*Acta Biologica Turcica*, 38(2), kswg20250203-12p Received 01 Jan. 2025; Accepted 16 Jun. 2025; Published Online 25 Jun. 2025

ACTA BIOLOGICA TURCICA



E-ISSN: 2458-7893, http://www.actabiologicaturcica.com

*Research article*

# Stomach content analysis of *Brycinus nurse* from Bontanga Reservoir, Ghana

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**Abstract:** Studies on the stomach content of fish are essential for understanding trophic interactions, as well as the population and community dynamics of aquatic ecosystems. This study aimed to analyze the stomach content of *Brycinus nurse* from the Bontanga Reservoir in the Kumbungu District of the Northern Region, Ghana. The study was conducted across two seasons: the dry season (February to April 2023) and the wet season (May to July 2023). The stomach contents of 155 fish were analyzed using the point method and frequency of occurrence method. Of the 155 stomachs examined, 39.8% were empty during the dry season, 29% during the wet season, and 35.5% for both seasons combined. Stomachs that were quarter-full constituted 28%, 22.6%, and 25.8% for the dry season, wet season, and combined seasons, respectively. Similarly, 15.1% of the stomachs were half-full during the dry season, 21% during the wet season, and 17.4% for both seasons combined. Fully filled stomachs accounted for 17.2% during the dry season, 27.4% during the wet season, and 21.3% for both seasons combined. The identified food items included insects, sand, algae, fish scales, fish, plant material, and fish parts. Among these, fish parts were the dominant food item. The findings indicated that *Brycinus nurse* is an omnivorous species, consuming both plant and animal materials.

**Keywords:** Kumbungu district, *Brycinus nurse*, Gut content, African Nurse fish, Frequency of occurrence

**Citing:** Abobi, S.M., Henewaa, A., & Baidoo, K. (2025). Stomach content analysis of *Brycinus nurse* from Bontanga Reservoir, Ghana. *Acta Biologica Turcica*, 38(2), kswg20250203-12p.

## Introduction

The species *Brycinus nurse*, also known as the African Nurse, is a species of freshwater fish found in many rivers and lakes across Africa. *Brycinus nurse* is important in African inland fisheries, due to its abundance, widespread distribution, food and commercial value (Paugy et al., 1986). This species is one of the most preferred species for consumption and has great significance in commercial fisheries in many African water bodies (Alabi et al., 2016).

Analysis of feeding dynamics in fish is an essential prerequisite for the rational and sustainable management of fish stocks. The spatial and seasonal fluctuations in abundance of the organisms that constitute the food of a species have been found to affect and influence the biological activities of fish such as growth, condition, shoaling behaviour, migration, and the fishery. In ecosystem-based fishery management studies, these data are integrated into conceptual models that allow a better understanding of the structure and function of

diverse aquatic ecosystems. Information on the gut contents of the fishes is necessary to understand community ecology, structure and stability of food webs, trophodynamics, resource partitioning, and functional role of different fishes in aquatic ecosystems and ecological energetics (Abobi et al., 2019). Agricultural expansion has led to an extensive ecological degradation of water bodies making them no longer sustainable in providing goods and services due to degradation and depletion and has the most immediate impact on rural poverty, food insecurity, malnutrition and under-nutrition are closely linked to the degradation of environment (Abban et al., 2002). The study area (Bontanga Reservoir) also shares those problems due to large-scale agricultural and recreational investment that is affecting fishing activity in the reservoir. Therefore, there is the need to promote the culture of *B. nurse* which will require information on the species' feeding behaviour and food items. As a result, the food and feeding habits of *B. nurse* in their habitat (Bontanga reservoir) should be studied because it forms the basis for assessing the farming/culturability of the species in the fast-developing aquaculture sector of Ghana. Feed diet analysis of *B. nurse* in Bontanga reservoir will contribute to the implementation of an ecosystem approach to fisheries management for the Bontanga fisheries and to have basis for understanding trophic interactions reservoir.

This study aimed at examining the gut content of *B. nurse* from the Bontanga reservoir to establish the diet and feeding habits of the species. Specifically, to determine the different food items that the species feed on in other to guide the management of the stock and to carry out the estimation of the proportions of the various food groups in the stomachs of *B. nurse* population. Ultimately, the study provides information for constructing a diet matrix for ecosystem modelling of the Bontanga reservoir.

## Materials and Methods

### *Study Area*

The research was conducted in the Bontanga reservoir, Northern Region of Ghana. The Bontanga reservoir was constructed in 1986 located between latitudes 9° 30′ and 9° 35′ N and longitudes 1° 01′ and 1° 03′ W. It has a surface area of 770 ha with an average depth of 8 m and 12 m at its deepest portion. The mean annual rainfall for the area is 1100 mm with relative humidity of 75%. Temperature is between 15 °C and 42 °C with a mean annual temperature of 28.3 °C. The wet season begins from April/May through to September/ October with peak season in July/August and the dry season starts from November to March.

### *Collection of fish samples*

Fish samples were obtained from fishers using cast and set nets from February to July 2023. The standard length (SL) and total length (TL) of the fish were measured from the tip of the snout to the caudal peduncle and from the tip of the snout to the tip of the tail, respectively to the nearest 0.1 cm using measuring board. Body weights of individual fishes were measured to the nearest 0.01 g using electronic balance. Stomachs were preserved in labelled bottles with 4% formalin solution to prevent post-mortem digestion of the content and transported to the laboratory for analysis.

### *Laboratory Investigations*

The individual stomach was weighed after which the stomach was dissected, and the content was weighed with Analytical Balance and recorded. A dropper was used to pick a few samples of the stomach content onto a slide and placed on the stage of a light microscope of magnification ×40 to identify the various food items. Organisms in the stomach were therefore, identified and grouped into categories of food items. The food categories are: scale, fish part, plant part, sand, digested particles, filamentous algae and insects.

### *Data Analysis*

#### *Stomach Content Analysis*

Stomach contents were analyzed using frequency of occurrence (Hyslop, 1980). Frequency of Occurrence of food item = Total number of stomachs with a particular food item/total number of stomachs with food ×100%.

### *Point Method*

The Point Method was applied to classify and evaluate the stomach contents of *B. nurse* based on the relative abundance and volume of food items. Food components were categorized as very common, common, frequent, or rare, with appropriate consideration given to their size and bulk during visual estimation. Each stomach was assigned a score based on a point scale ranging from 0 to 10: 0 points for an empty stomach, 2.5 points for a quarter-full stomach, 5 points for a half-full stomach, and 10 points for a full stomach. Points were then distributed among the identifiable food items present in each stomach. The total scores for each food item across all samples were summed and converted into percentages, representing the percentage composition of the diet. This approach enabled a semi-quantitative assessment of dietary preferences. All data were systematically tabulated to allow for the comparison of dietary patterns across individuals and seasons.

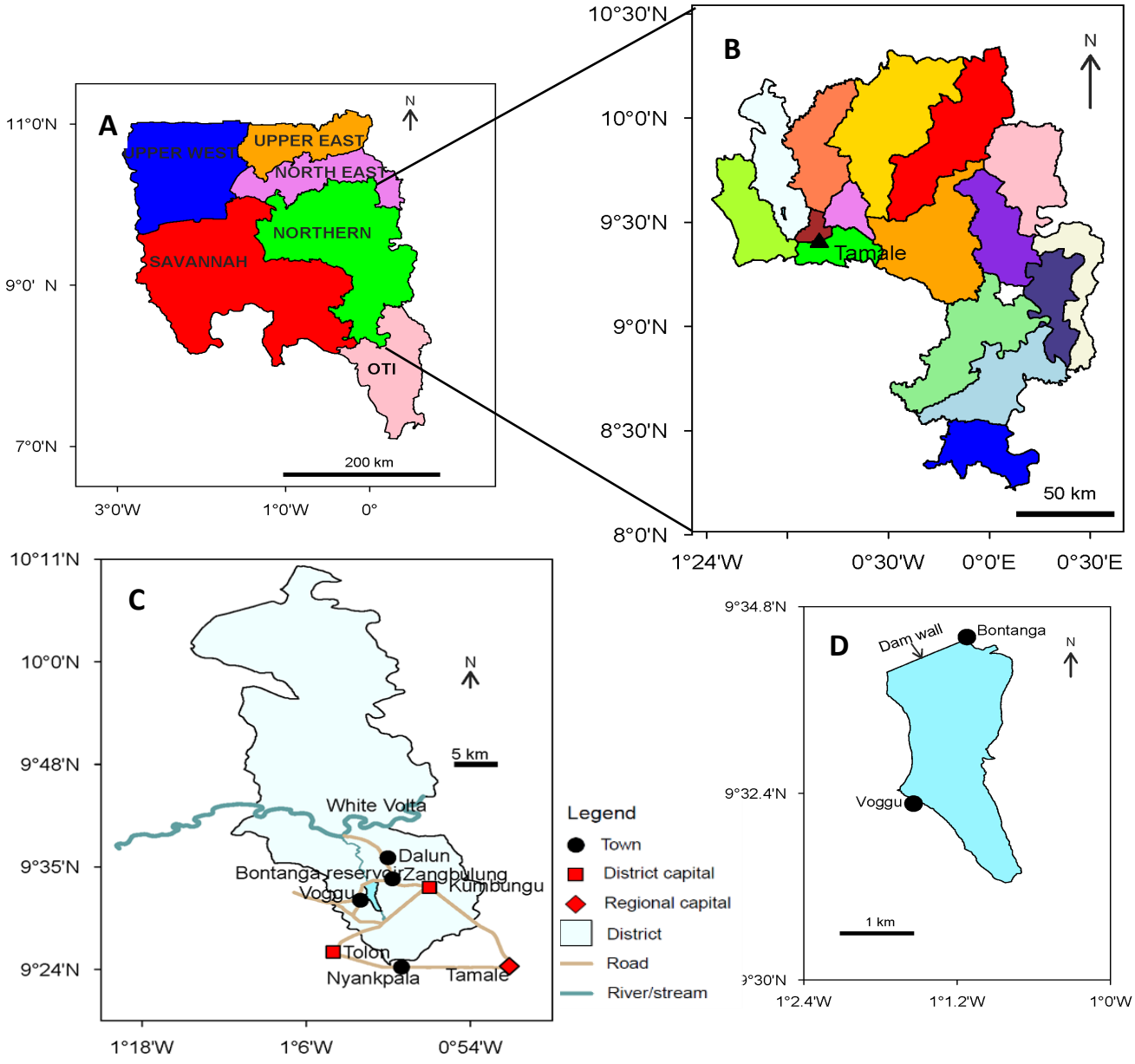


**Figure 1.** Map of Northern Ghana (Subplot A), the Northern Region (Subplot B), the Kumbungu District in the Northern Region (Subplot C), and the Bontanga Reservoir located within the Kumbungu District (Subplot D).

## Results

### *Stomach Fullness*

The study examined a total of 155 specimens from February to July 2023. The period was classified into two seasons (dry and wet seasons). The dry season comprising February, March and April and the wet season comprising May, June and July

The study revealed that out of a total of 155 stomachs examined; 39.8% were empty during the dry season, 29% during the wet season and 35.5% for both seasons combined. 28% were quarter-full during the dry season, 22.6% during the wet season and 25.8% for both seasons combined. 15.1% were half full during the dry season, 21% during the wet season and 17.4% for both seasons combined. 17.2% was full during the dry season, 27.4% during the wet season and 21.3% for both seasons combined.

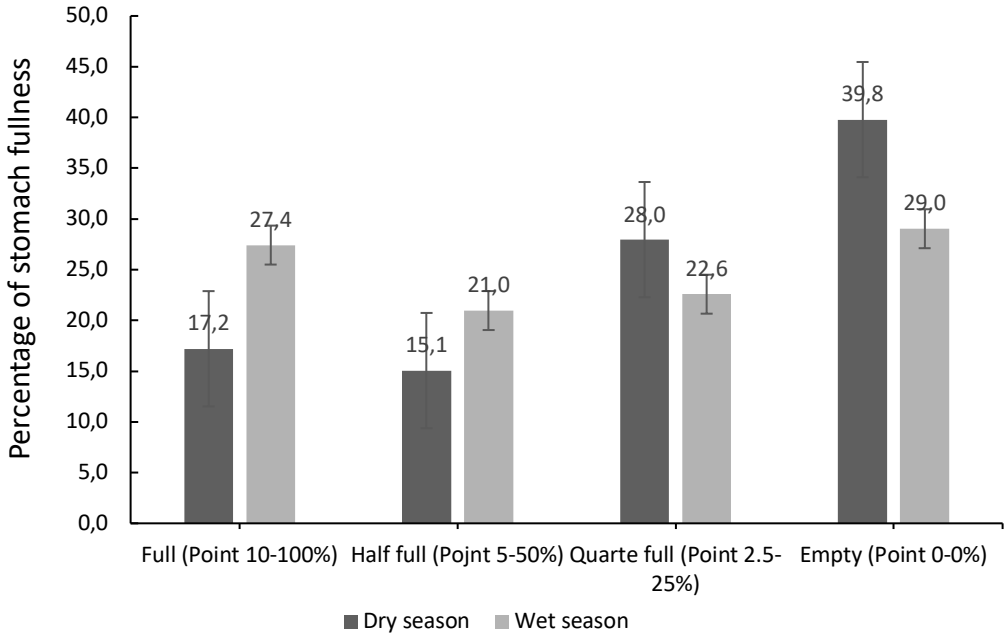


**Figure 2.** Stomach fullness of *Brycinus nurse* sampled from Bontanga reservoir

### *Stomach Content*

The examination of the contents of the stomachs of the sampled *B. nurse* for the stated period of the study found the following food particles: scales, plant parts, sand, fish parts, algae, insects, digested particles or identified particles, fish egg and prawn parts. During the dry season scale represented 23%, 11% during the wet season and 18% for both seasons. Plant parts in the dry season represented 35%, 15% during the wet season and 27.1% for both seasons. Sand represented 31% in the dry season, 18% in the wet season and 25.8% for both seasons. Fish parts represented 28% in the dry season, 44% in the wet season and 34.8% for both seasons Algae represented 26% in the dry season, 6% in the wet season and 18.1% in both seasons. Insects represented 11% in the dry season, 8% in the wet season and 9.7% for both seasons. Digested particles represented 37% in the dry season, 47% in the wet season and 40.6% for both seasons. Fish egg represented 2% in the dry season, 0% in the wet season and 1.3% for both seasons. Prawn parts represented 0% in the dry season, 2% in the wet season and 0.6% for both seasons.

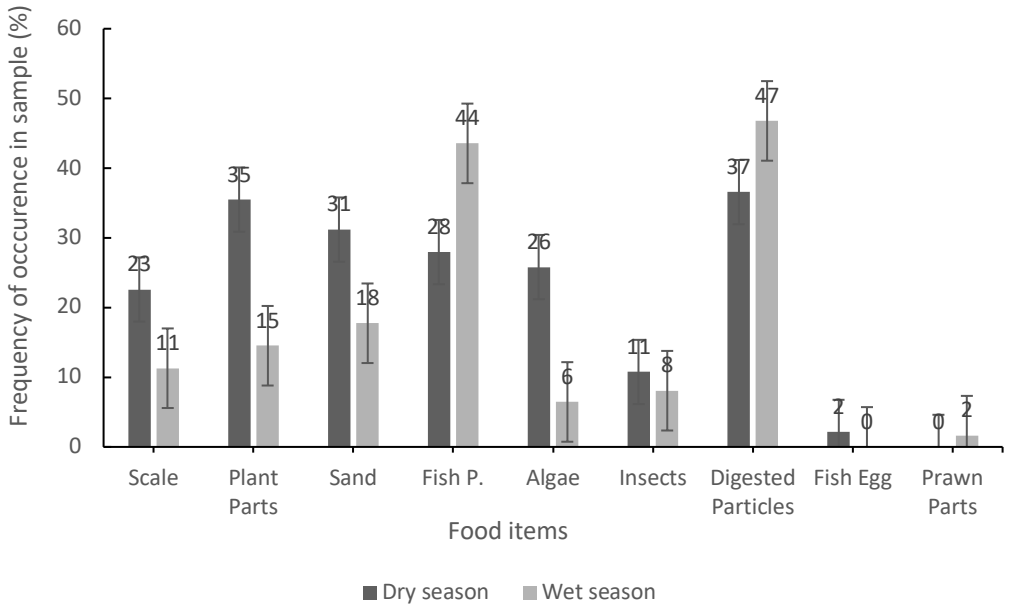


**Figure 3.** Frequency of occurrence of stomach content of *Brycinus nurse* sampled during dry and wet seasons

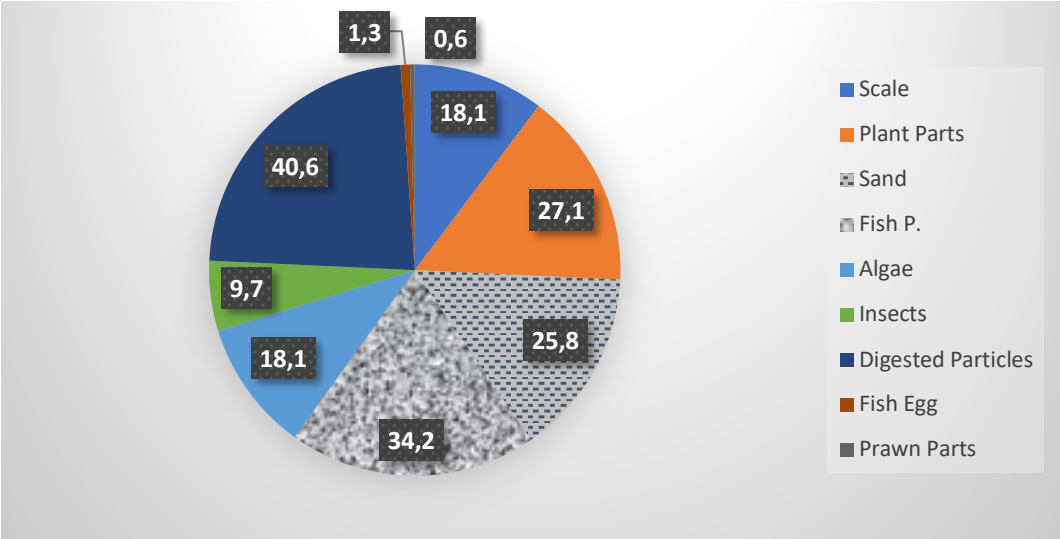


**Figure 4.** Proportion of food items found in the stomachs of the *Brycinus nurse* sampled during dry and wet seasons

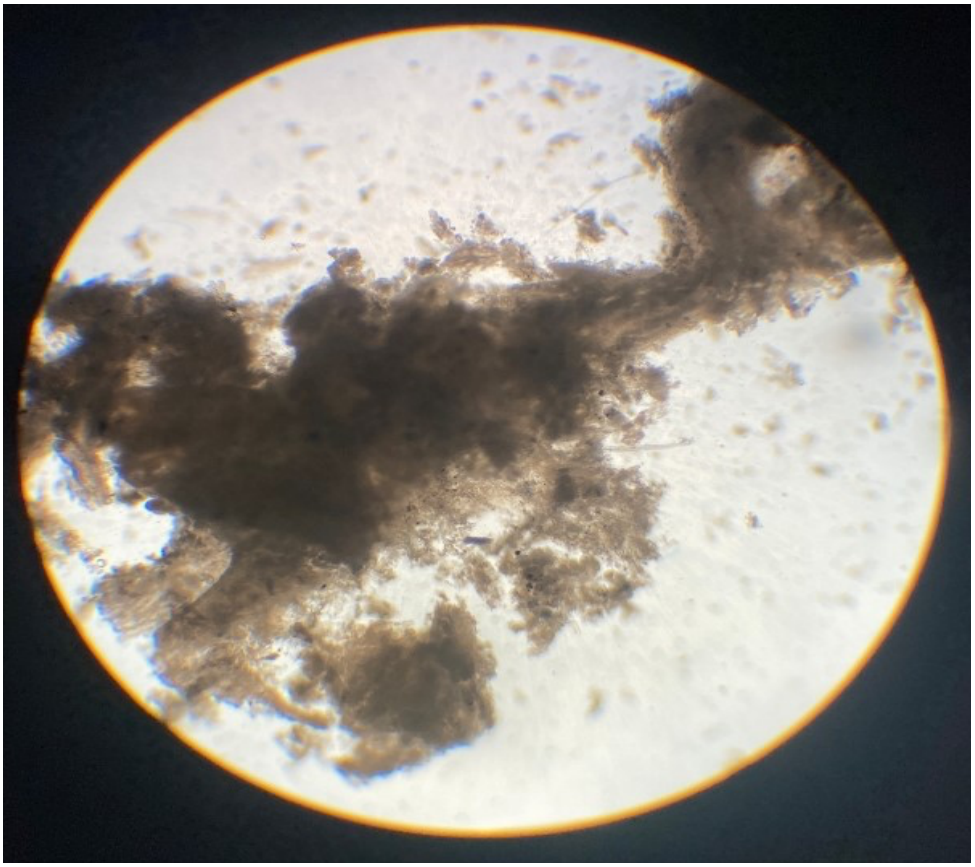

**Plate 1.** Digested particles from samples of this study examined under a light microscope


**Plate 2.** Fish in the gut of a sample from this study

**Plate 3.** Insect part from a sample of this study examined under a light microscope

***Body Weight And Gut Weight Relationship***

A model was brought up to determine whether there would be a relationship between the body weight and the gut weight of the fish sample. Analysis was done using Microsoft excel to determine if there would be a relationship between them according to the seasons and the whole six months period.

The size range for the species in Bontanga (Table 1) showed strong correlations ranging from 0.7204 to 0.9717. The size range and the modal class of *B. nurse* in the reservoir are presented in Table 1. A total of 115 fish were sampled from the reservoir from February to July. The species measured 9.1 cm total length in April to 18.7 cm in July. The mean length of the sampled specimens in February, March, April, and July were 15.2, 14.9, 12.5, and 15.8 cm, respectively. The body weight ranged from 7.1 g in April with gut wight of 0.1 g t0 670.17 g with a gut weight of 0.9 in June.

The length-weight relationship and the body weight-gut weight relationship presented in Table 2. The regression coefficient *b* was significantly higher to the hypothetical value of 3.0 in the months of April, May, June and July indicating that the species is growing isometrically. The regression coefficient *b* was significantly closer to the hypothetical value of 3.0 in the months of February and March in the Bontanga which is an indication that, the species are growing isometrically.

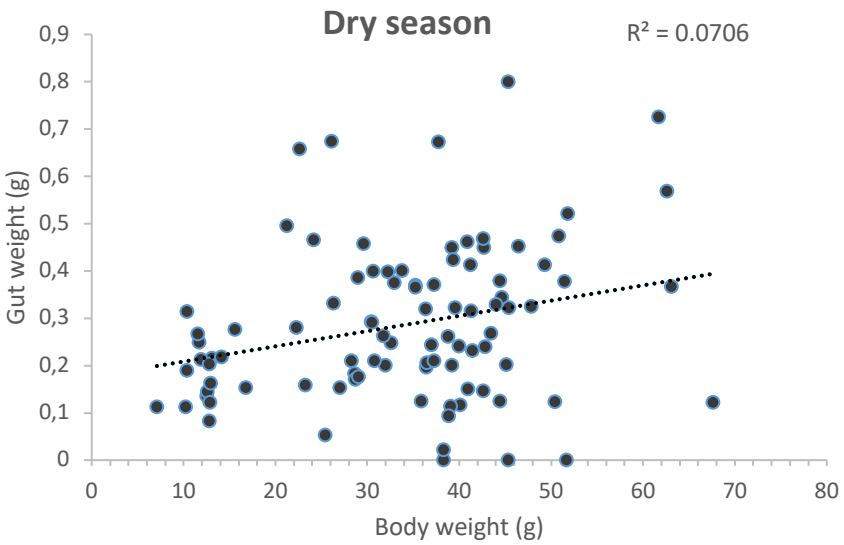


**Figure 5.** Body weight-gut weight relationship data of *Brycinus nurse* in the dry season (February to April 2023)

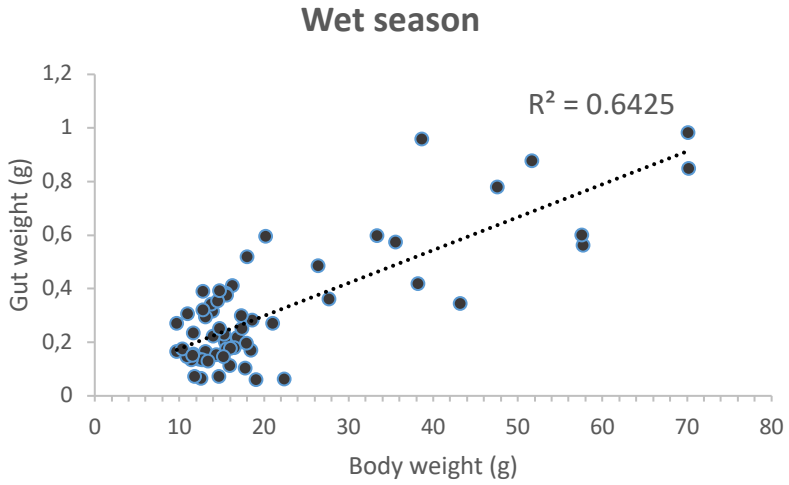


**Figure 6.** Body weight-gut weight relationship data of *Brycinus nurse* for the wet season (May to July 2023)

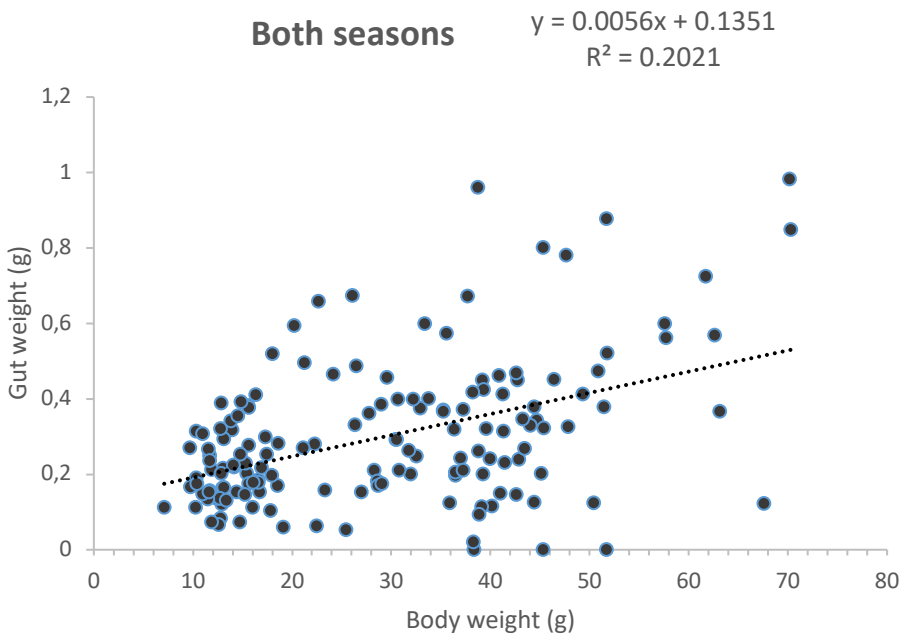


**Figure 7.** Body weight-gut weight relationship data of. *Brycinus nurse* for both seasons (February to July 2023)

**Table 1.** Size range and mean length of *Brycinus nurse*

| Month | Number of Fishes | SL (cm) range | TL (cm) range | L mean (cm) | BW (g) range | Gut weight (g) |
|---|---|---|---|---|---|---|
| February | 33 | 14-Oct | 12.6-17.1 | 15.2 | 26.99-67.59 | 0-0.7 |
| March | 30 | 10.1-14.9 | 12.6-17.6 | 14.9 | 21.24-62.6 | 0.2-0.8 |
| April | 30 | 7.1-14 | 9.1-17.6 | 12.5 | 7.1-63.12 | 0.1-0.7 |
| May | 20 | 8-10.5 | 10.3-13 | 11.4 | 9.69-27.74 | 0.1-0.6 |
| June | 31 | 8-14.5 | 10.5-18 | 12.4 | 10.3-670.17 | 0.1-0.9 |
| July | 11 | 15-9.5 | 12-18.7 | 15.8 | 15.23-70.25 | 0.1-0.9 |
| Total | **155** | | | | | |

**Table 2.** Summary of length-weight and body weight- gut weight relationship

| Month | LWR | | | BWGW Relationship | | |
|---|---|---|---|---|---|---|
| | a (Cl95%a) | *b* (Cl95%b) | *r* | a (Cl95%a) | *b* (Cl95%b) | *r* |
| February | 0.0325 | ±2.6216 | 0.8241 | 0.0008 | ±0.2034 | 0.00 |
| March | 0.0139 | ±2.9305 | 0.8289 | 0.0024 | ±0.3016 | 0.00 |
| April | 0.0068 | ±3.1387 | 0.9173 | 0.0042 | ±0.1527 | 0.02 |
| May | 0.0011 | ±3.8897 | 0.7204 | 0.0087 | ±0.0589 | 0.01 |
| June | 0.007 | ±3.0941 | 0.8247 | 0.0133 | ±0.0666 | 0.63 |
| July | 0.0021 | ±3.5769 | 0.9747 | 0.0106 | ±0.1321 | 0.18 |

## Discussion

### *Feeding Habits*

Food and feeding behaviour of any animal that has economic importance globally, forms a significant aspect of animal biology. Data on food and feeding habits are more vital, as they provide a lot of information on the growth, distribution and biology of the fish (Mbimbi et al., 2014). The variation in the consumption of the food items recorded in this study at the Bontanga reservoir is similar to the findings of

Safo et al. (2013) from the Asa reservoir in Nigeria, which reported that the *B. nurse* in the reservoir fed on food items ranging from plant parts, insect parts, fish parts, sand and algae and considered the *B. nurse* from the Asa reservoir to be omnivorous. The high percentage of the fish parts and plant parts encountered in the guts at the Bontanga reservoir is in line with the observation of Smith et al. (2019)., and Jobling (2012) but the only difference was the prawn part that was discovered in the gut in the study at the Bontanga reservoir.

It was observed from the study that, *B. nurse* fed well and most on the fish parts during the wet season than they did on the plant parts and in the dry season, they fed well and most on the plant parts than the fish parts and it could be as a result of seasonal dominance of these food items in the aquatic environment.

***Stomach Fullness***

The findings of the study on stomach fullness vary from the study by Olaosebikan and Raji (2010) that examined the stomach fullness of *B. nurse* from the Ethiope River in Nigeria and found 5 stomachs as quarter full, 9 stomachs as half full, 3 stomachs as 3quaters full and 26 stomachs as full. However, this study at the Bontanga reservoir found 55 stomachs empty, 40 quarter-full stomachs, 27 half-full stomachs and 33 full stomachs. During the study, it was observed that more stomachs were empty and quarterly filled which represented 39.8% and 28% respectively and only 17.2% were fully filled during the Dry season and in the Wet season, it was observed that more stomachs were fully filled which represented 27.4%. This could also be a result of the seasonal dominance of these food items in the aquatic environment.

***Food items***

*Brycinus nurse* in the Bontanga Reservoir, feed on various food items, such as fish scales, sand, plant parts, fish parts, algae, insects, digested or unidentified food particles, fish eggs and prawn parts. The dominant food items, that is the plant and fish parts found represent clearly that the species is omnivores. As they consume widely on both plants and animals.

Ntiba et al. (2019) reported the diet of *B. nurse* from the Asa reservoir in Nigeria to be omnivores with a vast array of food items including the 9 families (flagellates, bivalves, copepods, branchiopods, ephemeropterans, arachnids, chlorophytes and higher plants). In the Jamieson River, Niger Delta, Nigeria, *B. nurse* fed on allochthonous food items on the water surface and substratum and the primary food items consumed by the species were insects mainly Hymenoptera (tailor ants) and Coleoptera (Ikomi & Sikoki, 2003). The variation in the findings of these studies to that of the Bontanga reservoir is prawn parts that were found. Mwinuka and Ezekiel (2003) also found plant parts, fish parts, sand, insects, and algae and this finding supports the findings of the study at the Bontanga reservoir with the variation in prawn parts that was found at the Bontanga reservoir. The findings of Nsor et al. (2019) and Nitab et al. (2001) and the findings of this study at the Bontanga reservoir confirm the species as omnivores: they feed on both plants and animals.

***Proportion of Food Items***

The study found fish parts and plant parts as the dominant food items in the species at the Bontanga reservoir. Fish parts constitute 34.2% and plant parts 27.1%. this finding varies from Saliu (2002) who found plant parts as the dominant (63.8%) identified food item.

Garcia and Martinez (2005) compared the feeding habits of *B. nurse* and three congeneric species in the Amazon basin and discovered plant material as the dominant identified food item in the guts constituting 70% which differs from this study at the Bontanga reservoir which found fish parts as the dominant identified food item constituting 34.2%.

***Gut Weight and Body Weight Relationship***

The regression analysis did not show a predictive relationship because the R-square showed weakness. In the dry season, only 7% of the variation of the data could be explained. In the wet season, 60% of the variation of the data could be explained which is moderate. But putting all the six months of data

together, only 20% of the variation could be explained which shows weakness.

## Conclusion

The results from the study indicate that, *B. nurse* from Bontanga reservoir feeds extensively on fish parts and plant parts which makes them omnivorous. The study found different food items like (plant parts, fish parts, insect parts, sand, algae, prawn, fish scales, digested particles, fish egg) that the species feed on.

The results of the study show fish parts and plant parts as the dominant food items that *B. nurse* at the reservoir feed on and found digested particles/unidentified particles as the dominant portion of the identified items in the stomach, this is as a result of *B. nurse* being able to naturally digest food within the shortest period.

The result from the BWGW relationship did not show predictive relative because the R-square showed weakness.

## Acknowledgement

The authors gratefully acknowledge the fishers of Bontanga for their invaluable support and cooperation during the data collection phase of this study. We also extend our sincere appreciation to the staff of the Spanish Laboratory, University for Development Studies, Tamale, Ghana, for their technical assistance with the microscopic examination of the stomach contents.

## Ethical Approval

Not applicable to this study.

## Conflict of interest

The authors declare that there are no conflicts of interest related to this study.

## Funding Statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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