JFLS | 2020 | Vol 5(1) | Pp 9-14

OPEN ACCESS

Journal of Fisheries and Life Sciences
International Peer-Reviewed Biannual Journal
www.fishlifesciencejournal.com

Research Article

Feeding habits of *Synodontis schoutedeni* David, 1936 from lower course of Tsiémé River, Congo Brazzaville

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ISSN: 2456-6268

ARTICLE INFO
Received: 24 April 2020
Accepted: 11 May 2020
Available online: 18 June 2020

KEYWORDS
Tsiémé River
Synodontis schoutedeni
Omnivorous
Preponderance index
Congo

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ABSTRACT

The diet of *Synodontis schoutedeni* from the lower Tsiémé River was investigated according to specimen size, the sampling season and sex. Stomach contents of 195 individuals captured monthly from January 2013 to December 2014 were examined. The specimen size ranged between 50.51 and 97.12 mm, for an average of 63.73 ± 13.46. The intestinal coefficient varied between 0,054 and 2,579, for an average of 1.44 ± 0.4 mm, which suggests that the intestine of *S. schoutedeni* has omnivorous diet. All stomachs were full, representing a vacuity coefficient of 0%. The food spectrum of *S. schoutedeni* mainly consisted of sand (Ip = 50.41%) and unidentified preys (Ip = 23.63%). Horn's Food Overlap Index (Ch) showed a similarity of fish diet according to the size, the season and the sex.

INTRODUCTION

Synodontis schoutedeni is an endemic species from the Congo Basin (Daget *et al*., 1986), distributed along the Congo River, in its tributaries and sub-tributaries in the Republic of Congo, the Democratic Republic of Congo and Cameroon (Poll, 1971; Roberts and Stewart, 1976; Froese and Pauly, 2014). Analysis of fish diet in the wild is necessary for understanding their biology, ecology, ethology and physiology (Perrin 1980; Moreau, 1988; Kouamélan, 1999). Fish diet studies must also precede the establishment of a conservation or management policy for fish populations (Yao, 2006). *S. schoutedeni* like all species of Mockokidae, is a species very appreciated by the local population. Despite its ecological and socio-economic interest, the diet studies of this species are scarce; nevertheless, we can point out the qualitative study of the diet of this species carried out in the Ikela region and Tumba Lake (Matthes, 1964). Therefore, the present study aimed to provide qualitative and quantitative information on the diet of *S. schoutedeni* according to the specimen size, the season and the sex.

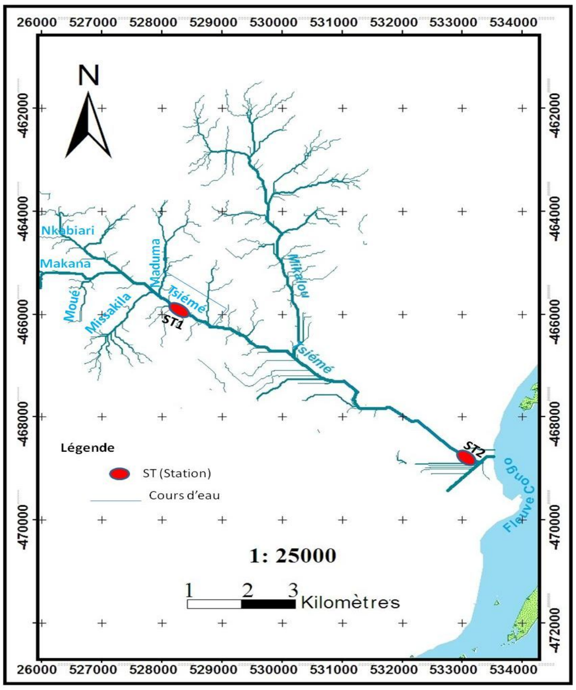

Fig. 1: Location of the study site

MATERIALS AND METHODS

Study site

The Tsiémé River, which crosses Brazzaville, is a tributary of the right bank of the Congo River. It is located between 4 ° 09 'and 4 ° 16' south latitude and 15 ° 12 'and 15 ° 18' east longitude (Denis, 1974). This river has its source in Djiri district under the hills of Massengo district. It flows north-west then south-east and flows into the Congo River upstream from Yoro harbor in Talangaï district (Fig. 1).

Sampling and analysis of stomach contents

The monthly samples of *S. schoutedeni* were taken at the lower Tsiémé River, from January 2013 to December 2014 (figure 1). Captured specimens with the cash net, were stored in 10% formalin. In the laboratory, the fixed fish were immersed in a large volume of water to remove the formalin. The standard length was measured to the nearest millimeter. After dissection of the specimens, the digestive tract was highlighted in order to photograph it. The intestines were measured, the stomach contents were extracted, examined and sorted under a binocular magnifier before being weighed to the nearest milligram. Preys identification was done according to Roth (1980), Durand and Lévêque (1980; 1981), Gerber and Gabriel (2002) and McGavin (2005). The following indexes were used for qualitative and quantitative diet analysis.

Intestinal coefficient (IC)

The intestinal coefficient makes it possible to predict the diet of the species studied, it is calculated by the following formula (Paugy, 1994):

$IC = \frac{IL}{SL}$ where, IL= Intestine length; SL: standard length

Vacuity coefficient (V)

It is the ratio in percentage between the number of empty stomachs (Ev) and the number of stomachs examined (N). This report makes it possible to specify the existence of trophic rhythms and to assess the availability of resources in the environment where fish lives (Rosecchi, 1983).

$V = \frac{E_v}{N} \times 100$

V = Vacuity percentage; Ev = Empty stomachs number; N = Examined stomachs number.

Percentage of occurrence (% OC)

It is the degree of presence of a prey or a category of prey in relation to the stomachs examined.

$\%OC = \frac{E_p}{E_e} \times 100$

Ep = number of stomachs containing a category of prey; Ee = total number of stomachs examined. This method provides information on prey items frequently consumed by fish. However, it does not provide any indication of the quantitative importance of the different preys (Windell, 1968; Lauzanne, 1977).

Weight percentage

It is the percentage ratio of the weight of a prey or a category of prey (Pi) over the total weight of the prey consumed (Pt).

$P = \frac{P_i}{P_t} \times 100$ Where, Pi= total weight of individuals of the same species i; Pt= total weight of prey.

Preponderance index

The preponderance index (Ip) of Nataraja and Jhingran (1961) modified by Amundsen *et al.*, (1996) was used to determine the contribution of each food item in the diet. It is a mixed index which integrates the percentages of occurrence and weight. It allows a much more real interpretation of the diet, minimizing the biases caused by each of these percentages. This index also allows a classification of prey as defined by Lauzanne (1975). It is given by the following formula:

$Ip = \frac{\%OC \times \%P}{\sum(\%OC \times \%P)}$ where, Ip = Preponderance index; % Oc = Occurrence percentage of; % P = Weight percentage.

The different categories of prey are classified according to the value of the preponderance index as follows (Kouamélan *et al.*, 2000): Ip≤10: accessory prey; 10 <Ip <25: secondary prey; 25 <Ip <50: important prey; Ip≥50: main prey.

Horn's Food Overlap Index

The Horn Food Overlap Index (Horn, 1966) is a similarity index that assesses the degree of overlap between ecological niches of the individuals across seasons, sexes and size classes. This index allows to know if the individuals feed on the same niches. This index is given by the following formula (Horn, 1966):

$C\lambda = \frac{2\sum^{s} xi.yi}{\sum_{i=1}^{s} xi^2 + \sum_{i=1}^{s} yi^2}$ where, S = Total number of food items; xi = Proportion of prey i consumed by specimens of a season x; yi = Proportion of prey consumed by specimens in season y. The overlap index (Cλ) varies between 0 and 1. This index is equal to 0 when diets are completely different and equal to 1 when diets are identical. Diets significantly overlap when the value of Cλ is greater than or equal to 0.6 (Mathur, 1977).

Sturges rule

Sturges rule (Schereck and Moyle, 1990) was used to determine the size class:

$CI = \frac{LSmaxi - LSmin}{NC}$ where, NC = 1 + (3,3Log N); CI= Class interval; SL max= maximum standard length; SL min= minimum standard length; NC= number of classes; N= number of specimens.

Statistical analysis

The ascending hierarchical classification analysis based on the preponderance index of the different preys was used to show the food similarity of the specimens between the seasons and the different size class.

RESULTS AND DISCUSSION

Morphology of the digestive tract

The digestive tract of *S. schoutedeni* is formed by a short esophagus, followed by a thick U-shaped stomach; there is the absence of pyloric cœcca. The relatively short intestine ventrally surrounds the stomach and then continues by forming a loop before the anus, at the level of the rectum with elastic walls (Fig. 2 and Fig.3).

Fig. 2: Curled digestive tract of *S. schoutedeni*

Fig. 3: Unrolled digestive tract of *S. schoutedeni*

Intestinal coefficient

The length of the intestine ranges from 37.7 mm to 248.36 mm, an average of 104±33 mm. The standard length varied between 50.51 mm and 97.12 mm, an average of 72±8 mm. The relationship between weight and standard length is y=2,340x-65.38 (Fig. 4). The coefficient of determination r^2 is equal to 0.45, a correlation coefficient r equal to 0.67. The intestinal coefficient varied between 0.054 and 2.579 mm, an average of 1.44 ± 0.4 mm, which suggests that the intestine of *S. schoutedeni* is relatively short. The length of the intestine depends on the diet and digestibility of the prey (Kappoor *et al.*, 1975). Thus, the longest intestine is observed in herbivorous, the shortest in carnivorous and the intermediate intestine in omnivorous (Fryer and Iles, 1972). In view of previous work defining the different trophic guilds on the basis of intestinal coefficient, we can conclude that *S. schoutedeni* is an omnivorous. In fact, the intestinal coefficients obtained cover those of Paugy, 1994 (0.80 <CI <3.01).

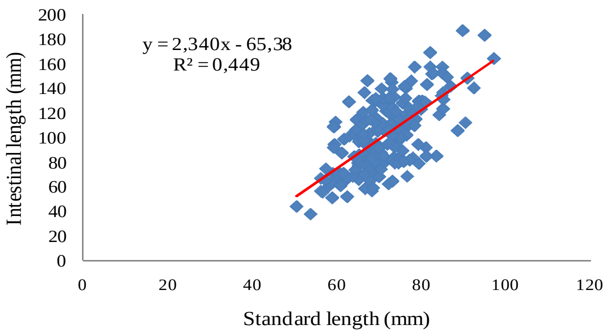

Fig. 4: Relation between intestinal length and the standard length of *S. schoutedeni*

Vacuity coefficient

All the 195 stomachs of *S. schoutedeni* examined contained food, the percentage of emptiness is 0%.

General diet profile

Analysis of the stomach contents of *S. schoutedeni* made it possible to distinguish 16 types of food items divided into four groups: invertebrates (insects, arachnids and crustaceans); vertebrates (fish); plants (plant debris and algaes) and other prey composed of unidentified prey and sand (Table 1). The general diet profile of *S. schoutedeni* shows that this species is omnivorous feeding mainly on sand (Ip=50.40%) and secondarily on plant debris (Ip=23.63%) and nematodes (Ip=11.89 %). The remaining preys (annelids, molluscs, coleoptera, diptera, trichoptera, hymenoptera, ephemeroptera, unidentified insects, crustaceans, fishes and algaes) constitute accessory prey with a preponderance index less than 5%. It should be noted that no data on the trophic clover of *S. schoutedeni* is available. However, these results are similar to those obtained for the genus Synodontis in general. Indeed, Lauzanne (1988), indicates that the Synodontis are fish which exploit benthic invertebrates, various plant and animal waste, especially insect larvaes and molluscs, but also oligochaetes, ostracodes, terrestrial insects and even scales and fish debris. Tembeni Makiadi Tambu (2017) shows that all the seven Synodontis species studied (*S. angelicus, S. acanthomias, S. alberti, S. congicus, S. decorus, S. greshoffi and S. notatus*) belong to the same trophic guild of omnivorous benthophagous. These species have the particularity of being better adapted to survive in the event of famine (Paugy, 1994). The significant presence of sand in the diet of *S. schoutedeni* proves that this species is a scraper.

Table 1: Composition of the diet of *S. schoutedeni*

	Prey	%OC	%P	Ip
Invertebrates	Nematodes	16,79	9,90	11,89
	Annelids	2,18	1,84	0,29
	Molluscs	0,38	0,04	0,00
	Coleoptera	5,50	1,56	0,61
	Diptera	3,89	1,11	0,31
	Ephemeroptera	6,36	1,22	0,55
	Hymenoptera	3,23	0,70	0,16
	Trichoptera	0,66	0,15	0,01
	Unidentified insects	8,73	3,31	2,07
	Arachnids	0,28	0,02	0,00
	Crustaceans	0,09	0,04	0,00
Vertebrates	Fishes	3,89	1,13	0,31
Plants	Algaes	2,37	0,23	0,04
	Plants debris	18,22	18,13	23,63
Other prey	Unidentified prey	13,47	10,08	9,72
	Sand	13,95	50,54	50,41

% Oc: Occurrence; % P: Weight percentage; Ip: Preponderance index

Diet according to the size

The size of the specimens examined varies between 50.51 and 97.12 mm in standard length, an average of 71.61±8 mm. The 9 size classes established according to the Sturges rule with a class interval (CI) of 5 mm are presented in Table 2. However, due to the very small number of specimens in class 1 (n=2), classes 1 and 2 were merged to form class 1-2, as well as classes 8 and 9 to constitute class 8-9.

Table 2: Size of *S. schoutedeni* specimens examined

Classes	Number of individuals	Class interval
Class 1-2	16	$50 \leq LS < 60$ mm
Class 3	21	$60 \leq LS < 65$ mm
Class 4	53	$65 \leq LS < 70$ mm
Class 5	46	$70 \leq LS < 75$ mm
Class 6	32	$75 \leq LS < 80$ mm
Class 7	13	$80 \leq LS < 85$ mm
Class 8-9	14	$85 \leq LS < 100$ mm

Analysis of the diet according to size classes showed that sand, which was a secondary prey (18.85%) in class 1-2 and a significant prey in classes 3 (39.43%) and 4 (42.07%), became the main prey of *S. schoutedeni* in class 5 (58.69%); class 6 (62.61%); class 7 (66.28%) and class 8-9 (60.33%). Plant debris is the main prey in class 1-2 (36.95%); class 3 (28.17%) and class 4 (26.05%). They constitute the secondary prey in classes 5, 6, 7 and 8-9 (with respectively 19.67%, 18.66%, 14.99% and 17.58%). Unidentified prey constitutes secondary prey in classes 1, 2 and 3 (14.73%, 11.56% and 12.80% respectively) and accessory prey in the remaining classes. Nematodes constitute secondary prey in classes 1-2, 3, 4 and 8-9 with the following preponderance indexes: 19.68%; 14.24%; 12.15% and 11.28%. The remain preys (unidentified insects, ephemeroptera, fish, coleoptera, diptera, hymenoptera, trichoptera, annelids, algae, arachnids, crustaceans and molluscs) constitute accessory prey with preponderance indexes less than 10% (Fig. 5).

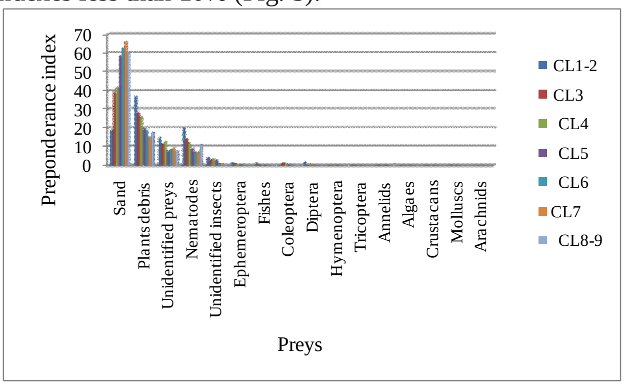

Fig. 5: Preponderance index of preys consumed by *S. schoutedeni* according to the size

The ascending hierarchical classification analysis carried out on the basis of the preponderance index of the different preys calculated in each size class makes it possible to consider three groups of size classes (Fig. 6). Group 1 is composed only of specimens of class 1-2. Group 2 includes classes 3 and 4. Group 3 is made up of classes 5, 6, 7 and 8-9.

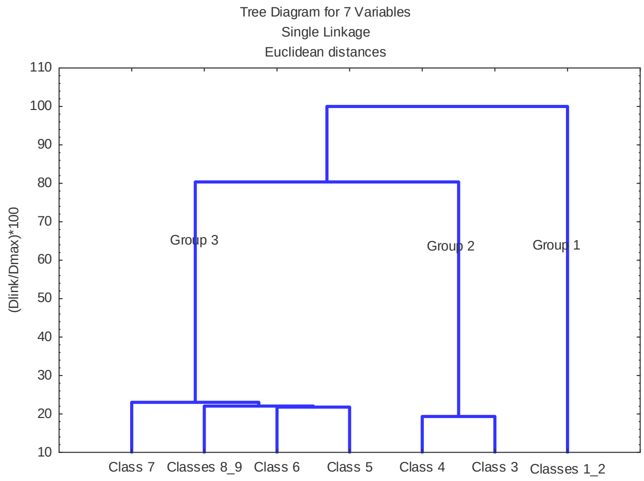

Fig. 6: Affinity dendrogram of the different food items consumed by *S. schoutedeni* according to the size

Diet of *S. schoutedeni* showed a certain plasticity which is noticed in specimens of class 1-2 which consume more plant debris and in those of classes 3 to class 8-9 which consume more sand. The variation in the ingestion of prey according to the specimen size can be linked to a biological problem with regard to the digestibility of the prey or even ecological considering the fact that all specimens were captured in the same biotope. In tropical fish, Lauzanne (1975) has shown that the change in food between individuals can be linked to a biological phenomenon. This change may also be linked to modifications of some anatomical and morphological structures (Lévêque, 1997). The diet affinity dendrogram between the different size classes shows a food similarity between classes 7 and 8-9 in group 3 and between classes 4 and 6 in group 2.

Diet according to hydrological seasons

The composition of the diet during the two seasons shows that in the rainy season sand is the main prey with a preponderance index of 53.65%. Plant debris and nematodes (Ip=21.45% and 11.40%) constitute the secondary prey. The remaining prey forms accessory prey, with a preponderance index less than 10%. In the dry season, sand and plant debris represent the important food items ingested (Ip=37.34% and 32.26%) by specimens of *S. schoutedeni*. Nematodes (Ip=13.60%) and unidentified preys (Ip=10.95%) constitute secondary prey. The remaining food items forms the group of accessory prey with Ip <10% (Fig. 7). This study showed no significant difference in the diet of *S. schoutedeni* between the rainy season and the dry season. Thus, we note a similarity of the diet between the seasons Cλ=0.93. This similarity could be linked on the one hand to the fact that the water level does not drop significantly at the level of this study station. Indeed, it is well established that the diet of fish in rivers that do not overflow undergoes no noticeable change (Lauzanne, 1988). On the other hand, the abundant presence of the vegetation constituting the habitats for many invertebrates, would favor the availability of resources in all seasons. The same observations were made in *Synodontis bastiani* of the fluvio-lacustrine complex of the Bia in Ivory Coast where Diomandé *et al.* (2001) found no significant difference in the consumption of prey between the two seasons.

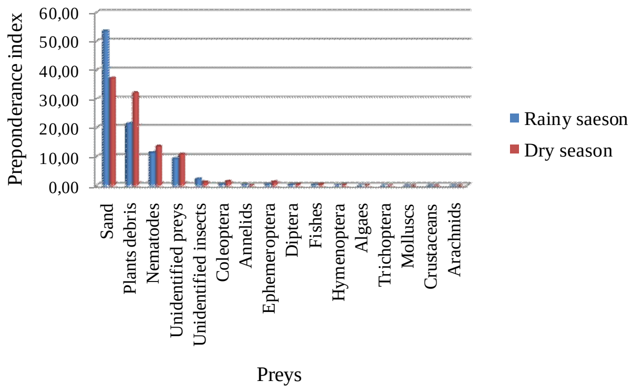

Fig. 7: Variation in the preponderance index of preys consumed by *S. schoutedeni* according to the season

Diet according to the sex

The study of the diet according to sex showed that in males, sand constitutes the main prey with a preponderance index of 53.75%; unidentified plants, nematodes and prey are secondary prey with respective indices of 21.25%, 11.06% and 10.59%. In females, sand and plant debris are important prey with weighting indices of 45.91% and 26.73% respectively. The remaining preys are accessory prey (Fig. 8). The study of diet by sex did not show any significant difference between males and females, because the calculated food overlap index was equal to 0.93. These results corroborate with those found by Yao *et al.* (2010) for *Synodontis koensis*, who did not note any significant difference in the consumption of prey in males as in females.

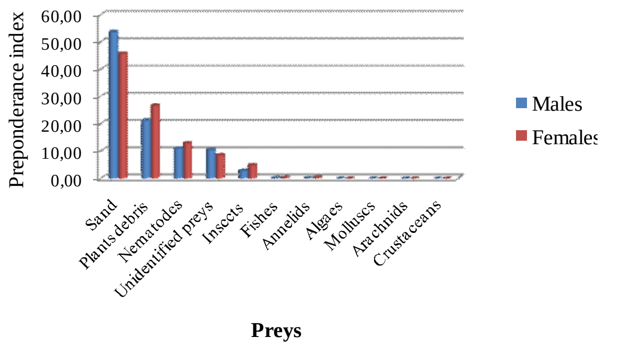

Fig. 8: Preponderance index of preys consumed by *S. schoutedeni* according to the sex

CONCLUSION

This first study of the diet of *S. schoutedeni* showed that this species has a thick-walled stomach and a relatively short intake allowing it to be classified in the group of omnivorous fish. Regarding the general profile of the diet, the presence of sand in greater quantity, led us to conclude that *S. schoutedeni* is a scraper. There is a change in the diet of this species depending on the size of the specimens. On the other hand, the analysis of the different trophic structures according to season and sex revealed no significant difference.

AKNOWLEDGEMENTS

The authors are grateful to Doctor Adolphe Kempéna, Assistant Master of Geomatics, Faculty of Sciences and Techniques, University Marien Ngouabi for the realization of the study area map**.**

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