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Full Length Research

Investigating the relationships between some physico-chemical parameters and growth patterns of two marine fish species from Ibeshe and Okunraye aquatic stations in Lagos, Nigeria

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ABSTRACT: Ensuring the sustainability of fishing and conserving fish diversity in the aquatic environments cannot be undermined. Hence, this study aimed to analyse some water parameters (Water temperature, dissolved oxygen, alkalinity, total dissolved solids, turbidity, salinity, phosphate, sulfate, nitrite, and nitrate) of Ibeshe and Okunraye aquatic stations and investigate if there exists any correlation between the physico-chemical parameters and growth patterns of *Chloroscombrus chrysurus* and *Pseudotolithus typus* from these aquatic stations. Water and fish samples were collected for three months (September to November 2022) while the physico-chemical parameters of water were determined using APHA standard procedures. The inter-relationship between water and morphometric parameters of the fish were analyzed using Pearson's correlation coefficient. All the mean values of physico-chemical parameters were within the standard permissible range. *P. typus* in Okunraye had a positive allometric growth (b=3.35) while *P. typus* (b=2.63) in Ibeshe and *C. chrysurus* at both Okunraye and Ibeshe had negative allometric growth patterns. The condition factor 'K' for *P. typus* in both stations was greater than one while K for *C. chrysurus* was greater than one in Okunraye (1.03) but less than one in Ibeshe (0.78). This indicates that the two fish samples (except *C. chrysurus* in Ibeshe) are in good condition. However, Pearson's correlation coefficient between morphometric characters of the fish and the water quality parameters showed no significant ($p>0.05$ and $p> 0.01$) correlation in most of the values signifying that the physico-chemical parameter of the habitat at present poses no major hindrance to the maximum growth of the examined fish species. However, some other factors such as the availability of food and rate of exploitation might be responsible for the slight disparity in body weight, total length and pectoral fins.

Keywords: Correlation, fish, exploitation, water quality, growth patterns.

INTRODUCTION

An array of biological, physical and chemical factors plays a crucial role in the growth of fish in aquatic ecosystems (Murugan *et al.*, 2020). For a balanced ecological community to exist, there must be a positive interaction between the environment and the living organisms (Rocha *et al.*, 2015; Mekuleyi *et al.*, 2023). Factors such as changes in phytoplankton abundance, predation, water temperature and dissolved oxygen concentrations among

others have been reported to influence fish growth and also result in measurable physiological changes in fish (Fazio *et al.*, 2013). For example, high temperature may generate high physiological demands apart from reducing the dissolved oxygen levels in a water body. The higher the temperature of the water body the lower the dissolved oxygen and vice versa. In particular, fish populations are highly dependent upon the variations of physico-chemical characteristics of their aquatic habitat which supports their biological functions (Mohamad *et al*., 2021). Furthermore, human activities within and around aquatic environments such as fishing, mangrove degradation, and breakwater construction, often influence the fish's lives, growth patterns and feeding habits. According to Aderinola *et al.* (2020), factors that influence the growth pattern of fish include seasonality, habitat type, gonadal maturity, sex, health, food availability, differences in species, and physical factors such as temperature and salinity. Due to various human activities around Okunraye and Ibeshe aquatic ecosystems in Lagos State, the necessity to assess the quality of its water parameters and biota cannot be over-emphasized. Therefore, the main aim of this study is to investigate the relationships between physico-chemical parameters and growth pattern of *Pseudotolithus typus* and *Chloroscombrus chrysurus* in Okunraye and Ibeshe sampling stations, keeping in view the economic importance of these fish species to the people living within Okunraye and Ibeshe coastal communities.

MATERIALS AND METHODS

Description of the study area

The sampling sites for this study were Okunraye and Ibeshe Sea Beach (Figure 1). The Ibeshe Beach is located in the satellite town of Amuwo-Odofin Local Government Area (LGA) on latitude 6^{o}23'53.1'N and Longitude 3^{o}15'48.2'E while the Okunraye Beach is located in Ibeju Lekki, TDH resort on latitude 6^{o}0.418197'N/ 6 ^{o}0.255508'N and longitude: 4^{o}0.049680 E/ 4^{o}0.258.848'E.

Collection of water samples

Water sample was collected twice a month for a period of three months (September to November 2022). Physico-chemical parameters such as dissolved oxygen, alkalinity, salinity, turbidity, phosphate, sulfate, nitrite, nitrate, total dissolved solids and temperature were measured using standard methods.

Collection of fish samples and identification

Fish samples (*Pseudotolithus typus* and *Chloroscombrus chrysurus*) were collected at site 1 (Okunraye in Ibeju Lekki) and site 2 (Ibeshe in Amuwo-odofin). The fishes in Ibeju Lekki water body were caught by Ghanaian fishermen while the fishes at (Ibeshe) sampling site were caught by mainly Yoruba fishermen. Both categories of fishermen used gill nets. Ten samples of *C. chrysurus* and *P. typus* were randomly selected monthly from each station, making a total of 120 fish samples collected during this study. All the fish samples collected at the landing site were carried in an ice cooler to the fish laboratory to prevent spoilage prior to measurement. The fishes were identified at the species level in the laboratory using the FAO identification guide.

Morphometric characteristics

Morphometric characters such as total length, standard length, head depth, body depth, head length, pre-orbital length, post-orbital length, length of caudal peduncle, depth of caudal peduncle of the fishes and pectoral fin were measured with a meter ruler to the nearest 0.1 cm in the Lagos State University Fisheries Laboratory. The weight of the fish was measured using an electronic scale to the nearest 0.1 grams.

Determination of length-weight relationship

The length-weight relationship was determined by linear relationship techniques to see if there is a correlation between the length and weight of the fish using the formula described below:

$W=al^{b}$----------(i) (Le Cren,1951)

The above equation (i) and data were transformed into logarithms (natural log) before the calculations. So, equation (ii) becomes:

Log W = log a + b log L ---------(ii) (Ricker, 1973)

Where: W(g) is the body weight of the fish, L(cm) is the total length, a is the intercept of the regression curve and b is the regression or allometry coefficient

Condition factor

The condition factor which is the representative of degree of well-being of a fish population (Rodriguez *et al.,* 2017), was calculated using Fulton's coefficient formula (Fulton, 1902):

K=W/L^{b} x 100 (Ricker, 1975)

Where: K = Condition factor**,** L = Total length in centimetres**,** W = Body weight in grams. B = allometry coefficient.

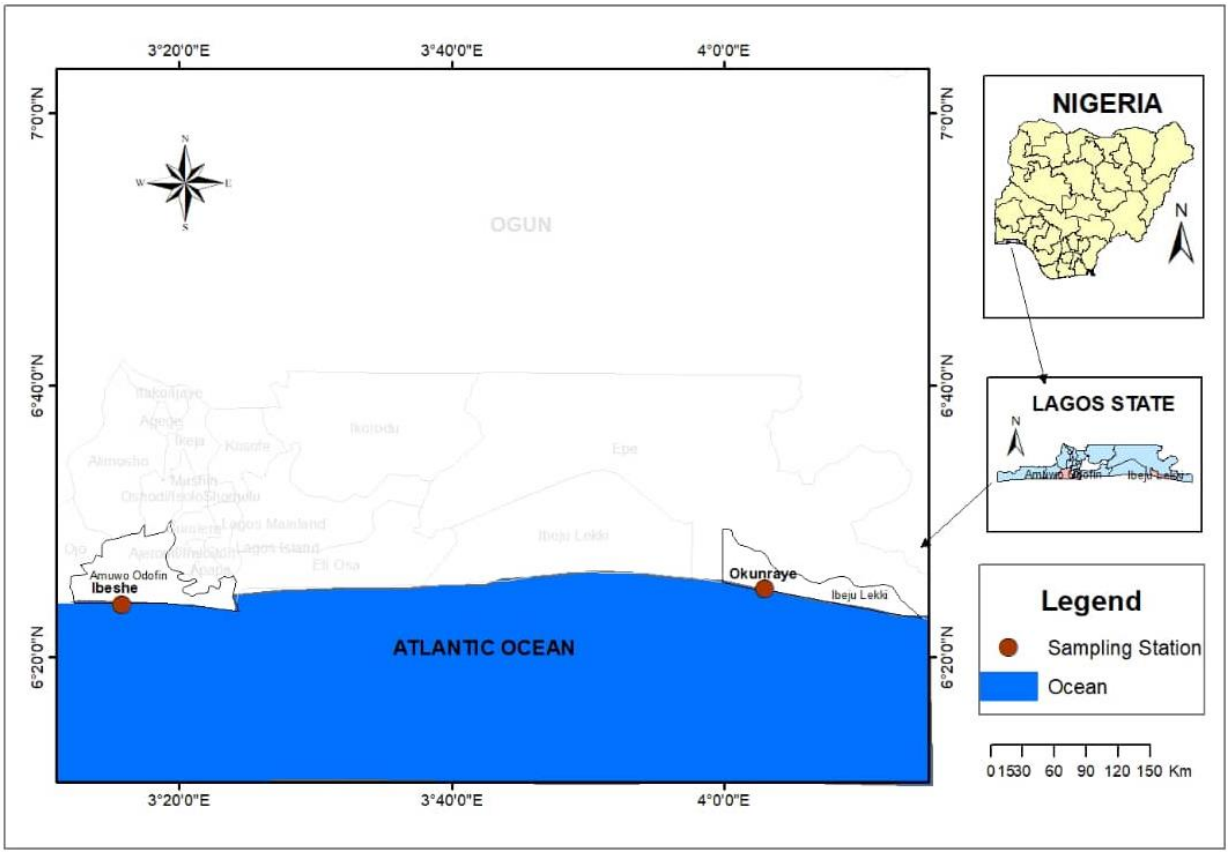

Figure 1. Map showing the location of the two sampling stations.

Statistical analysis

The data obtained from this study were reported using descriptive statistics (mean and standard deviation), and presented in graphs and tables. Data were also tested with t-test analysis using statistical package (SPSS version, 20) and significant differences level placed at $p<0.05$. The relationship between variables (length and weight) was analyzed using a regression equation and inter-relationship between physico-chemical parameters and morphometric parameters were analyzed using the Pearson's correlation coefficient.

RESULTS

Morphometric characteristics of *Chloroscombrus chrysurus* and *Pseudotolithustypus*

The result of the mean and standard deviation of *Chloroscombrus chrysurus* and *Pseudotolithus typus* from Okunraye and Ibeshe water body is presented in Table 1. There was a significant difference ($p<0.05$) between the body weight of *P. typus* in Okunraye and that of *P. typus* in Ibeshe. Also, there was a significant difference between the body weight of *C. chrysurus* in Okunraye and that of Ibeshe. The value of the total length of *P. typus* in Ibeshe was significantly higher than that in Okunraye. The pectoral fins of *P. typus* and *C.chrysurus* in Okunraye and Ibeshe were significantly different. However, the other morphometric parameters (standard length, head length, eye diameter, depth of caudal peduncle, length of caudal peduncle, body depth, pre-orbital length, post-orbital length) were not significantly different ($p>0.05$) between the stations.

Physico-chemical parameters of Okunraye and Ibeshe Beach

The spatio-temporal distribution of physico-chemical parameters (water temperature, dissolved oxygen, alkalinity, salinity, turbidity, total dissolved solids, phosphate, sulfate, nitrite and nitrate), recorded at Okunraye and Ibeshe Beach are presented in Table 2. There was no significant difference ($p>0.05$) between the mean value of water temperature recorded at Ibeshe and that of Okunraye. However, higher mean value of dissolved oxygen (16.8 mg/L) was recorded at Okunraye in comparison with that of dissolved oxygen (13.3 mg/L)

Table 1. Mean and standard deviation of *C.chrysurus and P.typus* from Okunraye and Ibeshe Beach.

Parameters	Okunraye		Ibeshe	
	P. typus	***C. chrysurus***	***P. typus***	***C. chrysurus***
BW (g)	74.48±39.16^{a}	67.08±12.41^{ab}	85.94±81.12^{b}	61.57±11.95^{c}
SL (cm)	16.67±4.16^{a}	15.75±0.89^{a}	16.82±4.65^{a}	15.95±2.56^{a}
TL (cm)	19.33±3.27^{a}	18.74±2.11^{a}	20.86±4.48^{b}	20.12±1.48^{b}
HL (cm)	6.53±5.53^{a}	8.71±7.11^{b}	6.87±6.29^{a}	9.21±8.26^{b}
ED (cm)	0.97±0.25^{a}	1.08±0.25^{a}	1.06±0.10^{a}	1.07±0.12^{a}
DCP (cm)	0.97±0.25^{a}	0.86±0.12^{a}	1.28±0.51^{a}	0.87±0.15^{a}
LCP (cm)	1.86±0.28^{a}	1.83±0.26^{a}	3.18±1.34^{a}	2.92±1.73^{a}
BD (cm)	5.66±1.39^{a}	6.68±0.44^{a}	5.84±1.32^{a}	6.83±0.76^{a}
POSTOL (cm)	2.05±0.59^{a}	1.50±0.12^{a}	2.03±0.57^{a}	1.50±0.15^{a}
PREOL (cm)	1.01±0.28^{a}	1.04±0.26^{a}	1.21±0.42^{a}	1.23±0.25^{a}
PECTFIN	17.48±2.73^{a}	17.63±2.36^{a}	8.47±4.14^{b}	8.47±5.87^{b}

BW=Body weight, SL=standard length, TL=Total length, HL=Head length, ED= Eye diameter, DCP=Depth of caudal peduncle, LCP=Length of caudal peduncle, BD=Body depth, POSTOL=Post orbital length, PREOL= Preorbital length, PECTFIN= Pectoral fin, C. chrysurus = *Chloroscombrus chrysurus, P .typus*= *Pseudotolithus typus.* Mean±SD with different superscript in the row is significantly different at p<0.05.

Table 2. Mean andstandard deviation of the physico-chemical parameters depending of station.

Parameters	Physico-chemical parameters		Acceptable levels in marine water (EPA, 2020 &WHO, 2022)
	Station 1 (Okunraye)	Station 2 (Ibeshe)	
Water Temperature (^{0}c)	27.80±1.16^{a}	28.30±0.64^{a}	15-30
Dissolved Oxygen (mg/L)	16.78±3.21^{a}	13.29±0.96^{b}	>5
Alkalinity (mg/L)	232.50±65.19^{a}	117.93±5.70^{b}	100-250
Turbidity (NTU)	2.91±0.06^{a}	1.44±0.09^{b}	0.5-10
Total Dissolved Solids (mg/L)	25219±14.86^{a}	28191±1995.5^{b}	30000-40000
Salinity (ppt)	23.67±3.14^{a}	22.58±1.31^{a}	30-40
Sulfate (mg/L)	1431.33±5.35^{a}	1656.80±69.74^{b}	2000-4000
Phosphate (mg/L)	0.001±0.00^{a}	0.00±0.01^{a}	0.01-0.1
Nitrite (mg/L)	0.22±0.11^{a}	0.03±0.01^{a}	0.01-1.0
Nitrate (mg/L)	4.27±0.22^{a}	3.12±0.19^{a}	0.1-10

Mean±SD with different superscript in the row is significantly different at p<0.05.

recorded at Ibeshe. Okunraye had higher alkalinity than Ibeshe while a higher mean turbidity value was recorded at Okunraye as against the mean value recorded at Ibeshe. Total dissolved solids were higher at Ibeshe, in comparison with total dissolved solids recorded at Okunraye. However, the mean values of salinity, sulfate, phosphate, nitrite and nitrate between the two samples were not significantly different.

Length-weight relationship of *Pseudotolithus typus* in Okunraye and Ibeshe Beach

The linear graph for the length-weight relationship of *Pseudotolithus typus* in Okunraye and Ibeshe were presented in Figures 2 and 3, respectively. *P. typus* in Okunraye had a positive allometric growth (b = 3.4) while *P. typus* (b=2.6) in Ibeshe had negative allometric growth patterns. However, the regression (r^2) of the species and the values of the intercept were similar at both stations.

Length-weight relationship of *Chloroscombrus chrysurus* in Okunraye and Ibeshe Beach

The linear graph for the length-weight relationship of *C. chrysurus* in Okunraye beach is presented in Figure 4. The 'b' value was recorded as 1.1, the regression value of the species was recorded as 0.4, while the intercept value was recorded as 0.9. The linear graph for the length-weight

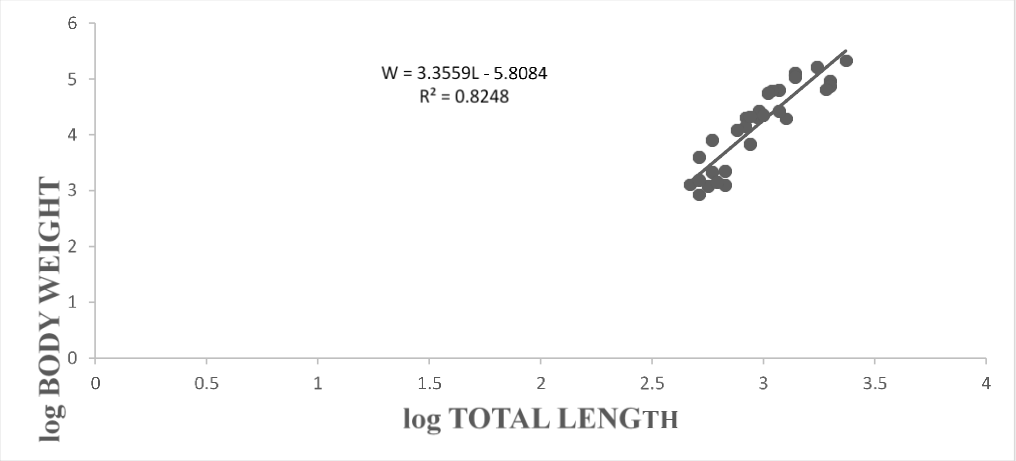

Figure 2. Length-weight relationship of *P. typus* in Okunraye.

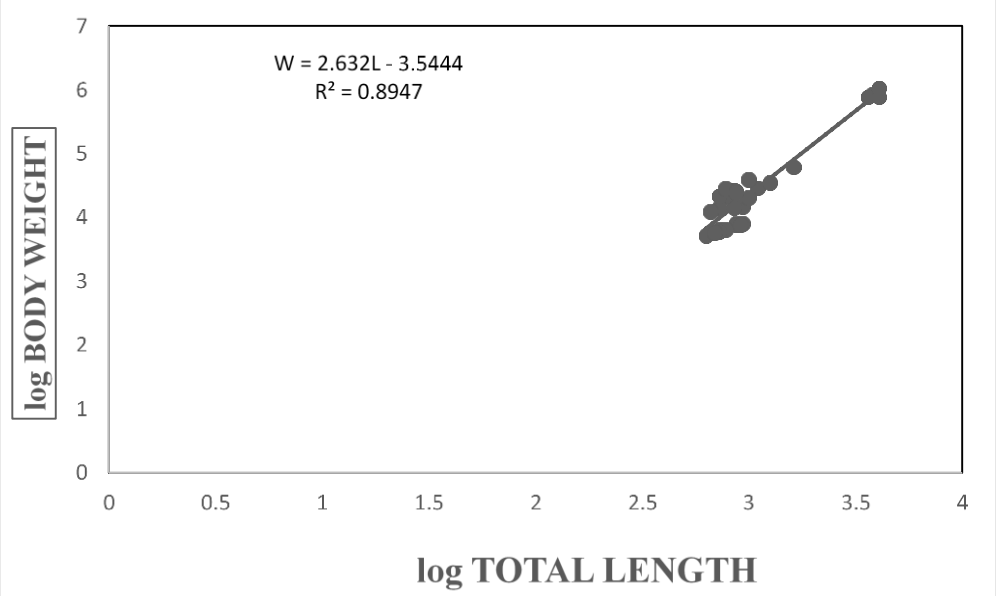

Figure 3. Length-weight relationship of *P. typus* in Ibeshe.

relationship of *C. chrysurus* in Ibeshe Beach is presented in Figure 5. The 'b' value was recorded as 2.1, the regression value of the species was recorded as 0.8, while the intercept value for the species was recorded as -2.3.

Pearson's correlation between morphometric parameters of *P. typus*and *C. chrysurus* and Physico-chemical parameters from Okunraye and Ibeshe Beach

Tables 3 and 4 showed the correlation between the morphometric characteristics of *Pseudotolithus typus* and the physico-chemical parameters from Okunraye and Ibeshe Beach, respectively. The body depth of *P. typus* in Okunraye showed a negative significant correlation (-0.4) with alkalinity (Table 3), while in Ibeshe, the morphometric parameters of *P. typus* showed no significant correlation with any of the physico-chemical parameters ($p>0.05$ and $p> 0.01$), respectively (Table 4).

The correlation between the morphometric parameters of *Chloroscombrus chrysurus* and the physico-chemical parameters in Okunraye and Ibeshe Beach is shown in Tables 5 and 6, respectively. The length of the caudal peduncle of *C. chrysurus* in Okunraye Beach showed a negative significant correlation with temperature (-0.8),

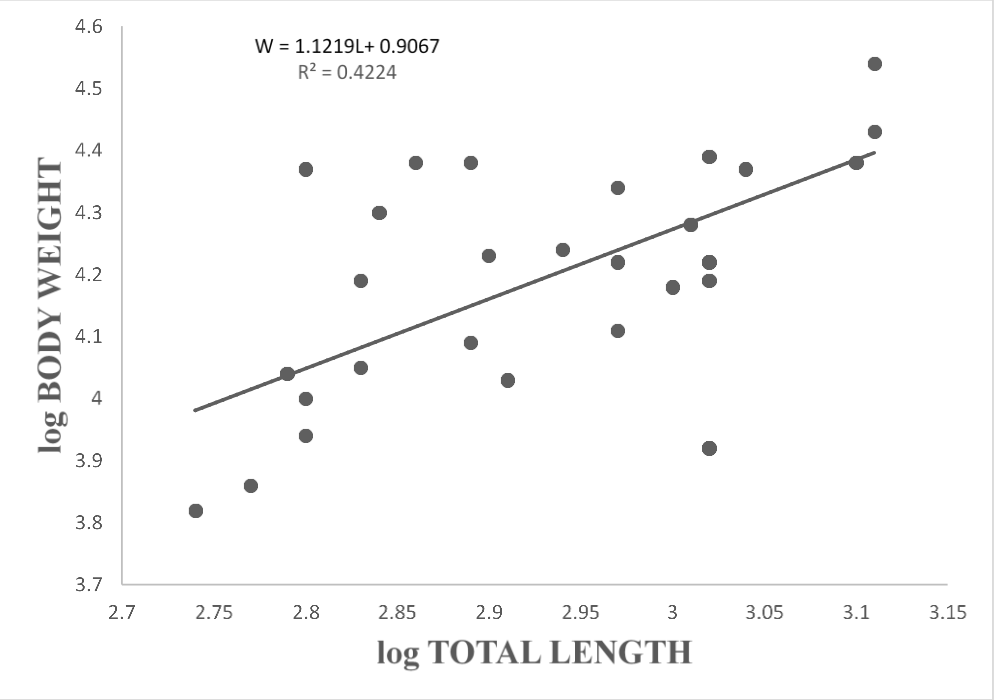

Figure 4. Length-weight relationship of *C. chrysurus* in Okunraye beach.

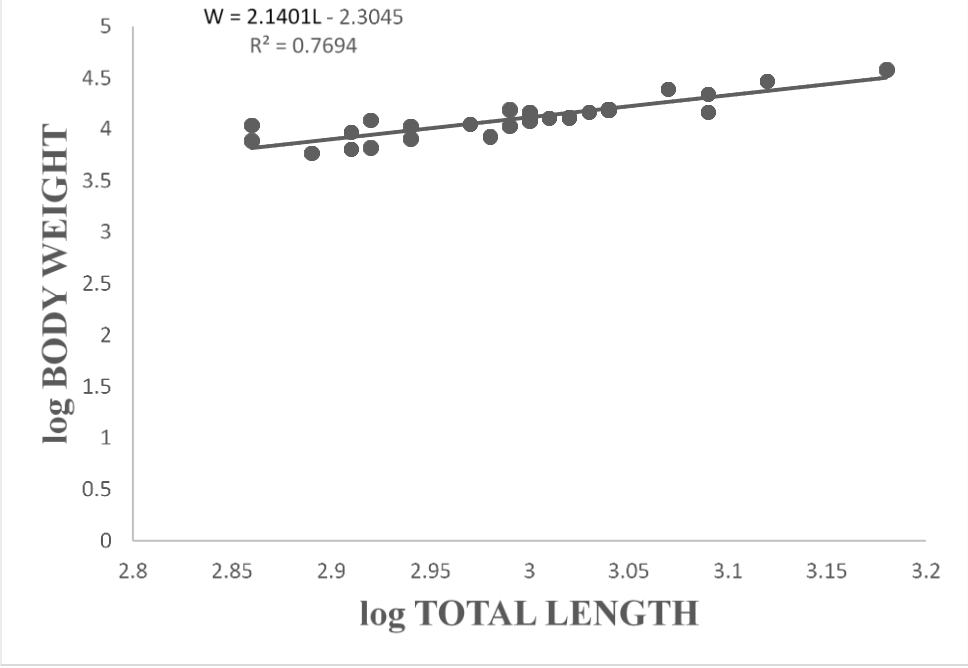

Figure 5. Length-weight relationship of *C. chrysurus* in Ibeshe Beach.

while body depth showed a negative significant correlation with temperature (-0.8) and nitrate (-0.9). The post-orbital of *C. chrysurus* showed a negative highly significant correlation with temperature (-0.9) and a positive highly significant correlation with alkalinity (0.9) while the pre-orbital length shows a positive significant correlation with

Table 3. Pearson's correlation coefficient of the morphometric parameters of *Pseudotolithus typus* and physico-chemical parameters of Okunraye Beach.

Parameters	Temp	DO	Alkalinity	TDS	Turbidity	Salinity	Phosphate	Sulfate	Nitrate	Nitrite
BW	0.055	0.147	-0.059	-0.0289	0.028	-0.059	0.132	-0.288	0.089	-0.271
SL	0.006	0.159	-0.155	-0.197	-0.014	-0.025	0.147	-0.253	0.085	-0.246
TL	-0.041	0.180	-0.167	-0.234	-0.038	0.029	0.151	-0.263	0.022	-0.237
HL	0.083	0.035	-0.172	-0.112	0.094	-0.102	0.049	-0.170	0.116	-0.138
ED	-0.112	0.036	-0.036	-0.127	-0.145	0.149	0.093	0.056	-0.024	-0.022
DCP	-0.068	0.193	-0.026	-0.104	-0.023	0.034	0.082	-0.255	0.107	-0.167
LCP	-0.250	0.356	0.065	-0.276	-0.238	0.280	0.077	-0.251	-0.096	-0.156
BD	0.165	0.088	-0.373*	-0.033	0.059	-0.166	0.199	-0.271	0.118	-0.351
POSTOL	-0.047	0.146	-0.018	-0.069	-0.015	0.033	0.005	-0.173	0.097	-0.085
PREOL	0.063	0.089	-0.189	-0.203	0.055	-0.060	0.042	-0.205	0.092	-0.162
PECTFIN	0.062	0.028	-0.194	-0.182	-0.042	-0.052	0.179	-0.070	-0.039	-0.202

BW= Body weight, SL= Standard length, TL= Total length, HL= Head length, ED=Eye diameter, DCP= Depth of caudal peduncle, LCP= length of caudal peduncle, BD= Body depth, POSTOL= Post orbital length, PREOL= Pre- orbital length, PECTFIN= Pectoral fin, Temp= Temperature, D0= Dissolved oxygen, TDS= Total dissolved solids. *Shows correlation at 0.05 (5%) levels (2-tailed) significant correlation.**Shows correlation at 0.01 (1%) levels (2-tailed) highly significant correlation.

Table 4. Pearson's correlation of the morphomeristic characteristics and the physico-chemical parameter of *Pseudotolithus typus* in Ibeshe Beach.

Parameters	Temp	DO	Alkalinity	TDS	Turbidity	salinity	Phosphate	Sulfate	Nitrate	Nitrite
BW	-0.099	0.139	-0.109	-0.106	0.044	-0.213	0.007	-0.100	0.029	0.027
SL	-0.173	0.201	-0.104	-0.185	0.006	-0.182	-0.066	-0.091	-0.044	0.107
TL	-0-121	-0.203	-0.099	-0,143	0.076	-0.203	-0.040	-0.077	0.026	0.034
HL	-0.169	0.200	-0.139	-0.197	0.028	-0.159	-0.113	-0.102	-0.080	0.127
ED	0.259	-0.236	-0.239	0.141	0.0236	0.310	-0.216	-0.090	-0.151	-0.38
DCP	-0.069	-0.069	0.032	-0.079	0.117	-0.139	0.035	0.008	-0.153	-0.086
LCP	-0.138	0.146	-0.083	-0.145	-0.052	-0.087	-0.089	-0.060	-0.111	0.142
BD	-0.175	0.201	-0.0145	-0.177	-0.056	-0.177	-0.089	0.130	-0.107	0.158
POSTOL	0.044	-0.079	0.207	0.033	0.066	0.133	-0.062	-0.10	-0.094	-0.094
PREOL	-0.044	0.182	-0.111	-0.195	0.098	-0.240	-0.39	-0.039	-0.41	0.103
PECTFIN	0.065	-0.078	-0.085	0.019	-0.17	0.133	-0.198	0.034	-0.212	0.158

BW= Body weight, SL= Standard length, TL= Total length, HL= Head length, ED=Eye diameter, DCP= Depth of caudal peduncle, LCP= length of caudal peduncle, BD= Body depth, POSTOL= Post orbital length, PREOL= Pre- orbital length, PECTFIN= Pectoral fin, Temp= Temperature, D0= Dissolved oxygen, TDS= Total dissolved solids. *Shows correlation at 0.05 (5%) levels (2-tailed) significant correlation.**Shows correlation at 0.01 (1%) levels (2-tailed) highly significant correlation.

alkalinity (0.864). However, for *C. chrysurus* in Ibeshe, only post-orbital length showed a positive significant correlation with salinity (0.9), the rest of the morphometric parameters showed no significant correlation at the 0.05 levels and 0.01 levels.

Condition factor of *Pseudotolithus typus* and *Chloroscombrus chrysurus* in Okunraye and Ibeshe Beach

The results of the condition factor (k) of *P. typus* and *C.chrysurus* in Okunraye and Ibeshe Beach are presented in Figure 6. The 'k' for *P. typus* in Okunraye Beach was 1.03, 'k' for *P. typus* in Ibeshe Beach was 1.1, while the 'k' for *C. chrysurus* in Okunraye Beach was 1.03 and 'k' for *C.chrysurus* in Ibeshe was 0.78.

DISCUSSION

In the present study, all values of water physico-chemical parameters from Okunraye and Ibeshe were within the standard permissible limits reported by EPA (2020) and WHO (2022). Therefore, it is obvious that the examined marine aquatic ecosystems have not been negatively

Table 5. Pearson's correlation of the morphometric characteristics of *Chloroscombrus chrysurus* and physico-chemical parameters in Okunraye Beach.

Parameters	Temp	DO	Alkalinity	TDS	Turbidity	Salinity	Phosphate	Sulfate	Nitrate	Nitrite
BW	-0.461	-0.42	0.730	0.457	-0.127	0.519	-0.598	0.424	-0.329	0.810
SL	0.572	0.180	0.470	0.461	-0.508	0.399	0.658	0.121	-0.420	-0.165
TL	-0.450	0.210	0.532	0.666	-0.292	0.180	0.594	-0.093	0.011	-0.222
HL	-0.450	0.210	0.532	0.666	-0.292	0.180	-0.485	-0.093	0.011	-0.222
ED	0.181	0.158	-0.212	-0.667	0.015	0.61	0.415	-0.107	0.047	-0.082
DCP	-0.551	0.120	0.719	0.626	-0.509	0.416	0.066	0.305	-0.354	0.070
LCP	-0.854*	0.491	0.732	0.319	-0.449	0.750	0.266	-0.151	-0.339	0.193
BD	-0.845*	0.338	0.660	0.110	-0.792	0.885*	-0.192	0.311	-0.859*	0.185
POSTOL	-0.581**	0.355	0.949**	0.615	0.615	0.647	0.221	0.135	-0.315	0.186
PREOL	1	-0.005	0.864*	0.715	0.715	0.547	-0.068	0.475	-0.442	0.540
PECTFIN	0.268	-0.337	-0.603	0.387	-0.288	0.033	0.033	-0.03	-0.068	-0.028

BW= Body weight, SL= Standard length, TL= Total length, HL= Head length, ED=Eye diameter, DCP= Depth of caudal peduncle, LCP= length of caudal peduncle, BD= Body depth, POSTOL= Post orbital length, PREOL= Pre- orbital length, PECTFIN= Pectoral fin, Temp= Temperature, D0= Dissolved oxygen, TDS= Total dissolved solids. *Shows correlation at 0.05 (5%) levels (2-tailed) significant correlation. **Shows correlation at 0.01 (1%) levels (2-tailed) highly significant correlation.

Table 6. Pearson's correlation of the morphometric characteristics of *Chloroscombrus chrysurus* and physico-chemical parameters in Ibeshe Beach.

Parameters	Temp	DO	Alkalinity	TDS	Turbidity	Salinity	Phosphate	Sulfate	Nitrate	Nitrite
BW	-0.053	0.084	-0.607	-0.182	-0.314	0.045	-0.593	-0.252	-0.784	0.609
SL	-0.009	-0.021	-0.425	-0.062	-0.368	0.186	-0.483	-0.140	-0.826	0.638
TL	0.268	-0.249	-0.532	0.161	-0.101	0.277	-0.390	-0.246	0.661	0.378
HL	0.240	-0.358	0.288	0.273	-0.087	0.845	0.093	0.098	-0.018	-0.170
ED	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null
DCP	0.424	-0.583	0.302	-0.409	-0.513	0.333	-0.175	0.333	-0.282	-0.016
LCP	-0.291	0.114	0.190	-0.129	-0.913	0.146	-0.170	0.146	-0.733	0.705
BD	-0.147	0.182	-0.601	-0.273	-0.153	-0.244	-0.619	-0.244	-0.790	0.660
POSTOL	-0.153	-0.051	-0.467	-0.105	-0.406	0.855*	-0.267	0.345	-0.382	0.284
PREOL	0.385	-0.169	-0.620	0.186	0.724	-0.513	-0.059	-0.311	0.256	-0.334
PECTFIN	0.681	-0.728	0.054	0.828	-0.274	0.461	0.606	-0.119	0.098	-0.343

BW= Body weight, SL= Standard length, TL= Total length, HL= Head length, ED=Eye diameter, DCP= Depth of caudal peduncle, LCP= length of caudal peduncle, BD= Body depth, POSTOL= Post orbital length, PREOL= Pre- orbital length, PECTFIN= Pectoral fin, Temp= Temperature, DO = Dissolved oxygen, TDS= Total dissolved solids. *Shows correlation at 0.05 (5%) levels (2-tailed) significant correlation.**Shows correlation at 0.01 (1%) levels (2-tailed) highly significant correlation.

impacted by the anthropogenic activities within these fishing communities. The observation could also imply that these marine ecosystems were not prone to direct discharge of domestic and industrial effluent which is a common trend in many Lagoons and Rivers in Nigeria (Ejike and Liman, 2017; Mekuleyi *et al*., 2021).

Most of the observed mean morphometric parameters of *Pseudotolithus typus* and *Chloroscombrus chrysurus* from Okunraye and Ibeshe marine water bodies were not significantly different and this outcome suggests that *P. typus* and *C. chrysurus* from both stations may have originated from the same genetic stock or due to the non-significant differences of most of the water parameters documented between the two sampling stations. Furthermore, morphometric parameters being not significantly different for *P. typus* and *C. chrysurus* from Okunraye and Ibeshe might imply that the selective pressure such as fishing exerted on the sampled fishes in both aquatic stations was not strong. However, the recorded morphometric parameters for *C. chrysurus* were lower than those reported from the waters of the Republic of Benin (Sossoukpe *et al*., 2017) and also not at par with those collected from Saloum Delta, Segenal (Ndiaye *et al*., 2021). On the other hand, similar sizes of *P. typus* for this study were reported by Awotunde (2021) and Mahe *et al.* (2024).

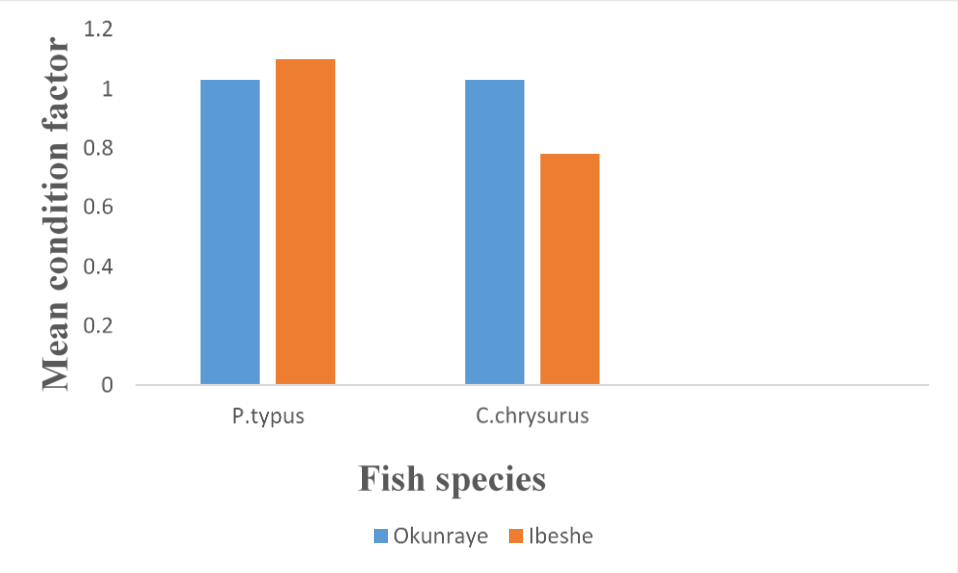

Figure 6. Mean Condition factor of *P. typus* and *C.chrysurus* in Okunraye and Ibeshe beach.

The length-weight relationship plays a major role in fisheries research since it is often associated with providing population parameters necessary for proper fisheries management and sustainable yield of the stocks (Whenu *et al.*, 2018). *P. typus* in Okunraye which exhibited positive allometry growth (b>3) indicated the rate of increase in weight is higher than the rate of increase in total length. The *C. chrysurus* from Okunraye and Ibeshe as well as *P. typus* in Ibeshe exhibited negative allometry growth as allometry coefficient (b) was less than 3 indicating that the rate of increase in total length was higher than the rate of increase in weight. The b' values for *C.chrysurus* in Okunraye (b = 1.12) and Ibeshe (b = 2.1) were significantly lower and these were not in accordance with the range of values usually encountered for this parameter in marine species, which often lies between 2.5 and 3.5 (Froese, 2006). The observation of *C. chrysurus and P. typus* from Ibeshe and *C. chrysurus* from Okunraye falling below Froese's recommended range could imply that probably the species have not grown to their maximum size yet. Howbeit, *P. typus* examined in this study had a similar b value to that reported by Awotunde (2021) for the same species which was obtained from Lagos Lagoon (a brackish ecosystem where the fish inhabit prior to returning to its marine habitat). However, *P. typus* and *C. chrysurus* whose b value agreed with Froese's recommended range have been reported in Lagos coastal waters (Akinbobola and Fakoya, 2021), as well as in Ghana and Senegal (Mahel *et al*., 2024).

Condition factor (k) is used to evaluate the physiological status or well-being of a fish based on the principle that those individuals of a given length which have a higher mass are in better condition (Froese, 2006). The range of mean condition factor obtained in this study for *P. typus* at both Okunraye and Ibeshe was in accordance with the findings of Akinbobola and Fakoya (2021), whose mean monthly condition factor ranged from 1.15 to 1.5 for *P. typus* in Lagos coastal waters. However, it was affirmed that a fish living in a favourable environment, with a required amount of food and good environmental conditions grows faster with a condition factor of one or more (Bagenal and Tesch, 1978). Studies have shown that the value of k is not constant for individuals, species or populations but is subject to wide variations for fish of average natural condition. It has been established that when the k value is greater than one, this indicates that the fish species is living well in the concerned habitat (Ikongbeh *et al.*, 2012). Thus, the k value for *P. typus* in this study both in Okunraye and Ibeshe indicated that *P. typus* is in good condition, living in a stable environment with optimum water quality. On the other hand, k values obtained for *C. chrysurus* were less than 1 at Ibeshe which indicates that the fish may not be in a favourable condition.

The Pearson's correlation results for *C. chrysurus and P. typus* in Okunraye and Ibeshe which showed no significant correlation between most of the value of morphometric parameters and the physico-chemical parameters might be perceived as a pointer that the current level of the water physico-chemical parameters may not be responsible for any variation in the growth pattern of the examined fish species and this was evidence by the status of all values of water physico-chemical parameter from Okunraye and Ibeshe being within the standard permissible limits, as well as the condition factor(k) which divulged that the sampled fish species are in good condition in their habitat. The observation in this

study could also be perceived that there exists a balanced ecological community as suggested by Rocha *et al*. (2015) and Mekuleyi *et al*. (2023).

With water parameters being within the standard limits in this study, it could therefore imply that some other factors such as availability of food and rate of exploitation might be responsible for the slight disparity between the body weight and total length of *P. typus and C. chrysurus* from Okunraye and Ibeshe. This view was buttressed by Ogunola *et al*. (2018) that fish is adjudged to be in a good condition when it is living in a stable environment with adequate food, optimum water quality, sustainable fishing practices, and appropriate carrying capacity. Furthermore, changes in phytoplankton abundance, predation, water temperature and dissolved oxygen concentrations among others have been reported to influence fish growth, and also result in measurable physiological changes in fish (Fazio *et al.*, 2013). Unlike the observation in this study, Senthil *et al*. (2012) reported that fish growth and diversity in the Kamala basin reservoir at Darbhanga District, Bihar, India was influenced by physico-chemical parameters like dissolved oxygen and nutrient levels, impacting species richness and population dynamics, and emphasising the need for conservation efforts; while Ali *et al*. (2020) pinpointed temperature, turbidity and pH as factors that influence growth and diversity of fish in the Andharmanik River Sanctuary in Bangladesh.

Conclusions

The non-significant difference of most of the mean morphometric parameters of *Pseudotolithus typus* and *Chloroscombrus chrysurus* from Okunraye and Ibeshe marine aquatic stations imply that the fish may have originated from the same genetic stock. While *P. typus* in Okunraye exhibited positive allometry growth, *C. chrysurus* from Okunraye and Ibeshe as well as *P. typus* in Ibeshe exhibited negative allometry growth patterns, however, both fish species are in good condition in their habitats.

The Pearson's correlation coefficient between morphometric characters of the fish and the water quality parameters showed no significant correlation in most of the values signifying that the physico-chemical parameter of the habitat at present poses no major hindrance to the maximum growth of the examined fish species.

Conclusively, the integrity status of the Okunraye and Ibeshe marine ecosystems was considerably good and suitable for the habitation of *P. typus* and *C. chrysurus* since all the examined chemical and physical parameters investigated complied well with the permissible or standard limits. However, further study may the necessary to check if some other factors such as availability of food and rate of exploitation might cause a disparity in the growth patterns of these fish species.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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