Available online at http://www.ifgdg.org

Int. J. Biol. Chem. Sci. 18(6): 2170-2179, December 2024

ISSN 1997-342X (Online), ISSN 1991-8631 (Print)

International Journal of Biological and Chemical Sciences

Original Paper http://ajol.info/index.php/ijbcs http://indexmedicus.afro.who.int

Diet of *Coptodon tholloni congica* (Cichliformes: Cichlidae) from the Nkéni River (Tributary of the Congo River)

D. B. C. OLABI-OBATH[1,2*], M. MIKIA[1], A. TSOUMOU[1], L. P. D. BOUKAMA[1] and I. MADY-GOMA DIRAT[1,2]

[1] *Animal Biology and Ecology Laboratory Research, High Normal School, University Marien NGOUABI, PoBox 69, Brazzaville, Congo.*

[2] *Faculty of Applied Sciences, University DENIS SASSOU-N'GUESSO, udsn@cg, Kintélé, Congo.*

[*]*Corresponding author; E-mail : durelle.enzonga@gmail.com*

Received: 26-10-2024 Accepted: 27-12-2024 Published: 31-12-2024

ABSTRACT

This study was undertaken to found out the feeding habits of *Coptodon tholloni congica* from the Nkéni River. The stomach contents of 62 fish specimens captured using a cast net were examined, 7 were empty (11,29%). The standard length of the specimens varied between 43.16 and 95.74 mm, an average of 63.3 ± 8.1 mm, examination of the structure of the digestive tract showed a small stomach and a long intestine (2 ,4< CI <7.13), thus indicating that the studied species is phytophagous. The diet was analyzed by calculating the preponderance index of each prey item according to the specimens size and the season. The emptiness coefficient was equal to 10.26%, *Coptodon tholloni congica* consumes plant debris (Ip=37.63%) and mud (Ip=33.50%) and algae (20.35%). The Schoener index shows that no significant seasonal variation in diet was observed.

Keywords: Nkéni River, *Coptodon tholloni congica*, Dietary indices, Phytophagous, Congo Brazzaville.

INTRODUCTION

Data on the trophic ecology of species provide knowledge not only on the trophic chain, the ecological niche and the feeding habits of the predator, but also on its influences and relationships with the prey consumed as well as on the dynamics of the aquatic food chain (Ulyel et al., 1991b). The continental waters of Congo Brazzaville belong to two ichthyological provinces which are the Lower Guinea Province corresponding to the Kouilou Niari basin and the Congolese Province which corresponds to the Congo basin. There are very few studies that have been carried out on fish from the right bank of the Congo basin. We can, however, cite the study of the diet of three species of catfish (*Chrysichthys ornatus*, *Schilbe marmoratus*, *Synodontis flavitaeniatus*) from the Léfini river carried out by Moutsinga et al. (2012). The rest of the studies focusing on diet were carried out on fish from the Malebo Pool: Mady-Goma Dirat in 2016 (*Schilbe intermedius*, *Brycinus comptus* and *Micralestes acutidens*); Mikia in 2017 (*Bryconaethiops boulengeri* and *Micralestes stormsi*); Tsoumou in 2018 (*Ctenochromis polli and Clypeobarbus pleuropholis*); Ognimba et al., 2018 (*Schilbe grenfelli*) and Olabi Obath (*Synodontis nummifer* and *Synodontis schoutedeni*).

DOI : https://dx.doi.org/10.4314/ijbcs.v18i6.9

The available data on the morphology, biology and trophic ecology of *Coptodon tholloni congica* which are very few and very old, come from Demaocratic Republic of Congo. *Coptodon (*ancient *Tilapia) tholloni congica* is an endemic species of the Congo Basin, which presents a generally dark coloration, without well-marked longitudinal or transverse bands. Its size can reach 280mm (Thys Van Den Audenaerde, 1964). However, Thys Van Den Audenaerde (1964) and Matthes (1964) carried out qualitative studies of the diet of this species. This species very widespread in the rivers of Congo Brazzaville which can reach a large size, represents also a good model for fish farming like *Oreochromis niloticus*, *Coptodon guineensis* and *Coptodon zilli.* Unfortunately, data on the diet of this species are almost non-existent. This is how the present study was carried out, to contribute to the knowledge of the diet of this species in the Nkéni River.

MATERIALS AND METHODS

Study site

The sampling site is located downstream of the bridge over the Nkéni at National Road Number 2 in Gamboma. The geographical coordinates recorded at this site are as follows: 01°52'56.3"S and 15°52'52'09"E (Figures 1 and 2).

Stomach contents analyzes

Analyzes were carried out exclusively on the basis of data collected in the Nkéni River. Sturge's Rule was used to determine the size classes number and interval (Scherrer, 1984). This rule is given by the following formula:

$NC = 1 + (3{,}3 \log_{10} Ni)$

With, NC: Classes number; Ni : Total examined specimens number.

From the class number found the interval of each class given was calculated by the following formula:

$$I = \frac{LSmax - LSmin}{NC}$$

With, I: Class interval; LSmax: Maximum standard length and LSmin: Minimum standard length.

Prey identification

The identification of the prey inventoried in the stomach contents was made using the key determination of Roth (1962) for invertebrates; Durand and Lévêque (1980, 1981) for aquatic flora and fauna.

Emptiness coefficient

The emptiness rate makes it possible to specify the existence of trophic rhythms as well as to assess the availability of resources in the environment where the fish lives. It is given by the following formula (Rosecchi, 1983):

$$V = \frac{Nv}{Nt} x\, 100$$

With, Nv: number of empty stomachs; Nt: total number of examined stomachs.

Occurrence percentage

It is a numerical method aimed at specifying the dietary preferences of a species. It provides information on the prey items frequently consumed by fish, but provides no indication of the quantitative importance of the prey ingested (Lauzanne, 1975; Hyslop, 1980; Kouamélan, 1999). The percentage of occurrence is calculated by the following formula:

$$\%OC = \frac{Ni}{Nt} x100$$

With, Ni = Total number of individuals from item i; Nt = Total number of all food items inventoried.

Weight percentage

It is a method which consists of sorting, then determining the weight of each category of prey ingested for the entire sample. It is given by the following formula (Hynes, 1950):

$$\%P = \frac{Pi}{Pt} x100$$

With, Pi = total weight of item i; Pt = total weight of all food items inventoried.

Preponderance index

It has the advantage of integrating the two previous percentages (occurrence and weight) and allows a much more real interpretation of the diet by minimizing the biases caused by each of these percentages. This index formula is calculated as follows (Natarajan and Jhingran, 1961):

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

With, % OC = Occurrence percentage ; %P = Weight percentage.

The index value which varies between 0 and 100, makes it possible to categorize the different types of prey (Kouamélan et al., 2000). Prey are incidental when the value of the preponderance index is less than 10%; prey are secondary when the index is between 10 and 25%. When the preponderance index is between 25 and 50%, it is qualified important prey; if the index is greater than or equal to 50%, the prey are main prey.

Intestinal coefficient

This is the first predictive information on diet. It is defined as the length ratio of the intestine (LI) to the standard length (LS) of the fish, given by the following formula (Paugy, 1994):

$$CI = \frac{LI}{LS}$$

Schoener index

The Schoener index makes it possible to evaluate the similarity degree in the diet of individuals between different seasons and size classes. The formula for calculating the value of this index is as follows (Schoener 1970):

$\alpha = 1\text{-}0{,}5\ (\sum_{i=1}^{n} |Pxi - Pyi|)$

With, Pxi = proportion of prey i consumed by individuals in a season x; Pyi = proportion of prey consumed by individuals in a season y. When the α index is greater than or equal to 0.6, the diets are considered to be similar (Werner and Hall, 1977).

Satistical analysis

Ascending hierarchical classification analysis based on Euclidean distance and Ward's method was carried out using the preponderance indices of prey consumed in each size class.

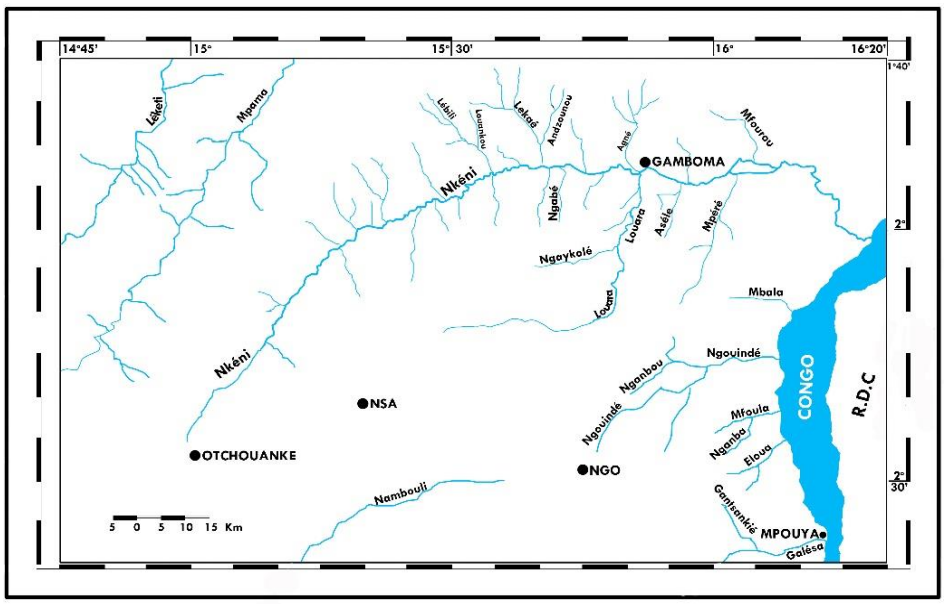

Figure 1 : Sampling site.

Figure 2 : Image of sampling site upstream of the bridge over the Nkéni River (source : LARBEA, 2017).

RESULTS

Diet of *Coptodon tholloni congica*

Morphology of the digestive tract

The study of the structure and morphology of the digestive tract of *C. tholloni congica* presents the following different parts. The esophagus with a thin wall, is followed by a poorly developed stomach and a relatively long intestine which ends in the anal orifice (Figure 3).

Intestinal coefficient

The value of the calculated intestinal coefficient varies between 2.40 and 7.13, with an average of 4.27± 1.00. This value shows that this species diet is phytophagous.

Emptiness coefficient

Out of sixty-two (62) stomachs of *Coptodon tholloni congica* examined, 35 contained food and 7 were empty, i.e. an emptiness coefficient of 11.29%.

Relationship of intestine length and standard length

The regression line shows there is a strong correlation (r=0.87) between the length of the intestine and the standard length of *Coptodon tholloni congica* (Figure 4). This figure shows that the length of the intestine increases with the individual size. The graph also shows that the intestine length of *C. tholloni congica* increases with size.

General diet profile

The qualitative and quantitative analysis of stomach contents revealed 11 food items represented by Figure 5. The quantitative expression of the diet shows that plant debris and mud represent secondary prey consumed by *C. tholloni congica* with respectively 37.63% and 33.50%, followed by sand (20.35%) and algae (6.59%). Other prey (hymenoptera, unidentified insects larvae, very rare fish) have a preponderance index of less than 1%.

Variation in diet according to the season

The 62 specimens of *C. tholloni congica* were divided into 25 specimens in the dry season and 37 in the rainy season (Table 1). During the rainy season, ten (10) food items were identified in the stomach contents. The preponderance index shows that plant debris (41.23%) and sand (33.50%) are important prey, mud (15.81%) is secondary prey and other prey are incidental (the unidentified insects, annelids, mud, hymenoptera larvae, dipteran larvae, hymenoptera and fish). These results show that in the rainy season, *C.*

tholloni congica has a phytophagous diet. In the dry season, eight (8) food items were found in the stomach contents. The preponderance index of consumed prey shows that plant debris (50.20%) constitutes main prey, algae (33.89%), are important prey and sand (21.15%) is secondary prey. Unidentified insects, annelids, mud, hymenoptera larvae and diptera larvae represent incidental prey. In the dry season, the diet of *C. tholloni congica* remains a phytophagous diet, because whatever the season, the main and important prey of *C. tholloni congica* remains plant debris. We also note that there is no significant difference between the two seasons, the α index as equal to 1.

Study of diet according to size class

Six size classes were determined according to Sturges' rule: class 1 (43.16 ≤ LS < 51.92) with 20.51%; class 2 (51.92 ≤ LS < 60.69) is the most represented with 43.59%; class 3 (60.69 ≤ LS <69.45) with 15.38%; class 4 (69.45≤ LS < 78.21) with 10.26%; class 5 (78.21 ≤ LS <86.98) with 7.69% and classes 6 (86.98 ≤ LS < 95.74) with 2.56%. The diet according to size class in *C. tholloni congica* is shown in Figure 6. It appears that plant debris is the prey consumed by all size classes, but in a variable manner, followed by mud and sand. Algae are the important prey consumed by class 1 and class 2. Mud is a main prey for class 4 (Ip=61.9%) and class 5 (Ip=77.1%), other prey are incidental.

The affinity dendrogram of the trophic spectrum of *C. tholloni congica* at 50% makes it possible to divide the 6 size classes into 3 groups of size classes (Figure 7). Group 1 is made up of classes 1, 3 and 6; group 2 only has class 2 and group 3 has classes 4 and 5.

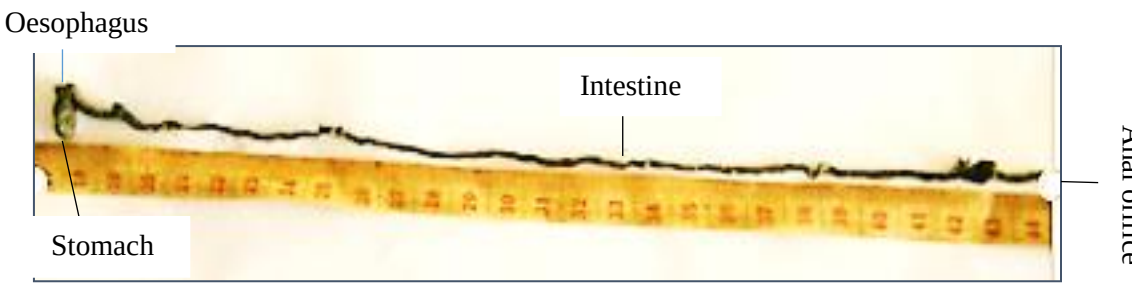

Figure 3 : Morphology of digestive tract of *C. tholloni congica*.

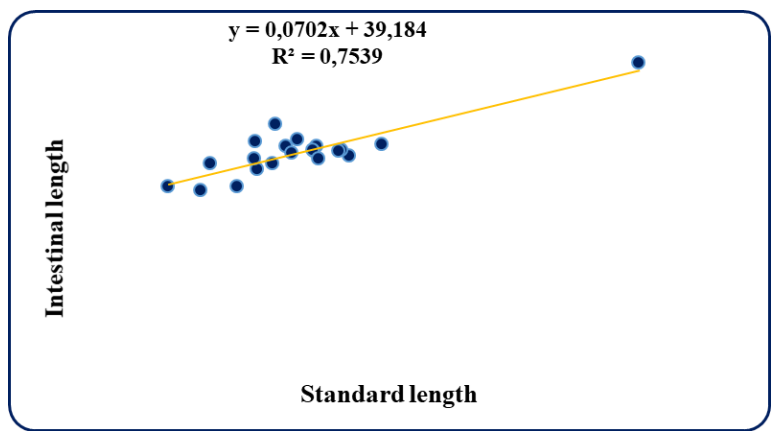

Figure 4: Intestinal length-standard length relation of *C. tholloni congica*.

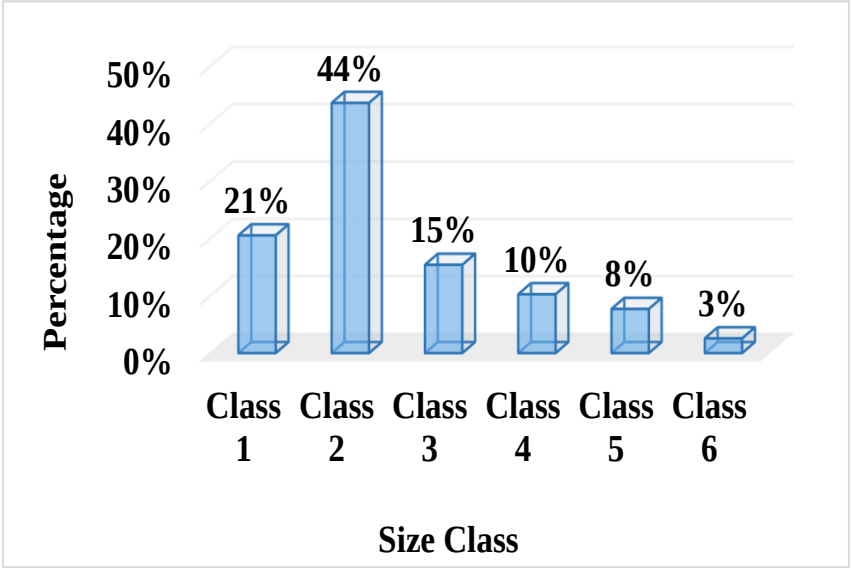

Figure 5 : General trophic spectrum of *C. tholloni congica*.

Table 1 : Trophic spectrum of *C. tholloni congica* according to the season.

Seasons	**Dry season**			**Rainy season**		
Prey	%OC	%P	%Ip	%OC	%P	%Ip
Plant debris	38.44	15.67	50.20	47.62	29.98	41.23
Algae	30.77	16.34	28.53	19.05	11.86	6.63
Sand	30.77	10.20	17.80	38.18	29.52	33.50
Unidentified insect	23,08	0.12	0.16	19.05	0.17	0.09
Annelids	15.38	2.33	2.04	9.52	1.71	0.48
Hymenoptera	7.69	0.06	0,03			
Mud	0.46	57.67	1.23	23.81	22.63	15.81
Diptera larvae	0.23	0.61	0.01	19.05	2.38	1.33
Hymenoptera larvae				14.29	0.21	0.09
Insect larvae				4.76	0.04	0.01
Fish				19.05	1.50	0.84

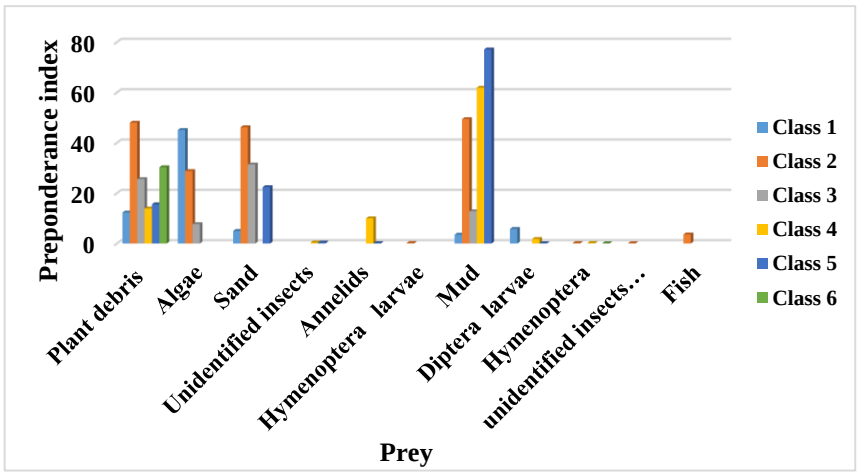

Figure 6: Trophic spectrum of *C. tholloni congica* according to class size.

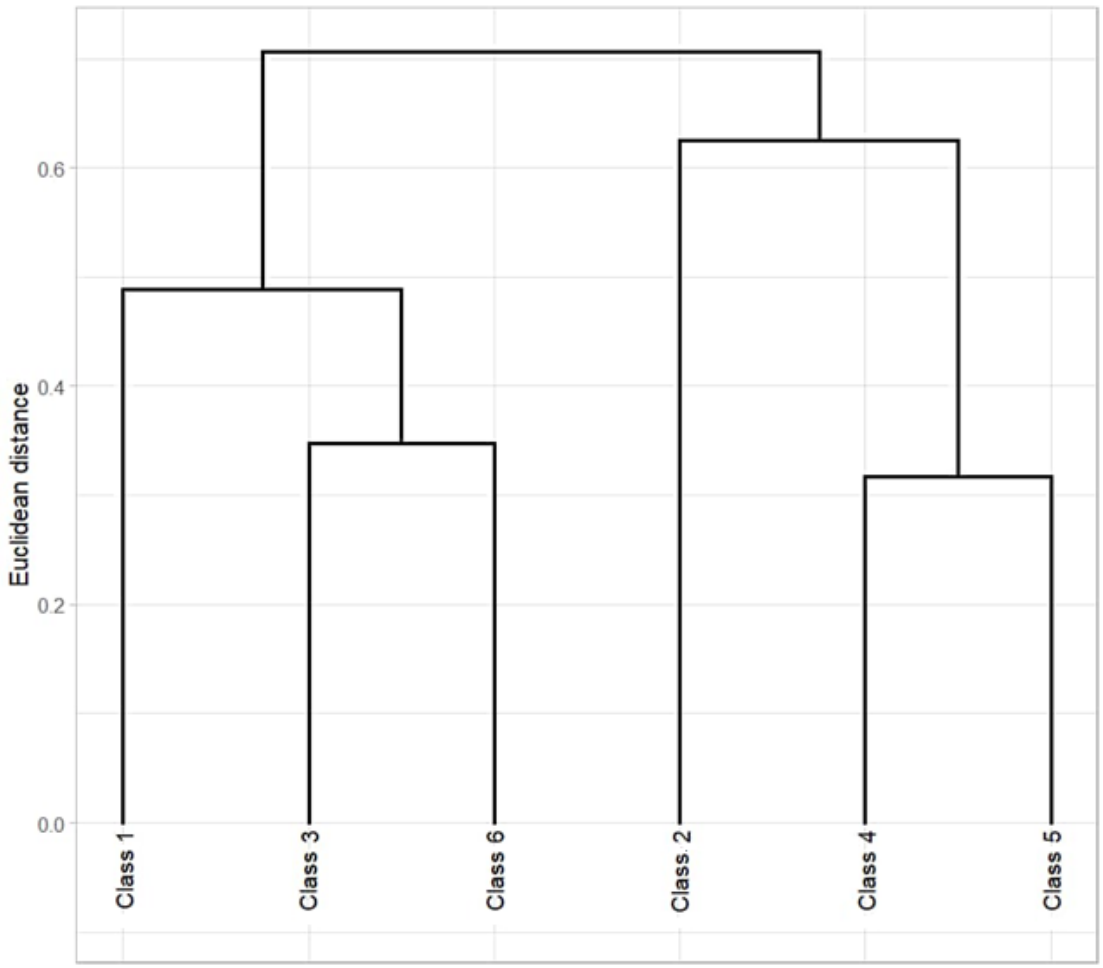

Figure 7 : Dendrogram showing feeding similarities between class size.

DISCUSSION

The study of the structure and morphology of the digestive tract of *Coptodon tholloni congica* presents a small stomach and a relatively long intestine which ends in the anal orifice. Studies of the morphology of the digestive tract of fish have shown that species with an underdeveloped stomach have a long intestine (Verighina, 1990; Kouamélan et al., 1997). The intestinal coefficient value which varies between 2.40 and 7.13, with an average of 4.27± 1.00, shows that this species diet is phytophagous (Paugy *et al.*, 2003)

The low vacuity coefficient (11.29%) obtained during this study shows that the capture of the fish took place just after taking food, which means at the start of digestion. The stomach contents consist of mud, sand, abundant plant debris, a small quantity of algae and insects which reflects a phytophagous diet of *C. tholloni congica*. Thys Van Den Audenaerde (1964) found the same results which show that this species consumed plants debris (90%), some unidentified insects and a small quantity of algae. The same observations were made in in the same country by Matthes (1964), who found that this species is macrophytophagous which consumes plants debris (95%), algae, a few quantity of unidentified insects, diatoms and cladocera. The recent diet studies only concern other species of the coptodon group in natural or farmed environments. Imorou Toko et al. (2010) showed that phytoplankton, zooplankton, plant debris, macroinvertebrates, grains of sand, etc., are the constituents of the stomach contents of *Tilapia guineensis* in natural and farmed environments

Conclusion

At the end of this qualitative and quantitative study of *Coptodon tholloni congica* diet, undertaken in September and November 2017, according to size class and season. The results of stomach contents analysis associated with the calculation of the coefficient showed that *Coptodon tholloni congica* has an omnivorous phytophagous diet. The plant debris and mud are important prey, all other prey are incidental and food availability for this species does not vary significantly seasonally. Furthermore, studies of this nature are important to help understand the ecology of *Coptodon tholloni congica* which was first studied in Congolese waters. In addition, studies of this nature are important to help understand the biology for which there is an absence of data. However, this study must be supplemented by an in-depth study on the feeding habits and strategies of this species.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTION

DBCOO analyzed the stomach contents and wrote the article, MM and AT carried out the measurements, LPDB participated in the fishing with the fishing technicians and IMGD corrected the manuscript.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to excellent fishing technicians: MOPOUNDZA Ferdinand, NGAMBOUE Octave and NKOUA Jean, who helped for fishing in the Nkéni River.

REFERENCES

Akenze Ognimba RB, Lenga A, Akenze TR. 2018. Étude du comportement alimentaire de poissons *Schilbe grenfelli* dans le fleuve Congo (environ de Brazzaville). *Journal of Animal & Plant Sciences*, **38**(2): 6231-6243.

Castillo-Rivera M. 2013. Influence of rainfall pattern in the seasonal variation of fish abundance in a tropical estuary with restricted marine communication, *J. Water Resource Protec*, **5**: 311-319. DOI : http://dx.doi.org/10.4236/jwarp.2013.53A032

Darwall W, Smith K, Allen D, Robert Holland R, Harrison I, Brooks E. 2011. *The Diversity of Life in African Freshwaters: Underwater, Under Threat an Analysis of The Status and Distribution of Freshwater Species Throughout*

Mainland Africa. IUCN: Cambridge, UK and Gland, Switzerland; 44-87.

Fryer G, Iles TD. 1972. *The Cichlid Fishes of the Great Lakes of Africa: their Biology and Evolution.* Oliver & Boyd: Edinburgh, Scotland; 641 p.

Hajisamae S. Chou LM, Ibrahim S. 2003. Feeding habits and trophic organization of the fish community in shallow waters of an impacted tropical habitat, *Estuar. Coast. Shelf. Sci*, **58**: 89-98. DOI : https://doi.org/10.1016/s0272-7714(03)00062-3

Hynes HBN. 1950. The food of fresh water sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*) with a review of methods used in studies of the food of fishes. *J. Anim. Ecol.*, **19**: 36-58. DOI: https://doi.org/10.2307/1570

Hyslop EJ. 1980: Stomach contents analysis, a review of methods and their application. *J. Fish Biol.,* **17**: 411- 429. DOI: https://doi.org/10.1111/j.1095-8649.1980.tb02775.x

Imorou Toko I, Attakpa EY & Elegbe H. 2010. Performances biologiques, zootechniques et nutritionnelles de Tilapia guineensis en milieux naturel et d'élevage. *Int. J. Biol. Chem. Sci.,* **4**(5): 1629-1640. DOI : http://ajol.info/index.php/ijbcs

Kone T, Kouamélan EP, Ouattara NI, Kicho AV. 2007.Régime alimentaire de *Pomadasys jubelini* (Pisces, Haemulidae) dans une lagune Ouest africaine (lagune Ebrié, Côte d'Ivoire). *Sciences et Nature*, **4**(1): 65-73 p. DOI : https://doi.org/10.4314/scinat.v4i1.42131

Kouamélan EP, Gourène G, Teugels GG, Thys van den Audenaerde DFE. 1997. Diversité morphologique du tube digestif chez 39 espèces de poissons africains et relation avec la classification ichtyologique. *J. Afr. Zool.*, **111**: 109-119.

Kouamélan EP, Gourene G, Teugels GG, Thys Van Den Audenaerde DFE, 2000. Habitudes alimentaires de *Mormyrops anguiloïdes* (Mormyridae) en milieux lacustre et fluvial d'un bassin ouest africain. *Cybium,* **24** : 67-79. DOI : https://doi.org/10.26028/cybium/2000-241-005

Lowe-Mac Connell RH. 1979 - Ecological aspects of seasonality in fish of tropical waters. *Symp. Zool. Soc. Lond.*, **44**: 219-241.
DOI: https://doi.org/10.5897/IJFA2015.0511

Matthes H. 1964. Les poissons du lac Tumba et de la région d'Ikela : étude systématique et écologie. *MRAC, Tervuren, Belgique Annales,* **126**(8): 1-132.

Mbega JD, Teugels G. 2003. Guide de détermination des poissons du bassin inférieur de l'Ogooué. IRAF, MRAC, 165p.

Micha JC. 1973. *Etude des Populations Piscicoles d'Oubangui et Tentatives de Sélection et d'Adaptation de quelques Espèces à l'Etang de Pisciculture*. Ed CTFT : Paris ; 110p.

Mukankomeje R, laviolette F, Descyi JP. 1994. Régime alimentaire de Tilapia, *Oreochromis niloticus*, du Lac Muhazi (Rwanda). *Annls Limnol.* **30**(4): 297-312. DOI : https://doi.org/10.1051/limn/1994022

Moutsinga AN, Ngokaka C, Akouango F, Mamonékéné V. 2012. Diversité du régime alimentaire des poissons chats du bassin de la rivière Léfini (Congo) en fonction des saisons. *Agronomie Africaine*, **24** (2) : 81 – 88.

Moreau Y. 1988. Physiologie de la nutrition. In *Biologie et Ecologie des Poissons d'Eau Douce Africains*, Levêque C, Bruton MN, Ssentongo GW (eds). ORSTOM : Paris; 137-152.

Natarajan AV, Jhingran AG. 1961. Index of preponderance – a method of grading the food elements in the stomach analysis of fishes. *Ind J. Fish.*, **8**: 54-59.

Paugy D. 1984. Characidae. In *Checklist of the Freshwater Fishes of Africa*, Daget J, Gosse JP, Thys Van Den Audenaerde DFE (éds). CLOFFA 1, ORSTOM (Paris) et MRAC (Tervuren); 140-183.

Paugy D. 1994. Ecologie des poissons tropicaux d'un cours d'eau temporaire (Baoulé, haut bassin du Sénégal au Mali)

: adaptation au milieu et plasticité du régime alimentaire. *Rev. Hydrobiol. Trop*., **27**(2): 157-172. DOI : https://doi.org/10.4000/books.irdeditions.29211

Paugy D, Lévêque C, Teugels GG. 2003. *The Fresh and Brackish Water Fishes of West Africa* (vols 1 & 2). Muséum National d'Histoire Naturelle : Paris ; 1272p. (Faune et Flore Tropicales ; 40).

Rosecchi E. 1983. Régime alimentaire du Pageot, *Pagellus erythrinus* Linné, 1758 (Pisces, Sparidae) dans le golfe du Lion. *Cybium*, **7**: 17-29.

Rosecchi E, Nouaze Y. 1987. Comparaison de cinq indices utilisés dans l'analyse des contenus stomacaux. *Revue des Travaux de l'Institut des Pêches Maritimes*, **49**: 111-123.

Roth M. 1962. Initiation à la systématique et la biologie des insectes. ORSTOM : Paris ; 145p.

Sanogo Y. 1999. L'ichtyofaune du parc national des oiseaux du Djoudj et de sa périphérie : biologie de la reproduction et croissance de *Tilapia guineensis*. Thèse de Doctorat de 3ème Cycle de Biologie Animale. Université Cheikh Anta Diop de Dakar (Sénégal), 78 p.

Scherrer B. 1984. Présentation des données. In: Morin G. édition Biostatistique, 2-123.

Schoener TW. 1970. Non-synchronous spatial overlap of lizards in patchy habitats. *Ecology*, **51**: 408-418. DOI : https://doi.org/10.2307/1935376

Shumway C, Levêque C, Paugy D, Teugels GG, Poll M, Gosse JP. 2002. Guide de champ des poissons de la République Démocratique du Congo à l'exclusion du lac Tanganyika, 145 p.

Snoeks J, Harrison IJ, Stiassny MIJ. 2011. The status and distribution freshwater fishes. In *The Diversity of Life in African Freshwaters: Underwater and Under Threat an Analysis of the Status and Distribution of Freshwater Species Throughout Mainland Africa*. IUCN: Cambridge, UK and Gland, Switzerland; 42-125.

Verighina IA. 1990. Basic adaptations of the digestive system in bony fishes as a function of diet. *J. Ichthyol*. **30**: 897-907. DOI:10.4314/scinat.v5i2.42162

Werner EE, Hall DJ. 1977. Competition and habitat shift in two sunfishes (Centrarchidae). *Ecology*, **58**: 869-976. DOI: https://doi.org/10.2307/1936222

Wootton R. 2012. Fish and Fisherie Serie 1, 1, 404p.