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Feeding Habits of *Bryconalestes tholloni* (Pellegrin, 1901) (Characiformes: Alestidae) from Mafoubou River (Sous-Affluent of Niari River) in Congo Brazzaville

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Abstract

The diet of *Bryconalestes tholloni* from Mafoubou River, Sous-affluent of Niari River was studied by examining the stomach contents of 75 specimens captured using the cast nets. This study is the first realized on the trophic ecology of a fish species of Niari Basin. Three stations were sampled monthly from July to December 2019. The diet was analyzed according to hydrological season and fish size. The vacuity coefficient is 27%, feeding habits of *Bryconalestes tholloni* were analyzed using the preponderance index which combines the occurrence percentage and the weight percentage. *Bryconalestes tholloni* is insectivorous (Ip = 95.54%) and becomes omnivorus to predominantly frugivorous, the preponderance index of fruits is equal to 93.6% in large individuals. There is no variation in diet according to the season. These results constitute a first database on the feeding habits Niari Basin fishes.

Keywords

Mafoubou River, *Bryconalestes tholloni*, Preponderance Index, Insectivorous, Congo Brazzaville

1. Introduction

The continental waters of Congo Brazzaville are divided into two fish provinces: the Congo Basin Province and the Lower Guinea Province. The ichthyofauna of these two provinces is the least studied in comparison with most countries in Central Africa; the research carried out is mainly focused on one-off inventories.

Knowledge of fish diet in the natural environment is an essential step in understanding their biology and ecology [1]. Trophic ecology studies allow us to understand the functional role of fish in any aquatic ecosystem [2] [3]. Data on food composition make it possible to understand trophic interactions with a view to fisheries development and the impact of fishing on the ecosystem [4].

A good knowledge of the feeding habits of a fish species constitutes an essential source of information for the development of an effective protection and management program for this species or the carrying out of domestication trials [5] [6]. There are a few bioecological studies on fish from the Congo Basin, but in Lower Guinea, we find almost exclusively inventories. The diet of *C. auratus* from Lake Loufoualéba in the Department of Pointe Noire has been studied by [7]. The structure of a fish community most often depends on a trophic factor (57%), a temporal factor (11%) or an environmental factor (32%) [8]. A few examples illustrate the primordial aspect of the trophic factor.

Bryconalestes tholloni is an uncommon species of Alestidae found in southern Gabon (haut Ogooué and Nyanga) and in Congo (Kouilou) [9]. This species has never been recorded in other basins in the region. It therefore seems endemic to these two basins of lower Guinea. The morphometric characteristics showed that the standard length of *Bryconalestes tholloni* varies between 69.5 and 109 mm [10] and are closed to *B. bartoni*, *B. longipinnis*, *B. derhami* and *B. intermedius*. In Congo, no study is available on the trophic ecology of this species. It is for this reason that we carried out a qualitative and quantitative study of *B. tholloni* diet, while analyzing the composition of ingested foods according to the season and the size of individuals.

2. Materials and Methods

2.1. Presentation of the Study Area

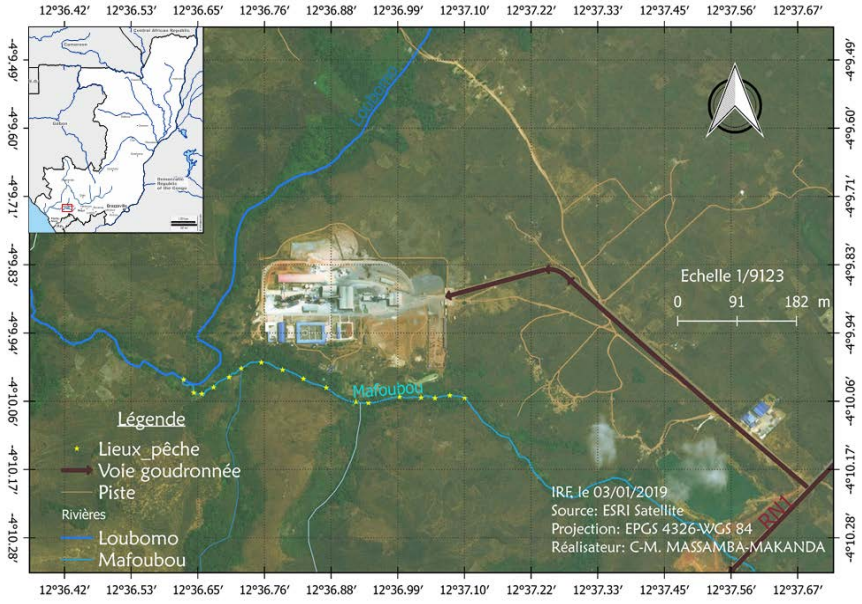

Figure 1. Map of sampling area (Forest Research Institute, 2019).

The Mafoubou River is located in the Niari Department, precisely in the Louvakou district near the town of Dolisie. This river is a tributary of the Loubomo and its source southwest of Dolisie where it flows in a SW-NW direction to the east of Dolisie. It receives two tributaries to the east and two other tributaries to the west before flowing in a northeast direction; South-west to the north of Dolisie a few meters before its confluence with the Loubomo (**Figure 1**).

2.2. Intestinal Coefficient

The intestinal coefficient (IC) was calculated for each individual according to the following formula described by [11]: IC = IL/SL, where IL is intestine length and SL represents the standard length.

2.3. Analysis of Stomach Contents

The study of fish diet often includes two types of analyses: qualitative analysis and quantitative analysis [12]. Qualitative analysis which consists of drawing up a complete list of the different prey encountered in the stomachs, followed by a quantitative analysis which specifies the importance of the different prey and highlights the possible variations in the diet according to size and season. To characterize the diet, five indices were used.

2.4. Emptiness Coefficient

The emptiness coefficient is the ratio expressed as a percentage between the number of empty stomachs *Es* and the total number of stomachs examined *NT*:

$$V = \frac{Es}{NT} \times 100$$

2.5. Degree of Presence or Percentage of Occurrence (%OC)

It is the dietary index used to analyze the dietary results of this species [13], it is given by the following relationship:

$$\%\mathrm{OC} = \frac{Ni}{NT} \times 100$$

Where, *Ni* is the number of stomachs containing a prey category *i*; *NT* represents the total number of full stomachs examined.

2.6. Weight Percentage (%P)

This percentage does not provide any indication of dietary preferences [14].

$$\%\mathrm{P} = \frac{Ni}{PT} \times 100$$

Where *Pi* = weight of item *i* and *Pt* = total weight of all items.

2.7. Preponderance Index (Ip)

This index of [15], modified by [16] makes it possible to quantify the proportion

of each food item in the diet. Its calculation is based on the occurrence percentage [13] [17] [18] and the weight percentage [14] [19]. Its formula is as follows:

$$\frac{\%Oc \times \%P}{\sum(\%Oc \times \%P)} \times 100$$

This index which varies from 0 to 100, the classification of the different prey is as follows according to [12]: Ip < 10: accessory prey; 10 < Ip < 25: secondary prey; 25 < Ip < 50: important prey and Ip > 50: main prey.

2.8. Schoener Index

The calculation of the Schoener index makes it possible to evaluate the degree of similarity in the composition of the diet between size class and seasons [20] Its formula is as follows:

$$\alpha = 1 - 0.5\left(\sum_{i=1}^{n} |Pxi - Pyi|\right)$$

Where, *Pxi* represents the proportion of prey consumed by individuals in a season *x* and *Pyi* is the proportion of prey consumed by individuals in a season *y*.

When the Schoener index is greater than or equal to 0.6, diets are significantly similar [21].

2.9. Statistical Analysis

The ascending hierarchical classification analysis based on Euclidean distance and by Ward's method was carried out using the preponderance indices of prey consumed in each size class. The dendrogram thus obtained made it possible to distribute the size classes by groups.

3. Results and Discussion

Figure 2 shows the photo of a fresh specimen of *Bryconalestes tholloni*.

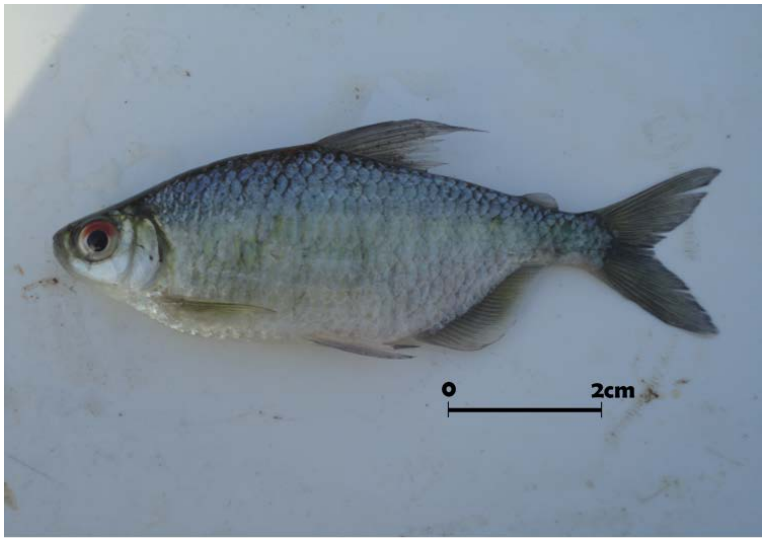

Figure 2. Specimen of *Bryconalestes tholloni* (LS = 125 mm).

3.1. Morphology of the Digestive Tract

The digestive tract of *Bryconalestes tholloni* has a thick-walled and muscular esophagus, followed by a developed U-shaped stomach. It has a well-individualized pyloric and cardiac branch. The pyloric caeca extend over the intestine which is short and folds on itself (Figure 3).

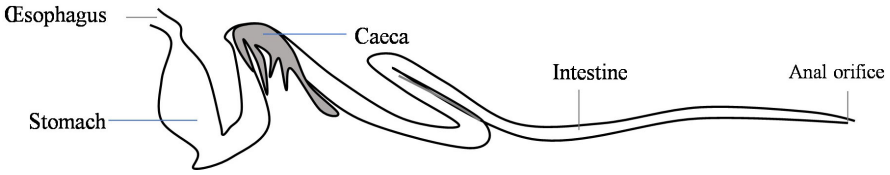

Figure 3. Anatomical structure of the digestive tract of *B. tholloni*.

3.2. Intestinal Coefficient

The intestinal coefficient calculation made it possible to find values between 0.48 and 1.09, with an average of 0.74 ± 0.09. The fact that these values are between 0.3 and 2.18 indicates that *Bryconalestes tholloni* is an omnivorous, invertivorous species [22] and [11]. There is a significant linear relationship (r = 0.66) between gut length and standard fish length (Figure 4).

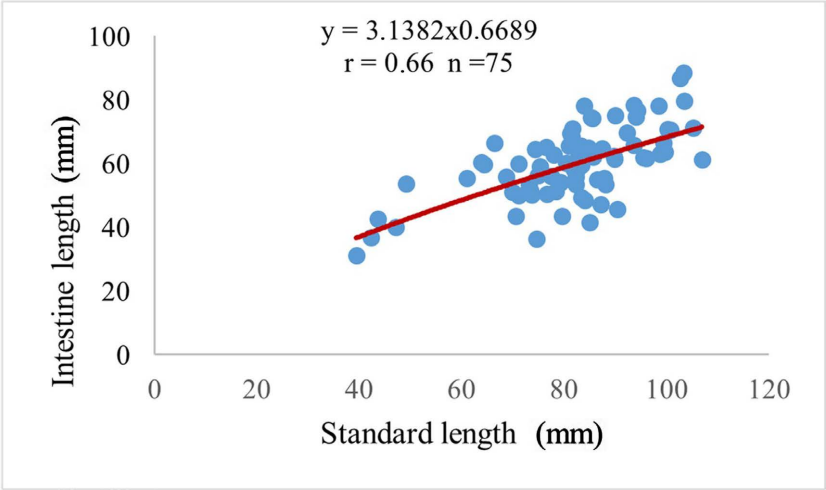

Figure 4. Relationship between intestine length and standard length of *B. tholloni*.

3.3. Emptiness Coefficient (%V)

Examination of the 75 stomachs showed that 7 were empty, which corresponds to an emptiness coefficient of 9.33%. During the dry season, 40 stomachs were examined, among which 6 were empty, the emptiness coefficient is 15%. During the rainy season, out of the 35 stomachs examined, only one stomach was empty, the emptiness coefficient is equal to 2.85%.

3.4. General Diet Profile of *B. tholloni*

The general profile of the diet made it possible to identify 15 food items grouped

into two fractions: the animal fraction (invertebrates) and the plant fraction (fruits). The animal fraction is made up of invertebrates forming 14 food items divided into 4 groups: insects (11 items), arachnids (1 item), nematodes (1 item), annelida (1 item). The plant fraction consists mainly of fruits (Table 1). *Bryconalestes tholloni* mainly consume insects (Ip = 95.54%), including hymenoptera which represent important prey (Ip = 32.27%) and beetles which are secondary prey (Ip = 13.26%). Fruits (Ip = 3.98%) are accessory prey (Figure 5).

Table 1. Diet composition of *B. tholloni*.

Food items	Global			Saison sèche			Saison de pluies		
	% P	%OC	Ip	% P	%OC	Ip	% P	%OC	Ip
Insect remains	23.04	89.70	47.08	30.80	82.5	63.11	4.09	80	9.69
Hymenoptera	16.70	82	32.27	13.88	60	20.65	16.68	82.35	36.66
Coleoptera	8.73	64.70	13.26	2.29	32.5	1.84	13.31	88.571	34.94
Diptera	1.11	41.18	1.08	0.77	30	0.57	1.35	45.71	1.84
Ephemeroptera	0.34	7.35	0.05	0.55	10	0.13	0.19	2.85	0.28
Heteroptera	21.74	11.76	0.33	1.43	10	0.35	2.05	2.85	0.45
Orthoptera	3.03	10.29	0.73	3.96	5	0.51	2.37	14.28	1.00
Blattoptera	3.06	8.82	0.57	3.46	2.5	0.21	2.25	14.28	0.95
Zygoptera	0.61	2.94	0.04	-	-	-	0.61	2.94	0.47
Trichoptera	1.19	2.94	0.08	-	-	-	1.19	2.94	0.73
Isoptera	0.74	2.94	0.05	-	-	-	0.74	2.94	0.52
Spiders	0.021	1.47	0.40	0.021	1.47	0.40	-	-	-
Nematodes	0.16	7.35	0.04	0.03	5	0.11	0.25	14.28	0.09
Annelida	0.22	10.29	0.04	0.17	7.5	0.05	0.25	5.71	0.06
Fruits	19.25	8.82	3.98	40.88	12.5	12.07	3.89	2.85	12.32

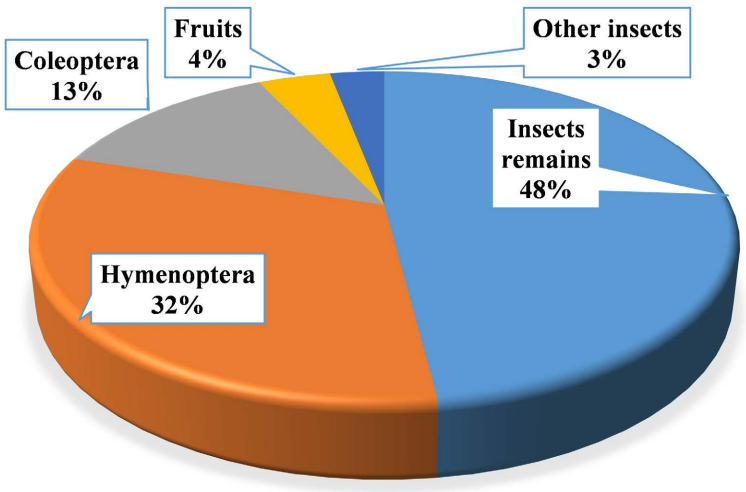

Figure 5. Spectrum of preponderance index of food items.

Specimens of *Bryconalestes tholloni* from the Mafoubou River have an omnivorous-insectivorous diet [11] [12], because its intestinal coefficient is between 0.48 and 1.09. Similar results were obtained in *Bryconalestes comptus* on the right bank of Pool Malebo by [23]. *Bryconalestes tholloni* mainly consumes insects and secondarily fruits, nematodes, annelids and spiders. Hymenoptera and beetles are the most consumed prey. This essentially insectivorous diet could be explained as reported by [24], by the presence of significant vegetation along the river. Similar diets of fish belonging to the same genus have been described by several authors in continental waterways. In the Niger River and the Chari, a diet essentially based on seeds, plants and insects was described by [25]. A diet based on macrophytes and terrestrial insects was demonstrated in *Brycinus macrolepidotus* by [26] as well as [23]. According to [27], these species almost all feed on terrestrial insects. *Bryconalestes comptus* from the right bank of the Pool Malebo (Congo River) also consumes insects [22].

3.5. Diet Profile According to the Size

Hymenoptera are important prey consumed by class 1 (38%), class 4 and class 5 (36%) of *Bryconalestes tholloni*. They constitute secondary prey (12%) for specimens of classes 3 and 6. Beetles are secondary prey (20.68%) consumed by class 5, dipterans are also secondary prey consumed by class 3. Mayfly larvae represent secondary prey for class 2 specimens (**Figure 6**).

Overall, insects constitute the main prey for class 1 (90%), class 2 (98.34%), class 3 (84%), class 4 (91%), class 5 (82%), class 6 (78.51%); in class 7, insects are accessory prey with an Ip equal to 7%. On the other hand, the fruits which are the secondary prey (21.11%) consumed by the specimens of *Bryconalestes tholloni* of class 6, become the main prey (93.6%) consumed by the specimens of class 7, the insects are accessory prey (7%). Annelids and nematodes are accessory prey (0.04%) consumed by class 2 specimens, as well as arachnids (0.02%) for class 4 specimens (**Figure 7**).

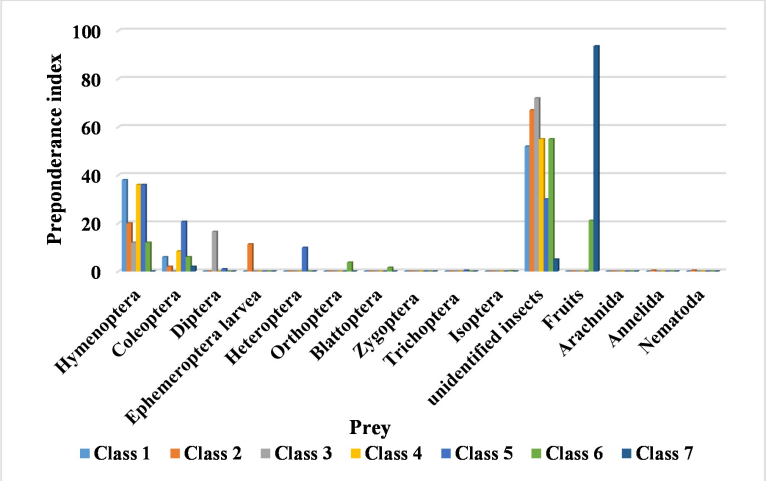

Figure 6. Food item consumed by *B. tholloni* according to the size.

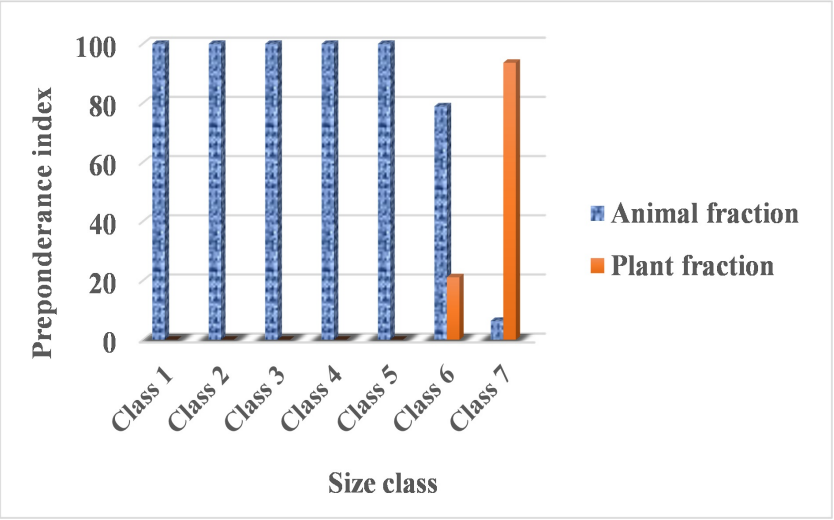

Figure 7. Prey groups consumed by *B. tholloni* according to the size.

Examination of the food affinity dendrogram between the different size classes of *Bryconalestes tholloni* made it possible to discriminate, three groups of size classes at the aggregation threshold of 30%. Class 7 stands out by forming group I which stands out from the other two groups of size classes. Specimens in this group mainly consume fruits. Group II is made up of size classes 5, 1 and 4; group III is made up of classes 6, 2 and 3 (**Figure 8**).

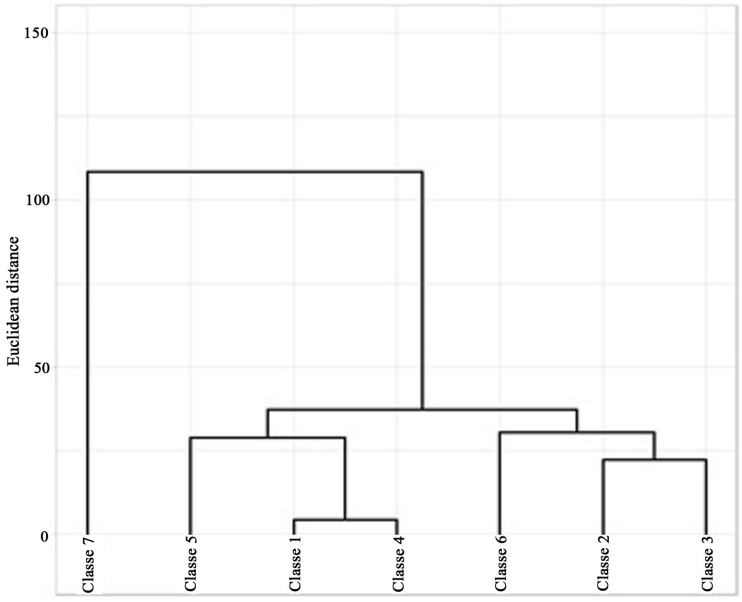

Figure 8. Dendrogram showing dietary similarities between size classes of *B. tholloni*.

3.6. Diet Profile According to the Season

In the rainy season, insects remain the main prey of *Bryconalestes tholloni*, with a preponderance index of 98%, other prey (fruits, nematodes, annelids) are accessory prey. Among insects, Hymenoptera (Ip = 36.66%) and Coleoptera (Ip =

32.27%) are secondary prey (Figure 9). In the dry season, insects represent the main prey of *Bryconalestes tholloni*, with a preponderance index of 87%, fruits are secondary prey with an Ip of 13%, Nematodes and Annelida are accessory prey (Ip = 0.04%). Among Insects, Hymenoptera and Beetles are secondary prey with an Ip of 20.25%. The diet does not present a significant difference between the two seasons, because the Schoener α index is greater than 0.6.

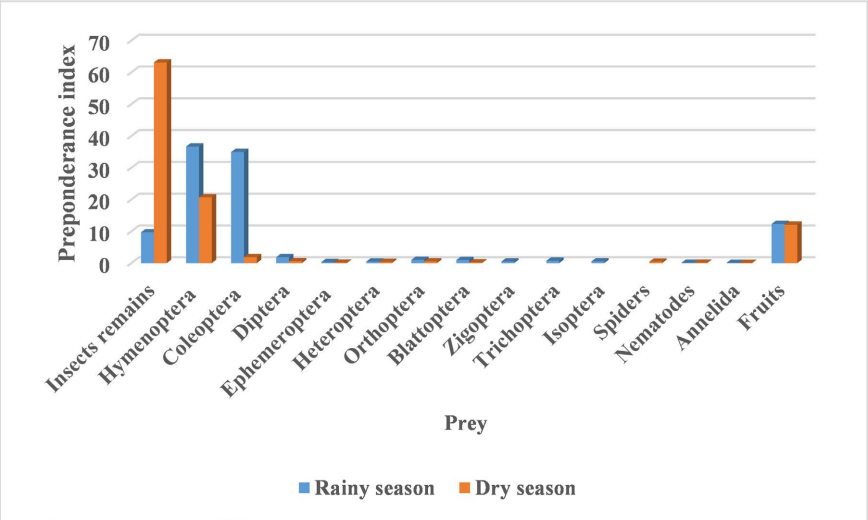

Figure 9. Food spectrum of *B. tholloni* according to the season.

4. Conclusion

The diet of *Bryconalestes tholloni* corresponds well to the diet of Alestidae which are consumers of terrestrial insects and fruits. Hymenoptera are important prey and Coleoptera are secondary prey. This diet does not vary depending on the season, but varies depending on the size, it is noted that the fruits appear in the digestive tracts of specimens of class 6 and become main prey of the larger specimens (class 7) with a standard length superior to 100 mm. This first study on the trophic ecology of *B. tholloni* must be extended to other fish species in this watercourse.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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