Age Structure and Estimated Age at First Maturity of Pellonula Leonensis in Ogobiri River, Niger Delta, Nigeria

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Abstract
Pellonula leonensis is an economically important small pelagic clupeid occurring in rivers, lakes, lagoons and other connected aquatic environments in West and Central Africa. Information on age structure is important for understanding population dynamics, growth and reproductive potential. This study investigated the age structure and estimated age at first maturity of Pellonula leonensis from Ogobiri River at Amassoma, Southern Ijaw Local Government Area, Bayelsa State, Nigeria. Specimens were collected at two-week intervals during May, June and July 2013 using gillnets and an Atalla lift-net. Samples were preserved in 10% formalin and subsequently subjected to length-frequency and length-at-age analysis. A total of 242 specimens represented in the sampling records were considered, comprising 50 specimens in the first May sample, 32 in the first June sample, 40 in the first July sample, 42 in the second May sample, 45 in the second June sample and 33 in the second July sample. The length-at-age data showed five relative age classes, with lengths of 5.5, 7.5, 8.5, 9.5 and 10.5 cm, respectively. Absolute growth was greatest between the first and second relative age classes (2.0 cm) and subsequently declined to 1.0 cm per age interval. Relative growth declined from 0.36 in the first age interval to 0.08 in the fifth. Published reproductive evidence for P. leonensis in the Lower Nun River indicates that approximately 50% maturity occurs within 5.5–6.5 cm total length. When this maturity-size range is related to the present length-at-age data, first maturity is estimated to occur between relative age classes 1 and 2, approximately corresponding to 1.0–1.5 relative age units. The population was represented by multiple age classes, with smaller and intermediate-sized individuals forming important components of the samples. The findings provide baseline information on the age composition and approximate maturity timing of P. leonensis in Ogobiri River and contribute to the biological information required for sustainable fisheries management.

Keywords: *Pellonula leonensis; age structure; age at first maturity; length-at-age; Ogobiri River; Niger Delta; Nigeria.*

1. Introduction

Age structure is a fundamental component of fish population dynamics because it provides information about recruitment, growth, survival and the reproductive contribution of different age groups within a population. Age information is particularly important for small, short-lived fishes because changes in the relative abundance of younger and older individuals can provide useful indications of recruitment success and exploitation pressure. Age information is also

important when interpreting maturity schedules and determining whether individuals are likely to reproduce before entering the fishery. *Pellonula leonensis* Boulenger, 1916, commonly known as the small-toothed pellonula, is a clupeid fish distributed in freshwater and brackish environments of West and Central Africa. The species occurs in rivers, lakes, lagoons and estuarine environments and is associated with both inland and coastal aquatic systems.

The species is of fisheries importance in several African inland waters and forms part of the fishery resources available to artisanal fishing communities. Previous investigations have documented variation in growth, reproduction, size structure and population dynamics among populations of *P. leonensis*. Ezenwaji and Offiah (2004), working in the Anambra River, Nigeria, reported total lengths of 3.4–8.5 cm and found that 50% of individuals of both sexes attained maturity at approximately 4.7 cm total length.

Studies from the Niger Delta have also demonstrated variation in the reproductive biology of *P. leonensis*. Kingdom and Allison (2009), working in the Lower Nun River, reported that males matured earlier than females and that approximately 50% of individuals matured within the 5.5–6.5 cm total-length range. They also recorded mature individuals throughout the year, with reproductive peaks during September/October and May/June.

Growth studies have shown that *P. leonensis* can attain relatively high growth rates. Kuenzel and Loewenberg (1990), using length-frequency information from the Cross River, Nigeria, estimated an asymptotic length of approximately 156 mm and a growth coefficient of 0.81–0.96 year^{-1}. Assi *et al*. (2019) identified four cohorts in *P. leonensis* from Aghien Lagoon, Côte d'Ivoire, with an estimated asymptotic length of 126.84 mm and a growth coefficient of 0.67 year^{-1}. Variation in growth and maturity among populations may occur because fish growth is influenced by environmental conditions, food availability, population density, fishing pressure and other ecological factors. Consequently, age and maturity information obtained from one water body should not automatically be assumed to represent another population.

Despite the fisheries importance of *P. leonensis* in the Niger Delta, information on the age structure of the population in Ogobiri River at Amassoma is limited. Establishing the relative age composition and relating the observed length-at-age distribution to known maturity-size information can provide useful baseline information for fisheries biology and management.

The objective of this study was to determine the age at first maturity and age structure of the *Pellonula leonensis* population in Ogobiri River, Niger Delta, Nigeria.

2. Study Area

The study was conducted in Ogobiri River at Amassoma, Southern Ijaw Local Government Area of Bayelsa State, Nigeria. The study site is approximately 30 km from Yenagoa. The river flows into the River Nun, which subsequently drains into the Atlantic Ocean. The geographical position of the study location approximately 4°58.177′N and 6°06.610′E.

The area is situated within the rainforest zone of the Niger Delta and experiences two major seasons: a rainy period extending approximately from April to September and a dry period from October to March. The hydrological characteristics of the area and its connection with the River Nun provide a suitable environment for a variety of freshwater and estuarine-associated fish species, including *P. leonensis*.

3. Materials and Methods

3.1 Collection of Fish Samples

Specimens of *Pellonula leonensis* were collected from Ogobiri River during May, June and July

2013 at approximately two-week intervals. Fish were obtained using gillnets and an Atalla lift-net. The samples were preserved in 10% formalin and transported to the laboratory for subsequent analysis. The sampling records represented six sampling occasions, with sample sizes of 50, 32, 40, 42, 45 and 33 individuals, giving a total of 242 specimens.

3.2 Length-Frequency Analysis

The length-frequency distribution of *P. leonensis* was examined to identify modal groups representing successive components of the population. Length-frequency distributions were plotted for the sampling occasions and the progression of modal groups was used to visualize the relative age structure of the population.

3.3 Determination of Length-at-Age

The length-at-age relationship of the fish was determined using the observed length-at-age data obtained during the study period. Five relative age classes were identified from the length-frequency distribution, and the corresponding mean length for each age class was recorded. The growth increment between successive age classes was then determined using both absolute and relative growth measures.

Absolute growth was calculated as:

$$\mathbf{AG = L_{t+1} - L_t}$$

where AG is the absolute growth increment (cm), L_t is the length at the current age class and L_{t+1} is the length at the subsequent age class.

Relative growth was calculated as:

$$\mathbf{RG = (L_{t+1} - L_t) / L_t}$$

Where RG is the relative growth increment.

3.4 Estimation of Age at First Maturity

Age at first maturity was estimated by relating the reported length at first maturity to the length-at-age relationship established for the sampled population. Kingdom and Allison (2009), working on *P. leonensis* from the Lower Nun River, reported that approximately 50% of individuals attained maturity within the 5.5–6.5 cm total-length range. This maturity-size range was therefore used as a biological reference for estimating the corresponding relative age in the present study. In the present length-at-age distribution, a total length of 5.5 cm corresponded to relative age class 1, while 7.5 cm corresponded to relative age class 2. Since the upper limit of the reported maturity range (6.5 cm) occurred between these two length classes, its corresponding relative age was estimated by linear interpolation. The interpolated value placed the 6.5 cm maturity length at approximately 1.5 relative age units. Accordingly, the age at first maturity was estimated to occur within approximately the first to second relative age classes, corresponding to about 1.0–1.5 relative age units. The estimate was based on the relationship between the observed length-at-age distribution in the present study and the published maturity-size reference for *P. leonensis* and was therefore interpreted as an estimated relative age at first maturity rather than a direct age determination from gonadal development.

4. Results

4.1 Sampling Composition

The six sampling occasions represented a combined sample of 242 *P. leonensis* specimens. Sample sizes varied from 32 individuals in the first June sampling to 50 individuals in the first

May sampling.

Table 1. Number of *Pellonula leonensis* specimens examined during the study

Sampling period	Number of specimens (n)
May 2013 – first sampling	50
June 2013 – first sampling	32
July 2013 – first sampling	40
May 2013 – second sampling	42
June 2013 – second sampling	45
July 2013 – second sampling	33
Total	242

4.2 Length-at-Age Structure

Five relative age classes were identified in the available length-at-age data. Length increased from 5.5 cm at relative age class 1 to 10.5 cm at relative age class 5. The greatest absolute growth increment occurred between the first and second age classes, when length increased by 2.0 cm. Thereafter, the absolute growth increment remained approximately 1.0 cm per age interval.

Table 2. Length-at-age and growth characteristics of *Pellonula leonensis*

Relative age class	Length at age, Lt (cm)	Subsequent length, Lt+1 (cm)	Absolute growth (cm)	Relative growth
1	5.5	7.5	2.0	0.36
2	7.5	8.5	1.0	0.13
3	8.5	9.5	1.0	0.12
4	9.5	10.5	1.0	0.09
5	10.5	11.5	1.0	0.08

4.3 Age Structure

The length-at-age distribution revealed five relative age classes within the sampled population. The observed lengths increased progressively across the identified age classes, ranging from approximately 2–3 cm in the youngest relative age class to about 10–12 cm in the oldest class. The occurrence of distinct size groups across the length-at-age distribution indicates the presence of multiple relative age components within the sampled population rather than a single homogeneous age group. The progressive increase in mean length among the relative age classes further reflects growth and recruitment of individuals into successive size groups within the population.

Table 3. Estimated age structure of *Pellonula leonensis* in Ogobiri River

Relative age class	Representative length (cm)	Population interpretation
1	5.5	Youngest identified age component
2	7.5	Intermediate age component
3	8.5	Intermediate age component
4	9.5	Older age component
5	10.5	Oldest identified age component

4.4 Estimated Age at First Maturity

Published reproductive information from the Lower Nun River indicates that approximately 50% of *P. leonensis* mature within the 5.5–6.5 cm total-length range, with males maturing earlier than females (Kingdom & Allison, 2009). In the present dataset, 5.5 cm corresponded to relative age class 1 and 7.5 cm to relative age class 2. Thus, the maturity-size interval corresponds approximately to relative age class 1 through 1.5.

Table 4. Estimation of age at first maturity from maturity length and present length-at-age data

Parameter	Value
Published 50% maturity size	5.5–6.5 cm TL
Present length at relative age 1	5.5 cm
Present length at relative age 2	7.5 cm
Estimated age corresponding to 5.5 cm	1.0 relative age unit
Estimated age corresponding to 6.5 cm	≈1.5 relative age units
Estimated age at first maturity	≈1.0–1.5 relative age units

4.5 Figures

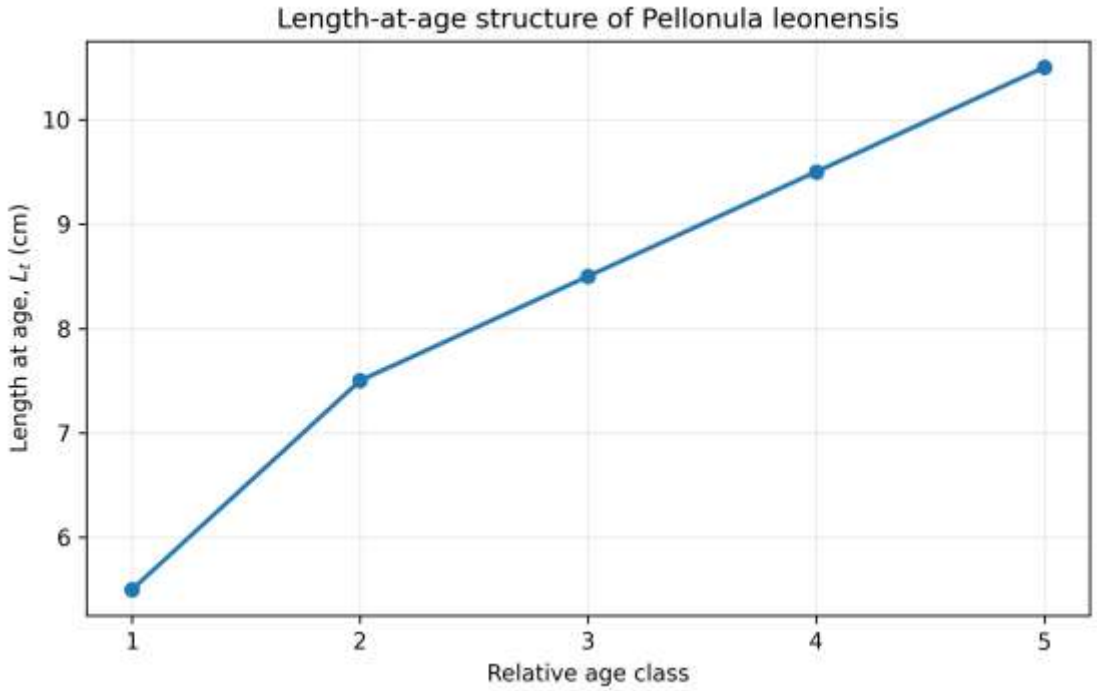


Figure 1. Length-at-age relationship of *Pellonula leonensis*.

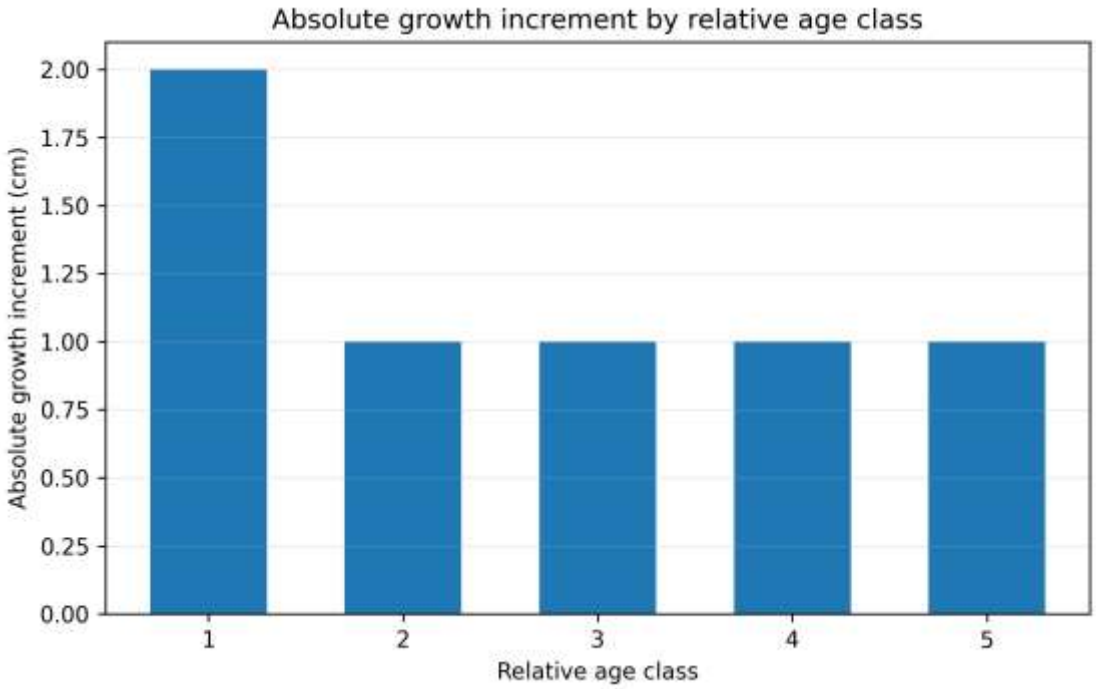


Figure 2. Absolute growth increment of *Pellonula leonensis.*

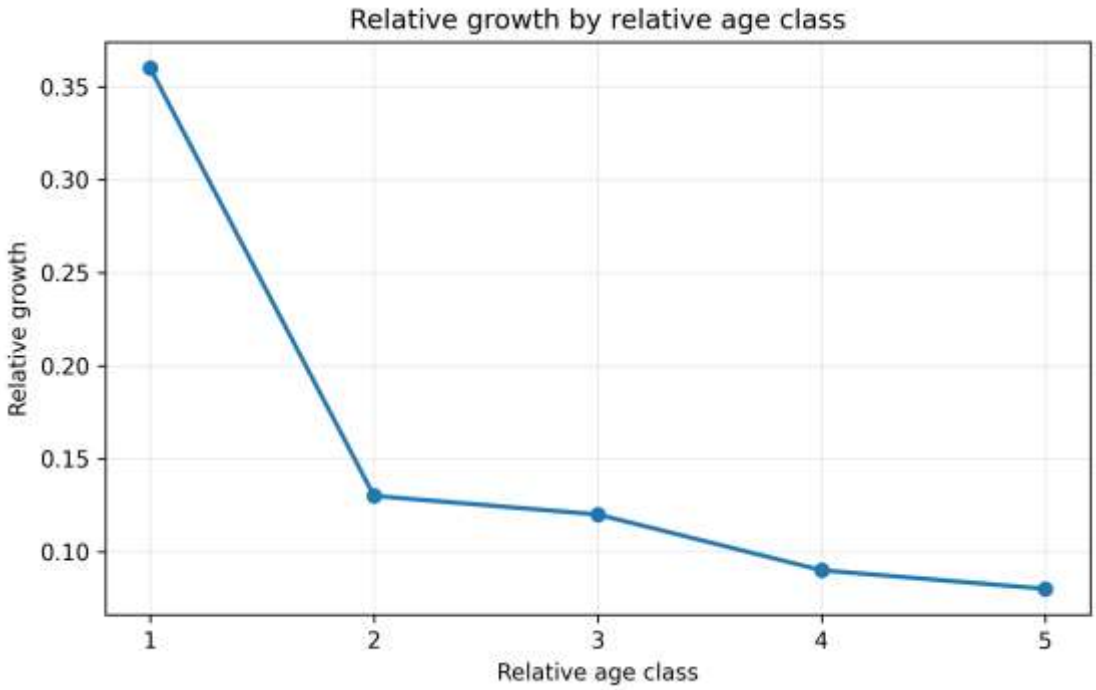


Figure 3. Relative growth of *Pellonula leonensis*.

5. Discussion

The present study identified five relative age classes of *Pellonula leonensis* in Ogobiri River. The length-at-age relationship showed an increase from 5.5 cm in the first relative age class to 10.5 cm in the fifth class, indicating continued somatic growth across the observed population structure. The absolute increment was greatest during the transition from the first to the second

age class, after which the increment stabilized at approximately 1.0 cm. The progressive reduction in relative growth from 0.36 to 0.08 indicates that the proportional increase in body length became smaller as fish moved into older size classes.

The observed pattern of declining relative growth is consistent with the general growth characteristics of fishes, in which younger individuals commonly exhibit proportionally greater increases in length than older individuals. Similar population-level growth patterns have been documented in other African aquatic systems. Kuenzel and Loewenberg (1990), studying the species for *P. leonensis* in the Cross River, Nigeria, estimated an asymptotic length of approximately 15.6 cm and a growth coefficient of 0.81–0.96 year^{-1}. Their results demonstrate that *P. leonensis* has a relatively rapid growth phase during its early life history.

Assi *et al*. (2019) identified four cohorts in *P. leonensis* from Aghien Lagoon, Côte d'Ivoire, with an estimated asymptotic length of 12.684 cm and a growth coefficient of 0.67 year^{-1}. The identification of several cohorts in that study is broadly comparable with the multiple relative age groups observed in the present study. However, the number of cohorts or age groups can differ among water bodies because recruitment timing, environmental conditions, fishing gears and sampling periods affect the size composition of sampled populations.

The present study also showed that the sampled population contained both relatively small and larger individuals. This is important because the coexistence of several age classes may indicate continuing recruitment into the population. However, because sampling period of this study covered only May to July, the observed age structure should be regarded as a snapshot of the population rather than a complete annual age structure.

The estimated age at first maturity requires particular caution. The present dataset contains length-at-age information but does not provide direct gonadal-stage observations. Consequently, maturity could not be determined by constructing a maturity ogive from the Ogobiri River specimens themselves. Instead, the present length-at-age data were related to the established maturity-size range reported for *P. leonensis* in the Lower Nun River.

Kingdom and Allison (2009) reported that approximately 50% of *P. leonensis* matured within 5.5–6.5 cm total length in the Lower Nun River, Niger Delta, and reported that males matured earlier than females. When this size range is superimposed on the present length-at-age relationship, 5.5 cm corresponds to relative age class 1, while 6.5 cm falls between relative age classes 1 and 2. Thus, the present study indicates an estimated first-maturity age of approximately 1.0–1.5 relative age units. The close relationship between maturity size and the youngest length-at-age class has biological significance. It suggests that *P. leonensis* is capable of entering the reproductive population relatively early in its growth trajectory. This is consistent with reproductive characteristics reported for the species in other Nigerian waters. In the Anambra River, Ezenwaji and Offiah (2004) found that 50% of both sexes matured at approximately 4.7 cm total length, which is smaller than the 5.5–6.5 cm maturity range reported by Kingdom and Allison (2009) for the Lower Nun River. The difference between the maturity sizes reported in Anambra River and the Lower Nun River demonstrates that maturity characteristics can vary among populations. Such differences may be associated with environmental conditions, food availability, growth rate, fishing pressure, population density or other ecological factors. Therefore, the 5.5–6.5 cm maturity range used in the present analysis should be regarded as a regional reference rather than a direct measurement of maturity in the Ogobiri population. Variation in reported growth and maturity characteristics among *P. leonensis* populations further supports the need for water-body-specific biological information. Nkuene and Nwafili (2024), for example, reported lengths of 4.50–14.50 cm and a growth coefficient of

2.30 for *P. leonensis* from Luubara Creek in the Niger Delta. Such differences from the Cross River and Aghien Lagoon estimates reinforce the importance of environmental and population-specific factors in determining growth characteristics.

The population structure observed in Ogobiri River also has implications for fisheries management. If individuals are harvested extensively before reaching maturity, the reproductive contribution of the population may be reduced. Conversely, the presence of multiple age classes, including larger individuals, provides evidence that at least some fish survive through successive growth stages. These implications should, however, be interpreted alongside fishing mortality, recruitment, spawning season and gear selectivity, none of which were directly estimated under the present objective.

6. Conclusion

The study demonstrated that the *Pellonula leonensis* population in Ogobiri River comprised at least five relative age classes based on the available length-at-age information. Fish length increased from 5.5 cm in the first relative age class to 10.5 cm in the fifth class, while absolute growth was greatest during the first growth interval and relative growth declined progressively with increasing age. By relating the present length-at-age data to the published 5.5–6.5 cm maturity-size range reported for *P. leonensis* in the Lower Nun River, the age at first maturity was estimated at approximately 1.0–1.5 relative age units. This estimate should be interpreted cautiously because gonadal maturity was not directly determined in the specimens examined in the present dataset. The occurrence of several relative age classes indicates a population comprising different developmental stages rather than a single cohort. The results provide useful baseline information on the age composition and approximate timing of maturity of *P. leonensis* in Ogobiri River. Future studies should include direct gonadal examination, sex-specific maturity assessment and year-round sampling to establish a population-specific maturity ogive and a more precise calendar age at first maturity.

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