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Morphometric measurements and meristic counts in mudskipper (*Periophthalmus papilio*) from mangrove swamps of Lagos lagoon, Nigeria

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ABSTRACT
Objective: To obtain information of morphometric measurements and meristic counts of the mudskipper, *Periophthalmus papilio,* Bloch & Schneider (1801) in mangrove swamps of Lagos lagoon in Nigeria. The Mudskipper, *P. papilio* is one of the fish species that contribute to the fisheries of Lagos lagoon. Its versatility is due to its benthic nature, crawling on the mudflats of the mangrove swamps. *Methodology and results*: A total of 2167 live specimens were caught from three (3) experimental stations located in the mangrove swamps. Morphometric measurements and meristic characters were determined on the specimens to ascertain the possibility of genetic diversity among them. The morphometric measurements, i.e. eye diameter (ED) varied from 4-8mm; head diameter (HD), 20-34mm; head length (HL), 22-43mm; body depth (BD), 15-33mm and total length (TL), 140-190mm. The meristic characters of the species included 10-13 anterior dorsal fin rays, 11-14 rays in the posterior dorsal fin and 10 anal fin rays. The upper jaw had between 18-20 teeth while 20 to 22 teeth were counted on the lower jaw. The populations of the species among the three (3) experimental stations in the lagoon showed variations in morphometric measurements and meristic counts but these did not differ significantly ($P \geq 0.05$), indicating that the populations from the stations may not be genetically diversified. These insignificant variations may be related to the geography, ecology and human activities of the lagoon.
Conclusion and application of results: In the present study there was no taxonomic variation to show presence of any other related species except *P. papilio* in Lagos lagoon based on the stated methodology, in furtherance to this work, a research programme was embarked on at molecular level of analysis (e.g. Randomly Amplified Polymorphic DNA (RAPD) primers, RAPD markers) which may provide better or more precise results on genetic and morphological diversities among the populations of this fish in Lagos lagoon, Nigeria.
Key words: Mudskipper, diversity, amphibious, lagoon, morphometric and meristic measurements.

INTRODUCTION
Periophthalmus papilio (Bloch & Schneider, 1801) belongs to the family Periophthalmidae but were formally classified under the family Gobiidae (Irvine 1947). Irvine (1947) also grouped *Periophthalmus* into a permanent element of the brackish waters of estuaries and lagoons. It has never been reported neither from the sea nor from the fresh water of rivers and lakes. Aspects of the biology and

ecology of *P. papilio* in the mangrove swamps of Lagos lagoon was described by Lawson (1998, 2004 a, b). Their importances as baits in capture fisheries and as a part of delicacies of Egun, Ilaje and Ijaw tribesmen in Nigeria cannot be overlooked. *P. papilio* is *a* bony and highly active fish whose versatility is reflected in their euryhaline and amphibious nature. It is found abundantly in the shallow and exposed inter tidal mudflats of the Gulf of Guinea including West African coasts, estuaries and lagoons (Irvine, 1947; FAO, 1990;). Other related species found in other parts of the world include *P. chrysospilos* in Singapore and *P. koelreuteri* in East Africa (Ip *et al.,* 1990), *Boleophthalmus boddaerti* and *B. woberi* are found inhabiting estuary of Pasir Ris in Singapore (Ip *et al.,* 1990). The presence of *P. papilio* in large numbers on the muddy flat of Lagos lagoon, and coupled with the fact that the species forms an important delicacy in Lagos and Niger delta region of the country makes the species important. It is commercially valued species even among the Taiwanese and Japanese, selling for as high as US$20/kg (Khaironizam & Norma-Rashid, 2002). It is useful as baits in both artisanal and offshore fisheries within Nigerian creeks, estuaries and lagoon system. There is scanty literature available on the biology of *P. papilio* in Lagos lagoon, especially on its morphometric measurements and meristic characters. Most works on the lagoon were based on the aspects of biology and ecology of non-related genera such as: *Tilapia* (Fagade, 1969); *Chrysichthys* (Kusemiju, 1973; Ezenwa & Kusemiju, 1981); *Elops* (Ugwumba, 1984); *Mugil* (Lawson, 1991).

This research aimed at investigating the morphological variations among the species populations and ascertains whether these populations are separable genetically. This work would contribute to the existing knowledge by acting as a baseline data for carrying out research especially on taxonomy, racial study, morphology and genetic diversity of other fish species in Lagos lagoon and its adjacent lagoons and canals.

MATERIALS AND METHODS

Study area: Lagos lagoon in Nigeria (Figure 1) is located between longitudes $3^0$20' and $3^0$50'W and latitudes $6^0$24' and $6^0$36'N. It is the largest lagoon system in the West African coast, covering 208 km^2. The lagoon (an open tidal estuary) is fed in the north by Ogun River, the southern margin is bounded by Five Cowries and Badagry creeks. In the east by Lekki and Epe lagoons. The lagoon opens into the Atlantic Ocean via Lagos habour. The experimental stations used for this study are Oko Baba station (marked Xa in Figure 1) located in the west; Ibese station (Xb) in the north and Ilubinrin station (Xc) in the south of lagoon.

Collection and analysis of specimens: A total 2167 specimens of *P. papilio* were caught using non-return valve traps from the experimental stations. Services of local fishermen with three (3) motorized canoes were employed for daily collection. In the laboratory, 50 specimens (between 140 and 190mm total length) from each of the stations were selected from the pool as only fish of similar size can be compared with each other when dealing with characteristics, which alter in size (Friedrich, 1972; Lawson, 1998). Measurements and counts were made on the fish with head turning left (Figure 2). Data recorded on the morphometric measurements included eye diameter (ED), head depth (HD), head length (HL), body depth (BD) and total length (TL) of the specimens.

The meristic features of the species were used to generate data on taxonomic differences. The meristic counts such as numbers of anterior and posterior dorsal fin rays; anal fin rays; and the upper and lower jaw teeth counts were recorded for the specimens.

Data analysis: Data on morphometric measurements and meristic characters were subjected to statistical analyses using Statistical Package for Social Sciences (SPSS version 9.0) in this study to determine if there was any morphological and genetic diversity among the populations of *P. papilio* from these stations.

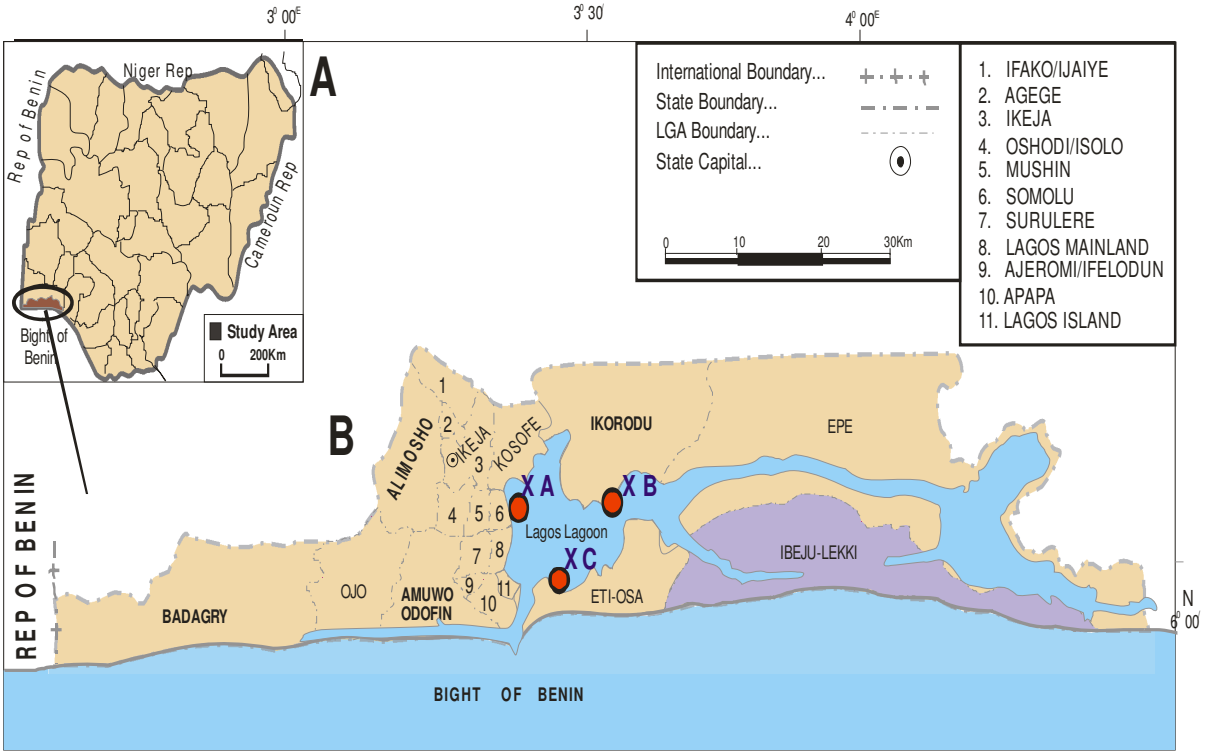

Figure 1: (A) Administrative Map of Nigeria (B) Insert: Lagos Map showing Lagos Lagoon

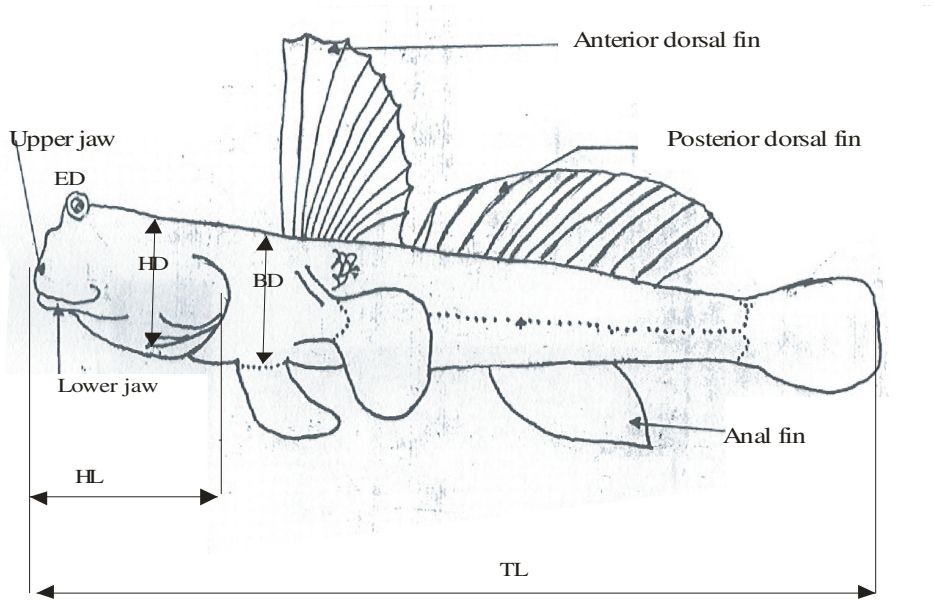

Figure 2: The morphometric measurements and meristic features used in describing *Periophthalmus papilio* in Lagos lagoon, Nigeria showing ED (eye diameter); HL (head length); HD (head depth); BD(body depth); TL (total length) measurements

RESULTS

Morphometric measurements in *P. papilio:* The morphometric measurements varied between the stations (Table 1). Eye diameter varied from 4-8mm, head diameter, 20-34mm; head length, 22-43mm; body depth, 15-33mm and total length, 140-190mm. Data on the body proportions of the specimens from the three stations showed that the ratio of body depth to total length of the fish varied between 5.00 and 7.89 in the lagoon. The highest mean of 6.20±0.72 and the lowest value of 5.85±0.67 were recorded at Ilubinrin and Oko Baba stations, respectively. The ratio of head length to total length indicated a range from 3.50 to 7.05. The mean values were 4.37±1.34, 4.30±1.67 and 4.16±1.53, respectively, for Oko Baba, Ibese, and Ilubinrin stations. Head depth: Head length ratio gave mean values of 1.31±0.94 and 1.31±0.44 (Oko Baba and Ilubinrin) and 1.30±0.88 for Ibese showing that the head was as long as its depth. The ratio of the eye diameter to head length ranged from 3.67 to 8.75 while the proportion of eye diameter to head depth was 3.29 to 6.25. The eyes were more in the length than depth of head of the fish at the three stations.

One-way analyses of variance on the morphometric measurements of *P. papilio* from the experimental stations showed that the calculated F-values were 0.0001 (for eye diameter), 0.00015 (head depth), 0.00036 (head length), 0.0194 (body depth) and 0.00291(total length) and the tabulated F-values at 5% level of significance and degree of freedom of 149 was 3.00. These variations of parameters across the three stations were not significantly different (P>0.05).

Table 1: Morphometric measurements of *P. papilio* from three (3) experimental stations in the mangrove swamps of Lagos lagoon, Nigeria.

Morphometric measurements and Body proportions	Oko Baba (N=50)			Ibese (N=50)			Ilubinrin (N=50)		
	Range		Mean ±SE	Range		Mean ±SE	Range		Mean ±SE
	min	max		min	max		min	max	
Eye diameter (ED) *	4	8	6.32±0.23	5	8	6.38±0.12	4	8	6.40±0.34
Head depth (HD) *	21	32	27.14±5.45	20	34	27.18±5.87	22	33	27.38±5.78
Head length (HL) *	22	43	35.30±8.56	23	40	35.12±7.59	27	42	35.60±8.58
Body depth (BD) *	20	33	26.30±5.87	15	30	25.32±5.43	18	32	23.96±5.72
Total length (TL) *	140	190	153.04±15.1	140	165	149.70±14.9	140	160	147.22±16.6
TL: BD proportion	5	7.16	5.85±0.67	5.0	10	6.02±0.89	4.83	7.89	6.20±0.72
TL: HL proportion	3.88	7.05	4.37±1.34	3.88	6.09	4.30±1.67	3.50	5.37	4.16±1.53
HL: HD proportion	1.0	1.53	1.31±0.94	1.05	1.55	1.30±0.88	1.10	1.60	1.33±0.44
HL: ED proportion	3.67	6.83	5.62±1.78	3.83	6.80	5.55±1.86	3.86	8.75	5.63±1.12
HD: ED proportion	3.29	5.33	4.32±1.64	3.29	5.60	4.30±1.97	3.43	6.25	4.32±1.23

*=Measurements in mm

Variations in Meristic counts: The meristic characters of the species were 10-13 anterior dorsal fin rays and 11-14 rays in the posterior dorsal fin (Table 2). The upper jaw had 18-20 teeth while 20 to 22 teeth were counted on the lower jaw. The anal fin ray count was 10 rays. One-way analyses of variance on the fin ray counts among the populations of this species from the three stations indicated that the calculated F-values were 0.000002 and 0.26027 respectively, when the F-crit values @ P=0.05, df=149 were 3.00 and 3.06. Hence, data showed that there was no significant difference in numbers of rays count in the anterior and posterior dorsal fin of the fish from the three stations in the lagoon. The upper jaw had 18-20 teeth and 20-22 teeth on the lower jaw. Simple teeth were observed on both jaws, the pharyngeal and palatine teeth were absent. The incisors were without cusps. The calculated F-values for the upper and lower jaw teeth

counts from the stations were 0.000059 and 0.586957 respectively, the F-crit values @ P=0.05; df=149 were 3.35 for both jaws. Hence, there was no significant difference (P>0.05) in numbers of teeth on both jaws of fish in Lagos lagoon, Nigeria.

Table 2: The meristic counts of *P. papilio* from three experimental stations in the mangrove swamps of Lagos lagoon, Nigeria.

Meristic characters	Oko Baba (N=50)			Ibese (N=50)			Ilubinrin (N=50)		
	Range		Mean ±SE	Range		Mean ±SE	Range		Mean ±SE
	min	max		min	max		min	max	
Anterior dorsal fin ray count	10	12	11.22±0.34	11	13	11.28±0.37	10	13	11.20±0.32
Posterior dorsal fin ray count	11	14	13.44±1.56	12	14	13.36±1.34	12	14	13.40±1.24
Anal fin ray count	-	-	10.00±0.0	-	-	10.00±0.0	-	-	10.00±0.0
Upper jaw teeth count	18	20	18.40±1.78	18	20	18.20±1.98	18	20	18.40±1.69
Lower jaw teeth count	20	22	20.40±2.45	20	22	20.20±2.78	20	22	20.40±2.75

DISCUSSION

In the presence study the morphometric measurements among the populations of *P. papilio* from the three experimental stations did show some variations, however, these variations were not significantly different (P≥0.05) enough to make a submission that the species was genetically or morphologically different. Data on eye diameter (4-8 mm), head depth (20-22 mm), head length (22-43 mm) and total length (140-190 mm) though may not be fully relied on as determinants for genetic diversity, but their importance in taxonomic characterization of this species can not be over-emphasized. Proportionally (Table 1) total length measurements were 5.85-6.2 times the body depth, and 4.1-4.37 times the head length. The head length was 1.31-1.60 times the head depth, and 5.62-5.63 times the eye diameter. However, the head depth proportionally was 4.3-4.32 times the eye diameter in Lagos lagoon. Data from these parameters suggest that the fish populations from the experimental stations were not separable taxonomically. These body proportions showed little variations among the specimens from the stations that were also not significantly different (P≥0.05). The meristic characters (Table 2) i.e numbers of anterior (10-13 rays)and posterior dorsal fin (11-14 rays); and 10 anal fin rays, upper (18-20 teeth) and lower jaw (20-22 teeth) counts were insignificantly different (P≥0.05) among the populations indicating the species were taxonomically inseparable in Lagos lagoon. Taxonomical and morphological features such as numbers of dorsal and pelvic fins, colour, numbers or rows of teeth on the upper jaw and external morphology were employed by Jaafar et al (2006) in Singapore to differentiate between two species of mudskippers, *Periophthalmus walailakae* and *Periophthalmodon schlosseri*. Characterizations of taxonomic features such as numbers of spines in the first, second and anal fins and pelvic fin ray counts were carried out by Jaafar & Larson (2008) to discover a new species of mudskipper, *Periophthalmus takita* in Australia and *Periophthalmus spilotus* in Sumatra (Murdy, 1989, 1999). Based on their morphological examinations in the Gulf of Guinea by Irvine (1947) and FAO (1990), *P. papilio* was described as the only indigenous or permanent element of the brackish waters of estuaries and lagoons. Etim et al (1996), King & Udo (1996), Udo (2000) and Etim et al (2002) at different periods worked on this species in different Nigerian waters. Related species, namely *Boleophthalmus boddarti*, *Periophthalmus chrysospilos, Periophthalmus grasilos, Periophthalmus novemoradiatus, Periophthalmodon schlosseri, Pseudapocryptes elangatus* and *Scartlaos histophoris* that were found in other parts of the world were never reported in Lagos lagoon or any Nigerian water.

The morphometric measurements and meristic counts of this species in Lagos lagoon did not show that the fish was taxonomically separable based on our methods. The populations among the three (3) experimental stations in the lagoon though showed variations in their morphometric measurements and meristic counts but these did not differ significantly

(P≥0.05), indicating that the populations from the stations may not be genetically diversified. These insignificant variations may be due to the geography, ecology and human activities in the lagoon.

In the present study no taxonomic variations were detected among the populations; *P. papilio* may probably be the only species in Lagos lagoon. Data obtained from this work will serve as template in systematic study and taxonomy of this and non-related fishes. In furtherance to this, a research programme was embarked on at molecular level of analysis (e.g. Randomly Amplified Polymorphic DNA (RAPD) primers, RAPD markers) which may provide better or more precise results on genetic and morphological diversities among the populations of this fish in Lagos lagoon, Nigeria.

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