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Research Article
Determination of Growth Indicators of *Tilapia sparrmanii* (Smith, 1840) in Molepo Dam, South Africa

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Abstract

Background and Objective: The sustainable management and conservation of fish biodiversity depends on studying fish biology. In this study, the length-weight relationships and condition factors of *Tilapia sparrmanii* were observed to gain a better understanding of their ecological and nutritional conditions. This information is crucial for the effective management of fisheries. **Materials and Methods:** During the study, 100 *T. sparrmanii* were collected from the Molepo Dam from October, 2022 to March, 2023. This fish's condition factor (CF) and length-weight relationship (LWR) were studied. To determine the size of each fish, the total length was measured using a caliper with a precision of 0.1 mm and the weight using a balance with an accuracy of 0.1 g. Differences were analyzed using ANOVA with the Tukey's *post hoc* test. A non-parametric Chi-square test was employed to evaluate the differences in sexes each month. **Results:** Their total length and body weight ranged from 4-15 cm and 0.96-57.96 g, respectively. The study found a strong positive relationship between the length and weight of the fish ($r = 0.96$). The regression coefficient (b) was more than 3.0, indicating a positive allometric growing rate. The condition factors (K) of males and females were not significantly different ($p>0.05$). The lowest CF value was observed in March ($K = 1.01 \pm 0.03$) and the highest in December ($K = 1.73 \pm 0.12$). The sex ratio of 1.0 male to 1.15 female was observed, which was significantly different from the theoretical ratio of one male to one female. This suggests that males were not significantly more than females ($p>0.05$). **Conclusion:** The study found that *T. sparrmanii* in Molepo Dam exhibited allometric growth, as evidenced by a strong correlation between length and weight represented by a high "r" value. This fish is in good condition because it has no competition for food due to ecological factors.

Key words: Length-weight relationship (LWR), condition factor (K), *Tilapia sparrmanii*, Molepo Dam, South Africa

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Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Banded tilapia, scientifically known as *Tilapia sparrmanii*, is a type of cichlid fish that is commonly found in freshwater habitats throughout Southern Africa. Although this fish can tolerate various conditions, it usually prefers slow-moving water bodies such as ponds, lagoons, rivers and impoundments. Banded tilapia prefer to live in water that has abundant plant cover[1]. This fish primarily feeds on crustaceans and insect larvae, while adults consume aquatic and terrestrial plants as well as other debris[2]. Banded tilapia are known to undertake short-distance migrations within their local habitat and they may form groups during the spawning season[3]. They do not exhibit mouthbrooding behavior like some other tilapia species but will guard and move their eggs[4]. The optimal temperature range for the growth and reproduction of *T. sparrmanii* is between 22-25°C[5]. This fish is an important part of the food chain, serving as forage fish for bass, used as bait and frequently preyed upon by larger fish species[3]. However, loss of habitat, pollution and destruction of breeding grounds pose significant threats to this fish species in its natural environment[6]. Banded tilapia is currently the primary focus of fisheries in these systems. The use of small mesh size monofilament gillnets and seine nets to catch this species may pose a threat if this trend continues to escalate. Additionally, the widespread use of dragnets could destroy the weeded habitats that this species relies on, further exacerbating the potential threat. *Tilapia sparrmanii* was most recently assessed for the IUCN Red List in 2018[7].

The condition factor is a commonly used index to measure the growth and feeding intensity of fish. This index decreases as the length of the fish increases, which can affect its reproductive cycle. The condition factor provides insight into how the fish is affected by seasonal and habitat differences and is a measure of its overall robustness[8]. Understanding length-weight relationships in aquatic organisms like fish is crucial to sustainable fishery management and conservation of biodiversity[9]. Assessing the average weight of a given length and the population's condition is important[8]. This study aimed to evaluate the condition factor and length-weight relationship (LWR) of *T. sparrmanii* at the Molepo Dam in South Africa.

MATERIALS AND METHODS

Study area: Specimens of *T. sparrmanii* were collected from the Molepo Dam (GPS coordinates: 24.0107°S, 29.7585°E). A total of 100 fish were caught by cast net from October, 2022 to March, 2023.

Specimen sampling: All collected samples were immediately stored in iceboxes and transported to the fish biology laboratory at the Aquaculture Research Unit for further analysis. The collected samples were then sorted into male and female groups. The total length of each sample was measured using a vernier caliper with an accuracy of 0.1 mm. The tilapia fish were weighed using a balance with an accuracy of 0.1g.

Growth pattern (length and weight): The total length of assessed tilapia fish was used to estimate their length-weight relationship through linear regression[10], using the following equation:

$$W = aL^b$$

Where:
W = Weight (g)
L = Total length (cm)
a = Intercept (regression constant)
b = Slope (regression coefficient)

Condition factor (CF): The condition factor (CF) is an indicator of the overall health of a fish. The CF was measured separately for each sex and each month. To calculate the condition factor for *T. sparrmanii*, the following formula[11] was used:

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

Where:
K = Condition factor
L = Length (cm)
W = Weight (g)

Sex ratio: During the sampling period, the sex ratio of male to female fish caught was estimated[12]:

$$M/F$$

Where:
M = Number of males
F = Number of females

Statistical analysis: The normality of the data was determined using the Shapiro-Wilk test. Analysis of Variance (ANOVA) with the Tukey's *post hoc* test was used to assess whether the differences obtained were significant. Every month, a non-parametric (Chi-square) test was used to determine the significant difference between the sexes. All statistical analyses were performed using SPSS (Version 16). Excel (Version 2022) was used to produce figures.

RESULTS

Length-frequency distribution: The mean weight and length of tilapia fish were 16.5±10 g and 9.14±5 cm, respectively. There was a significant difference in total length between the samples collected in different months ($p<0.05$). However, there was no significant difference in October, November and March ($p>0.05$), as shown in Table 1. The analysis of the body weight variance also indicated significant differences in different months ($p<0.05$). However, there was no significant difference in October, November and March ($p>0.05$), as depicted in Table 1.

Length-weight relationship: The plots of the length-weight relationship (LWR) in *T. sparrmanii*, a type of fish found in the Molepo Dam was shown in Fig. 1-3. The LWR graphs indicate a strong positive correlation between the length and weight of the fish, with a coefficient of determination (r^2) of 0.96 for males in Fig. 1, 0.97 for females in Fig. 2 and 0.96 for both sexes combined in Fig. 3. The regression coefficient (b) for males was 3.38 and for females was 3.18. A t-test was performed to compare the allometric growth rates (b-values) for this fish and it revealed significant differences ($p<0.05$), indicating positive allometry growth of *T. sparrmanii* in the Molepo Dam.

Table 1: Biological data of *T. sparrmanii* at the University of Limpopo Pond

Month	Weight (g)±SE	Length (cm)±SE
October	8.95±1.1^{a}	5.92±0.8^{a}
November	10.73±1.2^{ac}	7.59±0.7^{ac}
December	38.68±5.2^{b}	12.93±1.0^{b}
January	15.03±2.1^{c}	9.51±1.82^{c}
February	13.78±0.22^{c}	9.66±0.18^{c}
March	10.26±1.8^{ac}	8.73±0.7^{ac}

Similar letter(s) in a column are non-significant statistically at $p\leq0.05$

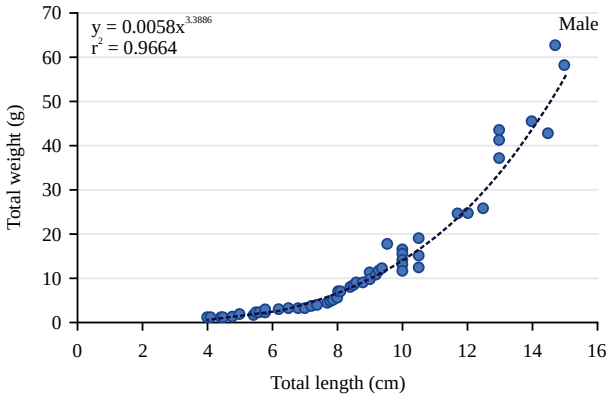

Fig. 1: Length-weight relationship of *T. sparrmanii* for male

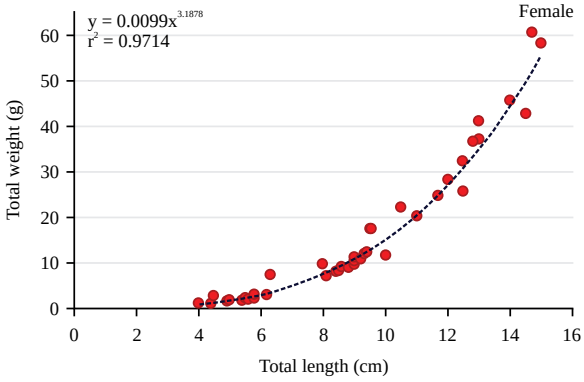

Fig. 2: Length-weight relationship of *T. sparrmanii* for female

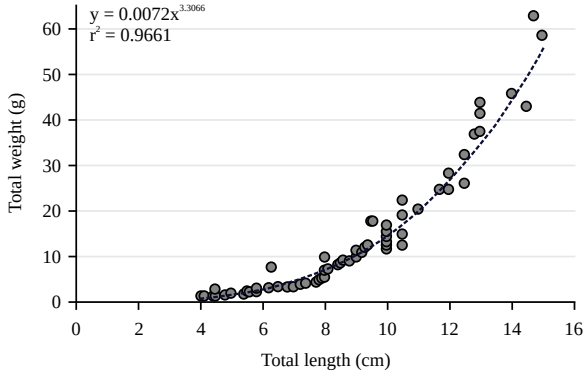

Fig. 3: Length-weight relationship of *T. sparrmanii* for both sex

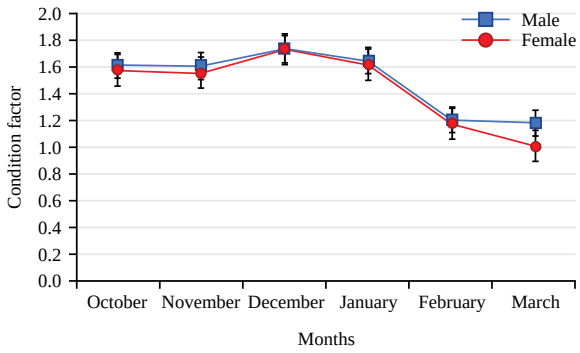

Fig. 4: Condition factor for both males and females in *T. sparrmanii* from Molepo Dam

Condition factor: Temporal variations in the condition factors of both male and female tilapia fish were observed and recorded in Fig. 1. For *T. sparrmanii*, the condition factor for males ranged from 1.18 in March to 1.73 in December, while for females, the range was from 1.01 in March to 1.74 in December (Fig. 4). No significant difference was observed in the condition factor between males and females ($p>0.05$).

Sex ratio: The male-to-female ratio was 1:1.12. No significant difference was found between the sexes ($\chi^2 = 58$, $p>0.05$), indicating equal sexual frequency in the population.

DISCUSSION

This study examines the length-weight relationship (LWR) of *T. sparrmanii*. There is a strong correlation between the total length and weight of *T. sparrmanii* according to the analysis of the length-weight relationship (LWR). The b values showed *T. sparrmanii* follow a positive allometric growth pattern, which was in agreement with the studies conducted by Mani *et al.*[13] and Dalu *et al.*[14] on *Oreochromis mossambicus* and Shalloof and El- Far[15] on *O. niloticus*, *O. aureus*, *T. zillii* and *Sarotherodon galilaeus* but Prchalová *et al.*[16] and Harrison[17] reported isometric growth pattern for *O. mossambicus* on Puerto Rico and South Africa, respectively. Factors such as growth phase, salinity, temperature, food, season, stomach fullness, gonad maturity, sex and fish health are known to influence the length-weight relationship of a species[15]; these factors were not accounted for in the present study. According to Moslen and Miebaka[18], the growth patterns of the fish studied showed that they became wider and more deep-bodied as they grew longer. The study found a strong correlation ($r^2 = 0.96$-0.97) between the length and weight of the fish, indicating that the analysis model used was a good fit for the data.

The condition factor was calculated to determine the health status of *T. sparrmanii* from the Molepo Dam. It was found that there was no significant difference in the condition factor between males and females. Furthermore, the highest condition factor was observed in January, which is a hot month in South Africa. Similar results were presented by Dalu *et al.*[14] in their study of *O. mossambicus* from Zimbabwe. Their findings showed that *O. mossambicus* was in good condition during the hot season. Zargar *et al.*[19] demonstrated

that the condition factor of *Carassius carassius* is strongly influenced by environmental factors. Aminisarteshnizi[9] reported that condition factors could vary due to factors such as feeding regime, time of the year, organisms used, biological factors and responses to environmental changes.

This report presents the first investigation of the length-weight relationship and condition factor of *T. sparrmanii* in South Africa. Information regarding this fish species is limited on a global scale and due to its inclusion on the IUCN Red List, sampling restrictions have been imposed. Consequently, further studies on *T. sparrmanii* are essential. An understanding of fish biology is crucial for the sustainable management and conservation of fish biodiversity. Therefore, the results of this report provide valuable insights into the ecology and biology of *T. sparrmanii*, which can contribute to the development of effective conservation and management strategies.

CONCLUSION

This study constitutes the initial report on the length-weight relationship and condition factor for *T. sparrmanii*. Due to the negligible information available in the literature on this particular fish, this research was found to be necessary. The study reveals that banded tilapia adheres to an allometric growth pattern in the Molepo Dam. Furthermore, the high value of the correlation coefficient "r" indicates a strong correlation between length and weight. The high value of the coefficient of determination r^2 also suggests that the model used for the analysis fits the data, thereby confirming its fitness. Additionally, the condition factor indicates a favorable environment for *T. sparrmanii* in the Molepo Dam, signifying that this location provides ideal conditions for the growth of *T. sparrmanii*. The knowledge of length-weight relationships and condition factors of introduced or invaded species is of paramount importance for assessing and managing alien and native species in an aquatic system.

SIGNIFICANCE STATEMENT

This study discovered the growth indicators such as length-weight relationship and condition factor in *T. sparrmanii* in the Molepo Dam. This study can benefit fish ecology and management. Therefore, this study is crucial to understanding the biological factors of fish to manage in the Molepo Dam effectively. In addition, this study will help the researchers uncover the critical areas of finding out the feeding strategy of the fishes that many researchers could not explore.

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