FRAME SURVEY OF FISHERIES RESOURCES OF OTAMIRI RIVER: MORPHO-ECOLOGICAL STUDIES OF FISH SPECIES AND IMPLICATION FOR FISHERIES DEVELOPMENT IN IMO STATE

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ABSTRACT
The study explained morpho-ecological adaptation of fish species sampled in Otamiri River, Imo state, Nigeria between May and December, 2017 and February to April, 2018. The indices employed were morphometric, gut and stomach content analysis, condition factor and length-weight relationship. The mean length ranged between 10.40 and 62.45 cm (Tilapia mariae and Malapterurus electricus respectively). The mean weight ranged between 70.50 and 207.55 cm (Tilapia dageti and Phractolaemus ansorgei respectively). Stomach content was analyzed using numerical methods. The fish fed mainly on higher plant materials (20%), fish remain (24%), palm-kernel shaft (22%) and detritus (34%), exhibiting omnivorosity. The fishes have a well-developed gut system. Their relative gut index ranged between 1.20 and 1.30 which supported omnivorous feeding habit. The fishes exhibited an allometric growth pattern, a pattern which supports easier movement in water. With favorable environmental conditions, availability of food and nutrient, the fishes display sustainable fishery production. Strategic management practices should be put in place to avoid over fishing and depletion of the fish stock by the indigenous inhabitants.

Keyword: Fish statistics, Abiotic factors, Opportunistic feeders, Bottom dwellers.

INTRODUCTION

Eco- morphology as explained by Faye *et al.* (2012) and Olawusi-Peters *et al.* (2015) is the relationship between the morphology of fish behavior and habitat use and adaptation to the environment. Fagade and Olaniyan (1972) explained that *Chrysichthys* species feeding on wide varieties of food, are bottom dwellers, with trophic flexibility and ecological adaptation. Hugueny and Pouilly (1999) and Motta *et. al* (1995) suggested that fish species are not only opportunistic feeders, but are influenced by phylogeny and morphological adaptation. Stergiou and Moutopoulous (2001) and Lagler *et al.* (1977) explained that length-weight relationship determines growth-in-length and growth-in-weight for stock assessment; estimation of condition factor of fish. This study is carried out to understand the morpho-ecological pattern of fish species in Otamiri River and relate same to the aquatic life of the fish species.

Study area

The study was carried out at Otamiri River. Otamiri River originated at Egbu in Owerri North LGA and confluences with Nworie stream in the Owerri Municipal area. The River lies between the longitude $06^0$57' to 0.11^0 46' E and latitude 05^0 20' to 0.35^0, 66'N' spanning 2 kilometers (Urban and Regional planning, Imo State Polytechnic, Umuagwo). The entire area lies within the Guinean Equatorial rain forest zone of Nigeria, (Nwadiaro and Okereke 1993). The source of the Otamiri River (Egbu) is in a low relief region in the range of 61-122m above sea level. The river starts as a first-order stream, then flows westward for about 7km to receive another first-order stream, Nworie. From that point, it flows southwards as a second-order river for 28 kilometers and receives a major tributary, River Oramirukwa. The length from source to mouth is approximately 82 kilometers. (Nwadiaro and Okereke, 1993).

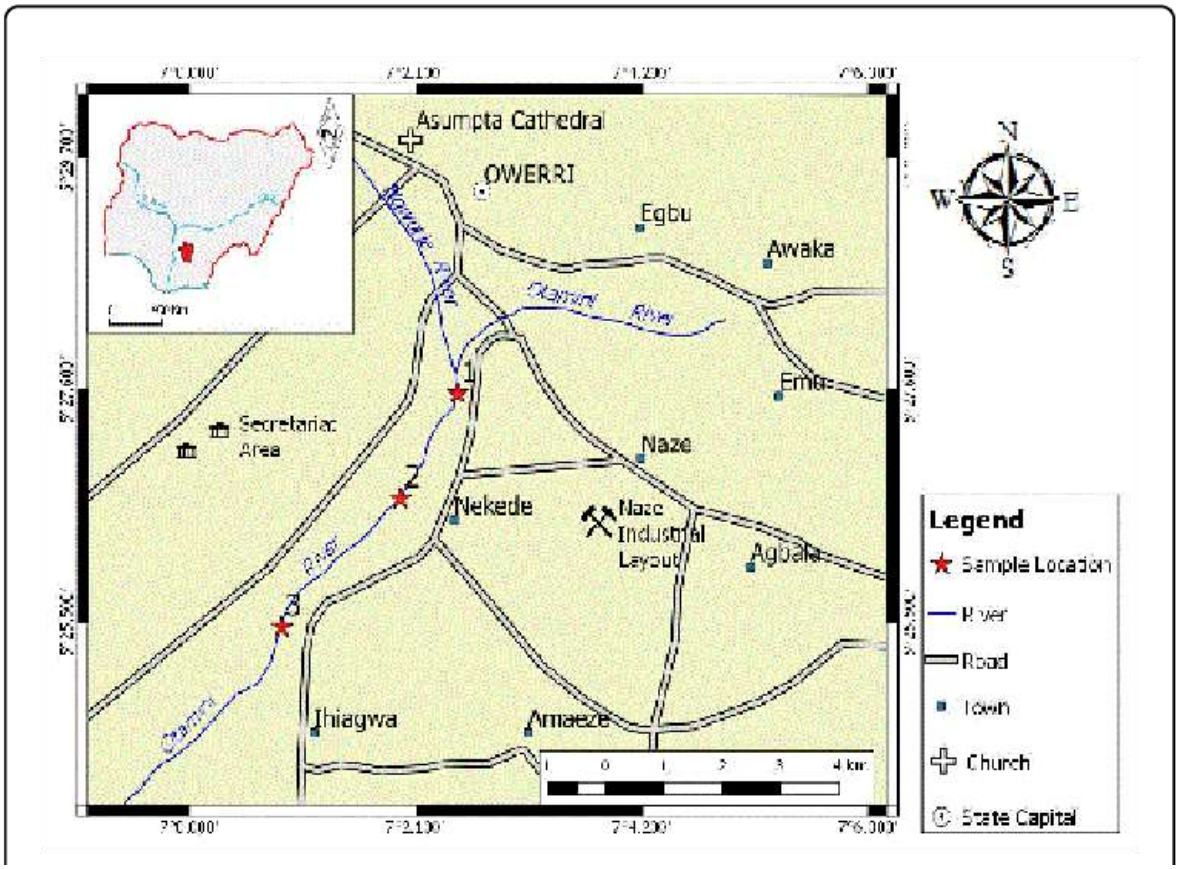

Figure1: Map of Otamiri River showing the sampled stations.

MATERIALS AND METHODS

Sampling Procedure

Fishing was carried out by fishers who used fishing gear such as cast net, set long-line, wire trap, seine net and set-gill net in eighteen (18) sampling stations. The sampling procedures were as described by Onwuka *et al*. (2018).

Monitoring and Measuring Abiotic Factors of Otamiri River

The abiotic factors were recorded on board includes temperature, pH, dissolved oxygen and salinity. Dissolved Oxygen was measured in milligrams per liter (mg/l) with Oxygen Meter Model Oxyguard Handy MKII, temperature in degree centigrade (^{OC}) with thermometer, pH with a pH meter (Model: H18915 ATC), while salinity was recorded in parts per thousand (ppt or %) using salinometer (Model: News – 100

Relative Gut Index (RGI)

The fish were dissected through the abdomen to show the esophagus to the cake. The RGI was calculated using Odum (1971) the formula:

$$Relative\ Gut - Index\ (RGI) = \frac{Gutted\ length\ (cm)}{Standard\ length\ (cm)}$$

Stomach content analysis

Numerical method of food analysis (Windel and Bowen, 1978) was used to examine this parameter, to determine the food and feeding habits of the fish species.

$$\%\ Number\ of\ food\ item = \frac{Total\ number\ of\ particular\ food\ item}{Total\ number\ of\ all\ food\ item} \times \frac{100}{1}$$

The stomachs of ten (10) dominant fish species were removed and the contents extracted, blotted dry and weighed on a mettle analytical balance. The contents were subsequently preserved in 10ml of 5% formalin and later observed under the microscope for identification of the food items. The total number of each food item was recorded and expressed as a percentage of the total food items.

Determination of Condition Factor

The Condition Factor (K) explains the relative well-being of the fish and evaluated by the formula:

$$K = \frac{100W}{L^3} \quad (Bagenal\ and\ Tesch, 1978)$$

where K = Conductor factor, W = observed weight of the fish (g), L = Observed total length of the fish (cm). One fish from the ten (10) most abundant species was selected for evaluation.

Length – Weight Relationship

The Length – Weight relationship was computed from the formula described by Bagenal and Tesih (1978): $W = aL^b$, where W = Weight of fish (g), L = Total length of fish (cm), b = Exponent (or regression coefficient slope), a = Constant (or regression intercept). Both a and b above were estimated by least square linear regression after logarithmic transformation of the equation into the form: $Log_{10}W = a + b\ Log_{10}L$

RESULTS

Morphometric Data

Tables 1a and 1b show that *Tilapia dageti* had the minimum length of 14.12cm while *Phractolaemus ansorgeii* had the maximum length of 51.40cm. *Tilapia dageti* had the minimum weight of 10.50g while *Malapterurus electricus* had the maximum weight of 255.21g. *Tilapia maria* had the shortest gut length of 5.25cm and the lowest weight of 3.90g. *Gymarchus niloticus* had the highest gut length of 19.01cm whereas *Malapterurus electricus* had the highest gut weight of 14.70g.

Physico-chemical parameters of Otamiri River

The maximum temperature of 30.60°C was recorded in January 2018 with a minimum of 24.20°C in June 2017. The temperature ranged from 24.20°C to 30.60°C with a mean value of 27.62°C. pH values ranged between 5.38 in May 2017 to 5.89 in April, 2018, with a mean value of 6.08. The highest value of pH (6.57) was recorded in January, 2018 while the lowest value (5.61) was in February, 2018. The dissolve oxygen ranged from 5.00mg/l in July, 2017 to 8.40mg/l in April, 2018. The mean for the period was 6.95mg/l. The salinity ranged between 13.00ppt in January, 2018 and 19.00ppt in June, 2017. The mean salinity was 15.63ppt (table 2).

Relative Gut Index (RGI)

Each fish has an oesophagus which is long and muscular, grading into a distinct muscular stomach. The stomach grades into a large muscular grinding apparatus. The gut comprises of an esophagus with a short intestine ending in a long intestine. The anterior end bears numerous pyloric caeca. In nearly 80% of the fish samples, the intestine is long, forming a tape-like structure which terminates at the tip of the muscular stomach. The other end of the stomach was swollen to form the beginning of the pyloric caeca which extend to the cloacal opening. The RGI of the fishes ranged between 1:15 and 1:45. *Epiplatyssexfasates* was observed to have the least RGI of 1:1.5. *Tilapia dageti* has the highest RGI of 1:4.5

Stomach Content Analysis

Detritus and unidentified food items constituted 98% of the food materials found in the stomach of the fishes, (Table 4). Fish remains constituted74% while palm-kernel shaft and leaves of higher plants were 62% and 61% respectively. *Chromidotilapiaguentheri* had the highest number of food materials (21.02%) consumed, while *Hemichronusfaciatus* had the least (3.39%).

Condition Factor (K)

Condition Factor (K) ranged from 0.595 to 2.443. *Tilapia maria* had the highest value of K (2.443) while *Clarias angullaris* had the least K value of (0.595), (Table 5)

Length-Weight Relationship

Length of the species evaluated ranged between 8 and 68cm while the weight ranged between 5 and 230g. (Tables 1a and 1b, above). This study shows that growth in the individual species was allometric as "b" value was less than 3. All the species showed negative allometric growth.

Table 1a: Length range fish species from Otamiri River between May and December, 2017 and January to April 2018

Fish family	Species	No. Of Samples	Length range (cm)		Mean Statistics	Standard Error
			Min	Max		
Notopteridae	*Papyrocranusafer*	25	32	68	42.38	4.82
	Xenomystusnigri	29	28	47	40.38	4.22
Phractolaemidae	*Phractolaemusansorgei*	52	35	55	51.40	5.26
Hepsetidae	*Hepsetusodoe*	25	29	51	50.90	5.15
Characidae	*Brycinuslongipinnis*	29	25	32	31.23	3.12
Cyprinidae	*Barbuscallipterus*	54	15	22	20.40	1.88
Polypteridae	*Erpetoichthyscalabaris*	53	17	24	21.95	2.12
Pantodontidae	*Pantodonbuchhozii*	71	25	32	30.62	2.95
Clariidae	*Clariasgariepinus*	230	31	37	35.68	3.50
	Clariasmacromystax	104	31	37	35.69	3.52
	Clariasangillasris	201	31	36	35.71	3.62
Bagridae	*Auchenoglanisoccidentalis*	240	28	33	32.68	3.01
	Auchenoglanisbiscutatus	210	23	29	28.45	2.12
Cyprinodontidae	*Epiplatys sex fasciates*	52	17	24	22.44	2.10
Malapteriuridae	*Malapteruriuselectrius*	159	58	65	62.45	6.50
Nandidae	*Polycentropsis abbreviate*	92	23	29	28.43	2.68
Gymnarchidae	*Gymnarchusniloticus*	5	45	53	50.98	5.16
Cichlidae	*Chromidotilapiaguentheri*	307	20	24	21.45	2.04
	Hemichromisbimaculatus	59	20	25	20.90	2.01
	Hemichromisfasciatus	410	18	24	23.80	2.68
	Oreochromisniloticus	49	18	24	22.70	2.22
	Oreochromisaureus	25	17	22	20.68	1.98
	Tilapia dageti	10	14	25	21.72	2.05
	Tilapia zilli	203	18	23	20.69	1.96
Clupeidae	*Tilapia mariae*	200	8	12	10.40	0.52
	Ilishaafricana	5	16	22	21.50	2.06
Mormyridae	*Brienomyriusbronchistius*	74	20	25	22.70	2.40
	Isichthyshenryii	62	33	38	35.40	3.42
	Hyperopisusbebeoccidentalis	45	38	40	36.20	3.60
Channidae	*Parachannaafricana*	98	25	30	28.58	2.61
	Parachannaobscura	97	21	40	34.70	3.20
Schilbeidae	*Schilbeintermeduis*	26	38	43	39.10	3.75

Table 1b: Weight fish species sampled from Otamiri River sampled between May to December, 2017 and January to April 2018

Fish family	Species	No. Species	Weight range		Mean statistics	Standard error	Correlation constant (a)	Length exponent (b)	Correlation coefficient (r)	Type of growth
			MIN	MAX						
Notopteridae	*Papyrocranus afer*	25	51.62	175.54	168.54	58.1	-0.154	1.0792	0.982	Allometric
	Xenomystus nigri	29	72	210.4	192.65	69.5	-0.149	1.0829	0.984	Allometric
Phractolaemidae	*Phractolaemus ansorgei*	52	54.2	219.4	207.55	84.2	-1.14	1.083	0.978	Allometric
Hepsetidae	*Hepsetus odoe*	25	70.24	210.41	205.48	83.2	-0.182	1.054	0.994	Allometric
Characidae	*Brycinus longipinnis*	29	25.7	230.4	204.57	82.2	-0.177	1.1202	0.984	Allometric
Cyprinidae	*Barbus callipterus*	54	40.2	140.2	125.46	43.2	-0.214	1.1027	0.98	Allometric
Polypteridae	*Erpetoichthys calabaris*	53	25.4	210.15	190.7	46.1	-0.271	1.065	0.921	Allometric
Pantodontidae	*Pantodon buchhozii*	71	70.45	200.19	189.25	45.2	-0.222	1.189	0.985	Allometric
Clariidae	*Clarias gariepinus*	230	15.2	215.2	204.48	82.2	-0.203	1.064	0.98	Allometric
	Clarias macromystax	104	68.9	210.4	199.5	70.12	-0.252	1.103	0.989	Allometric
	Clarias angillasris	201	49.12	212	189.4	45.22	-0.306	1.1074	0.988	Allometric
Bagridae	*Auchenoglanis occidentalis*	240	49.12	191.2	179.4	63.01	-0.352	1.103	0.976	Allometric
	Auchenoglanis biscutatus	210	52.7	230.15	204.55	82.1	-0.322	1.115	0.912	Allometric
Cyprinodontidae	*Epiplatys sex fascinates*	52	70.1	140.2	123.29	42.24	-0.337	1.118	0.914	Allometric
Malapteriuridae	*Malapterurius electrius*	159	40.5	255.18	205.21	95.5	-0.353	1.121	0.956	Allometric
Nandidae	*Polycentropsis abbreviate*	92	56.7	220.17	201.44	82.17	-0.368	1.124	0.983	Allometric
Gymnarchidae	*Gymnarchus niloticus*	5	40.1	210	200.2	83.1	-0.384	1.126	0.939	Allometric
Cichlidae	*Chromidotilapi aguentheri*	307	25.4	160.5	109.7	41.2	-0.412	1.129	0.982	Allometric
	Hemichromis bimaculatus	59	27.1	120.7	104.2	30.15	-0.415	1.132	0.982	Allometric
	Hemichromis fasciatus	410	25.42	120.4	100.9	30.1	-0.431	1.135	0.917	Allometric
	Oreochromis niloticus	49	10.7	124.1	106.01	31.2	-0.446	1.138	0.982	Allometric
	Oreochromis aureus	25	25.42	102.1	92.11	28.16	-0.462	1.141	0.978	Allometric
	Tilapia dageti	10	10.5	95.7	70.5	28.1	-0.478	1.144	0.982	Allometric
	Tilapia zilli	203	25.45	120	104.1	30.17	-0.493	1.147	0.915	Allometric
Clupeidae	*Tilapia mariae*	200	15.17	151.7	146.7	45.7	-0.509	1.151	0.968	Allometric
	Ilishaafricana	5	50.4	140.8	123.74	42.68	-0.524	1.153	0.918	Allometric
Mormyridae	*Brienomyriusbronchistius*	74	60.7	162.1	123.24	40.7	-0.54	1.156	0.932	Allometric
	Isichthyshenryii	62	58.25	210	192.52	70.15	-0.555	1.159	0.962	Allometric
	Hyperopisusbebe occidentalis	45	62.1	220.6	198.51	77.75	-0.571	1.162	0.933	Allometric
Channidae	*Parachanna africana*	98	73	235	204.1	83.01	-0.587	1.165	0.983	Allometric
	Parachanna obscura	97	75.12	210.12	199.2	71.75	-0.602	1.168	0.933	Allometric
Schilbeidae	*Schilbei ntermeduis*	26	62.2	221.17	194.95	68.7	-0.618	1.171	0.984	Allometric

Table 2: Physico-chemical parameters of Otamiri River

	Temperature %	pH	DO_2	Salinity
May (2017)	23.70	5.38	6.20	15.00
June	22.20	6.50	7.70	19.00
July	22.10	6.06	5.00	15.05
Aug	24.70	5.66	7.30	17.00
Sept	24.40	6.76	8.20	14.00
Oct	25.40	6.29	8.00	15.00
Nov	26.40	6.01	7.80	14.00
Dec	26.80	6.13	7.00	16.00
Jan (2018)\	27.60	6.57	6.08	15.00
Feb	27.90	5.61	5.50	13.00
March	27.80	6.07	6.30	17.00
April	26.50	5.89	8.10	17.50
Mean	25.29 ± 2.10	6.07 ± 0.90	6.93 ± 0.90	15.62 ± 9.20

Table 3: Relative Gut Index of 32 fish species in Otamiri River

No.	Species	Gut Length/cm	Standard length/cm	Relative gut index/cm
1	Papyrocranus afer	16.86	40.50	1:2.5
2	Xenomystus nigri	13.65	38.30	1:3.0
3	Phractolaemus ansorgei	17.98	45.70	1:2.5
4	Hepsetus odoe	15.20	44.90	1:3.0
5	Brycinus longipinnis	11.98	26.40	1:2.5
6	Barbus callipterus	8.24	15.39	1:2.0
7	Erpetoichthys calabaris	16.23	46.95	1:2.5
8	Pantodon buchhozii	8.90	26.51	1:3.0
9	Clarias gariepinus	18.20	36.52	1.2.0
10	Clarias macromystax	15.90	30.72	1:2.0
11	Clarias angillasris	11.60	31.68	1:2.5
12	Auchenoglanis occidentalis	10.90	28.68	1:3.0
13	Auchenoglanis biscutatus	11.60	24.42	1:2.0
14	Epiplatyssex fasciates	13.65	17.45	1:1.5
15	Malapterurius electrius	23.70	58.47	1:2.5
16	Polycentropsis abbreviate	11.75	23.40	1:2.0
17	Gymnarchus niloticus	16.01	45.92	1:2.5
18	Chromidotilapia guentheri	11.95	26.45	1:2.5
19	Hemichromis bimaculatus	15.90	44.95	1:3.0
20	Hemichromis fasciatus	15.40	43.80	1:3.0
21	Oreochromis niloticus	16.20	48.50	1:3.0
22	Oreochromis aureus	14.80	37.67	1:2.5
23	Tilapia dageti	8.90	39.91	1:4.5
24	Tilapia zilli	12.95	37.67	1:3.0
25	Tilapia mariae	8.25	15.47	1:2.0
26	Ilisha africana	6.75	15.60	1:2.0
27	Brienomyrius bronchistius	6.20	19.70	1:3.0
28	Isichthyshenryii	12.90	34.42	1:3.0
29	Hyperopisusbebe occidentalis	13.20	38.80	1:3.0
30	Parachanna africana	9.80	24.52	1:2.5
31	Parachanna obscura	13.90	36.70	1:2.5
32	Schilbeintermeduis	13.40	38.70	1:3.0

Table 4: Summary of Food Items in Ten (10) Most Dominant Fish Species Sampled During the Period

Species	Leaves of higher plants	Fish remains	Palm Kernel Shaft	Detritus / Unidentified	Number of food items	% Number
Clarias gariepinus	4	2	4	2	12	4.07
C. gacromystax	3	2	5	4	14	4.75
C. angillaris	4	2	5	4	15	5.08
Auchenoglanis occidentalis	9	17	6	21	53	17.96
A. biscutatus	6	9	11	8	34	11.53
Malapterurius electricus	8	16	8	20	52	17.63
Chromido tilapia guentheri	11	18	9	24	62	21.02
Hemichromis faciatus	4	2	3	1	10	3.39
Coptodon zilli	5	3	7	6	21	7.12
Tilapia maria	7	3	4	8	22	7.45
Total	61	74	62	98	295	100
% Occurrence	20	24	22	34		

Table 5: Condition Factor dominant fish species in Otamiri River

Fish family	Species	No of species	Condition factor (K)
Clariidae	*Clarias gariepinus*	230	0.719
Clariidae	*C. macromystax*	104	0.688
Clariidae	*C. angillasris*	201	0.595
Bagridae	*Auchenoglanis occidentalis*	240	0.760
Bagridae	*A. biscutatus*	210	1.404
Malapteriuridae	*Malapteruriuselectrius*	159	0.127
Cichlidae	*Chromidotilapiaguentheri*	307	1.141
Cichlidae	*Hemichromisfasciatus*	410	1.133
Cichlidae	*Coptodon zilli*	203	1.886
Cichlidae	*Tilapia mariae*	200	2.443

DISCUSSION

Malapterus electricus was of highest length, 62.45cm while *Tilapia mariae* had the minimum length of 10.40cm. *Malapterus electrics* are known to be long in length, unlike *Tilapia Mariae*. The maximum weight of 207.55g was attained by *Phractoloemus ansorgei* and *Tilapia dageti had* the minimum weight of 70.50. This agrees with Oluwusi-Peters *et al*., (2015), Abowei (2009), Offem *et al.* (2008), Adedokun *et al.*, (2013), Odo *et al*. (2012). However, Alfred-Ochiya (1998, 2000) showed that the maximum size of fish is determined by the location and the environmental factors coupled with aquatic pollution and fishing pressure. All the fish species evolved allometricgrowth,"b" value was less than 3 which means that the rate of increase in body length was not proportional to the rate of increase in body weight. (Gayanilo and Pauly, 1997). This agrees with Offem *et al*., (2008); Ezekiel and Abowei (2014) but disagrees with Olurin and Aderibigbe (2006) who observed isometric growth in juvenile *Oreochromis niloticus* reared in ponds. Olurin and Adrinbigbe (2006) explained that differences in length and weight relationship may be due to differences in sex and developmental stages of the fish. They rooted their argument to Weatherly (1972), Lackey and Hubert (1978), Aliakbar and Ali (1978) who showed that growth pattern in fishes go through four different developmental stages: the larva, the juvenile growth, the maturity growth and senility growth. The calculated gut length/standard length ratio was high in *Xenomystus nigri*, *Hepsetus odoe*, *Pantodon buchozii*, *Hemichromis bimaculatus*, *Hemichromis fasciatus* and *Hemichromis niloticus*, indicating that the species are piscivarous (Hugueny and Pouilly, 1999) The long intestine with spiral valves and folds, the possession of distinct pyloric cacea at the intestinal ampulla which forms a device to increase the surface area for intestinal digestion and absorption, are adaptations to microphages and plantivorus (Arawomo, 1972; Lagler*et. al.* 1977). The condition factor ranged between 0.127 to 2.443 which agrees with Abowei (2009); Ayandiran and Fawole (2014) who reported 'K' value ranging between 0.54 and 1.94 for trophical fishes. Olawusi-Peters *et al.,* (2015) summarized the works of Fawole and Adewoye (2004), Ayandiran

and Fawole (2014), Stewart (1988), Bakhoum (1994), Khallat*et. al.*(2003) and explained that major factors that influence condition factors of fish are sex, season, environmental conditions, stress, availability of food and pollution.

CONCLUSION

The fishes of Otamiri Rivers are enjoying favourable environmental condition for sustenance. They evolved striking morphological and ecological adaptations. They exhibit allometric growth pattern and good condition factor as a result of excellent water quality and environmental condition. From the influx of nutrients from Owerri Municipal Area, food is readily available.Thus, the fisheries are abundant to a sustainable level. However, there is the need for conservation mechanism by the indigenous fishers of Umuagwo and Mgburichi to avoid overfishing and consequently, depletion of the fish stock.

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