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# Growth analysis and sex ratio of fish species from the Ovia River, Edo State, Nigeria

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This study investigated the length-weight relationships, the condition factor, and the sex ratio of *Hemichromis fasciatus*, *Synodontis nigrita*, and *Tilapia zillii* in the Ovia River, Edo State, Nigeria. Fish specimens were collected with the assistance of artisanal fishermen using fishing traps, cast and gill nets of various mesh sizes from February to April 2021. Taxonomical identification, morphometric measurements, and macroscopic examination of the fresh gonads were carried out. The linear regression equation was used to determine the relationship between fish length and body weight, while the condition factor and the sex ratio were analysed using standard techniques. Length-weight relationship (LWR) showed a significant ($p < 0.05$) correlation and the growth exponent $b = 2.973$, 2.340, and 2.565 for *H. fasciatus*, *S. nigrita* and *T. zillii*, respectively, indicated a negative allometric growth pattern. Mean condition factor values ranged from 2.34 to 5.68 and was indicative of good health condition for the fishes. Sex ratios did not differ significantly ($p > 0.05$) from the one male to one female distribution in *H. fasciatus* (1:1.11), *S. nigrita* (1:0.89), and *T. zillii* (1:0.93). The study has provided information on some aspects of the fish biology of *Hemichromis fasciatus*, *Synodontis nigrita*, and *Tilapia zillii* in the Ovia River, and these data are helpful tools for fisheries management and conservation of freshwater fishes.

**Keywords:** freshwater fishes, length-weight relationship, negative allometric growth, condition factor, artisanal fisheries, the Ovia River

## INTRODUCTION

The world's fishes have enjoyed an effusive proliferation that has produced an estimated 32,600 living fish species in 536 families and 85 orders, more than all other species of vertebrates combined (Nelson et al., 2016). The success of the fishing industry depends largely on the growth and reproductive potential of the respective fish species, while development and improvement of fish species mostly depends on the knowledge of its biology such as the shape and structure of fins and fin rays, which show modifications due to varied swimming habits, habitat, sex, growth factors, age, and size of the fishes (Weisel, 2000). The condition and length-weight parameters of the aquatic species are relevant to understanding their growth and development.

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Length-weight relationships are useful for a wide number of studies, such as estimating growth rates, the age structure, and other aspects of fish population dynamics (Tsoumani et al., 2006). Also, length-weight relationships are useful for comparisons of life histories of a certain species between regions (Nurul-Amin et al., 2009). Several authors have researched the length-weight relationships and the condition factor of freshwater fishes (Adeyemi, 2010; Oribhabor et al., 2011; Obasohan et al., 2012; Dan-Kishiya, 2013; Ikongbeh et al., 2013; Faguaro et al., 2016; Konan et al., 2017; Dienye, Olopade, 2018; Omotayo et al., 2018; Olapade et al., 2019; Kefas et al., 2020). Studies on the sex ratio provide information on the proportion of male to female fish in a population; it also indicates the dominant sex in a given population and is basic information necessary for fish reproduction and stock size assessment (Vicentini, Araujo, 2003). Variation in the adult sex ratio is often the result of factors that cause sex-biased mortality. These factors could include predation (Berger, Gompper, 1999; Sommer, 2000), parasitism, resource limitation, and reproductive costs (Promislow, 2003; Liker, Székely, 2005).

In Nigeria, the greater part of inland fisheries is artisanal and provides families with food and income (Adaka et al., 2014; Egun, Oboh, 2022). The present study was undertaken to ascertain the pattern of growth, general well-being, and sex ratio of selected fish species: *Hemichromis fasciatus*, *Synodontis nigrita*, and *Tilapia zillii* in the Ovia River at Unuamen community, Edo State, Nigeria.

## MATERIALS AND METHODS

**Description of the study area.** This study was carried out in the Ovia River, which flows within the region of swamp forests of Edo State, Nigeria. The Ovia River is a tributary of the Benin River and empties into the Atlantic Ocean (Fig. 1). It provides several ecosystem functions and services to the aquatic fauna and the people residing along the watercourse.

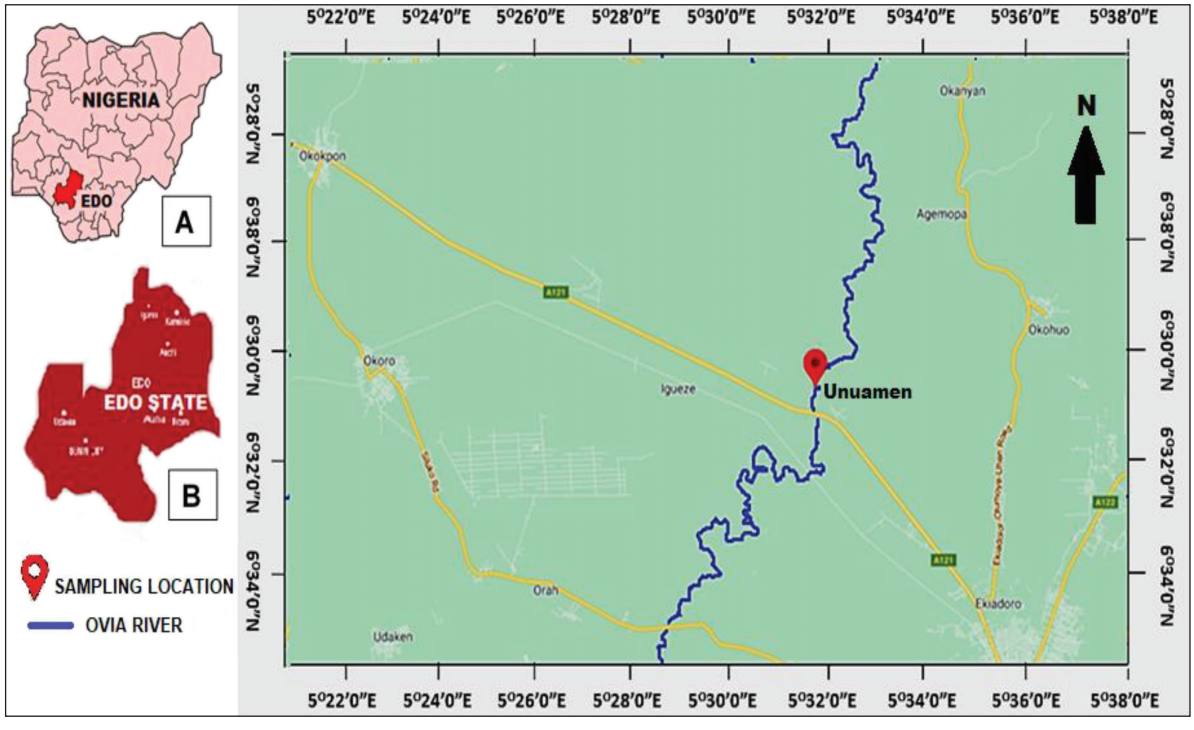


**Fig. 1.** The Ovia River showing the sampling site in Unuamen Community, Edo State. Inset: Map of Nigeria (A), Map of Edo State (B)

**Collection of fish samples and identification.** The fish species selected for the study were collected at the landing site in Unuamen Community (latitudes 06°33'60" N and 005'3114" E), Edo State, fortnightly for a period of three months from February to April 2021, with the assistance of artisanal fishermen using fishing traps, cast and gill nets of various mesh sizes. The fish samples were preserved in ice blocks and transported to the laboratory. Samples were properly identified using taxonomic guides of Idodo-Umeh (2003) and counted to determine species abundance.

**Laboratory analysis.** Morphometric measurements of the standard length, total length, and body weight of all fish samples were taken to the nearest 0.1 cm and 0.1 g using a metre rule and a digital electronic weighing balance (Mettler Toledo, PL203 model), respectively.

**Sex determination and sex ratio.** The sex of each fish specimen was determined by macroscopic examination of the fresh gonads after dissection. The sexed specimens were categorised into males and females for each species. The total number of each sex for the various species was pooled monthly, and the ratio of males to females was determined for each species.

The chi-square analysis was calculated using the equation:

$$X^2 = \frac{(F_i - f_i)^2}{F_i}$$

where, $f_i$ = observed frequency, $F_i$ = expected frequency

**Length-weight relationship (LWR)**. The LWRs of the fishes were calculated using the equation:

$$W = aL^b$$

where $W$ = the observed total weights of the fishes in grams.

$L$ = the observed standard lengths in centimetres.

$a$ and $b$ are constants.

$b$ is the slope usually between 2 and 4, and $a$ is the intercept on the length axis (Bagenal, 1978).

The logarithmic transformation of the equation gives a straight-line relationship

$$Log\ W = Log\ a + b\ Log\ L.$$

When $Log_{10}W$ is against plotted $Log_{10}L$, the regression coefficient is $b$, and $Log\ a$ is the intercept on the $Y$ axis.

**Condition factor (K).** This was computed for the individual fish according to Le-Cren (1951), using the equation:

$$K = \frac{100\,W}{L^3}$$

where $K$ = condition factor.

$L$ = standard length in centimetres.

$W$ = body weight of fish in grams.

**Data analysis.** The data in this study were analysed using the statistical package for social sciences (SPSS) version 16.0. The chi-square test was performed on monthly and overall sex ratios of the population. One-way analysis of variance (ANOVA) was carried out to test for significant differences. Regression analysis was used to test for linear relationships.

## RESULTS

**Length-weight relationship (LWR).** The ranges for the standard length and weight for *H. fasciatus* (SL: 7.00 to 13.00 cm; weight: 9.00 to 142.00 g), *S. nigrita* (SL: 6.00 to 12.00 cm; weight: 9.00 to 46.00 g) and *T. zilli* (SL: 5.00 to 12.00 cm; weight: 10.00 to 113.00 g) were recorded. A significant length-weight relationship ($p < 0.05$) with the correlation coefficient ($r$) value of 0.527 was recorded for *H. fasciatus*. The value for the slope ($b$) indicated negatively allometric growth (2.973) (Fig. 2). A plot of body weight against standard length for *S. nigrita* showed a significant ($p < 0.05$) positive correlation, with $r$ value of 0.608 (Fig. 3). The slope ($b$) produced the value of 2.340, which indicated a negative allometric growth pattern. Length-weight relationship was highly significant for *T. zilli* ($p < 0.001$) with $r$ value of 0.779. The slope ($b$ value) 2.565 indicated negative allometric growth (Fig. 4).

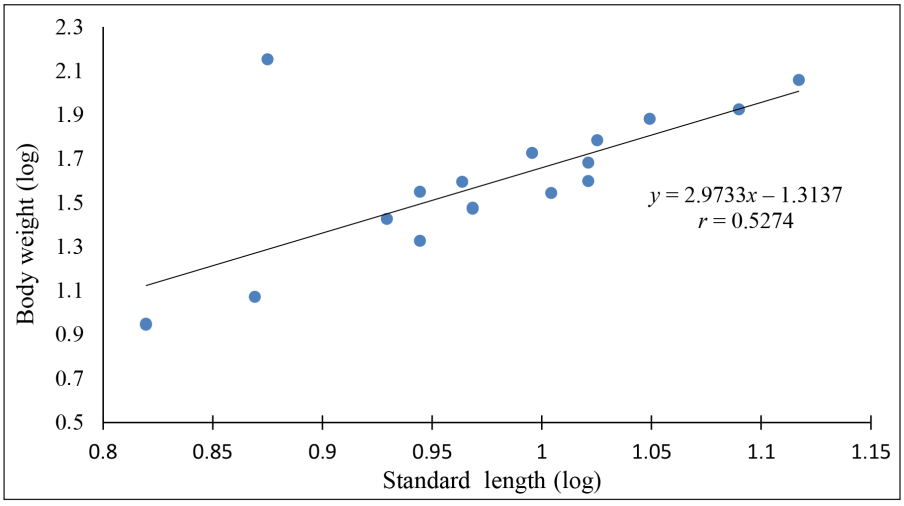


**Fig. 2.** Length-weight relationship of *Hemichromis fasciatus* from the Ovia River

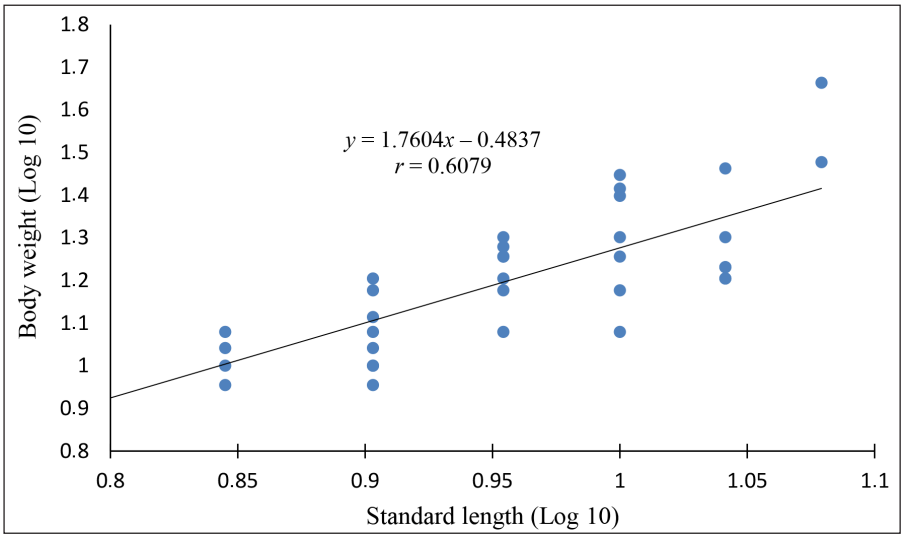


**Fig. 3.** Length-weight relationship of *Synodontis nigrita* from the Ovia River

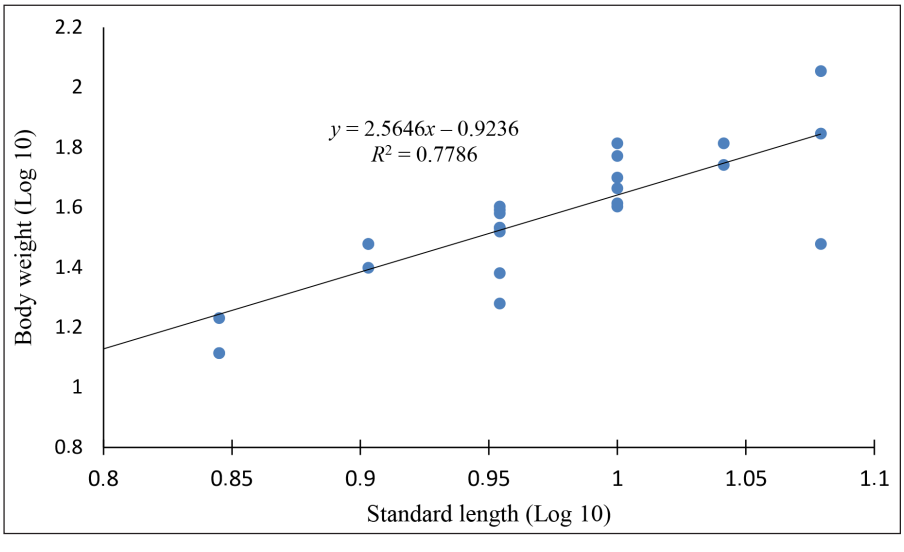


**Fig. 4.** Length-weight relationship of *Tilapia zilli* from the Ovia River

**Condition factor (K).** The values of the mean condition factor (K) for the selected fish species in this study ranged from 2.13 to 6.17 and was the highest in *H. fasciatus*, followed by *T. zilli*, while *S. nigrita* was the least (Fig. 5).

**Sex ratio.** Fish specimens collected during the period of study had observable gonads. The summary of the sex ratio for *H. fasciatus*, *S. nigrita*, and *T. zilli* are presented in Tables 1, 2, and 3, respectively. For *H. fasciatus* (1:1.11),

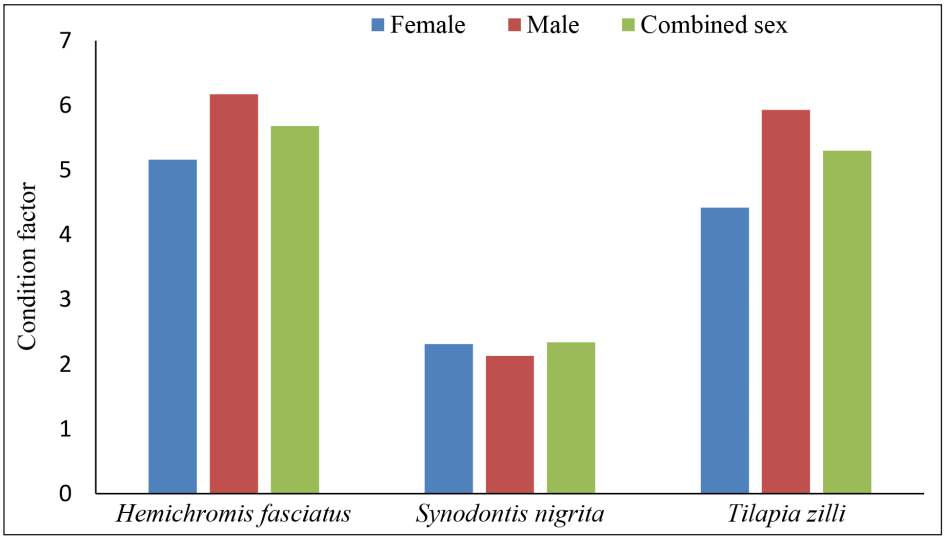


**Fig. 5.** Condition factors of fish species from the Ovia River

Table 1. **Monthly and overall sex ratio of *Hemichromis fasciatus* from the Ovia River**

| MONTH | No. of fish sexed | No. of males | No. of females | Sex ratio (M:F) |
|---|---|---|---|---|
| February 2021 | 1 | 1 | 0 | 1:0 |
| March 2021 | 0 | 0 | 0 | 0:0 |
| April 2021 | 18 | 8 | 10 | 1:1.25 |
| Total | 19 | 9 | 10 | 1:1.11 |

Table 2. **Monthly and overall sex ratio of *Synodontis nigrita* from the Ovia River**

| MONTH | No. of fish sexed | No. of males | No. of females | Sex ratio (M:F) |
|---|---|---|---|---|
| February 2021 | 3 | 3 | 0 | 3:0 |
| March 2021 | 2 | 0 | 2 | 0:2 |
| April 2021 | 30 | 16 | 14 | 1:0.93 |
| Total | 35 | 19 | 16 | 1:0.89 |

Table 3. **Monthly and overall sex ratio of *Tilapia zilli* from the Ovia River**

| MONTH | No. of fish sexed | No. of males | No. of females | Sex ratio (M:F) |
|---|---|---|---|---|
| February 2021 | 7 | 4 | 3 | 1:0.75 |
| March 2021 | 0 | 0 | 0 | 0:0 |
| April 2021 | 21 | 11 | 10 | 1:1 |
| Total | 28 | 15 | 13 | 1:0.93 |

*S. nigrita* (1:0.89), and *T. zilli* (1:0.93), it was observed that the population did not differ significantly ($p < 0.05$) from the 1:1 expected distribution.

## DISCUSSION

**Length-weight relationship (LWR).** Length-weight relationship of fishes, also known as the growth index, is an important management tool used in fisheries and fish biology since it permits the assessment of the average weight of the fish of a given length group by establishing a mathematical relation between them (Araoye, 2004; Sarkar et al., 2008; Abowei, Hart, 2009; Mir et al., 2012; Singh, Nautiyal, 2017). The *b* values of 2.9733, 1.7604, and 2.5646 obtained for *Hemichromis fasciatus*, *Synodontis nigrita*, and *Tilapia zilli* indicated that growth was negatively allometric. This could probably occur due to the landing of mainly sexually immature and juvenile fish which were in active growth stages of their lifecycles (Anyanwu, Ugwumba, 2003; Muyideen et al., 2010). The length-weight relationship observed showed positive correlation coefficients, specifying an increase in the weight as the length increases. Negative allometric growth reported in this study was similarly observed by Adeyemi (2010) for *Protopterus annectens* (2.55); Dan-Kishiya (2013) for *Tilapia zilli* (2.2–2.3), *Tilapia mariae* (1.4–1.6), *Oreochromis niloticus* (2.1–2.3), *Barbus occidentalis* (1.9–2.2), and *Barilius loati* (2.3–2.4); Dienye and Olopade (2018) for *Ethmalosa fimbriata* (2.13); Olapade et al., (2019) for *Lates niloticus* (2.66), and *Notopterus afer* (2.70), and Kefas et al., (2020) for *Oreochromis niloticus* (1.0637). The *b* value of 1.7604 recorded for *S. nigrita* was lesser than that for the same species (2.997 and 2.675) (Akombo et al., 2011 and 2014) and for related species; *Synodontis resupinatus* were *b* = 2.990 (Akombo et al., 2011), values of 3.051 and 3.096, indicative of isometric growth were reported for *Synodontis clarias* and *Synodontis membranaceus* from the lower Benue River (Akombo et al., 2011) and Elias (2016), who reported positive allometric growth (3.24) for *S. schall* from Lake Chamo, Ethiopia. A value lower than 3.0 shows that the fish become lighter (negative allometric); a value higher than 3.0 indicates that the fish become heavier (positive allometric) for a particular length as it increases in size (Zafa et al., 2003). Le-Cren (1951) and Fagbenro et al. (1991) stated that the obedience to the cube law (isometric growth, $b = 3$) is rare in the majority of fishes. The relationship can be influenced by several factors such as sex, gonad maturity, health of the fish, seasonal effect, the degree of stomach fullness, preservation techniques, and differences in the observation length ranges of the specimen weight (Tesch, 1971). *Synodontis schall* was comparable to that (2.855) from the Benue River by Akombo et al. (2014).

**Condition factor (K).** The condition factor is a veritable tool for assessing the health status of the aquatic ecosystem (Abowei, 2009; Ighwela et al., 2011). Mean condition factor (K) values observed in this study ranged from 2.13 to 6.17 for *H. fasciatus*, *S. nigrita*, and *T. zilli*. This was outside the range of 2.9 to 4.8 reported by Omotayo et al. (2018), as the recommended range suitable for mature freshwater species in the tropics is 2.9 to 4.8. The observed values were indicative of a good health condition for *H. fasciatus*, *S. nigrita*, and *T. zilli* and comparable to that reported for *S. schall* (2.855) from the Benue River by Akombo et al. (2014). The mean values in this study were in contrast to those of Adeyemi (2010) for *P. annectens* (0.23 to 0.76), Olowosegun and Ataguba (2010) for *H. forskali* and *H. brevis* (1.313 and 1.431), Obasohan et al. (2012) for *P. afer*, *P. obscura*, *M. electricus*, *T. mariae*, and *O. niloticus* (<1), Dan-Kishiya (2013) for *T. zilli*, *T. mariae*, *O. niloticus*, *B. occidentalis*, and *B. loati* (1.06 and 2.02), Ikongbeh et al. (2013) for *A. occidentalis* (1.53), Omotayo et al., (2018) for *T. zillii*, *O. niloticus* and *M. anguilodes* (>1), Fagbuaro et al., (2019) for *C. gariepinus* (<1), and Kefas et al. (2020) for *Oreochromis niloticus* (2.03). The condition factor is also a useful index for monitoring of the feeding intensity, age and growth rates in fish (Ndimele et al., 2010). It is strongly influenced by biotic and abiotic conditions (Egbal et al., 2011). These include sex, age,

state of maturity, size, state of stomach fullness, sampling methods and sample sizes and environmental conditions affect fish condition and parameters of length-weight relationships in fish (Ama-Abasi, 2007; Yem et al., 2007; Adeyemi et al., 2009).

**Sex ratio.** The overall sex ratios reported for *H. fasciatus*, *S. nigrita* and *T. zilli* were not significantly different from the expected 1:1 ratio. The sex ratios of 1:1.11, 1:0.93 for *H. fasciatus* and *T. zilli* compares with the reports of Omotayo et al. (2018) for *T. zilli* (1: 1.35) and *O. niloticus* (1: 0.85) and Kefas et al., (2020) for *O. niloticus* (1: 1.56), where males and females occurred in almost equal proportions. Results from this study were in contrast to the findings of Omotayo et al. (2018) for *M. anguilodes* (1:5.5) and Fagbuaro et al. (2019) for *C. gariepinus* (1:0.33), where females outnumbered males and males outnumbered females, respectively. The sex ratio observed for *S. nigrita* (1:0.89) was similar to the ratio of 1:1.47 reported for same species by Olojo et al. (2012) and related species *S. schall* (1:1.1), *S. clarias* and *S. schall* (1:1, 1:1), *S. schall* (1:1.04), *S. eupterus* (0.96:1), *S. schall* (1:0.9), *S. schall* (1:1.35), *S. schall* (1:1.39) by Laleye et al. (2006), Akombo et al. (2011), Mekkawy and Hassan (2011), Shinkafi and Dameji (2011), Oboh et al. (2013), Akombo et al. (2015), and Elias (2016). However, a ratio of 1:2.5 and 1:3 was reported for *S. nigrita* by Laleye et al. (2006) and Olele and Etim (2011), where females significantly outnumbered males. The differences in sex ratios among same and related fish may be due to fishing gear selectivity during sampling, mortality and survival rate among species, migration of different sexes during feeding and spawning, the age difference, and the sex present during sampling (Oboh et al., 2014).

## CONCLUSIONS

This study provides information on some important aspects of the fish biology of *Hemichromis fasciatus*, *Synodontis nigrita* and *Tilapia zillii* in the Ovia River, which includes morphometric characters, length-weight relationship, the condition factor, and sex ratios. These data are helpful tools for fisheries management and conservation for freshwater fishes.

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## OVIJOS UPĖS ŽUVŲ RŪŠIŲ AUGIMO ANALIZĖ IR LYTIES SANTYKIS (EDO VALSTIJA, NIGERIJA)

*Santrauka*

Šiame tyrime buvo analizuotas *Hemichromis fasciatus, Synodontis nigrita* ir *Tilapia zillii* ilgio ir svorio santykis, būklė ir lyties santykis Ovijos upėje, Edo valstijoje (Nigerija). Padedant žvejams amatininkams, žuvys buvo gaudomos 2021 m. vasario–balandžio mėnesiais įvairaus dydžio tinklais. Atliktas lytinių liaukų taksonominis identifikavimas, morfometrinis matavimas ir makroskopinis tyrimas. Žuvies ilgio ir kūno svorio ryšys buvo nustatytas tiesinės regresijos lygtimi, o būklė ir lyties santykis analizuoti standartiniais metodais. Ilgio ir svorio santykis (LWR) rodo reikšmingą ($p < 0,05$) koreliaciją, o *H. fasciatus*, *S. nigrita* ir *T. zillii* augimo eksponentas „*b*“ (atitinkamai 2,973, 2,340 ir 2,565) – neigiamą alometrinį augimo modelį. Vidutinės būklės reikšmės svyravo nuo 2,34 iki 5,68 ir patvirtino gerą žuvų sveikatos būklę. Santykis tarp patinų ir patelių reikšmingai nesiskyrė ($p > 0,05$): *H. fasciatus* (1:1,11), *S. nigrita* (1:0,89) ir *T. zillii* (1:0,93). Šis tyrimas suteikė informacijos apie kai kuriuos *Hemichromis fasciatus*, *Synodontis nigrita* ir *Tilapia zillii* žuvų biologijos aspektus Ovijos upėje. Gauti duomenys yra naudingi žvejybos valdymui ir gėlavandenių žuvų išsaugojimui.

**Raktažodžiai:** gėlavandenės žuvys, ilgio ir svorio santykis, neigiamas alometrinis augimas, būklė, amatinė žvejyba, Ovijos upė