*Research Journal of Animal, Veterinary and Fishery Sciences* _____ISSN 2320 – 6535
Vol. **12(2),** 6-13, November **(2024)** *Res. J. Animal, Veterinary and Fishery Sci.*

# Diet of Micralestes stormsi Boulenger, 1902 (Characiformes: Alestidae) from Djiri River (tributary of the right bank of Congo River)

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**Available online at: www.isca.in, www.isca.me**
Received 8th September 2023, revised 24th May 2024, accepted 7th July 2024

## Abstract

*The composition of the diet of 300 specimens of Micralestes stormsi from the Djiri River (northern suburbs of Brazzaville) was studied according to fish size, sampling stations and hydrological seasons. The fish were captured using cast net from January 2010 to December 2012. The results obtained showed that the vacuity index is equal to 22%. The diet of Micralestes stormsi was assessed using the preponderance index (Ip) which combines numerical occurrence (%OC) and weight percentage (%P).Insects (Ip=84.53%) and green algae (Ip=15.47%) constitute the bulk of the diet of Micralestes stormsi; there is no significant variation in diet according to fish size, sampling stations and hydrological seasons. This species has an insectivorous diet.*

**Keywords:** Djiri River, *Micralestes stormsi*, diet, insectivorous, Congo.

## Introduction

Knowledge of diet of a fish species provides a key to the understanding of many aspects of fishbiology, physiology and behavior. From the ecological point of view, such studies allow investigation of trophic interactions between and within species, namely predator-prey relationships and competition. Knowledge of feeding habits is important basic data in conservation and sustainable stock management strategies[1].

The diet of most dwarf species is not yet well known, and studies of particular aspects of diet, including variation according to size, sex, environment and hydrological seasons are also rare. In addition, the study of the diet allows to understand how the sharing of resources takes place in the environment and the phenomena of competition[2]. The study of the diet of fish in the Congo Basin has until now only been the subject of fragmentary studies concerning a very small number of species. *Micralestes stormsi* is a species of dwarf Alestidae present in the Congo Basin[3], recorded in the main tributaries of the right bank of the Congo River[4-7].

There is very little information available about this species. An author studied the diet of *Micralestes acutidens* in the Ikéla region and Lac Tumba of the Democratic Republic of Congo[8], he gave only qualitative data. The present study provides quantitative information on the diet as well as its variation according to size class, sampling stations and hydrological the season.

## Materials and Methods

**Sampling area:** The Djiri River is a tributary watercourse of the right bank of the Congo River whose source is located to the south of the Mbé plateau and in the high hills which extend the plateaux Batékés. It is 50 kilometers long, its surface area is equal to 853km$^2$, its flow rate is 27 l/s/km$^2$ and its flow coefficient is equal to 47%. The Djiri River, which flows in a NW-SE direction, has five main tributaries, three of which are located on the left bank: the Bilolo River and the Bitatolo River and the Kouala-Kouala River. On the right bank are the Bamba River and the Souo River[9]. The sampling area geo references are: 04.18117-04.13095 south latitude and 15.31177-015.32192 east longitude (Figure-1).

**Analysis of stomach contents:** The analysis of the diet was done using different indices:

**Coefficient of emptiness (CV)** = (Ev/Nt) x 100, where, Ev corresponds to the empty stomachs number and $N_t$ is the total number of the stomachs examined.

**Intestinal coefficient (IC)**[11] = IL/SL, where IL represents the intestine length and SL the standard length. This index makes it possible to define different types of diets: ichthyophagous (0.85), invertivorous (0.32-2.18), omnivorous (0.80-3.0), phytophagous (4.71-6. 78), limnovorus (10-17).

**Coefficient of occurrence (%CO)**[12] = (Nev/Nt) x 100, where Nev represents the number of stomachs containing a category of prey i and $N_t$ the total number of full stomachs examined.

**Weight percentage (%P)**[12] = Pi/Pt, where Pi represents the total weight of item i and Pt the total weight of all food items inventoried.

**Indice de preponderance (Ip)**[2,14] = [%OCx%P/∑(%OCx%P)] x 100. The different prey were classified according to the values of the preponderance index: Ip≥50: main prey, 25≤Ip<50: important prey, 10≤Ip<25: secondary prey, Ip≤10: accessory or accidental prey.

Size structure was determined using Sturges' rule[16]: NC = 1+3,3 x $Log_{10}$ N where, NC represents the total number of specimens examined; Lsmax is the maximum standard length and LS min is the minimum standard length. The size class interval was calculated by the following formula: I=(Lsmax-Lsmin)/NC.

**Schoener index (α)** = 1-0,5($\sum_{i=1}^{n}|Pxi - Pyi|$)was calculatedfor evaluationof the similarity degreeof the diet between size, stations andseasons[17], where, Pxi represents the proportion of prey consumed by specimens of a season x and Pyi is the proportion of prey consumed by specimens in a season y. Diets are considered significantly similar when the value of α is greater than or equal to 0.6[18].

**Statistical analyses:** Statistical analyzes were carried out using Excel software and the Statistica 7.1 program (StatsoftInc). A Cluster analysis based on Euclidean distance is performed from matrix the prey occurrence -size classes, to identify the similarities between diets of specimens at different sizes. The combination of monthly results in two hydrological seasons makes it possible to determine seasonal variations in the diet of the species studied.

## Results and Discussion

Emptiness coefficient: Among the three hundred (300) stomachs of *Micralestes stormsi* examined, 234 contained food and 66 were empty, that is an emptiness coefficient of 22%. *Micralestes stormsi's* emptiness coefficient is moderately low, so food is sufficiently available in the Djiri. This availability of food in the Djiri River well explains the relative abundance of *Micralestes stormsi.*

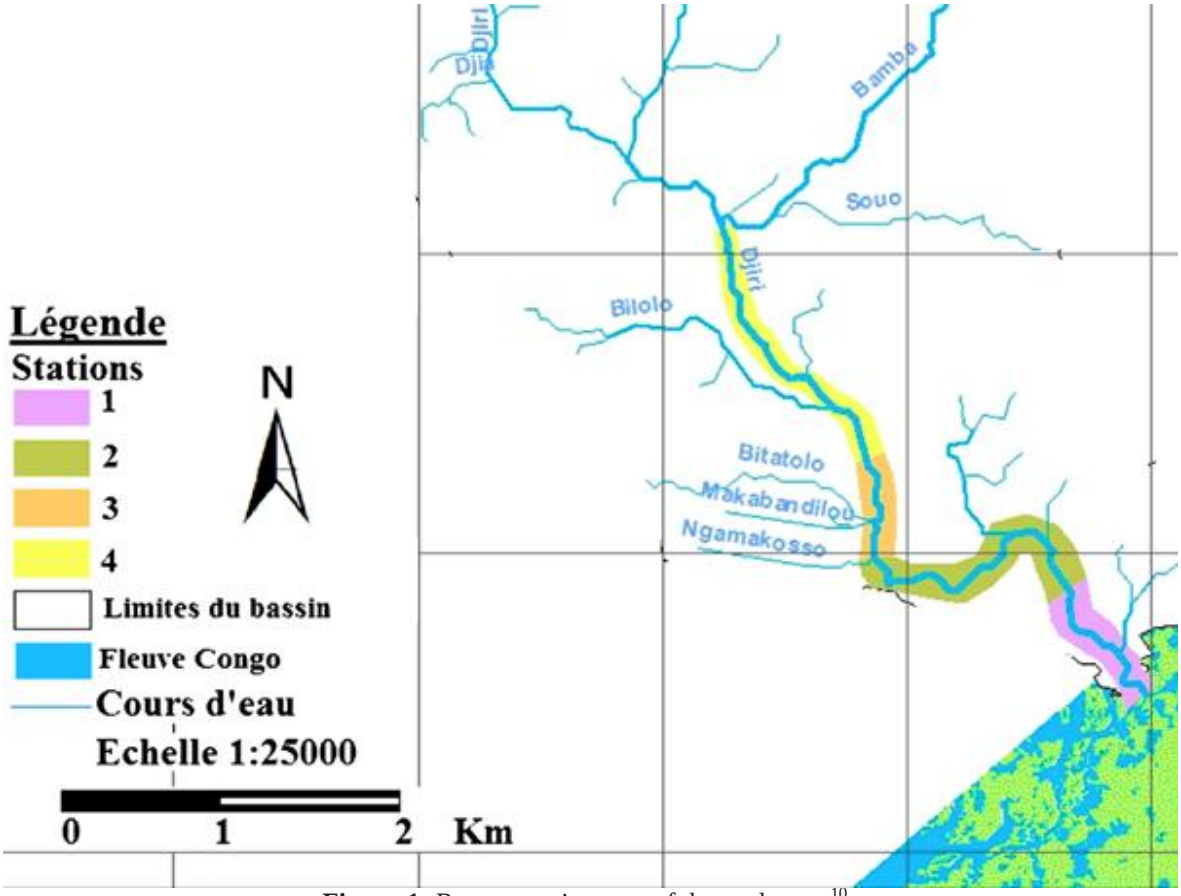


**Figure-1:** Representative map of the study area[10].

**Intestinal coefficient:** There is a significant linear relationship ($r = 0.69$; $p < 0.05$) between gut length and standard fish length (Figure-3). The value of the intestinal coefficient is between 0.42 and 0.65, for an average of 0.54±0.23, this value shows that the intestine of *M. stormsi* is short, which means that this species is classified among the carnivorous fish[19,20].

**General diet profile:** Twelve categories of food divided into two groups were identified: insects and macrophytes (Table-1).

The preponderance index shows that insects are the main prey consumed by *Micralestes stormsi* of Djiri with a preponderance of 84.53%. Among the insects, we find Coleoptera (55.18%), Ephemeroptera (14.90%) and Hymenoptera (12.22%). Green algae constitute the secondary prey with a respective preponderance index of 15.47%. These results are close to those of Ikélarégion and lac Tumba[8], which shows that *Micralestes stormsi* is polyphagous with an entomophagous tendency. This agree with the value of the intestinal coefficient, which corresponds to the carnivorous[19,20]

Study of diet according to size class: The specimens examined measured between 45.44 and 79.27 mm in standard length. Nine size classes were determined according to Sturges' rule. Due to the very small number, classes 8 and 9 were merged with class 7 in the analysis of the results: Class 1 ($n = 6$): $45 \leq SL < 49$mm; Class 2 ($n = 28$): $49 \leq SL < 53$mm; Class 3 ($n = 50$): $53 \leq SL < 57$mm; Class 4 ($n = 63$): $57 \leq SL < 61$mm; Class 5 ($n = 48$): $61 \leq SL < 65$mm; Class 6 ($n = 23$): $65 \leq SL < 69$mm; Class 7 ($n = 13$): $69 \leq SL < 73$mm; Class 8 ($n = 2$): $73 \leq SL < 77$mm; Class 9 ($n = 2$): $77 \leq SL < 79$mm. The feeding behavior of *Micralestes stormsi* by size class is summarized in Table-2. It appears that, whatever the size class considered, insects remain the predominant prey of *Micralestes stormsi*, algae being accessory prey. However, specimens of the class 8 and class 9 consume only insects.

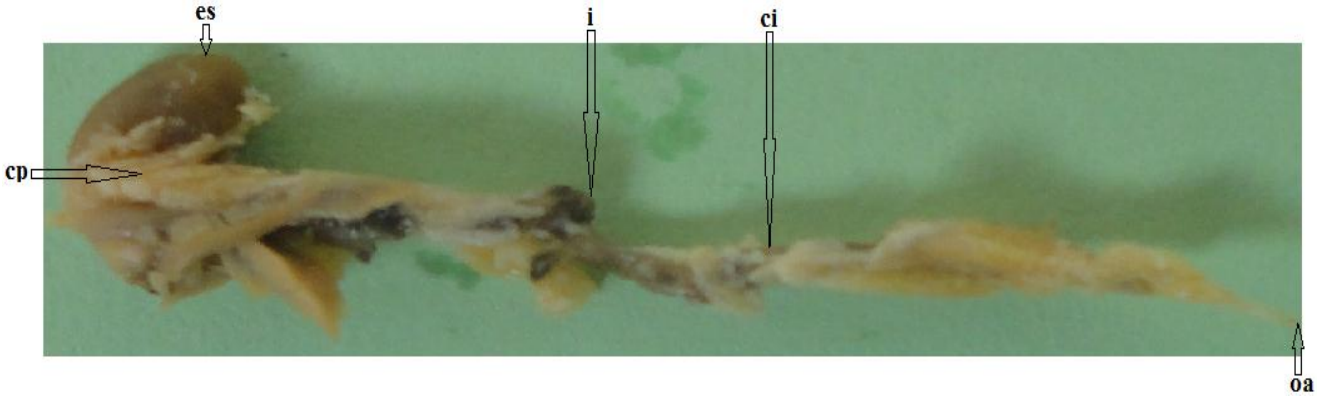


**Figure-2:** Digestive tract of *Micralestes stormsi* (cp=pyloric ceoca, es=stomach, i=intestine, ci=circumvolution, oa=anal orifice).

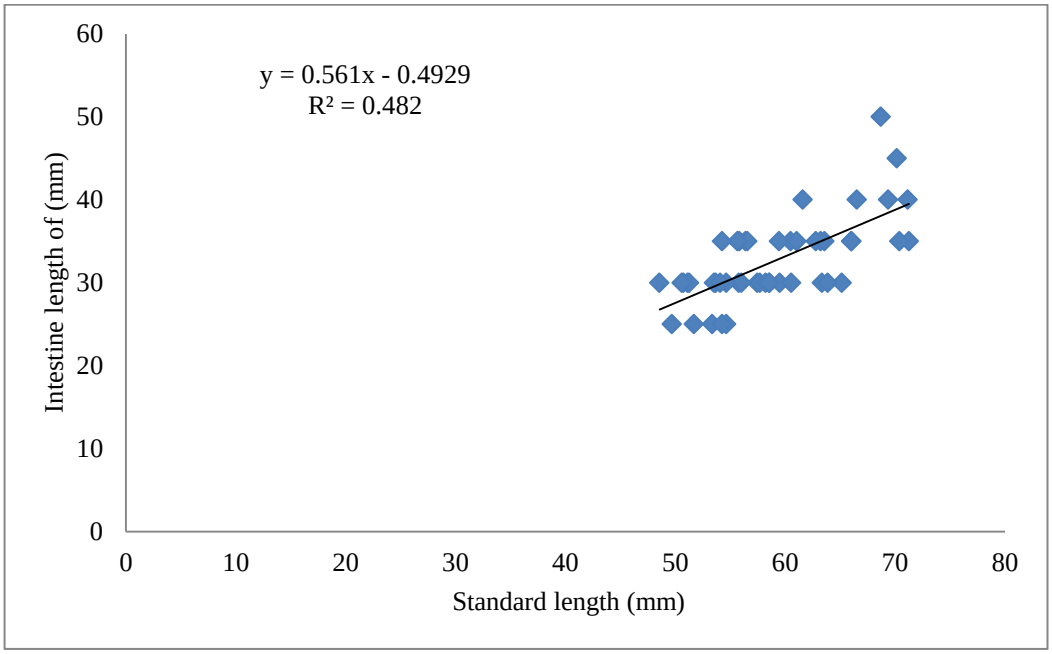


**Figure-3:** Relationship between intestinal length and standard length of *M. Stormsi.*

**Table-1:** Food items consumed by *Micralestesstormsi.*

| Prey | | % Oc | % P | Ip |
|---|---|---|---|---|
| Insects | Diptera | 2.56 | 1.98 | 0.19 |
| | Ephemeroptera | 22.65 | 17.49 | 14.9 |
| | Coleoptera | 43.59 | 33.66 | 55.18 |
| | Trichoptera | 1.28 | 0.99 | 0.05 |
| | Plecoptera | 1.28 | 0.99 | 0.05 |
| | Hymenoptera | 20.51 | 15.84 | 12.22 |
| | Lepidoptera | 0.43 | 0.33 | 0.01 |
| | Odonata | 2.14 | 1.65 | 0.13 |
| | Orthoptera | 3.85 | 2.97 | 0.43 |
| | Megaloptera | 0.43 | 0.33 | 0.01 |
| | Unidentified insects | 6.84 | 5.28 | 1.36 |
| Parasites | Nematoda | 0.43 | 0.33 | 0.01 |
| Plants | Green algae | 23.08 | 17.82 | 15.47 |
| Others | Feathers | 0.43 | 0.33 | 0.01 |

**Table-2:** Diet of *Micralestes stormsi* according to size class.

| | Class 1 n=6 | Class 2 n=28 | Class 3 n=50 | Class 4 n=63 | Class 5 n=48 | Class 6 n=23 | Class 7 n=13 | Class 8 n=2 | Class 9 n=2 |
|---|---|---|---|---|---|---|---|---|---|
| Coleoptera | 96 | 53.37 | 48.1 | 58.46 | 79.29 | 67.16 | 26.16 | | 25.74 |
| Orthoptera | | | | 0.43 | 0.24 | 0.12 | 1.45 | | |
| Ephemeroptera | | 2.01 | 24.1 | 10.09 | 6.37 | 21.44 | 35.49 | 3.97 | 74.26 |
| Hymenoptera | 3 | 8.12 | 20.45 | 18.05 | 9.17 | 7.32 | 4.55 | | |
| Odonata | | | | 1.46 | 0.02 | | | | |
| Diptera | | | 0.26 | 2.44 | 0.22 | | | | |
| Plecoptera | | | 0.1 | | | | 1.27 | 96.03 | |
| Lepidoptera | | | | 0.02 | | | | | |
| Megaloptera | | | | 0.07 | | | | | |
| Trichoptera | | | 0.22 | 0.03 | 0.08 | | | | |
| Insects | | 0.12 | 3.12 | 2.67 | 0.4 | 0.86 | 1.27 | | |
| Nematodes | | | 0.06 | | | | | | |
| Green algae | 1 | 9.38 | 3.59 | 6.19 | 4.2 | 3.09 | 29.8 | | |
| feathers | | | | 0.1 | | | | | |

The ascending hierarchical classification analysis carried out on the basis of the preponderance index of the different foods calculated in each size class makes it possible to consider two groups of size classes (Figure-4): Group 1 composed of all the specimens whose size is less than 69 mm and group 2, composed of specimens whose size is greater than or equal to 69 mm. Insects are the main prey of *Micralestes stormsi* in both size class groups, with a preponderance index of 95.40% for the first group and 70.20% for the second group. Algae are accessory prey (Ip=4.57%) in the first group while they constitute important prey in the second group with 29.50% preponderance index. The Schoener index is equal to 0.75, so the difference in diet is not significant between the two groups. There is no significant change in the diet of *Micralestes stormsi* as a function of size in the Djiri River, the Schoener index being greater than 0.6. However, the diet similarity dendrogram presents two groups of individuals, group 1 (consisting of individuals whose size is less than 69 mm) feeding almost exclusively on insects and group 2 (consisting of individuals whose size is less than 69mm) feeding on insects, algae being secondary prey.

Study of diet according to the season: In the rainy season, insects are still the main prey of *Micralestes stormsi*, with a preponderance index of 94.82%, algae are accessory prey with a preponderance index of 5.16%. Among insects, beetles are the main prey with a preponderance index of 56.91% followed by ephemeroptera (31.49%) which are important prey and hymenoptera during this season are accessory prey with an index of preponderance of 3.99% (Table-3). Plants are consumed very little and represented exclusively by green algae. The study of the diet according to the hydrological season shows that the diet of *Micralestes stormsi* does not vary, whatever the season, the Schoener index is 0.66, therefore greater than 0.60. These results agree with authors[13] who indicate that the diet of fish in non-overflowing rivers does not undergo any notable change.

In the dry season, insects remain the main prey of *Micralestes stormsi*, with a preponderance index of 93.7%, green algae are accessory prey with 6.29%. Among insects, coleoptera are the main prey with 58.22% followed by hymenoptera (26.68%) which represent important prey and ephemeroptera are secondary prey with 7.23% (Table-4).

Study of the dietof *Micralestes stormsi* according to the stations: The diet was studied in the three different biotopes (station 1, station 2 and station 3) in order to assess the impact of the environment on eating behavior.

Diet of *Micralestes stormsi* in station 1 : In the first station, twelve food categories belonging to two groups were identified (Table-5). Insects are the main prey of *Micralestes stormsi*, with a preponderance index of 91.61%, followed by green algae which constitute accessory prey (8.39%). Among insects, coleoptera are the main prey with 67.74% followed by hymenoptera which are secondary prey (18.9%). Ephemeroptera constitute accessory prey (2.45%).

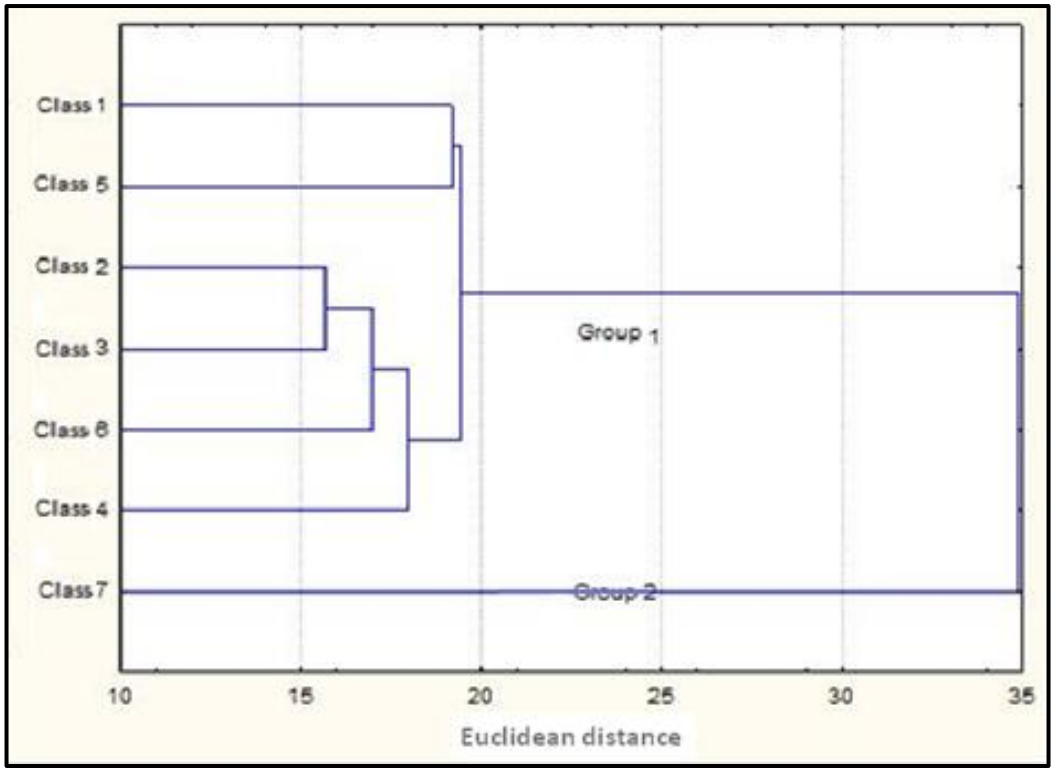


**Figure-4:** Affinity dendrogram of different food items according to the size classes of *Micralestes stormsi.*

**Table-3:** Diet of *Micralestes stormsi* in the rainy season.

| Prey | | % Oc | %P | Ip |
|---|---|---|---|---|
| Insects | Coleoptera | 39.84 | 37.75 | 56.91 |
| | Orthoptera | 4.07 | 2.32 | 0.36 |
| | Ephemeroptera | 26.83 | 31.02 | 31.49 |
| | Hymenoptera | 13.01 | 8.10 | 3.99 |
| | Odonata | 3.25 | 1.64 | 0.2 |
| | Diptera | 0.81 | 0.21 | 0.01 |
| | Lepidoptera | 0.81 | 0.10 | 0.01 |
| | Trichoptera | 0.81 | 0.21 | 0.01 |
| | Plecoptera | 1.63 | 5.82 | 0.36 |
| | Unidentifiedinsects | 8.13 | 4.80 | 1.48 |
| Plants | Green algaes | 20.33 | 6.71 | 5.16 |
| Others | Feathers | 0.81 | 1.33 | 0.04 |

**Table-4:** Diet of *Micralestes stormsi* in the dry season.

| | | | | |
|---|---|---|---|---|
| | Orthoptera | 3.6 | 1,1 | 0.13 |
| | Ephemeroptera | 18.02 | 12.53 | 7.23 |
| | Hymenoptera | 28.83 | 28.92 | 26.68 |
| | Odonata | 0.9 | 0.58 | 0.02 |
| | Diptera | 4.5 | 6.06 | 0.87 |
| | Plecoptera | 0.9 | 0.51 | 0.01 |
| | Megaloptera | 0.9 | 0.37 | 0.01 |
| | Insects | 5.41 | 2.59 | 0.45 |
| | Trichoptera | 1.8 | 1.46 | 0.08 |
| Nématodes | Nématodes | 0.9 | 0.26 | 0.01 |
| Plants | Green algae | 26.13 | 7.52 | 6.29 |

**Table-5:** Diet of *Micralestes stormsi* in station 1.

| Prey | | %Oc | %P | Ip |
|---|---|---|---|---|
| Insects | Coleoptera | 47.76 | 47.28 | 67.74 |
| | Orthoptera | 4.48 | 2.53 | 0.34 |
| | Ephemeroptera | 13.43 | 6.07 | 2.45 |
| | Hymenoptera | 25.37 | 24.83 | 18.9 |
| | Odonates | 2.99 | 0.83 | 0.07 |
| | Lepidoptera | 1.49 | 0.24 | 0.01 |
| | Plecoptera | 1.49 | 0.73 | 0.03 |
| | Insects ni | 11.94 | 5.78 | 2.07 |
| Plants | Green algae | 23.88 | 11.71 | 8.39 |

Diet of Micralestes stormsi in station 2 : In the second station, nine food categories belonging to two groups were identified (Table-6). As in station 1, insects are the main prey of *Micralestes stormsi*, with a preponderance index of 91.12%. Among the insects, coleoptera and ephemeroptera are important prey with a respective preponderance index of 44.18% and 41.67%, followed by hymenoptera which are accessory prey (4.29%). Algae are accessory prey (8.84%).

**Table-6:** Diet of *Micralestes stormsi*in station 2.

| Prey | | % Oc | % P | Ip |
|---|---|---|---|---|
| Insects | Coleoptera | 41.46 | 33.61 | 44.18 |
| | Orthoptera | 3.66 | 0.91 | 0.11 |
| | Ephemeroptera | 39.02 | 33.68 | 41.67 |
| | Hymenoptera | 12.2 | 11.1 | 4.29 |
| | Odonates | 3.66 | 2.14 | 0.25 |
| | Diptera | 1.22 | 0.27 | 0.01 |
| | Plecoptera | 2.44 | 6.7 | 0.52 |
| | Megaloptera | 1.22 | 0.46 | 0.02 |
| | Unidentified insects | 2.44 | 0.89 | 0.07 |
| Plants | Green algae | 31.71 | 8.79 | 8.84 |
| Others | Feathers | 1.22 | 1.46 | 0.06 |

Diet of *Micralestes stormsi* in station 3: In the third station, eight food categories belonging to three groups were identified (Table-7). As in the two previous stations, insects are the main prey of *Micralestes stormsi*, with a preponderance index of 98.45%. Among the insects, coleoptera constitute the main prey, followed by hymenoptera which constitute secondary prey with 24.17% preponderance index and ephemeroptera with 8.22% preponderance index, are accessory prey. Green algae and nematodes constitute the accessory prey, with respectively a preponderance index equal to 1.54% and 0.02.

**Table-7:** Diet of *Micralestes stormsi* in station 3.

| Prey | | % Oc | % P | Ip |
|---|---|---|---|---|
| Insects | Coleoptera | 43.37 | 37.89 | 61.99 |
| | Orthoptera | 3.61 | 2.07 | 0.28 |
| | Ephemeroptera | 14.46 | 15.06 | 8.22 |
| | Hymenoptera | 25.30 | 25.32 | 24.17 |
| | Diptera | 6.02 | 8.55 | 1.94 |
| | Trichoptera | 3.61 | 2.33 | 0.32 |
| | Unidentified insects | 7.23 | 5.6 | 1.53 |
| Plants | Green algae | 14.46 | 2.82 | 1.54 |
| Others | Nematodes | 1.20 | 0.36 | 0.02 |

The study of the diet according to the sampling stations does not show any significant variation in the diet between the three biotopes; the Schoener index remains above 0.6 between the three stations. This observation shows that the diet of a species is substantially identical throughout its range[13].

## Conclusion

The study of the diet of *Micralestes stormsi* from the Djiri River, made it possible to calculate the intestinal coefficient, the value of which corresponds to a short intestine, an indicator of a carnivorous (insectivorous) diet. This result corroborates the analysis of the food composition of this species of fish which is insectivorous. The variation of the diet according to the season, the size class and the station is not significant.

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