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Spatio-seasonal distribution and condition factors of *Clarias buthupogon* and *Heterobranchus longifilis* from Asa River, Nigeria

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Abstract
Studies on the spatio-distribution and condition factors of *Clarias buthupogon* and *Heterobranchus longifilis* from polluted Asa River, Ilorin, Nigeria was conducted, using standard laboratory procedures. The study was carried out between April, 2011 - March, 2013. The two fish species were well distributed in the river; *C. buthupogon* was found to be 49.26 % while *H. longifilis* was 50.74 % in compositions. The percentage catch of *C. buthupogon* for dry and rainy seasons were 27.77 % and 72.23 % respectively, while *H. longifilis* was 44.52 % and 55. 48 % respectively. Thus, more fishes were caught in the rainy season than in the dry season, and the fish populations were more concentrated in the downstream. *C. buthupogon* males has K value that ranged between 0.10±0.02 – 0.50±0.34 while the female ranged between 0.11±0.33 – 0.36±0.02 and their combined sexes recorded a range of 0.11±0.02 – 0.43±0.19. *H. longifilis* males ranged between 2.84±1.32 – 0.36±1.16; females had K values that ranged between 0.12±1.20 – 1.23±0.73, while combined sexes ranged between 0.35±0.01 – 2.84±1.99. In relation to standard length range (SLR), males, females and combined sexes of *C. buthupogon* had highest condition factor value at 10.0 – 14.9 cm and the least K values at 40.0 – 44.9 cm while males, females and combined sexes of *H. longifilis* had their highest K value at 15.0 – 19.9 cm and the least K value at 35.0 – 39.9 cm. The mean condition factor (K) value of *C. buthupogon* for males, females and combined sexes were 0.22, 0.18 and 0.21 respectively, while *H. longifilis* recorded mean K value of 1.05, 0.66 and 1.04 for male, female and combined sexes respectively, and this implied that *C. buthupogon* and *H. longifilis* female were not in good physiological condition in the river. The determination of k values of the two fish species in this aquatic system is useful in assessing the well-being, growth performance and feed utilization in natural systems. Therefore, low K values recorded in this work are indicative of poor quality of water in Asa River and this call for serious concern.

Keywords: Condition factor, *Clarias buthupogon*, *Heterobranchus longifilis,* Asa River, spatio-seasonal and pollution

1. Introduction
Fishing practice is attracting a lot of focus because it contributes significantly to the world proteins requirement [37]. Nigeria is blessed with abundant natural water bodies with abundant fish resources, and her freshwater bodies are the richest in West Africa in terms of fish abundance [35]. The fish resources, apart from being a major source of high quality animal protein for man, provide several socio-economic values as sources of job opportunities and raw material for some industrial activities as well as recreational purposes [50]. Nigeria's populations live near water bodies such as lakes, lagoons, reservoirs, rivers, swamps and coastal lagoons. Many depend heavily on the resources of such water bodies for their main source of animal protein and family income [2]. About 268 different species in 34 well known Nigerian freshwater rivers, lakes, reservoirs, which constitute about 12% of Nigeria's total surface area of about 98,185,000 hectares (26). However, according to [27], the yields of most of these inland waters are generally on the decline due to environmental degradation such as water pollution and improper or poor management of fisheries resources. Environmental Protection Agency (EPA) recommended species richness and relative abundance as ecological risk assessment in aquatic ecosystem [12]. An estimated fifty two fish species belonging to seventeen [17] families from Anambra River, Nigeria [39]. The fish stock diversities are directly dependent on the quality and quantity of water resources in the country [9].

Condition factor is a useful index for the monitoring of feeding intensity, age, and growth rates in fish [41]. Condition factor is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the quality of the aquatic ecosystem in which fish live [5]. Condition factors of different tropical fish species were investigated and reported by [44; 32] and similar studies particular to cichlid fish including, [45; 49; 15; 16; 10; 7; 41]. Knowledge of some morphometric aspects such as seasonal abundance, sex ratio, condition factor (k) or ponderable index of fishes is an important tool for the study of fish biology and related pollution effects. When fishes are kept in lentic water, their feeding potentials tend to be negatively affected, most especially polluted water bodies like Asa River. Dams and / or reservoirs have downstream effects on riverine environments and subsequently block nutrients flow along the strata of the ecosystem, thus, affecting fisheries production in downstream reservoir and river channels [25].

Most rivers and their resources are constantly threatened by socioeconomic factors that compromise environmental conditions by altering water parameters as well as health quality [43; 8]. As a result of this phenomenon, freshwaters have especially been deprived of their common usage to man which includes irrigation, recreation, fishing, drinking water supply among others [28; 11]. Biological indicators such as fishes are known to constitute veritable tools in the assessment of the ecological quality of aquatic environments [22; 38; 21; 4].

Fish has been particularly identified as one of the best biological indicators for evaluating aquatic health, owing to its wide distribution, easy identification and the ability of providing integral assessment results and this has led to several fish-based methods been developed and used in the assessment of large river health [34, 47]. In fisheries science, the condition factor is used in or der to compare the “fatness” or wellbeing of fish. And it is based on the hypothesis that heavier fish of a particular length are in a better physiological condition. It is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem in which fish live. The condition factor and the relative condition factor [19] are the quantitative parameters of the well-being state of the fish and it also reflect the recent feeding condition of the fish. It is based on the hypothesis that heavier fish of a given length are in better condition [19]. This factor varies according to influence on the physiological factors, fluctuating according to different stages of development. Condition factor has also been used as an index of growth, feeding intensity and also influences the reproductive cycle in fish [19].

Both the condition factors and organ somatic indices are used as indicator of the wellbeing of individual organism. Previous researchers [13; 14] reported that the condition factor is an organism level response, with factors such as nutritional status, pathogen effect and toxic chemical exposure causing greater than normal and less than normal weights. Numerous other studies have examined the effects of different environmental indices on the condition of inhabiting fish population in which many deformation and adverse effects have been reported and in relation to health [31]. These temporal and seasonal fluctuations of the condition factor are influenced by endogenous parameters (e.g., nutritional aspects, sex, and the state of gonadal maturation) or exogenous parameters (environmental factors) affecting a population [1]. Condition factors of different tropical fish species were investigated and reported by [41]. Due to the established high pollution index of Asa River, the aim of this work is to determine the distribution pattern and condition factor of the two selected fish species in the river.

2. Materials and Methods

2.1 Sampling Sites

The three sampling sites (A, B & C) used in this work were selected in the study in relation to the industrial, agricultural and domestic effluents that enter the stream. Site A is upstream popularly called Osere stream which is about 1.5 km from the effluent discharge point B. It receives refuse and sewage from homes, cassava processing units and run-offs from agricultural and poultry farms. Sites B is midstream at which soap and detergent, flour mills and pharmaceutical effluents are discharged along Okun stream that also receives significant run-off water from agricultural, poultry farms lands, cassava processing units and refuse dumps from homes including laundering activities. Site C is the downstream portion of the river, which is about 1km from the point of discharge (i.e site B). The stream receives effluents from some soft drinks plants (CocaCola and 7up), cassava processing units, agricultural, poultry wastes, and run-offs from diffuse sources. Therefore, the choice of the afore-mentioned sampling points was based on the accessibility, the rate at which they receives effluents and wastes from different sources and their distances from the industrial premises.

2.2 Collection of fish samples

The two fish species used in this work were *Clarias buthupogon* and *Heterobranchus longifilis*, both of which are the predominant species in the water body. Fishing was carried out late night by professional local fishermen. Gill nets about 12.192 m long and 1.828 m wide with a cork line at the top rope and metal line with the ground rope made locally of nylon were used for fishing. The gill nets consisting of 25 mm, 38 mm, 51 mm, 64 mm, 102 mm, 114 mm and 127 mm stretched mesh sizes were used. Fish samples were also collected using hooks of various sizes, traps and cast nets. Fishing was done twice monthly starting from April, 2011 to March, 2013. The collected fish samples were identified immediately after collection using the methods of [17] and 40), and then transported to the Ecotoxicology and fisheries Laboratory, LAUTECH in well aerated containers into which ice cubes were added to maintain the temperature of the water before the commencement of further studies.

2.3 Morphometric studies of fish

Monthly catches of the two fish species were subjected to morphometric studies, which includes determination of body weight (g), Standard length (cm) and total length (cm). Measurements were done with length measuring board and tape, while weight was taken using an electronic weighing balance (ATOM, Model-110C) after removal of excess water from the body surfaces. The total length was measured from the tip of the Snout to the tip of the caudal fin while the standard length was taken from the tip of the snout to the base of the caudal fin. The condition factor which measures physiological well-being or condition of the fish or the coefficient of condition was calculated according to (46) as:

$$K = \frac{100[W]}{L^3} \quad (36)$$

Where, K = Condition Factor
W = Weight (g)
L = Length (cm)

3. Results
3.1 Species Distribution
An increase in the level of water and water depth were observed during the rainy season while there was decrease in the volume of water in the dry season, a situation that exposed large area of shore line. The total number of the two species caught during the rainy season was higher than that obtained during the dry season with the same fishing effort. A total number of 501 and 516 respectively of *Clarias buthupogon* and *Heterobranchus longifilis* were collected during the entire study period. Relatively, *C. buthupogon* was the least abundant having the percentage composition of 49.26 % while *H. longifilis* had 50.74 % catch within the period of study. The percentage catch of *C. buthupogon* per catch effort for dry and rainy seasons were 27.77 % and 72.23 % respectively, while *H. longifilis* recorded 44.52 % and 55. 48 % for dry and rainy seasons respectively. Thus, more fishes were caught in the rainy season than in the dry season. The total length of *C. buthupogon* sampled throughout the study period ranged between 10.0 to 44.9 cm while *H. longifilis* ranged between 15.0 to 64.9 cm (Table 1). The mean weight of combined sexes of *C. buthupogon* ranged from 7.68 to 101.88g, while the combined sexes of *H. longifilis* the mean weight range between 135.37 to 221.10g (Table 2). The study revealed that a wide range of sizes were harvested throughout the study period. The size range with the highest occurrence of combined sexes of *C. buthupogon* was 15.0 – 19.9 cm and that of combined sexes of *H. longifilis* was 35.0 – 39.9 cm.

Table 1: Condition Factor (K) values for *C. buthupogon*in in Asa River

S/L	Male				Female				Combined Sexes			
Size Range	F	MSL	MWT	K	F	MSL	MWT	K	F	MSL	MWT	K
10.0 – 14.9	67.00	12.57	07.65	0.50	69.00	12.45	07.70	0.36	136	12.51	07.68	0.43
15.0 – 19.9	86.00	16.96	10.42	0.21	83.00	17.08	10.90	0.20	169	17.02	10.66	0.21
20.0 – 24.9	36.00	21.26	15.14	0.14	60.00	21.89	15.07	0.15	096	21.58	15.12	0.15
25.0 – 29.9	10.00	26.89	19.75	0.10	12.00	26.64	19.47	0.10	022	26.77	19.61	0.10
30.0 - 34.9	03.00	31.17	82.67	0.28	04.00	31.45	40.38	0.12	007	31.31	61.53	0.20
35.0 – 39.9	02.00	36.00	95.00	0.20	03.00	37.00	104.33	0.21	005	36.50	99.67	0.21
40.0 – 44.9	04.00	41.43	103.75	0.14	05.00	41.64	100.00	0.14	009	41.54	101.88	0.14
Mean K	0.22				0.18				0.21			

Table 2: Condition Factor (K) values for *H. longifilis*in in Asa River

S/L	Male				Female				Combined Sexes			
Size Range	F	MSL	MWT	K	F	MSL	MWT	K	F	MSL	MWT	K
15.0 – 19.9	01.00	17.40	150.00	2.84	-	-	-	-	01.00	17.40	150.00	2.84
20.0 – 24.9	04.00	23.50	205.25	1.59	-	-	-	-	04.00	23.50	205.25	1.59
25.0 – 29.9	13.00	27.02	172.77	0.90	06.00	26.77	235.85	1.23	19.00	26.89	204.30	1.07
30.0 – 34.9	33.00	31.75	144.24	0.45	28.00	31.15	126.49	0.42	61.00	31.45	135.37	0.44
35.0 – 39.9	47.00	35 62	174.18	0.36	37.00	37.20	220.24	0.42	84.00	36.41	197.21	0.39
40.0 – 44.9	40.00	41.69	448.83	0.57	24.00	42.06	288.04	0.12	64.00	41.86	368.43	0.35
45.0 – 49.9	31.00	46.93	904.58	0.88	30.00	46.88	682.47	0.61	61.00	46.91	793.53	0.75
50.0 – 54.9	28.00	50.59	1,491.61	1.08	27.00	48.89	1,425.74	0.98	55.00	49.74	1,458.68	1.03
55.0 – 59.9	38.00	57.65	1,721.58	0.88	37.00	57.32	1,804.54	0.98	75.00	57.49	1,763.06	0.93
60.0 – 64.9	23.00	58.04	2,156.74	0.97	29.00	61.52	2,263.45	0.97	52.00	59.78	2,210.09	0.97
Mean K				1.05				0.66				1.04

Key: F = Frequency, S/L = Standard Length (cm), MSL = Mean Standard Length (cm), MWT = Mean Weight (g), K = Condition Factor

3.2 Condition Factor of the Sampled Species
The mean monthly condition factor for male *Clarias buthupogon* in Asa River specifically revealed variations in the value of condition factor which lies between 0.33 and 1.99 with the lowest mean value of 0.33 ± 0.03 recorded in male in the month of January at downstream A portion of the river, while the highest mean value of 1.99 ± 0.10 recorded in the month of September for female at downstream B part of the river (Figures 1 and 2).The monthly mean condition factor for *H. longifilis* in Asa River also revealed variations in the monthly mean condition factor between 0.27 and 1.81 with the lowest mean value of 0.27 ± 0.12 recorded in male, in the month of January at downstream A, while the highest value of 1.81 ± 0.04 recorded in the month of December for male at downstream B section of the river (Figures 3 and 4). However, classifying the months into two broad seasons of the year showed that mean K value ranged from 0.33 to 1.89 between October and March which coincide with the dry season while, in the rainy season (April to September), the value of K fluctuated between 0.50 and 1.99 for *C. buthupogon*. The K values for *H. longifilis* ranged from 0.27 to 1.81 for dry season and between 0.99 and 1.77 for the rainy season. Generally, mean K value was found to be moderately higher in the rainy season compared to the dry season of the year (Figures 1, 2, 3 & 4). In relation to sex and size, the condition factor of the two sampled fish exhibited mean values of 0.21, 0.22 and 0.18, which translated to 34%, 36% and 30% respectively of the combined sexes, male and female for *Clarias buthupogon* (Figures 6)*,* while 1.05, 1.04 and 0.66 were recorded for male, female and combined sexes which equally translated to 38%, 24% and 38% of *H. longifilis* (Figures 6).

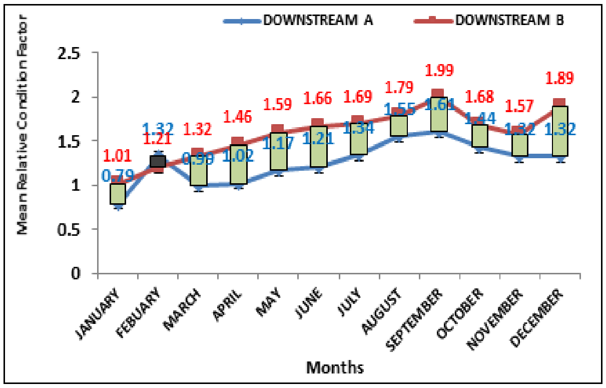

Fig 1: Mean Monthly Relative Condition Factor of *C. buthupogon* Female in Asa River

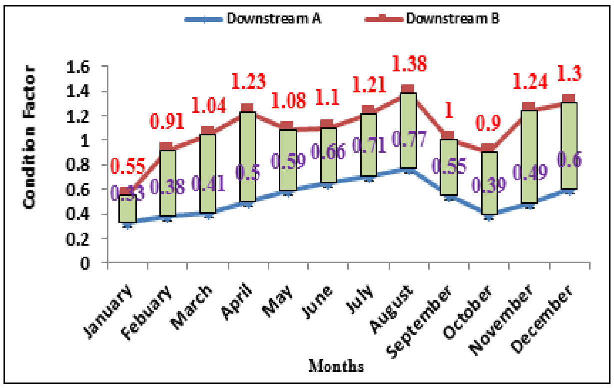

Fig 2: Mean Monthly Relative Condition Factor of *C. buthupogon* Male in Asa River

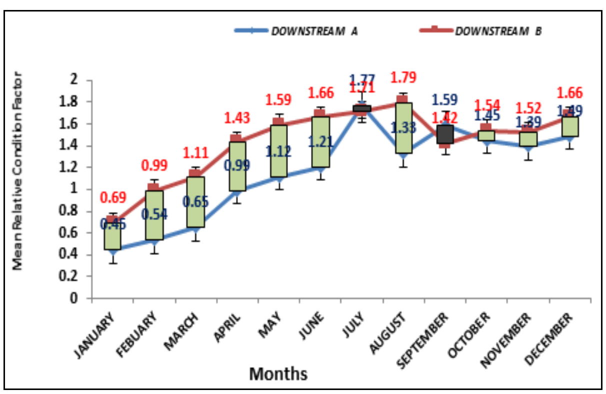

Fig 3: Mean Monthly Relative Condition Factor of *H. longifilis* Female in Asa River

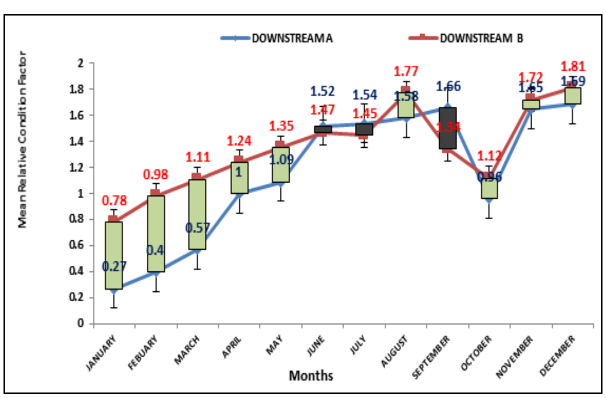

Fig 4: Mean Monthly Relative Condition Factor of *H. longifilis* Male in Asa River

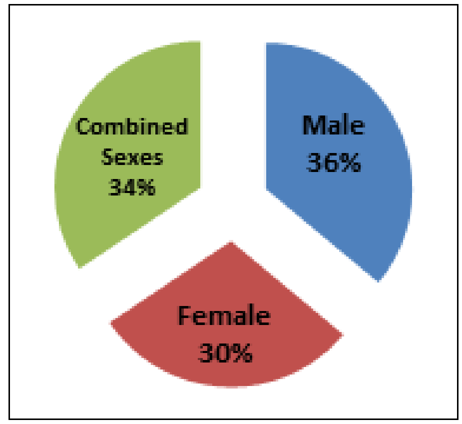

Fig 5: Mean Relative Condition Factor of *C. buthupoigon* Sampled in Asa River

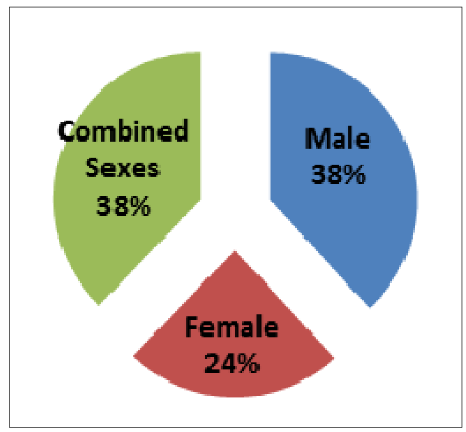

Fig 6: Mean Relative Condition Factor of *H. longifilis* Sampled in Asa River

4. Discussion

4.1 Species Distribution

Abiotic and biotic factors have important roles in supporting fish diversity and distribution in natural ecosystems. Physico-chemical variables like pH and dissolved oxygen are key habitat features correlated with fish diversity and found to be the most important variables in shaping fish distribution. *C. buthupogon* and *H. longifilis* of different size range were well distributed in Asa River. In numerical terms, the least abundant species was *C. buthupogon* with a total catch of 501 while *H. longifilis* was the most abundant with 516 of specimens, which translated to 49.26% and 50.74% respectively. The general pattern of distribution and abundance of these species in Asa River supported the conceptual models proposed by other researchers, in that there was downstream increase in the diversity of species and abundance of fish [42]. However this pattern was complicated by the occurrence of clarrids, which can migrate throughout the length of the stream [20; 30]. As a result of various timing of migration and recruitment throughout their lifecycles and the large variation in abundance, clariids in Asa River exhibited a complex seasonal pattern in fish assemblage structure.

4.2 Seasonal Distribution

Seasonally, there were more fish specimens caught during the high flow (Rainy season) than the low flow (Dry season) period of the year with the same fishing efforts. The percentage catch for the dry and rainy seasons was 27.77% and 72.23% respectively for *C. buthupogon* while 44.52% in dry season and 55.48% in rainy season were recorded for *H. longifilis*; this may be due to more volume of water noticed during the rainy than in the dry season and this may also be attributed to the manifestation of an increased turbidity which brought about a decrease in the visibility and consequently the inability of such species to avoid cast/gill nets or cages, hence they were caught in fairly greater numbers. Also, an increase in water volume due to the floods and the higher rate of inflow of water might have forced many fish specimens downstream and thus resulting in their being caught in greater numbers than in the dry season. Relatively, more fish species were encountered during the first year of study which corresponds to April, 2011 to March, 2012 while there was a decline in the population of fish caught the following year (i.e April, 2012 to March, 2013); this may be connected to the increased pollution status of the river as year progresses.

The two specimens were available all-round the year, with the lowest catch recorded in December and January that corresponds to the peak of the dry season, while the highest catch was obtained between the months of April through July which coincided with the peak of rainy season. Low catches observed during the peak of dry season may probably be due to extremely cold weather prescribed by harmattan during this period. This may also be attributed to environmental factors such as river flows and temperature [33]. Also, it may be linked to a wide variety of distribution and changes in environmental quality [29]. However, the anthropogenic factor that probably contributes most to the decline of such fish species is the destruction, degradation or alteration of their habitat through water diversion due to waste and probably construction of barriers to migration [29]. A similar trend in seasonal relative abundance was observed for both sampling locations. The lowest relative abundance was found in the dry season and became greatly increased in the rainy season and this may be linked to the inflow of more species from the dam areas when water volume overshoot its boundary during rainy season, while the decline in abundance during the dry season likely reflected a seasonal movement of large fish to shallow offshore areas or among smaller individuals to bury in shallow sediments [23]. Although, availability of food may also be a factor in habitat selection and increased species caught at downstream site of Asa River, and this may be linked to availability of wide varieties of food and this is in consonance with the submission of [19].

4.3 Species Condition Factors

Fish body condition is known to vary seasonally depending on changes in gonadal development, food availability, and other environmental factors. The condition factor (K) for *C. buthupogon* and *H. longifilis* at all times of the year were fairly and moderately high and this is an indication of fairly good condition in the river. The condition factors (K) were higher than 1 in rainy season while they fell below 1 during the peak of dry season (January - March). The relatively high condition factors (K) recorded during the rainy season can be attributed to a fairly favorable environment with probably high availability of food resources [18]. Another important factor that could be traced to the high condition factors recorded during the rainy season in this work is the possession of matured gonads by the two studied species. The low mean condition factors (K) manifested by these two species during the dry season of the year may be an indication that the fish species are not enjoying good or favorable condition in Asa river, which may be as a results of the pollution status of the river. This could also be a reflection of depletion in energy resources [24]. The values of mean condition factor varied fairly significantly for male and female of the two fish species. High mean condition factors recorded for males in this study suggested that males were more robust than the females of the examined fish species and this could be linked to the fact that females generally expends a lot of metabolic energy during physiological activities and such energy could have been used for body building, egg laying and care for the young ones.

Generally, it was observed in this work that the K-value was higher in small sized fishes compared to the larger sized fishes and this is a pointer to the fact that the relatively small sized fishes are better suited and adapted to the impaired ecological status of the polluted river. This may be in terms of feeding habits and the activities of the two species under investigation. Similarly, [19] attributed such decrease in condition factor to the deposition of materials for gonad formation, which may lead to an increase in weight and actual spawning which in turn may leads to reduction in weight respectively. This is in consonance with the opinion of [19; 18] who recorded higher condition factor in males than the females *Clarias gariepinus* in Oba Reservoir.

The results of this present study also shed light on the state of well-being of the two species examined. The condition factor value of *C. buthupogon* for male, female and combined sexes were 0.22, 0.18 and 0.21 respectively and this is lower than 1; while *H. longifilis* recorded 1.05, 0.66 and 1.04 for male, female and combined sexes respectively, most of which were greater than 1 except for female. This implied that *C. buthupogon* and *H. longifilis* female were not in good physiological condition in the river but both male and combined sexes of the same species were in good condition. Many factors such as, sex, age, state of maturity, size, and state of stomach fullness, sampling methods, sample sizes and most importantly environmental conditions affects fish condition and parameters of length-weight relationship in fish [19; 6; 3].

5. Conclusions

Conclusively, the condition factor values (K) obtained for the fish population showed that the population was not in good condition, an indication of the unhealthy status of the population with less tissue energy reserves, depressed reproductive potential and low survival. It is equally an indication of the inability of the studied Asa River to sustain the population of the two sampled fish species. Thus it can be suggested that the health of the environment can decide the diversity and productivity of a system. Hence for sustaining and maintaining the diversity of aquatic organisms, it is important to know the factors that control the quality of life in these systems. The best approach to the conservation and well distribution of species is to disseminate conservation information, education and practices to fisherman and other stake holders about the danger of extinction of species and the need for its conversation as prevention is not only better but also cheaper than looking for ways for recalling the lost species. Thus a holistic approach in the management and conservation of the ecosystem is the need of the hour if these species of aquatic organisms are to the preserved.

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