Mouhoun River basin, few works have been conducted on fish growth. However, without reliable information on fish populations stock, it will be difficult to sustainably manage these fishing sites. That is why this study was initiated with the objective of assessing the situation of the fish fauna and evaluating the growth parameters of the main species in three fishing sites of the upper Mouhoun River basin for the purpose of promoting the sustainable management of the resources.

2. Material and Methods
2.1 Material
2.1.1 Study area
The study area is located in the upper basin of the Mouhoun River, west of Burkina Faso. The study was carried out in three fishing sites which straddle between Bama and Satiri municipalities. These sites include those of Samendeni (Samendeni Dam Lake), Bama (Bama Pool) and Balla (Balla Pool)). The location of the three sites is presented in Figure 1.

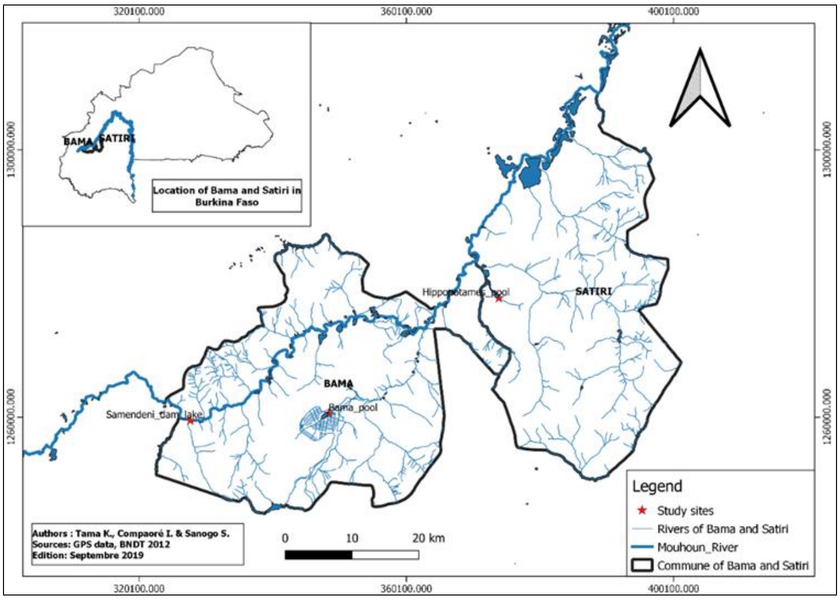


Fig 1: Geographic location of the three fishing sites

2.1.2 Technical equipment
The fishing gears used in this study for the capture of fish were a battery of gillnets, cast nets, long lines and traps. The identification of the sampled fish was performed using identification keys [9, 10]. Three electronic scales with different capacity were used to record the weight of the sampled fish. An ichthyometer and a caliper (200 ± 0.2 mm) were used for measuring the fish length (standard and total).

3. Methods
3.1. Fish sampling
Data collection was performed during two periods: the first period was the rainy season (July to August 2018) and the second corresponds to the dry season (February to April 2019) in each site. In the three sites, 5 fishing stations were selected, of which 3 were located in the Samendeni site because of its size and 1 station in each of the other two sites (Bama and Balla). This approach was applicable for both periods (rainy and dry season). In each fishing station, we selected 10 voluntary fishermen for the monitoring and the identification of the captured species, i.e. 50 fishermen for all the 5 sites. For each fisherman and after each fishing time, 1 to 30 individuals of each fish species were selected for the study. Each individual was identified, the total length (Lt) and the standard length (Lst) were measured and the total weight (WT) was recorded.

3.2. Measured parameters
The different parameters to be considered in order to report on the status of the fish fauna and to assess the growth parameters in the three sites were defined as follow:

- **Specific richness S:** The species richness S represents the total number of species at a site.
- **Specific contribution (CS):** The specific contribution (CS) is defined as the ratio of the specific frequency to the sum of the frequencies of all surveyed species. It is a relative frequency. Its formula is $CSi = \left(\frac{FSi}{\sum_i^n FSi}\right) * 100$, where CSi represents the contribution of species i, in the number of individuals of species i, and FSi, the specific frequency of the species i.
- **Length-weight relationship:** The relationship between the total length of the fish and their weight is a parameter that allows us to verify the growth of the fish. It is represented by the relation of Le Cren (1951): $Wt = a\ Lt^b$. Where Wt = total weight of the fish in grams (g); Lt = total length of the fish in centimeters (cm); the constants a and b are deduced after linearization of the relation by logarithmic transformation in the form: $logWt = \log a + b \log Lt$. Constants a and b reflect environmental and species-specific factors, respectively. The coefficient b (slope of the regression line) varies between 2 and 4, but is often close to 3, and expresses the relative shape of the fish body. When b = 3, the growth is said to be isometric; b > 3, the growth is said to be positive allometric and thus reflects a better growth in weight than in length; b < 3, the growth is allometrically negative and indicates poor growth in weight than in length of the fish.
- **Condition factor (K):** The condition factor or coefficient K is defined by the ratio between the weight and the size of the fish. The formula used is: $K = (Wt/Lt^b) * 100$. Where Wt = total weight of fish in grams (g); Lt = total length of fish in centimeters (cm); the constant b is the coefficient of allometry derived from the weight-length relationship Wt = aLt^b.

4. Results and discussion
4.1 Results
4.1.1 Specific richness in the three fishing sites
From this study, 43 species were identified and classified in

31 genera belonging to 18 families. In terms of the Bama site, a total of 22 species in 17 genera and 13 families were counted. In Balla, 24 species in 19 genera and 14 families were identified. With regard to the Samendeni fishing site, it was observed 34 species in 24 genera which belong to 17 families (Table I).

Table 1: List of the main species encountered in the three fisheries during the dry and wet seasons

Families	Scientific names	Bama		Balla		Samendeni	
		RS	DS	RS	DS	RS	DS
Claroteidae	*Auchenoglanis occidentalis* (Valenciennes, 1840)	*		*	*	*	*
	Chrysichthys auratus (Geoffroy St-Hilaire, 1808)					*	*
Bagridae	*Bagrus bajad* (Forsskäll, 1775)			*		*	*
	Bagrus docmack (Forsskäll, 1775)						*
Alestidae	*Alestes baremoze* (de Joannis, 1835)					*	*
	Brycinus nurse (Rüppell, 1832)	*	*	*	*	*	*
Clariidae	*Heterobranchis bidorsalis* (Geoffroy St-Hilaire, 1809)			*			
	Clarias sp	*	*	*	*	*	*
Anabantidae	*Ctenopoma kingsleyae* (Günther, 1896)	*	*				
	Ctenopoma petherici (Günther, 1864)	*	*		*		
Gymnarchidae	*Gymnarchus niloticus* (Cuvier, 1829)	*	*	*	*		*
Osteoglossidae	*Heterotis niloticus* (Cuvier, 1829)	*	*	*	*	*	*
Cichlidae	*Coptodon zillii* (Gervais, 1848)	*	*	*	*	*	*
	Chromidotilapia guntheri (Sauvage, 1882)					*	*
	Hemichromis bimaculatus (Gill, 1862)	*	*	*	*	*	
	Hemichromis fasciatus (Peters, 1857)	*	*	*	*	*	*
	Oreochromis niloticus (Linnaeus, 1758)	*	*	*	*	*	*
	Sarotherodon galilaeus (Linnaeus, 1758)	*	*	*	*	*	*
Cyprinidae	*Labeo coubie* (Rüppell, 1832)				*	*	*
Latidae	*Lates niloticus* (Linnaeus, 1762)					*	*
Malapteruridae	*Malapterurus electricus* (Gmelin, 1789)					*	*
Mormyridae	*Hippopotamyrus pictus* (Marcusen, 1864)	*					
	Hyperopisus bebe (Lacépède, 1803)					*	*
	Marcusenius senegalensis (Steindachner, 1870)	*	*	*	*	*	*
	Mormyrops anguilloides (Linné, 1758)						*
	Mormyrus rume (Valenciennes, 1846)					*	*
	Petrocephalus bovei (Valenciennes, 1846)				*		
Channidae	*Parachanna obscura* (Günther, 1861)	*	*	*	*	*	
Polypteridae	*Polypterus ansorgii* (Boulenger, 191O)			*			
	Polypterus bichir Lapradei (Steindachner, 1869)		*	*	*		
	Polypterus endlicheri endlicheri (Heckel, 1849)			*	*		*
	Polypterus senegalus senegalus (Cuvier, 1829)	*	*		*		
Protopteridae	*Protopterus annectens* (Owen, 1839)	*				*	
Schilbeidae	*Schilbe intermedius* (Rüppell, 1832)	*	*	*	*	*	*
Mochokidae	*Hemisynodontis membranaceus* (Geoffroy St-Hilaire, 1809)				*	*	
	Synodontis clarias (Linné, 1758)					*	*
	Synodontis nigrita (Valenciennes, 1840)	*	*	*	*	*	
	Synodontis ocellifer (Boulenger, 1900)					*	
	Synodontis schall (Bloch et Schneider, 1801)	*	*			*	*
	Synodontis punctifer (Daget, 1964)					*	*
	Synodontis batensoda (Rüppell, 1832)					*	
	Synodontis vélifer (Norman, 1935)	*					
Tetraodontidae	*Tetraodon lineatus* (Linné, 1758)						*
18 families	43 species	21	18	19	21	29	27

Legend: (*) = presence; RS = rainy season; DS = dry season

4.1.2 Species Specific contribution in the fishing sites based on seasons

The species specific contribution varied from species to species and from fishing site to another. In the site of Bama, two species had the highest specific contribution (CS) (>10%) during the two seasons. The first species was *S. galilaeus* of which the CS was 41.59% and 31.4% during the rainy and dry season, respectively. *O. niloticus* was the second species with a CS of 27.31% in the rainy season and 40.78% in the dry season. Concerning Balla site, *S. galilaeus* (37%) and *H. niloticus* (30.68%) had the highest specific contribution (>10%) recorded during the rainy season. In the dry season, *S. galilaeus*, *O. niloticus* and *H. niloticus* had the highest values of CS representing 37.87, 21.37 and 14.95% respectively. In the site of Samendeni, four species, namely *S. schall*; *A. occidentalis*; *O. niloticus* and *S. galilaeus* were found to have the highest values of CS (15.8%; 15.2%; 14.42% and 12.02%, respectively) in the rainy season. However, during the dry season, the species of which the CS was higher than 10% were *C. zillii* (35.62%) followed by *S. galilaeus* (27.84%) and *O. niloticus* (15.95%).

4.1.3 Size class structure of the main species

The determination of the size classes was performed for species of which the specific contribution in each site and by season was found to be greater than 10%. This is a means of assessing the selectivity of the fishing gears used by the fishermen. Thus, for each fishing site, these species were *O.*

niloticus and *S. galilaeus* for Bama, *O. niloticus, S. galilaeus* and *H. niloticus* for Balla, and *A. occidentalis, S. schall, O. niloticus, S. galilaeus* and *C. zillii* for Samendeni.

4.1.4 Size classes structure of the main species in Bama

The size class structure of *O. niloticus* and *S. galilaeus* is presented in the Figures 2a and 2b, respectively. From Figure 2a, it was observed that *O. niloticus* with maximum sizes were captured during the dry season. Thus, 41% of captured fish had a size ranging from [12.5-15[cm and 31% of captured fish had a size varying from [15-17.5] cm. However, in the rainy season, the maximum size varied from [7.5-10[and [10-12.5] cm, for 25% of captured fish, respectively. Fish with a Size greater than 20 cm are poorly captured during the rainy season. For *S. galilaeus*, the maximum size was also recorded during the dry season (Figure 2b). Thus, captured fish were abundant in the size classes [15-17.5[and [17.5-20] cm with respective frequencies of 39.22 and 46.68%. During the rainy season, the capture size ranged from [10-12.5[and [12.5-15] for both species.

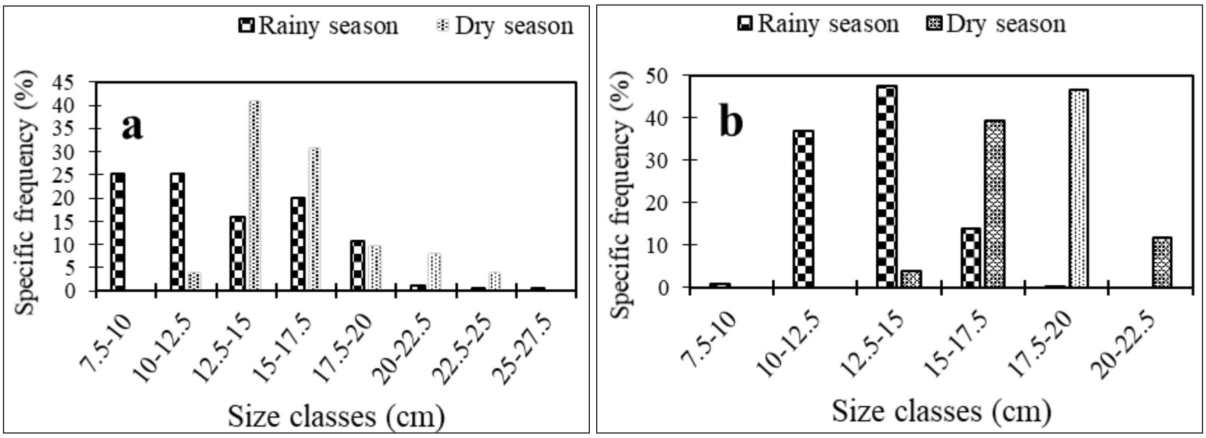
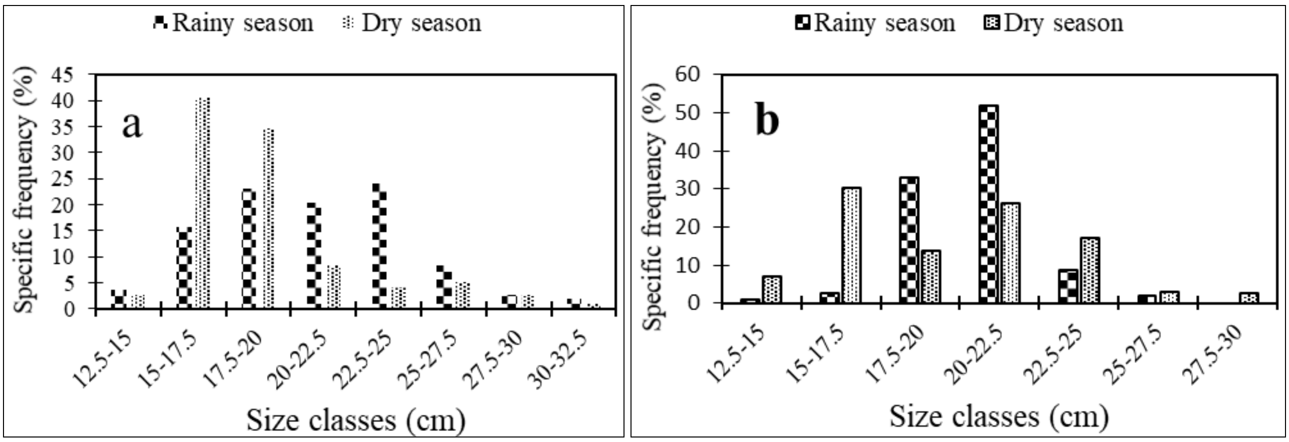


Fig 2: Size class structure of *O. niloticus* (a) and *S. galilaeus* (b) by season in Bama

4.1.5 Size class structure of the main species in Balla

In Balla, the main captured species were *O. niloticus, S. galilaeus* and *H. niloticus* regardless of the season. The Figure 3a shows the size class distribution for captured *O. niloticus*. The largest capture sizes during the dry season found between size classes [15-17.5[and [17.5-20], representing 75.13% of the captures. In the rainy season, the largest sizes were among [17.5-20[, [20-22.5[and [22.5-25[size classes with frequencies of 23%, 20% and 24%, respectively. These results showed that more individuals of *O. niloticus* with a large size were captured during the rainy season as compared to those in the dry season. The Figure 3b shows the size class structure of *S. galilaeus*. From it, the major part of the catches was found to be between the size classes of [17.5-20[and [20-22.5] in the rainy season, corresponding to 85% of the total capture size. However, in the dry season, the important size classes were found between the class of [15-17.5[and [20-22.5[. This stands for more than 56% of the catches. Thus, it was observed that large-sized individuals of *S. galilaeus* were captured during the rainy season in Balla fishing site. In rainy season, the major catch of *H. niloticus* in Balla was found in classes of [30-35] and [35-40], representing 82.5% of the total catches (Figure 3C). In dry season, the most frequent catch sizes were observed in classes of [40-45], [45-50] and [50-55]. These results indicated that individuals of *H. niloticus* captured during the dry season had large sizes.



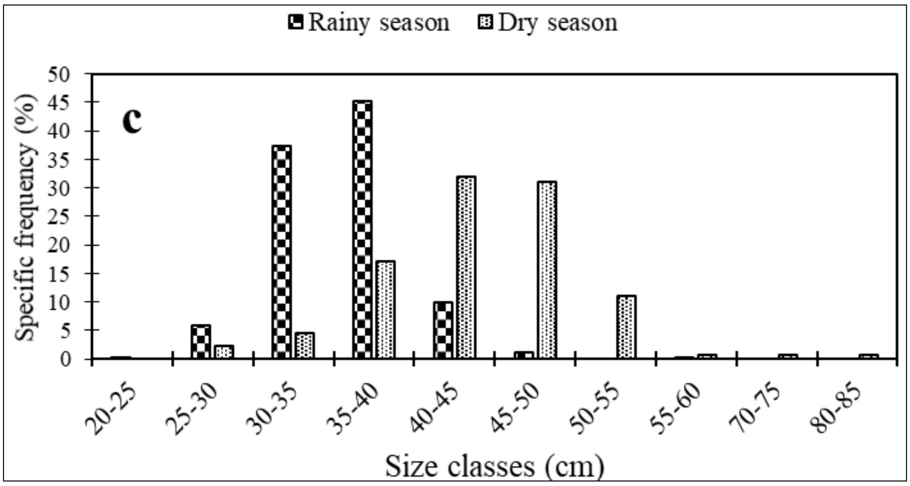


Fig 3: Size class structure of *O. niloticus* (a), *S. galilaeus* (b) and *H. niloticus* (c) in Balla

4.1.6 Size class structure of the main species in Samendeni

The Figure 4a shows the size classes of *A. occidentalis* and *S. schall* in the Samendeni fishing site. These species were only captured during the rainy season with a specific contribution >10%. The frequent catch sizes of *A. occidentalis* were encountered in size classes of [15-20[and [20-25[, representing 87.75% of the catches. However, concerning *S. Schall*, catches were found in size classes of [25-30[and [30-35[at a frequency of 90.12% of total catches. *O. niloticus* was captured at large quantities during both rainy and dry seasons (Figure 4b). Thus, in the rainy season, the frequent size classes for captures were within the range of [20-22.5] with a frequency of over 50%. In the dry season, the same size class was predominant in the catches at 64.07% of the catch. Figure 4c presents the size classes of *S. galilaeus* and *C. Zillii* in the dry season. For *S. galilaeus* the frequent size of the captured individuals was found in the class of [20-22.5] at a frequency of 59.41%. In *C. zillii*, the frequent sizes were found in classes of [15-17.5[and [17.5-20[with a cumulative frequency of 69.81%.

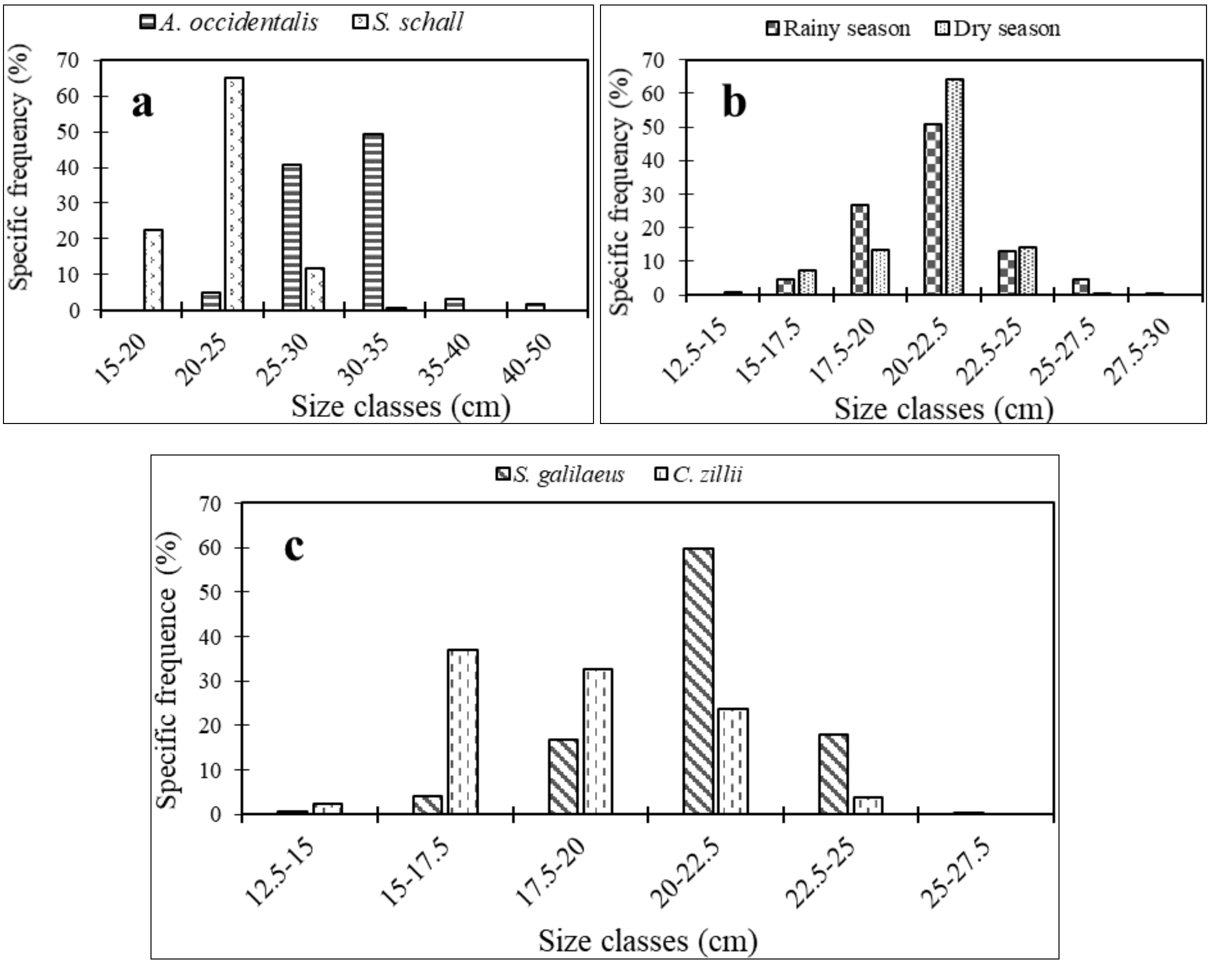


Fig 4: Size class's structure of the main species in Samendeni fishing site

4.1.7 Weight-length relationship

The weight-length relationship was determined for the five most abundant species in each of the fishing sites and for each season. Results are presented in tables II, III, and IV corresponding to the values of a and b for the different species in Bama, Balla and Samendeni, respectively. During the rainy season, it was observed in Bama that *Clarias sp* and *G. niloticus* were the species showing a positive allometric growth while it was negative for *C. zillii*, *O. niloticus* and *S. galilaeus*. In the dry season, the allometric growth was positive for *C. zillii* and *G. niloticus* while *Clarias sp* and *O. niloticus* had isometry growth. With regard to *S. galilaeus*, a negative allometry was always observed. In the fishing site of Balla, *O. niloticus* and *S. galilaeus* showed a negative allometric growth regardless of the season. *G. niloticus* changed positive into a negative allometry from the rainy to the dry season. For *Clarias sp*, it changed negative allometric into an isometric growth during the dry season. In the site of Samendeni, *A. occidentalis* showed a negative allometric growth in the rainy season and positive during the dry season. The opposite was observed for *C. zillii* and *O. niloticus*. *S. galilaeus* changed from a negative allometric growth in the rainy season to an isometric growth in the dry season. As for *S. schall*, a negative allometric growth was found regardless of the season.

4.1.8 Condition factor K

The values of the condition factor K and the coefficient of determination R^2 for all species are shown in tables II, III and IV for the fishing sites of Bama, Balla and Samendeni. Values of the condition factors were different from season to another for the same species. In Bama, the condition factor K was 0.35 for *G. niloticus* and 7.226 for *S. galilaeus* during the rainy season. In the dry season it was 0.003 for *G. niloticus* and 5.85 for *S. galilaeus*. Considering the fishing site of Samendeni, K was 1.085 for *O. niloticus* and 10.359 for *A. occidentalis* during the rainy season. In the dry season, it was 1.711 for *A. occidentalis* and 5.85 for *C. zillii*.

Table 2: Summary of the a, b, K parameters in the weight-length relationship for the 5 dominant species in Bama

Period	Species	weight (g)	Lst (cm)	Number of fish	a	b	R^2	K	TG
Rainy season	*Clarias sp*	33-575	14,0-33,5	77	0,009	3,100	0,972	1,108	A+
	Coptodon zillii	5-155	4,5-16	87	0,139	2,710	0,943	9,68	A-
	Gymnarchus niloticus	27-1450	20,5-66,2	111	0,002	3,135	0,966	0,305	A+
	Oreochromis niloticus	7-1150	5,0-27	367	0,319	2,940	0,771	7,004	A-
	Sarotherodon galilaeus	12-269	5,8-17	559	0,144	2,892	0,812	7,226	A-
Dry season	*Clarias sp*	49-1690	16,5-53	53	0,013	2,950	0,984	3,478	I
	Coptodon zillii	12,0-86	6,5-12	67	0,233	3,196	0,814	2,77	A+
	Gymnarchus niloticus	87-6600	23,5-110	31	0,183	3,100	0,974	0,003	A+
	Oreochromis niloticus	25,0-565	8,5-23,5	500	0,048	3,027	0,967	4,272	I
	Sarotherodon galilaeus	43-233	10,0-18	385	0,093	2,880	0,919	5,818	A-

Legend: A+ = positive allometric growth; A- = negative allometric growth; I = isometric growth; Lst = standard length; TG = type of growth.

Table 3: Summary of the a, b, K parameters in the weight-length- relationship for the 5 dominant species in Balla

Period	Species	weight (g)	Lst (cm)	Number of fish	a	b	R^2	K	TG
Rainy season	*Clarias sp*	110-3300	[13,0-63]	48	0,268	2,154	0,808	2,487	A-
	Gymnarchus niloticus	76,0-2700	[28,0-78]	94	0,0009	3,402	0,986	0,107	A+
	Heterotis niloticus	138-1450	[20,0-45]	354	0,014	3,016	0,915	1,457	I
	Oreochromis niloticus	50-1655	[10,0-35]	98	0,060	2,895	0,977	7,088	A-
	Sarotherodon galilaeus	28-1246	[8,5-32,5]	427	0,142	2,832	0,843	7,67	A-
Dry season	*Clarias sp*	43-2017	[17-57,5]	43	0,009	3,043	0,986	1,187	I
	Gymnarchus niloticus	33-4100	[21-96,5]	50	0,0039	3,012	0,885	0,029	I
	Heterotis niloticus	248-4800	[24,5-76]	135	0,0348	2,844	0,976	2,559	A-
	Oreochromis niloticus	56-1060	[11-30,5]	193	0,0509	2,922	0,971	5,840	A-
	Sarotherodon galilaeus	48,0-714	[10,0-27]	342	0,0645	2,859	0,982	4,548	A-

Legend: A+ = positive allometric growth; A- = negative allometric growth; I = isometric growth; Lst = standard length; TG = type of growth.

Table IV: Summary of the a, b, K parameters in the weight-length- relationship for the 5 dominant species in Samendeni

Period	Species	weight (g)	Lst (cm)	Number of fish	a	b	R^2	K	TG
Rainy season	*Auchenoglanis occidentalis*	89-1346	[12-36]	253	0,130	2,555	0,855	10,359	A-
	Coptodon zillii	47-213	[10,5-18]	121	0,046	3,277	0,932	2,284	A+
	Oreochromis niloticus	67-425	[12,0-28]	226	0,408	3,479	0,881	1,085	A+
	Sarotherodon galilaeus	50-331	[10,0-27]	183	0,772	3,059	0,831	3,708	A+
	Synodontis schall	38-336	[11,0-21]	264	0,046	2,883	0,807	4,823	A-
Dry season	*Auchenoglanis occidentalis*	66-1240	[14-36]	30	0,022	3,133	0,988	1,711	A+
	Coptodon zillii	39-284	[10,0-20]	659	0,056	2,866	0,920	5,850	A-
	Oreochromis niloticus	64-299	[11,5-19,5]	295	0,071	2,926	0,895	5,060	A-
	Sarotherodon galilaeus	51-525	[11,0-24]	515	0,066	2,984	0,906	4,500	I
	Synodontis schall	88-235	[14-19]	12	0,404	2,927	0,912	4,153	A-

Legend: A+ = positive allometric growth; A- = negative allometric growth; I = isometric growth; Lst = standard length; TG = type of growth.

4.2 Discussion

4.2.1 Specific richness and specific contribution

This study identified 43 fish species in 31 genera and 18 families. The dominant species in catches in the three sites were *S. schall, A. occidentalis, O. niloticus, S. galilaeus, C. zillii,* and *H. niloticus* which were captured during both seasons. This dominance was found to different from site to site and from season to season. Among these species, those belonging to the *Cichlidae* family were predominant. Indeed, the abundance of *Cichlidae* in the water bodies of Burkina Faso has been confirmed by several studies in particular [8][11]. In fact, this fauna was characteristic to that in the West African rivers [2].

4.2.2 Size class structure

In all the three fishing sites, analysis of the size structure showed that catches in the site of Bama had smaller size fish than those in Balla natural pond and Samendeni dam. In fact, in the dry season, most captured individuals of *O. Niloticus* in Bama and in Balla had a size less than 17.5 cm. However, in the rainy season, a large proportion of the captured individuals had a size greater than 20 cm in the sites of Samendeni and Balla. This seems to be the most judicious situation as the size of *O. niloticus* at first maturity is generally ranged between 14 and 20 cm. Further, Plisnier and *et al.*, [12] highlighted that this first maturity size was 19 cm for females and 20 cm for males. However, it may change within the same population depending on the fluctuating environmental conditions. Regarding this information, it can be stated that most captured individuals of *O. Nilotic* us were not mature. Concerning *S. galilaeus*, the size of all captured individuals in the rainy season was less than 17.5 cm in Bama. On the other hand, during the dry season, individuals caught in Bama were larger than 17.5 cm. In Balla as well as in Samendeni most individuals caught exceed 17.5 cm regardless of the season. According to Baijot and Moreau [13], the size at first maturity of *S. galilaeus* is 16.3 cm. Other studies also showed that the size at first maturity of *S. galilaeus* is achieved when individuals had a total length of 13.1 and 10.6 cm for males and females, respectively [14]. The size of captured individuals of *C. zillii* was found to be higher than 15 cm in the site of Samendeni. This is greater than the size at first maturity as defined by Lévêque [15] which was 7 cm. Based on these results, we can say that some species such as *O. niloticus* and *S. galilaeus* have been exploited when the size was smaller than that of the first sexual maturity, i.e. immature individuals. This type of exploitation is especially observed in the fishing site of Bama and the opposite situation in the other two sites. This could be explained by the fact that fishermen were using small-sized mesh nets, particularly the cast nets (10 to 15 mm) which influence the catch size. Indeed, the use of cast nets is becoming one of the major obstacles for some species to reach the optimal size in this water body. According to Baijot and *et al.* [16], the use of large size gillnets resulted in low yields while nets with small mesh sizes (10 to 25 mm) were more profitable. As a result, the use of nets with small mesh size and cast nets by some fishermen became an adaptive strategy in order to compensate the fishing effort. For *H. niloticus* species, the sexual maturity is achieved when the total length individuals is 48 cm and 54 cm for males and females, respectively [17]. of These results showed that many species in the three fishing sites were exploited below the age at sexual maturity as compared to previous studies[14]. This strongly influenced the structure of the fish population in the water bodies in the long term. According to Sanyanga and *et al.* [18], this leads to a major change in the composition and structure of the fish communities. Thus, this could be the case of the large number of *Cichlidae* caught in the dry season as opposed to the rainy season in the natural pond of Bama. This practice could be one of the reasons for the disappearance of some species as reported by fishermen in Bama. According to Lévêque and *et al*. [9], some fish families, especially *Mormyridae*, *Alestidae* are not tolerant to strong environmental disturbances. In response to these disturbances, some species exhibit eco physiological adaptations and/or develop adaptations affecting the growth or reproduction phenomena: early sexual maturity, dwarfism, variation in growth [39, 20].

4.2.3 Weight-length relationship

In all three fishing sites, *Clarias sp* and *H. Niloticus* had the lowest b values in the rainy and dry seasons, respectively. The highest b value was observed in *O. niloticus* in the rainy season and *C. zillii* in the dry season. Some b values found in the rainy and dry seasons were close to those reported by the studies of Da Costa and *et al* [21] and Mikembi and *et al*. [22] in which species showed a good growth. According to Ricker (1980), when the coefficient b is greater than 3, this indicates a better growth in weight than in length for the species. In this study, approximately 53.33% of the studied species had a negative allometric growth (b<3), 6.67% had isometric growth (b = 3) and 40% had positive allometric growth (b>3) during the rainy season. In the dry season, 46.67% of the studied species had a negative allometric growth (b<3), 33.33% had an isometric growth (b = 3) and 20% showed a positive allometric growth (b>3). Overall, 50% of the studied species have negative allometric growth and about 20% of the species have isometric growth and 30% of the species have positive allometric growth (b>3). These results showed that most of the studied species do not show a good growth. This could be attributed to the ecological conditions that might be unfavorable for these species to reach the optimal growth. This can be explained by the fact that these water bodies are threatened by anthropogenic activities such as the release of agricultural inputs (pesticides, herbicides), the silting and climate change through the variation of the physico-chemical parameters of the water. In addition, b values can be influenced by fish sex, growth stage, stomach contents gonad development and environmental conditions [23]. In this study, these parameters were not considered for data processing. Therefore, this might have biased our results as these factors were not analyzed.

4.2.4 Condition factor K

In this study it was shown that K condition factors varied within the same species, depending on the season, but also among species. As reported by Bagenal and Tesch [24], freshwater fish are in good condition when the condition factor (K) is ranged between 2.9 and 4.8. In the present study, about 43% of the studied species had a lower K value than that of the average and 57% would be in good ecological conditions. The observed K values showed that a large part of the studied species were under unfavorable ecological conditions this confirming the observed allometry coefficient values (b). This could be explained by the high seasonal hydrological variability which occurred in these water bodies. According to Lévêque [15], the hydrological variability resulting from the seasonal rainfall distribution or the interannual variability of precipitation have important consequences on the condition factor (K). Indeed, seasonal changes in water levels along with the floods at varying duration have an impact on the functioning of tropical hydrosystems [25]. These periodic alternating high and low water levels provided a great diversity of habitats impacting the biology, physiology and ecology of fish populations [26]. Thus, these important seasonal hydrological variations could explain the observed K values fin the present study. This could indicate that most of the fish species inhabiting these water bodies were sensitive to seasonal variations. These results corroborated with the findings of previous studies[26].

5. Conclusion

This study provides a very useful information for the sustainable management of the targeted fishing sites located in the upper basin of the Mouhoun River. This information includes the species richness, the size class distribution and the growth parameters such as weight-length relationship and condition factor K. Thus, it appears that the three sites were species abundant with 43 species divided into 31 genera and 18 families. Among these species (*O. niloticus*, *S. galilaeus*, *H. niloticus*, *A. occidentalis* and *S. schall*), five were predominant regarding the catches with specific contributions greater than 10%. The structure of the size class for the 5 predominant species in each site showed that some species were highly exploited before reaching the size at first sexual maturity, especially in the fishing site of Bama. Those species were mainly *O. niloticus* and *S. galilaeus*. Results on the weight-length relationship showed that 50% of the surveyed species had a negative allometric growth, indicating that most of these species showed a poor growth. This was confirmed by the low coefficient of the condition factor (K) indicating that some species were under unfavorable conditions to better express the optimal growth.

6. References

1. Kamdem Toham A, Teugels G. First data on an Index of Biotic Integrity (IBI) based on fish assemblages for the assessment of the impact of deforestation in a tropical West African river system, *Hydrobiologia* 1999;397:29-38.
2. Lévêque C. Les poissons des eaux continentales africaines. Diversité, écologie, utilization par l'homme, IRD Éditio. Paris 2006.
3. Searcy SP, Eggleston DB. Is growth a reliable indicator of habitat quality and essential fish habitat for a juvenile estuarine fish, Can. J Fish Aquat. Sci 2007;64:681-691. doi: http://dx.doi.org /10.1139/F07-038.
4. Chikou A, Laleye AL, Raemakers V, Vandewalle P. Etude de l'âge et de la croissance chez Clarias gariepinus (Pisces, Clariidae) dans le delta de l'Ouémé au Bénin (Afrique de *l'Ouest*), Int. J Biol. Chem. Sci 2008;2(2):157-167.
5. Da N, Ouédraogo R. Relation poids-longueur et facteur de condition de Clarias anguillaris et Sarotherodon galilaeus pêchées dans le lac Bam et le reservoir de la Kompienga au Burkina Faso. Int. J Biol. Chem. Sci 2018;12(4):1601-1610.
6. Morize E. Age et croissance des poissons tropicaux marins, Brasilia, février 2006.
7. Coulibaly ND. Relation longueur-poids chez quatre espèces de poissons de la rivière *Sourou* au Burkina Faso. Int. J Biol. Chem. Sci 2008;2(3):331-338.
8. Sirima O, Toguyeni A, Zougranan KY. Faune piscicole du bassin de la Comoé et paramètres de croissance de quelques espèces d'intérêt économique. Int. J Biol. Chem. Sci 2009;3(1):95-106.
9. Paugy D, Lévêque C, Teugels G. Faune des Poissons d'Eaux douces et saumâtres de l'Afrique de l'Ouest, Paris: Ins. Belgique: Tervuren: Musée royal de l'Afrique centrale 2003a.
10. Paugy D, Lévêque C, Teugels G. Faune des Poissons d'Eaux douces et saumâtres de l'Afrique de l'Ouest, Paris: Ins. Belgique: Tervuren: Musée royal de l'Afrique central 2003b.
11. Ouédraogo R, Soara AE, Ouéda A. Description du peuplement piscicole du lac sahélien de Higa, un site Ramsar du Burkina Faso, Afrique de l'Ouest, J Appl. Biosci 2015;95:8958-8965.
12. Plisnier PD, Micha JC, Frank V. Biologie et exploitation des poissons du lac Ihema (Bassin de l' Akagera, Rwanda), Presses Un. Belgique 1998.
13. Baijot J, Moureau E. Biology and demographic status of the main fish species in the reservoirs of Burkina Faso., in In E. Baijot, J Moreau and Bouda (eds) Hydrobiological aspects of fisheries in small reservoirs in the Sahel region. Technical center for Agricultural and Rural Cooperation ACP-EU, *Wageningen*, Natherlands, 1997, 79-110.
14. Gbaguidi MH, Adite A. Reproductive ecology and establishment of naturally colonized tilapine cichlid, Sarotherodon galilaeus (Pisces: Actinopterygii: Perciformes) from a man-made lake, Southern Benin, West Africa: implications for sustainable fisheries and aquacultural valoriz, Int. J Fish. Aquat. Stud 2016;4(3):278-287.
15. Lévêque C. Biodiversity dynamics and conservation. The freshwater fish of tropical Africa, Cambridge. Cambridge 1997.
16. Baijot E, Moreau J, Baijot S. Aspect's hydrobiologiques et piscicoles des retenues d'eau end zone soudano-sahélienne, Centre Tec. Belgique 1994.
17. Soro Y, Kouakou FKI, Koné T, N'Da K, Ouattara M. Reproduction De Heterotis Niloticus (Cuvier, 1829) de La Rivière Agneby (Cote d'Ivoire), Eur. J. Sci. Res 2016;12(6):83-96.
18. Sanyanga RA, Machena C, Kautsky N. Abundance and distribution of inshore fish in fished and protected areas in Like Kariba, Zimbabwe. Abundance Distrib. Inshore fish fished Prot. areas Like Kariba, Zimbabwe 1995;306:67-78.
19. Legendre M, Ecoutin JM. Aspects de la stratégie de reproduction chez Sarotherodon melanotheron (Ruppel, 1852), in comparison entre une population naturelle (Ébrié Lagoon, Côte d'Ivoire) et différentes populations d'élevage 1996, 360-374.
20. Duponchelle F, Panfili J. Variations in age and size at maturity of female tilapia, Oreochromis niloticus, populations from man-made lakes of Côte d'Ivoire, Environ. Biol. Fishes 1998;52:453-465.
21. Da Costa SK, Tah L, Gouli BG. Length-weight relationships for 36 freshwater fish species from two tropical reservoirs: Ayamé I and Buyo, Côte d'Ivoire, Rev. Biol. Trop. Int. J Trop. Biol 2012;60(4):1847-1856.
22. Mikembi BLA, Zamba IA, Mamonekene V, Tenda LDH, Ngot PHF, Vouidibio. J. Relations longueurs-poids et coefficients de condition pour 13 espèces de poissons de

la rivière Dzoumouna, affluent du cours inférieur du fleuve Congo (*République* du Congo)., J Anim. Plant Sci 2019;39(1)6384-6393.
23. Baby F, Tharian J, Abraham KM, Ramprasanth MR, Ali A, Ranghavan. R. Length-weight relationship and condition factor of an endemic stone sucker, Garra gotyla *stenorhynchus* (Jerdon, 1849) from two opposite flowing rivers in southern Western Ghats, J Threat. Taxa 2010;3(6):1851-1855.
24. Bagenal TB, Tesch FW. Age and growth. Methods for assessment of fish production in fresh waters. IBP Handbook No. 3, Blackwell, Oxford, England, in T. Bagenal (ed.) 1978, 101-136.
25. Lowe-MacConnel RH, Broad characteristics of the ichthyofauna. In: Lévêque C, Bruton MN. & Ssentongo GW. (eds), in Biology and ecology of African freshwater fishes, *Orstom*, Tr., Paris 1988, 93-110.
26. Lévêque C, Paugy D. Fish communities in river systems and associated biotopes. In: Paugy D, Leveque C. et Otero O. (eds):, in The inland water fishes of Africa: Diversity, Ecology and Human use, Institut d 2017, 349-360.