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SEX RATIO, GONADO-SOMATIC INDEX AND HEPATO-SOMATIC INDEX OF *Coptodon zilli* and *Oreochromis niloticus* INHABITING UREJE RESERVOIR, ADO-EKITI

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ABSTRACT

The impacts of fishing activity on the natural stocks of fish are hard to evaluate because of the scarcity of studies on their natural status. Thus, this study investigated the sex ratio, gonado-somatic index (GSI), and hepato-somatic index (HSI) as some aspects of the reproductive biology of *Coptodon zilli* and *Oreochromis niloticus* of Ureje reservoir, Ado Ekiti Nigeria. 296 samples were collected between October and December from fishermen operating on the reservoir. The sexes were determined by visual inspection while individual gonad and liver were dissected from fish to determine the GSI and HSI respectively. The sex ratio did not significantly deviate from the expected 1:1 even though there were more males in the reservoir. In *C. zilli*, GSI was 3.06% in females, 2.98% in males, and 3.01% in combined sexes while in *O. niloticus*, GSI ranged from 2.59% for females and 2.83% for males while the GSI for combined sexes was 2.75% indicating maturity and normal reproductive physiology. HSI was 1.02 (female), 1.11 (male), and 1.08 (combined sexes) for *C. zilli* while it was 0.44%, 0.78%, and 0.68% for male, female, and combined sexes of *O. niloticus* respectively. The HSI reflected that the fish and the reservoir cannot be linked with pollution. The study concludes that the GSI and HSI indicated normal reproductive physiology of the fishes. This study has provided basic information on the biology of *C. zilli* and *O. niloticus* of the Ureje reservoir. However, there is a need for further ecological study in the study area.

Keywords: Cichlids, Fish biology, Reproduction, Liver, Inland fisheries

INTRODUCTION

Nigeria is endowed with a wealth of water bodies that support a diverse range of fish species, including both finfish and shellfish, which are harvested in significant quantities (Ajibare and Loto, 2023). Tilapias (Cichlidae), a family of fish native to Africa, have been introduced to various countries worldwide. These fish begin to spawn at a young age, often when they are still under market weight and early sexual maturity can negatively affect their growth rates (Valikhani et al., 2018). The large number of fishermen, using various types of fishing gear, can put significant pressure on natural fish stocks, potentially leading to overfishing (Olawusi-Peters, 2015). Fishermen are already observing stock depletion in many reservoirs (Valikhani et al., 2018). Unfortunately, assessing the impact of fishing activities on fish populations remains challenging due to a lack of comprehensive studies on the status of natural fish stocks in many areas. This knowledge gap complicates the efforts of relevant agencies to implement sustainable management practices (Dewi and Probowo, 2017; Ajibare and Loto, 2023).

The gonado-somatic index (GSI), which relates the size of the gonads to the overall size of the fish, serves as an effective indicator of gonadal development (Nandikeswari et al., 2014). It reflects the percentage of body weight used in egg production. Additionally, the hepato-somatic index (HSI) provides insights into the health condition of the fish and the quality of the surrounding aquatic environment. A higher HSI suggests good growth and a healthy environment, while a low HSI indicates poor growth and potential environmental stress (Singh and Srivastava, 2015). Both GSI and HSI are valuable for understanding fish development patterns.

Furthermore, studies on sex ratios help determine the proportion of males and females in a population, which is crucial for assessing reproductive potential and estimating stock size (Olanrewaju et al., 2017). While research on the reproductive biology of several economically significant fish species exists (Vazzoler, 1996; Olurin and Savage, 2011; Prased et al., 2011; Isengedighi and Umoumoh, 2011; Ajibare and Loto, 2023; Ajibare, 2024), there is limited literature on the reproductive biology of *C. zilli* and *O. niloticus*. Given the scarcity of information on these species, particularly in the Ureje reservoir, this study aims to investigate the gonadal-somatic index (GSI) and hepato-somatic index (HSI) of these fish species in the reservoir. The findings from this research are expected to contribute valuable data to the scientific community and support efforts in fisheries and aquaculture management.

MATERIALS AND METHODS

Study Area

This study was done in Ureje reservoir, Ado-Ekiti in Ekiti State Nigeria which primarily serves as a source of water for both domestic and agricultural use. The socioeconomic characteristics of the surrounding region are influenced by agriculture, water access, and local industries. The area has a largely rural population, with most residents engaged in farming activities, such as crop cultivation and livestock rearing. The presence of the reservoir also supports some level of fishing and water-based industries (Fatoba *et al.*, 2019). The climate of the study area is divided into two seasons: dry and wet seasons. The dry season lasts from November to March with a high temperature, sometimes reaching above 30°C, the wet season lasts from April to late October with an average temperature of 30°C. The study area lies between latitude 7º 37' north and longitude 5º 13' east of the equator (Figure 1). The topography of the area revealed that most area in the town lies between 1,200 meters and 2,200 meters above mean sea level, with the North tops taking the heights (Oso *et al*., 2013).

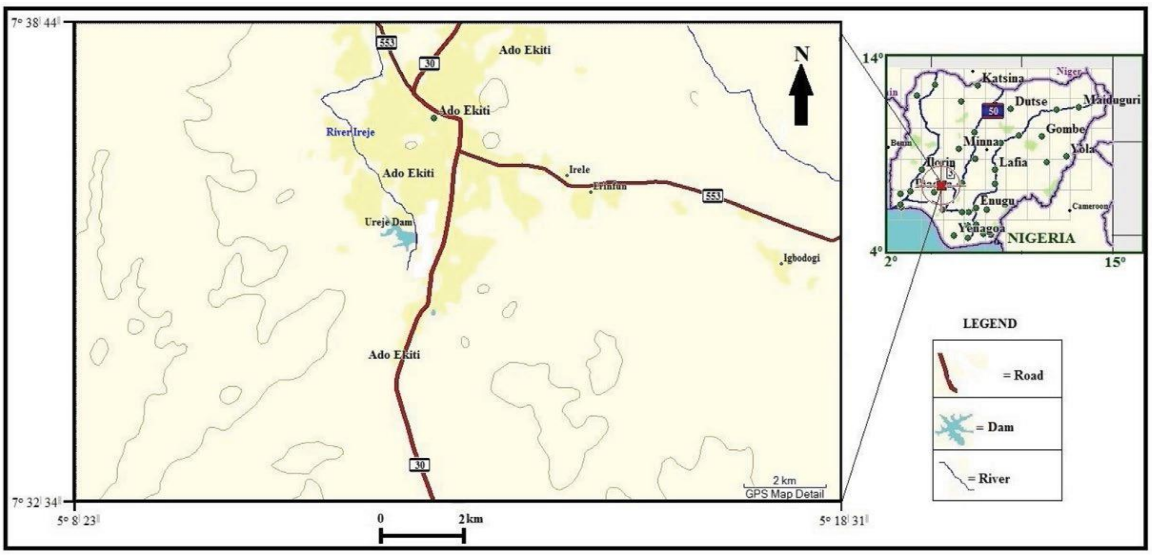

Figure 1: Ureje Reservoir. Source: Fatoba *et al.,* 2019

Collection of Samples

Samples identified as *Coptodon zilli* and *Oreochromis niloticus* (Olaosebikan and Raji, 2013) were collected on a monthly basis from October to December 2021. The samples were obtained from fishermen operating on the reservoir, who used cast nets with a 3.5mm mesh size to capture the fish. The samples were immediately transported in an ice chest to the laboratory of the Fisheries Technology Department, Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria for analysis.

Determination of Fish Sex Ratio

The sex of the fish was identified through both visual and microscopic examination of the gonads. Males were distinguished from females by the presence of genital papillae located just before the anal fin (Ajibare, 2024). The number of males and females was counted and recorded, and the sex ratio was calculated by comparing the proportions of each sex. To test for statistical significance, the sex ratio was evaluated using the chi-square method, following the procedure outlined by Indarjo et al. (2021). A 1:1 male-to-female ratio was assumed under the null hypothesis, with a 95% confidence interval (CI) using the formula:

$$X^2 = \sum \frac{(O-E)^2}{E}$$

Where; X^2 = Chi-square test, O = observed values, and E = expected values.

The null hypothesis (H_0) asserts that there is no significant difference in the proportion of males and females in the sample.

Determination of Gonadal-Somatic Index (GSI)

The gonads of each fish were carefully extracted from the dissected specimens by making an incision in the abdominal region. Forceps were used to delicately remove the gonads (Fryxell et al., 2015). The gonadal-somatic index (GSI) for each fish was calculated using the following formula:

$$GSI = \frac{Gonad\ Weight\ (g)}{Fish\ Weight\ (g)} \times 100$$

Determination of Hepato-somatic Index

The Hepato-somatic Index (HSI) was determined following standard procedures (Béarez and Chaves, 2020) to assess the relative condition of the liver in fish species. The collected fish samples were weighed individually to obtain the total body weight (W). The liver was then carefully excised, cleaned of any adhering tissue, and weighed to obtain its liver weight (L). The HSI was then calculated using the formula (Béarez and Chaves, 2020):

$$HSI = \frac{Liver\ Weight\ (g)}{Fish\ Weight\ (g)} \times 100$$

Statistical Analysis

Statistical analyses were performed using SPSS version 20.0. The analysis was carried out separately for males, females, and combined sexes, where combined sexes referred to the aggregation of both male and female specimens. The sex ratio was determined using the Chi-square test. A significance level of $P<0.05$ was used for all relationships.

RESULTS AND DISCUSSION

The sex ratio of *C. zilli* and *O. niloticus* caught from Ureje reservoir is presented in Table 1 which revealed that there was no significant difference between the male and female population ($P>0.05$) for both species. The gonado-somatic index of *C. zilli* and *O. niloticus* caught from the Ureje reservoir is presented in Table 2. The table revealed that for *C. zilli* in October, GSI was 2.68% in females, 3.46% in males and combined sexes was 3.16%, and in November, 3.67% in females, 2.80% in males and 3.16% in combined sexes while in December was 2.80% in female, 2.83% in male and 2.82% for combined sexes while the mean value was 3.06% in female, 2.98% in male and 3.01% in combined sexes. For *O. niloticus*, the table revealed that the GSI was 2.23% for female and 2.77% for male while the GSI for combined sexes was 2.61% in October. The GSI was 2.93% in females and 2.62% in males while the combined sexes were 2.74% in November. The table also revealed that in December, GSI was 2.51% in females and 3.02% in males and the combined sexes was 2.75%. Furthermore, the hepato-somatic index of *C. zilli* and *O. niloticus* from the Ureje reservoir was presented in Table 3 which revealed that HSI of *C. zilli* was 0.95% in females, 1.15% in males, and 1.07% in combined sexes for the month of October and was 1.14% in females, 1.02% in males 1.07% in combined sexes in December and the mean was 1.02% in female, 1.11% in male and 1.08% combined sexes. Similarly, the HSI of *O. niloticus* was 0.28% in females and 0.62% in males and the combined sexes was 0.52% in October while it was 0.45% in female, 0.79% in male and 0.82% in combined sexes in November and the mean was 0.44% in female, 0.78% in male and 0.68% in combined sexes.

Table 1: Sex Ratio of *C. zilli* and *O. niloticus* caught from Ureje reservoir in Ekiti State

Species	Parameter	October	November	December	Mean
C. zilli	Sex Ratio	1.5:1	1.4:1	1.3:1	1.4:1
	X^2	0.25	0.16	0.09	0.16
	P	0.50	0.50	0.70	0.50
O. niloticus	Sex Ratio	2.0:1	2.0:1	2.5:1	2.1:1
	X^2	1.00	1.00	2.25	1.21
	P	0.30	0.30	0.10	0.20

Table 2: Gonado-Somatic Index of *C. zilli* and *O. niloticus* from Ureje reservoir, Ado Ekiti, Nigeria

Species	Month	Female	n	Male	n	Combined Sexes	n
C. zilli	October	2.68	16	3.46	24	3.16	40
	November	3.67	20	2.80	28	3.16	48
	December	2.80	24	2.83	32	2.82	56
	Overall	3.06	60	2.98	84	3.01	144
O. niloticus	October	2.23	16	2.77	32	2.61	48
	November	2.93	16	2.62	32	2.74	48
	December	2.51	16	3.02	40	2.89	56
	Overall	2.59	48	2.83	104	2.75	152

n= number of fish samples analyzed

Table 3: Hepato-Somatic Index of *C. zilli* and *O. niloticus* from Ureje reservoir, Ado Ekiti, Nigeria

Species	Month	Female	n	Male	n	Combined Sexes	n
C. zilli	October	0.95	16	1.15	24	1.07	40
	November	0.92	20	1.19	28	1.08	48
	December	1.14	24	1.02	32	1.07	56
	Overall	1.02	60	1.11	84	1.08	144
O. niloticus	October	0.28	16	0.62	32	0.52	48
	November	0.45	16	0.79	32	0.66	48
	December	0.6	16	0.9	40	0.82	56
	Overall	0.44	48	0.78	104	0.68	152

n= number of fish samples analyzed

Discussion

The reproductive biology of *Coptodon zilli* and *Oreochromis niloticus* provides valuable insights into their population dynamics, including the timing and extent of recruitments. The overall sex ratio for both species in the study favoured males, although the difference from the expected 1:1 ratio was not statistically significant. This observation aligns with Ajibare (2024), who suggested that deviations in the sex ratio could serve as a population-regulating mechanism. In this study, the near-equal distribution of males and females, with a slight male dominance, is in line with findings from other researchers who have reported similar trends in African water bodies (Ajibare and Loto, 2023).

The predominance of males observed in this study is consistent with previous studies (Isangedighi and Umoumoh, 2011; Olurin et al., 2011; Prasad et al., 2011; Adebiyi, 2013; Oso et al., 2013) and may be explained by factors such as the migration of females to breeding grounds or the positioning of fishing gear away from these sites (Nandikeswari et al., 2014). This potential spatial separation could be detrimental to sustainable fishery management, as excessive male capture might skew population dynamics. Interestingly, while male dominance was observed in this study, several other reports have indicated a much higher sex ratio imbalance, with varying male-to-female ratios across different freshwater species (Al-Ghais, 1995; Asebere-Ameyaw, 2001; Jega, 2017; Indarjo et al., 2021; Ajibare and Loto, 2023; Ajibare, 2024). However, the absence of significant deviation from the expected 1:1 ratio in this study suggests that the fish stocks in Ureje Reservoir are ecologically stable and undisturbed.

Regarding the gonadosomatic index (GSI), the values observed—3.01% for *C. zilli* and 2.75% for *O. niloticus*—reflect typical reproductive maturity, with similar findings reported by Kaur et al. (2018) in River Sutlej (GSI = 4.5). The GSI is a crucial indicator of fish reproductive health, with high values signaling peak gonadal development and egg production (Ajibare, 2024). The values observed in this study were consistent with studies by Ikomi and Odum (1998) for *C. auratus* and Offem et al. (2008) for *C. nigrodigitatus*, where high GSI values were indicative of optimal reproductive conditions. The hepatosomatic index (HSI) values, ranging from 0.68% to 1.08%, were relatively low, suggesting that the fish in Ureje Reservoir were not exposed to significant environmental stress or pollution. This is in contrast to studies by Billiard and Khan (2003) and Sadekarpawar and Parikh (2013), who found elevated HSI values in more disturbed areas, often linked to effluent discharge and contamination. The low HSI values in this study, coupled with normal GSI patterns, suggest that the fish populations are in healthy reproductive condition and that the reservoir is free from pollution-related disruptions.

In conclusion, this study provides evidence that the fish stocks in Ureje Reservoir are in good ecological health, with no significant deviation from expected biological norms in terms

of sex ratio, GSI, or HSI. These findings align with previous studies, reinforcing the notion that the ecosystem remains relatively undisturbed. However, continued monitoring is necessary to ensure sustainable management of the fish populations and to prevent potential future disruptions caused by environmental or anthropogenic factors.

CONCLUSION

This study provided information on the sex ratio, gonado-somatic index, and hepato-somatic index of *C. zilli* and *O. niloticus* in the Ureje reservoir in Ekiti State, Nigeria and it revealed that the sex ratio did not significantly deviate from the expected 1:1 even though there were more males in the reservoir. The study also revealed that the GSI and HSI values indicated normal reproductive physiology. It is therefore hoped that the present data will complement the limited information on the reproductive biology of *C. zilli* and *O. niloticus* in Nigerian water bodies, and prove useful in the management and conservation of this important commercial fish species.

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