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Relationship between Otoliths and Fish Length of Selected Catfish in Niger Delta, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author UAP designed the study, wrote the protocol and wrote the final draft of the manuscript. Author OVO performed the statistical analysis and wrote the first draft of the manuscript, authors OVO and MM managed the analyses of the study. Authors OVO and ULI managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Catfish are important fishery resources in the Niger Delta therefore they require studies on its growth patterns and morphometrics. This study examined the relationship between the length and width of catfish otoliths and their fish length. Catfish samples were harvested from New Calabar and Ase Rivers, Niger Delta, Nigeria, by fishers using cast net and purse seines. The fishes were identified, measured, otoliths removed and measured using standard methods. Simple linear regressions expressed the relationship between otolith dimensions and fish length. A total of 80 individuals made up of 7 species from 5 families (Ariidae, Claroteidae, Claridae, Schilbeidae and Mochokidae) were selected for this study. Correlation analysis between the morphometric parameters of the otoliths from the catfish species in the study area revealed a strong positive correlation between the total length of the fish and the length of the otoliths, with R^2 values ranging from 0.86 to 0.98. There was also a strong positive correlation between total fish length and otolith

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width. The relationship between otolith length and width with the fish length in this study showed curvilinearity, indicating the usefulness of the otolith proportions in back calculation of the length of the fish in biological and paleontological studies.

Keywords: Otolith; catfish; total length; new Calabar River; Ase River; Niger Delta.

1. INTRODUCTION

Catfish are the most important fish species in inland water environments of Africa mainly due to their rich economic value. They belong to the order Siluriformes scientifically classified into families and species. They are highly diverse and of worldwide distribution [1]. Certain species of catfish are more common in some countries than in others. For instance, about 13 species from the Family Ariidae are common around the Mexican Pacific Coast as well as three species in the Gulf of Mexico. Amidst other species, the *Clarias* species are unique to Africa. In Nigeria, the most common species of catfish include; *Clarias* spp. mostly found in the South west, *Heterobranchus* spp. in the South East, and *Chrysichthys* spp. around Niger Delta [2].

Otoliths are structures found in the inner ear cavity of teleost fishes. They are used to identify fish species and the estimation of the age and size of the fishes. This information helps study feeding habits, archaeology and population management [3]. Structurally, otoliths are three dimensional, but they do not compulsorily grow equally or at the same rate in all dimensions. Each species of fish has a specific otolith size and shape [4]. There are three pairs of otolith in bony fishes; the sagittae, asteriscus, and lapillus. The sagittae are the largest pair of otoliths in all bony fishes except Cypriniformes and Siluriformes [5]. Otoliths are composed of inert minerals made of calcium carbonate in aragonite, in a protein matrix. They are physiologically important for auditory reception, mechano-reception and equilibration processes that allow fishes to better perceive their own environment [6]. Otoliths have been used to carry out a lot of studies ranging from age determination [7], to ecological studies [8], to the determination of the diet of predatory fishes [9] to carrying out stock assessment [10,11] and length and weight determination [12,13]. Trout [14] and [15] were the first to relate otolith size to fish size. Subsequently other researchers have demonstrated their use in back calculating the fish size from regression models, using the size of their otolith [16,17,3]. The believed comparativeness between otolith growth and fish body growth has been the chief study tool for the reconstructuring of individual growth history [8]. The studies of [4], [18] and [19] have revealed that this proportionality has a significant potential for analyzing the impacts of the environment on growth forms in populations. This research aims to study the relationship between otolith length and width and the lengths of selected catfish in two communities of the Niger Delta, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

The fish samples were collected from two rivers located in Southern Nigeria: the middle reaches of the new Calabar River in Rivers State (04°53'47.66N 006°53'59'.676E) and the Ase River (05°20'36.37N 006°20'17.308E) in Delta State (Fig. 1). The rivers have very similar hydrologic conditions such as seasonal rainfall and flooding, freshwater, unidirectional and tropical.

2.2 Collection of Samples

Fish samples were caught by fishermen using cast net and purse seines. The fishes were examined in the field and transported in ice chests to the laboratory to be examined same day. Sample collection was from May to June 2019. Sampling was random from the fishers weekly during the sampling period. The species and number of fishes collected in each sampling period depended on the catch. The fish samples were identified with the aid of identification guides [20]. The total length of each fish was measured to the nearest mm using a ruler and the fish was weighed on a top pan balance (Denver Instrument, model TP-512A) to the nearest 0.01g.

2.3 Otoliths Preparation and Examination

The sample preparation process involved the removal of otoliths from the selected catfish samples. The removal began by cutting through the mouth using a sharp bread knife and

separating with a pair of scissors (Plate 1A). Otoliths were then removed from the posterior portion of the skull using a pair of forceps (Plate 1B). Otoliths were washed in 70% alcohol, dried with serviette and stored in envelopes marked with reference numbers.

2.4 Examination of Otoliths

Otolith length (OL) and width (OW) were examined separately using imaging software, Image J version 1.51k. The horizontal distance between the anterior and the posterior tips of the otolith is otolith length [21]. The vertical distance from the dorsal to the ventral otolith edge is the otolith width [22].

2.5 Statistical Analysis

The relationship between otolith dimensions and fish length was expressed by a simple linear regression using SPSS (Statistical Package for Social Sciences) software.

3. RESULTS

3.1 Catfish Species in the Study Area

A total of 80 individuals consisting of 6 species from 5 families (Ariidae, Claroteidae, Claridae, Schilbeidae and Mochokidae) were collected from the two rivers. The mean total length of the fish species are as follows: *Arius heudelotti* 32.38 ± 2.89 cm, *Chrysichthys furcatus* 14.26 ± 0.45 cm, *Clarias gariepinus* 36.51 ± 8.41 cm, *Clarias species A* 32.57 ± 6.46 cm, *Clarias species B* 19.22 ± 3.14 cm, *Schilbe uranoscopus* 21.61 ± 1.97 cm and *Synodontis membranaceus* 10.55 ± 0.72 cm.

3.1.1 Relationship between fish length and otolith length

The correlation coefficient R^2 between the fish and otolith length of the catfish species ranged from 0.89 to 0.98. The scatter plot and line of best fit are presented in Fig 2 for the different fish species of study, while the R^2 and slope are tabulated in Table 1.

3.1.2 Relationship between fish length and otolith width of fish

The correlation coefficients between the length of fish and the otolith width ranged from 0.86 to 0.99. The scatter plot and line of best fit are presented in Fig 3. The slope of the line graph ranged from 0.01 to 0.03 (Table 1).

4. DISCUSSION

Certain characters that separate species and populations of fishes include the surface morphology of the otoliths (length, width and weight) and the relationships between size and weight of the fish. These relationships can be utilized to assess the fish size and biomass in food and feeding studies [23]. The regression

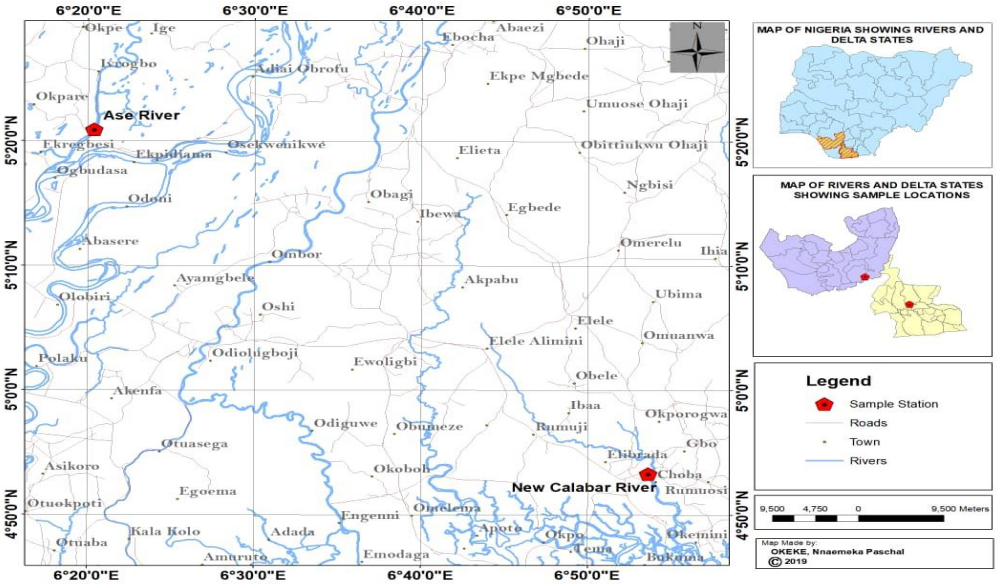


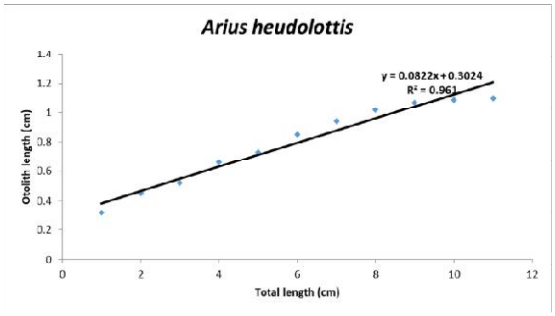
Fig. 1. Map of the study area in Ase and New Calabar Rivers, Nigeria

analysis was used to compare the morphometric parameters of the otoliths from six catfish species within the study area, and from the results, a strong positive correlation was revealed between the total length of the fish and the width and length of the otoliths. This agrees with studies done on Lionfish by [24]. The relationships between otolith length and width with the fish total length in this study showed a curvilinearity, which is in agreement with the work of Mugiya and Tanaka (1992) but in contrast with some other studies on fish [25,26,3,22]. This study indicated that otolith linear dimensions were related to fish length by the linear regression model. The increase in linear dimensions (length and width) seemed to be at par with the increase in the fish length. These results agree with those of [12] on several species collected from the Northwest Atlantic Ocean and several other authors [21,27]. Vallisneri [28] stated that if otolith and somatic growth were closely related, differences in otolith size between females and males, corresponding to differences in somatic size would be expected. However, otolith and somatic growth are however not always tightly related as shown by [29] proving that otoliths still grow either in the absence or in the slowing down of somatic growth. Such an effect will produce larger otoliths for slower-growing specimens [30]. All data fitting well with the regression model makes it advisable to use these equations to estimate fish or otolith size within the fish size range limits given in this study for these species. The regressions from this study can be helpful for investigators examining the food habits of predators of the species in question when only their otolith is recovered. The sexes were not separate in this study as in [31], however the regression model generated for each species could have use for both male and female fish.

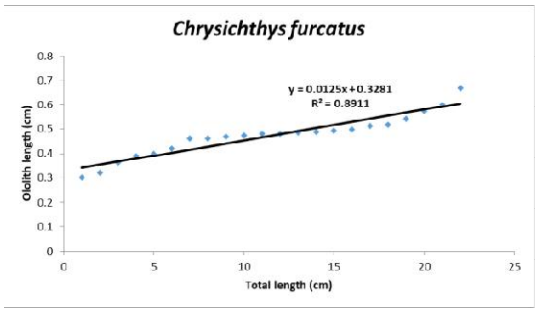
.

A  B 

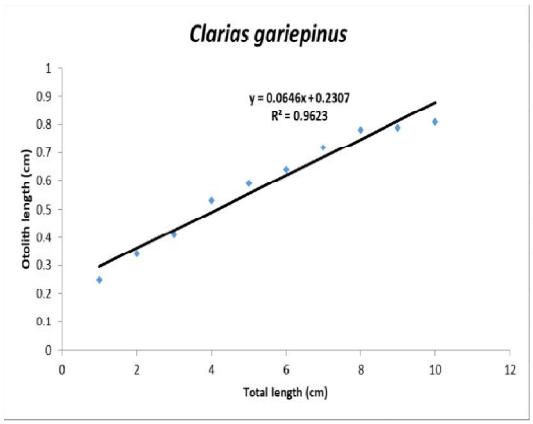
Plate 1. A) Extraction of Otoliths B) Otoliths from *Clarias spp*



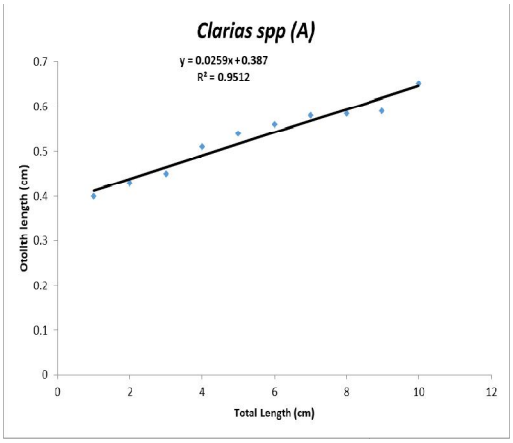
a) Arius heudelotti



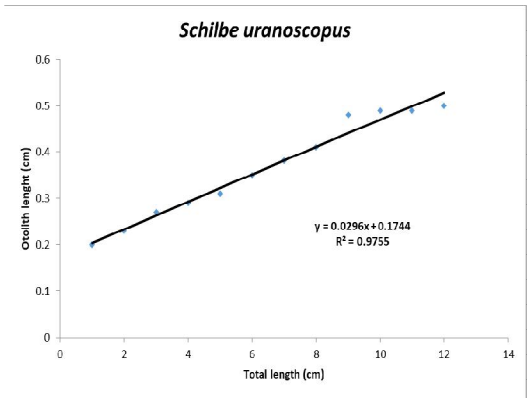
b) *Chrysichthys furcatus*



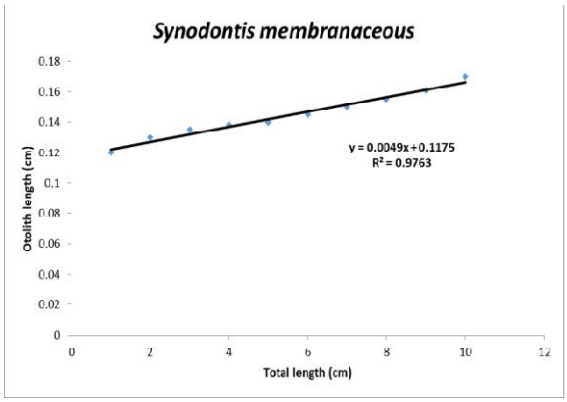
c) *Clarias gariepinus*



d) *Clarias spp (A)*

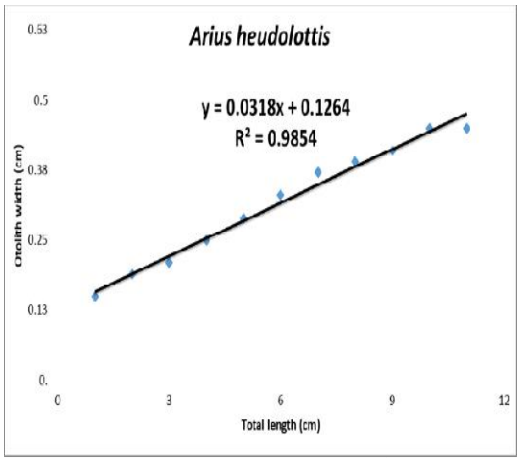


e) *Schilbe uranoscopus*

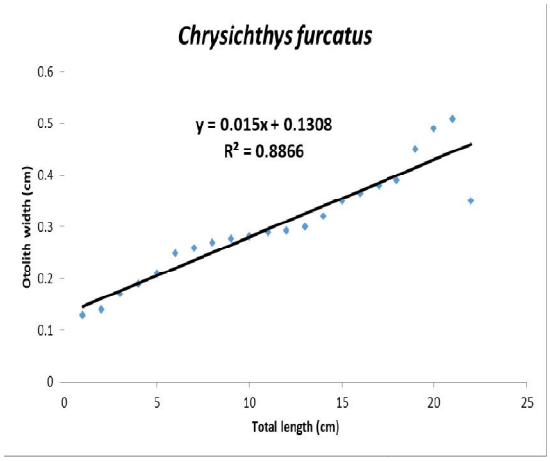


f) *Synodontis membranaceus*

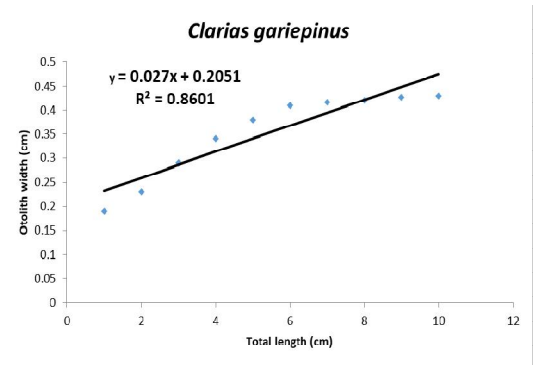
Fig. 2. Linear regression of otolith length and total length of some catfish species from Niger Delta, Nigeria



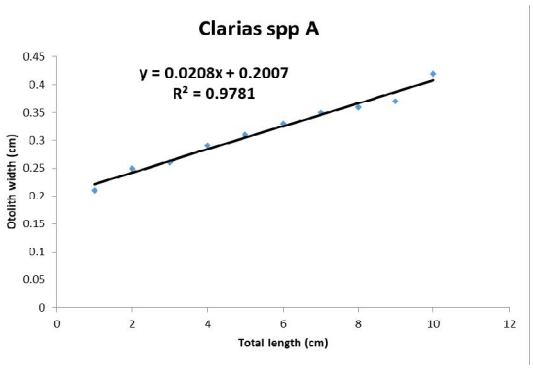
a) *Arius heudelotti*



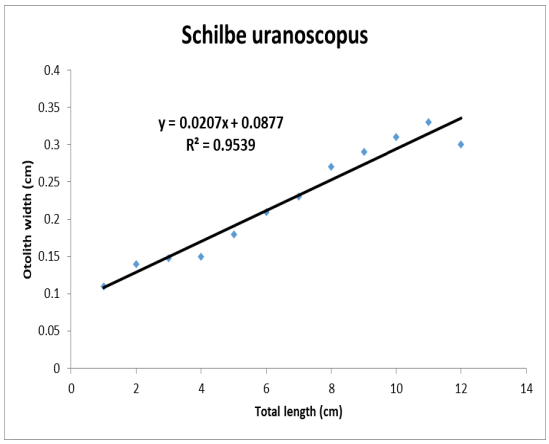
b) *Chrysichthys furcatus*



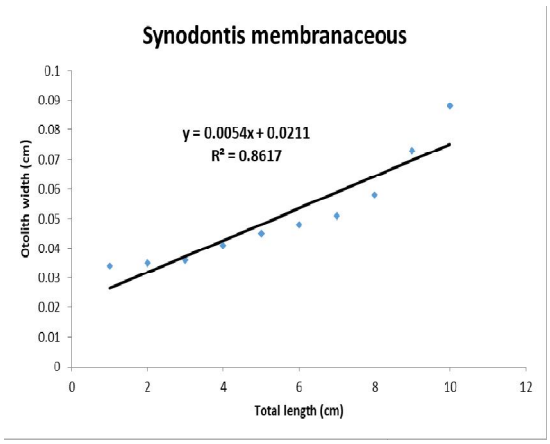
c) *Clarias gariepinus*



d) *Clarias spp A*



e*) Schilbe uranoscopus*



f) *Synodontis membranaceous*

Fig. 3. Correlation between otolith width and total length of fish in some catfishes in Niger Delta, Nigeria

Table 1. Regression coefficients of otolith length, otolith width and total length of fish

	Otolith Length and Total Length			Otolith Width and Total Length		
Species	**r^2**	**b**	**a**	**r^2**	**b**	**a**
Arius heudelotti	0.96	0.08	0.30	0.99	0.03	0.13
Chrysichthys furcatus	0.89	0.01	0.33	0.89	0.02	0.13
Clarias gariepinus	0.96	0.07	0.23	0.86	0.03	0.20
Clarias species A	0.95	0.03	0.39	0.98	0.02	0.20
Schilbe uranoscopus	0.98	0.03	0.17	0.95	0.02	0.09
Synodontis membranaceus	0.98	0.01	0.12	0.86	0.01	0.02

5. CONCLUSION

This study has shown a strong correlation between the catfish length and otolith dimensions, indicating that otolith length and width could be used to determine fish length. A linear regression model was generated for the species which could therefore be used in fish studies to reconstruct body size from otolith measurement.

ETHICAL APPROVAL

Animal Ethic committee approval has been taken to carry out this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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