Biometric relationships of Fish (*Bostrichus africanus* and *Periopthalmus papillus*) from Iwofe and Bakana Rivers Located along the New Calabar River, Niger Delta, Nigeria

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Abstract
A total of 240 populations of fish (B. africanus and P. papillus) were bought from fishermen at the landing sites of both Iwofe and Bakana Rivers along the new Calabar River, Niger Delta in Nigeria. Fish sampling was for a period of seven months, from October, 2016 to May, 2017. The Biometric relationships of these fish, the length-weight relationship, condition factor and gut length/intestinal length ratio were examined and analyzed. Standard length of fish samples were taken to the nearest 0.1mm using a standard meter rule, while the weight of each sample was taken to the nearest 0.01g, using a Denver weighing balance. The result of the student's T- test for significance used to compare the mean condition factor of both species of fish from both sampling stations showed that they were not significantly different ($p > 0.05$) and all samples were in good condition because they all had a mean condition factor (Kn) value which was greater than 1.

Keywords: *condition factor, gut/intestinal length, B. africanus, P. papillus, Iwofe and Bakana Rivers, New Calabar River*

Introduction

Biometric relationships in fish include the length-weight relationship, condition factor and gut length/intestinal length ratio. The length – weight relationship (b) is used to determine whether there is a negative allometry (whereby the fish length increases than its weight, as growth proceeds), positive allometry (whereby the fish weight increases more than its length, as growth proceeds) or isometric growth (a proportional growth in length and weight of the fish).

When a fish has a negative allometry, it means that the value of "b" is less than 3 but a fish with a positive allometry has a value of "b" greater than 3. While a fish with proportional growth in length and weight has a value of "b" equal to 3. That is, $b = 3$ (Proportional growth in length of fish), $b < 3$ (Negative allometry) and $b > 3$ (Positive allometry).

Condition factor (Kn) is a measurement of the general health condition of fish as calculated by the ratio of body weight to body length. Kn is used to compare growth conditions fish and is indicative of environmental quality.

When the condition factor (Kn) of a fish is equal to or greater than 1, it implies that the fish is healthy, thus its health is in a good state but if the value of Kn is less than 1 it implies a poor health state and the fish is unhealthy (Jin *et al*., 2015).

The gut length to standard length ratio is calculated to determine the mode of feeding of a particular fish species. Carnivorous fishes have their gut-standard length ratio less than or equal to 1 cm, Omnivorous fishes have theirs between 1cm and 3cm and herbivorous fishes

have theirs greater than 4cm.

Materials and methods

Sample duration and locations: Sampling was for a period of seven months, from October, 2016 to May, 2017. Fish samples were bought from fishermen at the landing sites of both Iwofe and Bakana Rivers, between 6.00am and 8.00am of each sampling day, which was done biweekly.

Collection of fish samples: Two hundred and forty (240) samples of each family of gobies (Eleotridae and Periophthalmidae) were bought from fishermen at the sea shore (land site) of Iwofe River and the Bakana reaches of the new Calabar River in Degema Local Government Area, River State, as early as 6:00am just immediately after catches. Fish samples were conveyed to the laboratory by the use of plastic cans and estuarine water gotten from the Rivers, to help preserve the fish samples. Fish samples were dissected and analyzed, on getting to the laboratory. The life specimens (not dissected) were preserved in an aquarium with an aerator inserted in it, to help in circulation of oxygen. While the dead sample were preserved in 10% formalin.

Laboratory Analysis of Fish Samples: Standard length of fish samples was taken to the nearest 0.1mm using a standard meter rule, while the weight of each sample was taken to the nearest in 0.01g, using a Denver weighing balance, serial number TP512.

Computation of biometric relationships:

The length – weight relationship were determined by the linear regression analysis of the log-transformation and scatter diagrams of length and weight plotted, this was worked out as per cube law given by Le Cren (1951):

$W = aL^b$

Where; W = Weight of fish (g); L = Observed standard length (cm) ; a = Regression intercept b = Regression Slope

The logarithmic transformation of $W = aL^b$ is Log W = Log a + Log L

The condition factor of the fish samples was calculated as follows: Condition factor (Kn) = Observed weight of fish/Expected weight of fish

Where Expected weight of fish is calculated as: $W = aL^b$

In order to compute the gut length/standard length ratio, data collected were analyzed as follows: Gut length of fish/Standard length of fish

Statistical test for significance: With JMP statistical software, Students T- test was used to compare the condition factor of the specimens from different sampling stations.

Results

Mean Standard Length (cm, ± Standard Error)

The mean standard length and standard error of *B. africanus* sample from Iwofe River was evaluated to be 7.92cm and ±0.18 respectively, while the mean standard length and standard error of *B. africanus* from Bakana River was 6.97cm and ±0.10 respectively. The *P. papillus* sample from Iwofe River had an estimate of its mean standard length and standard error as 8.48cm and ±0.20 respectively, while *P. papillus* from Bakana River had an estimate of its mean standard length and standard error as 7.88cm and ±0.13 respectively.

Range of Length (Standard length) (cm)

The range of standard length of *B. africanus* sample from Iwofe River was between 12 cm to

5cm that of *B. africanus* from Bakana River was between 8.5cm to 3cm, *P. papillus* from Iwofe River recorded between 15cm to 5.9cm and *P. papillus* from Bakana River recorded between 10.1 cm to 6.7cm.

Mean Weight (g) ± Standard Error

The mean weight and standard error of *B.africanus* sample from Iwofe River was calculated to the 11.07g and ±0.82 respectively, *B. africanus* samples from Bakana River had a mean weight and standard error of 7.66g and ±0.27 respectively. *P. papillus* samples from Iwofe had a mean weight and standard error of 9.53g and ±0.68 respectively. The mean weight and standard error of *P. papillus* samples from Bakana had a record of 7.74g and ±0.41 respectively.

Range of Weight (g)

The range of weight of *B.africanus* samples from Iwofe River measured was between to 3.0g to 36.1g, *B. africanus* samples from Bakana River measured between 3.2g to 13.7g, *P. papillus* samples from Iwofe River measured between 4.0g to 28.2g and *P. papillus* samples from Bakana River measured between 3.6g to 14.0g.

The results are tabulated in Table 1 which shows the descriptive statistics of the measured parameters in both *B. africanus and P. papillus* from both locations.

Table 1: Descriptive Statistics of measured parameters of *B.africanus* and *P. papillus* from Iwofe and Bakana Rivers

Descriptive Statistics	***B. africanus* Iwofe**	***B. africanus* Bakana**	***P. papillus* Iwofe**	***P. papillus* Bakana**
Mean standard length (cm) ± S.E	7.92 ± 0.18	6.97 ± 0.10	8.48 ± 0.20	7.88 ± 0.13
Range of standard length (cm)	5 – 12	3 - 8.5	5.9 – 15	6.7 – 10.1
Mean weight (g) ± S.E	11.07 ± 0.82	7.66 ± 0.27	9.53 ± 0.68	7.74 ±0.41
Range of Weight (g)	3 – 36.1	3.2 – 13.7	4 – 28.2	3.6 - 14

Length-Weight Relationship (b), Condition Factor (Kn) and Gut Length/Intestinal Length Ratio of Fish (*B. africanus*and *P. papillus*) from Iwofe and Bakana Rivers.

Length – Weight Relationship (b): The length – weight relationship of *B.africanus* samples from Iwofe River had a "b" value of 2.94 that is approximately 3, which means that there is a proportional growth in length and weight of the fish species. *B. africanus* samples from Bakana River had a "b" value of 1.51 which implies a negative allometry, *P. papillus* samples from Bakana River had a "b" value of 2.95value of 2.51, indicating a negative which also implies a positive allometry and samples of *P. papillus* from Iwofe River had a "b" allometry. Figures 1 to 4 illustrate the length-weight relationship of the fish samples from both locations.

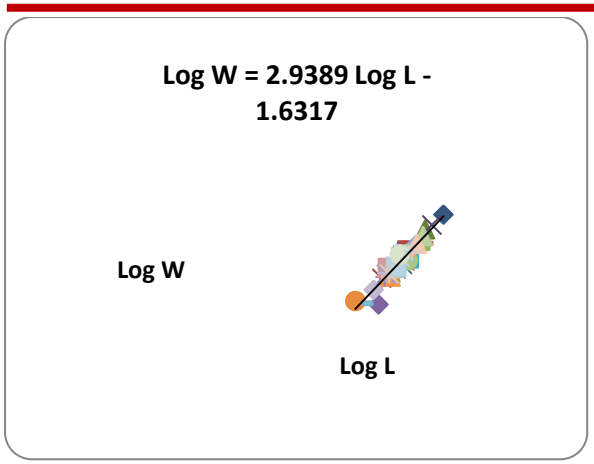


Figure 1: A Graph showing the Length – Weight Relationship (b) of *B.africanus* from Iwofe River

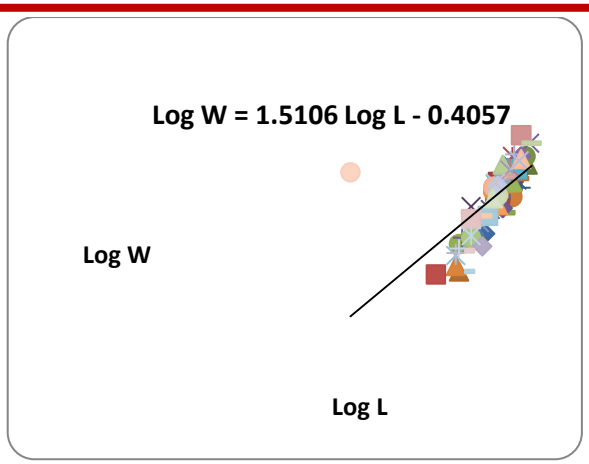


Figure 2: A Graph showing the Length – Weight Relationship (b) of *B.africanus* from Bakana River

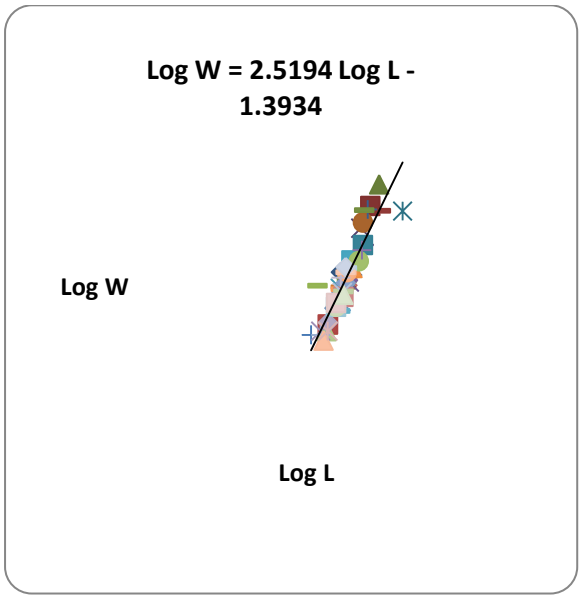


Figure 3: A Graph showing the Length – Weight Relationship (b) of *P. papillus* from Iwofe River

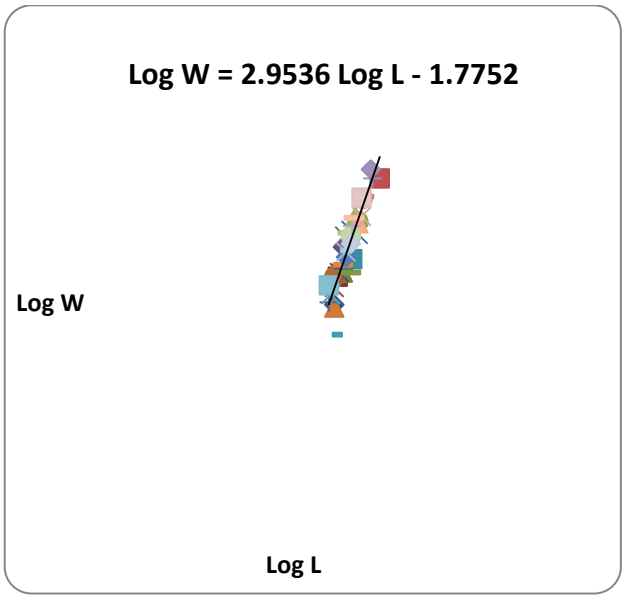


Figure 4: A Graph showing the Length – Weight Relationship (b) of *P. papillus* from Bakana River

Condition Factor (Kn) ±Standard Deviation

The mean condition factor and the standard deviation of *P. papillus* samples from Bakana River had a "Kn" value± SD value of 0.94 ±0.11 and 1.05±0.09 during the sampling periods of December,2016 and May, 2017 respectively, while *P. papillus* samples from Iwofe River had a "Kn" value± SD value of 1.20±0.27, 0.97±0.04 and 8.37±2.21 during the sampling periods of October, 2016, January, 2017 and May, 2017 respectively.*B.africanus* samples from Iwofe River had a "kn" value± SD value of 1.06±0.00, 1.05±0.11, 1.01±0.06 and 0.99±0.15 during the sampling periods of October, 2016, November, 2016, January, 2017 and May, 2017 respectively. *B.africanus* samples from Bakana River had a "kn" value±SD value of 0.94±0.12 and 0.97±0.20 during the sampling periods of December, 2016 and May, 2017 respectively.

Condition Factor (Kn) ±Standard Deviation per Sex of fish species

The mean condition factor and the standard deviation of *P. papillus* samples from Bakana River had a "Kn" value±SD value of 0.95±0.10 and 1.00±0.11 for female and male species respectively, while *P. papillus* samples from Iwofe River had a "Kn" value±SD valueof 1.15±0.27 and 1.02±0.20for female and male species respectively. *B.africanus* samples from Iwofe River had a "kn" value± SD value of 1.06±0.12 and 1.12±0.19for female and male species respectively. *B. africanus* samples from Bakana River had a "kn" value± SD value of 0.95±0.13 and 0.95±0.16 for female and male species respectively. The figures (5-12) below are illustrations of the condition factor computed per season, sex and sampling period.

Fig.5 A Graph showing the Condition Factor (Kn) per Sampling Period of *P.papillus* from Bakana River.

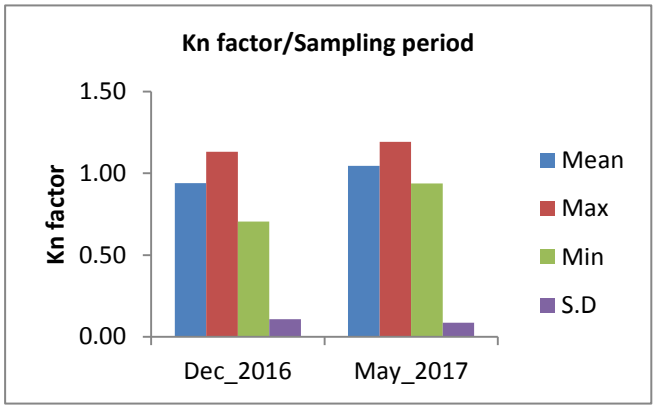


Fig. 6 A Graph showing the Condition Factor (Kn) per Sex of *P.papillus* from Bakana River.

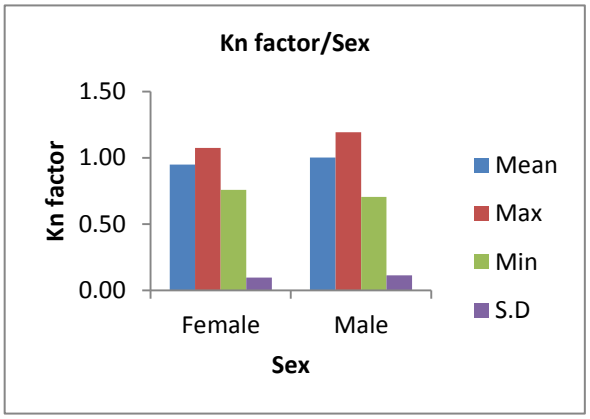


Fig. 7 A Graph showing the Condition Factor (Kn) per Sampling Period of *P.papillus* from Iwofe River.

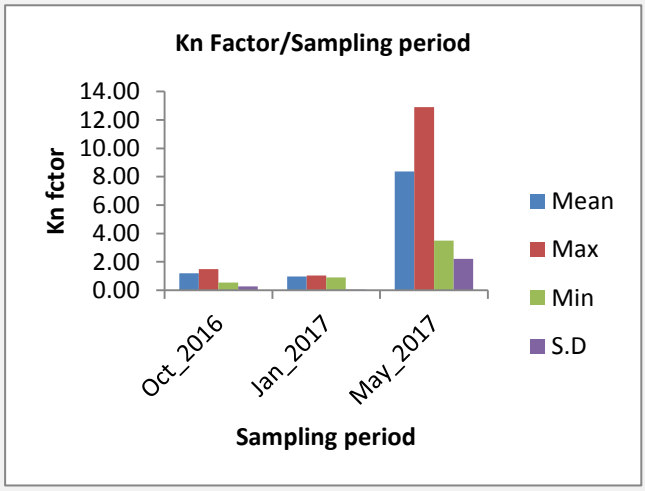


Fig. 8 A Graph showing the Condition Factor (Kn) per Sex of *P.papillus* from Bakana River.

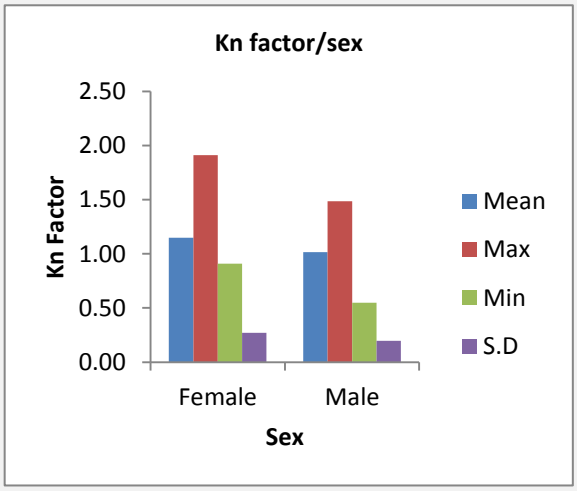


Fig.9 A Graph showing the Condition Factor (Kn) per Sampling Period of *B.africanus* from Iwofe River.

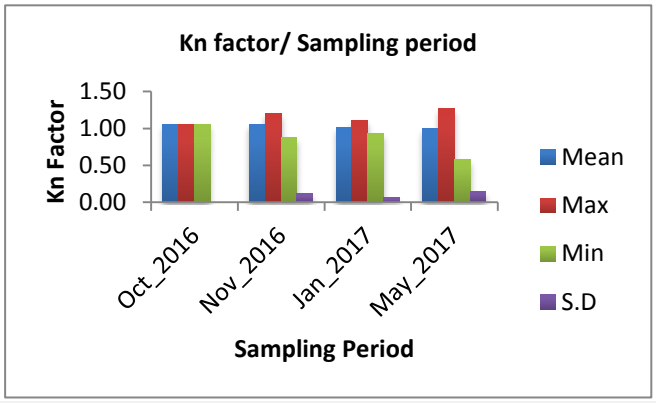


Fig. 10 A Graph showing the Condition Factor (Kn) per Sex of *B.africanus* from Iwofe River.

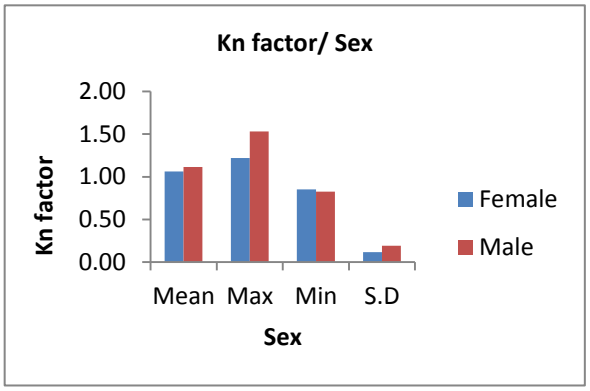


Fig.11 A Graph showing the Condition Factor (Kn) per Sampling Period of *B.africanus* from Bakana River.

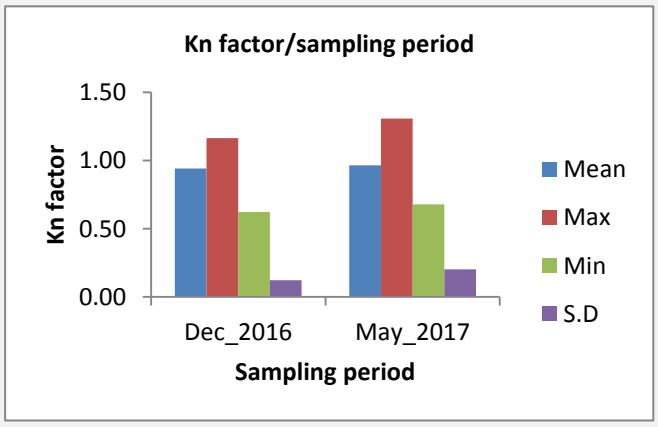
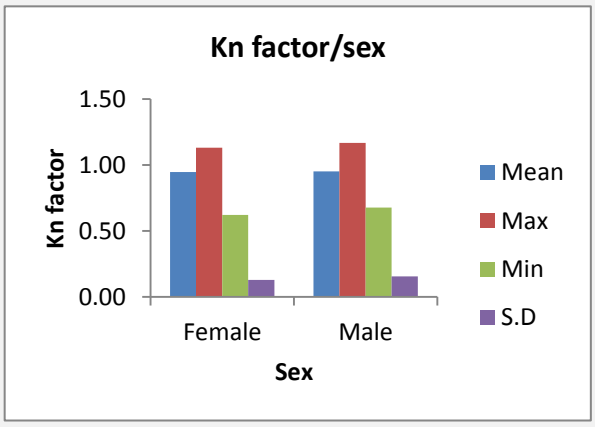


Fig. 12 A Graph showing the Condition Factor (Kn) per Sex of *B.africanus* from Bakana River.



Gut-Standard Length Ratio of Fish (cm)

The mean gut- standard length ratio and the standard error of *B. africanus* from Iwofe River were 0.8cm and ±0.03 respectively. The mean gut-standard length ratio and standard error of *B. africanus* from Bakana River was 0.8cm and ±0.03, *P. papillus* from Bakana was 0.9 and ±0.04 and *P. papillus* from Iwofe was 0.8cm and ±0.05.

Table 2 represents the summary of the biometric relationships of the fish samples from both locations.

Table 2: Length-Weight relationship (b), Condition factor (Kn) and Gut-Standard length ratio of *B. africanus* and *P. papillus* from Iwofe and Bakana Rivers.

S/N	Species-Station	Mean Gut Length: Standard Length(cm) ±S.E	Length-Weight relationship (b)	Mean Condition factor per sampling period ±S.D
1.	*B.africanus* – Iwofe	0.8 ±0.03	2.94	1.0 ±0.08
2.	*B.africanus* – Bakana	0.8 ±0.03	1.51	1.0 ±0.16
3.	*P. papillus* – Bakana	0.9 ±0.04	2.95	1.0 ±0.01
4.	*P. papillus* – Iwofe	0.8 ±0.05	2.52	3.5±0.08

Tables 3 and 4 shows the mean comparison between the condition factor (Kn) of *P. papillus* from Iwofe and Bakana River, shows that they are not significantly different, while the mean comparison between the condition factor (Kn) of *B. africanus* from Iwofe and Bakana River, shows that they are not significantly different.

Table 3: LSD threshold Matrix of student's T – test to show the mean comparison between the condition factor (Kn) of *P. papillus* and *B. africanus* from Iwofe and Bakana River

	Kn_*P.papillus* (Iwofe)	Kn_*B.africanus* (Iwofe)	Kn_*P.papillus* (Bakana)	Kn_*B.africanus* (Bakana)
Kn_*P.papillus* (Iwofe)	-0.07411	-0.02397	-0.00952	0.03478
Kn_*B.africanus* (Iwofe)	-0.02397	-0.07411	-0.05967	-0.01537
Kn_*P.papillus* (Bakana)	-0.00952	-0.05967	-0.07411	-0.02981
Kn_*B.africanus* (Bakana)	0.03478	-0.01537	-0.02981	-0.07411

Table 4: Connecting Letters Report of student's T – test showing the mean comparison between the condition factor (Kn) of *P. papillus* and *B. africanus* from Iwofe and Bakana River.

Level	Letters	Mean
Kn_*P.papillus* (Iwofe)	A	1.06
Kn_*B.africanus* (Iwofe)	AB	1.01
Kn_*P.papillus* (Bakana)	AB	0.99
Kn_*B.africanus* (Bakana)	B	0.95

Discussion

The total of 240 specimens used in this study belongs to two species of the Gobies family. The most abundant species were the *B. africanus*, while the least abundant were *P. papillus.* The length ranges (minimum and maximum), parameter of length – weight relationships (b) and condition factor (Kn). Many factors such as the change in physicochemical properties of

the water body, fish species, food, sex and stage of maturity (Obasohan, 2012) can be responsible for the change of b values for the length – weight relationships of Gobies. The length- weight relationship analysis of both species of Gobies from both sampling stations, shown in table 4.3 indicates negative allometric growth (b <3). This implies more increase in length than weight as growth proceeds. These findings is similar with the findings of Atama *et al.* (2013) and Soyinka *et al.* (2012) which reported negative allometric growth for different fish speices.

The mean condition factor using student's T-test of the two species of Gobies in this study showed that *P. papillus* and *B. africanus* from Iwofe had a mean condition factor greater than 1, while *P. papillus* and *B.* africanus from Bakana had a mean condition factor less than 1. These results does not conform to the mean condition factors of the Cichlid species reported by Atama *et al.* (2013) in Anambra River which showed variations in species due to seasonal variations. The condition factor of fish describes the physiological state of the fish with respect to its welfare and nutritional status (LeCren, 1951). The mean condition factor of the studied specimens per sampling period is summarized in table 4.3 and the result shows that *B. africanus* specimens from both sampling stations and *P. papillus* specimens from Bakana River had a mean condition factor of 1.0, which indicates that fish specimen were in good health. *P. papillus* from Iwofe had a mean condition factor of 3.5, indicating that fish specimens were in better state of health than the other specimens of Gobies studied. The result of the student's T- test for significance was used to compare the mean condition factor of both species of Gobies from both sampling stations and it shows that they are not significantly different ($p > 0.05$) and all specimens were in good condition because all Kn values were greater than 1.
The ratios of mean gut length to standard length of all studied specimens from both sampling stations were approximately 1.0, which implies that these Gobies are carnivorous feeders.

Conclusion

Many factors such as change in physicochemical properties of a Rivers, fish species, food, sex and stage of maturity (Obasohan, 2012) can be responsible for the change of b values for the length – weight relationships of Gobies and other species of fish. The biometric study of fish relationship is very useful in fish management and conservation, as bioindicators to reveal the status of an environment and as biomapping to study the water quality of Rivers in the Niger Delta region, due to the high level of exposure to pollutants.

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