



Food Habits of *Schilbe Intermedius*, Rüppel, 1832 (Siluriformes: Schilbeidae) of Right Bank of Pool Malebo(Congo River)

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Abstract: The diet of *Schilbe intermedius* of the right bank of Pool-Malebo (Congo Brazzaville) was studied by examining the stomach contents of 942 individuals captured using the cash nets. Three stations were sampled monthly from January 2010 to December 2011. The analysis covered individuals with a standard length ranging from 23.93 to 129.3 mm according to sampling stations, hydrological season and fish size. The preponderance index combining the numerical occurrence percentage and the weight percentage was calculated. The percentage of emptiness is 27%, fishes are the main preys consumed by *Schilbe intermedius* with a preponderance index equal to 64%. There was variation in diet according to the season and the specimens size. The correlation coefficient of Spearman showed that the proportions of the different foods vary according to the size of the specimens ($r_s = 0.42$, $p = 0.05$). *Schilbe intermedius* is insectivorous in small juveniles that are becoming piscivorous predators in older, larger specimens.

Keywords: Congo River, Feeding habits, *Schilbe intermedius*, preponderance index, Schoener index

1. INTRODUCTION

The knowledge of fish feeding in the wild is an essential step in understanding their biology and ecology. The knowledge of the ingested prey as well as that of the fish's feeding habits are essential to understand their place and their function in the ecosystem (1). The study of fish feeding can provide data, not only on the presence of prey, but also on the abundance and availability of the trophic potential of the environment. In addition, it helps to understand the relationships between fish and prey, as well as interspecific relationships (2). The knowledge of the diet of a fish allows to define its ecological niche and by extension its habitat. The analysis of stomach contents makes it possible to determine the composition of the diet and to appreciate the use of the food available in the environment. The knowledge of fish preferences and the strategies used to colonize habitats are important data in conservation and sustainable management strategies for stocks (3).

Schilbe intermedius, commonly known as silver catfish, is a species of catfish of the family Schilbeidae prized for the quality of its meat organoleptic point of view (4) and its abundance in catches on the Congo River (5). In addition, the Schilbeidae are one of the groups of freshwater and brackish water fish economically more important worldwide [6]. This species is widespread in most of Africa, absent in North Africa and South Africa (7). Despite the global economic importance of *Schilbe* (8). Enormous literature exist on the food and the feeding habits of the fish in most inland water bodies, many investigations on the diet of this type of fish (9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23), have been undertaken in West Africa and South Africa. No dietary studies in *Schilbe intermedius* have been carried out in the Congo Basin, so to fill this gap, we have undertaken the study of the diet of this species according to the season, the station and the size.

2. MATERIALS AND METHODS

2.1. Study Area

The *Schilbe intermedius* diet was sampled in three stations on the right bank of the Pool Malebo (Figure 1). The three stations were investigated each month from January 2010 to December 2011. Kintele station or Station 1 is located between 04° 12.745' south, 015 ° 15.064 East and 04° 08.967'

south, 015°21.909 'East longitude. This station is located between the Congo River confluence and Ngapouyi waterway and Kintele village in front of Faignond Island. Chacona station or Station 2 has the following geographical location: 04°17.006 'South, 015 ° 16.350' East and 04° 16.655' South and 015° 17.006' East. This station is located between the confluence Congo River and Tsieme River and the thermal power station of Mpila. In some places, there is very little vegetation dominated by *Echinochloa stagnina*, *Echornia crassipes* and *Hypomea aquatica*. Port Leon station or Station 3 is positioned between 04 ° 14.860' South latitude - 015° 18.352' East longitude and 04° 14. 352' South latitude 015° 18.102' East. This station is located between the ATC port and the Chad ravine where the rest of the vegetable belt of Brazzaville is observed.

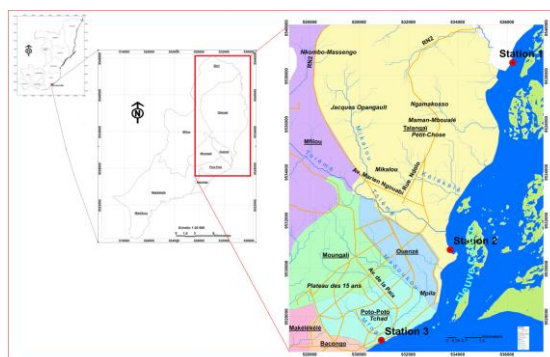


Figure1. Study area

The distribution of numerical abundance of specimens by station and sampling period is summarized in Table 1.

Table1. Spatio-temporal repartition of numerical abundance of *Schilbe intermedius*

Stations	Kintélé Station		Chacona Station		Port Léon Station	
	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season
Numerical abundance	143	113	177	58	254	185

2.2. Intestinal Coefficient

The intestinal coefficient (IC) was calculated for each individual according to the following formula (8):

$$IC = \frac{IL}{SL}$$

IL= Intestine length;

SL = Standard length

This coefficient allows to determine predictably the trophic guilds.

2.3. Analysis of Stomach Contents

The study of the fish diet often includes two types of analysis: qualitative analysis and quantitative analysis (24). Qualitative analysis which consists in drawing up a complete list of the different preys encountered in the stomachs, followed by quantitative analysis which specifies the importance different preys and highlights the possible variations of the diet according to the individuals size and the season.

2.4. Coefficient of Emptiness (CE)

Coefficient of emptiness is the ratio expressed as a percentage between the empty stomachs number and the total number of full stomachs examined:

$$CE = \frac{E_s}{N_T} \times 100$$

Es = empty stomachs number;

NT = total number of full stomachs examined.

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

It is the only dietary index used to analyze the diet results of this species (2), it is given by the following formula:

$$OC = \frac{n_i}{N_T} \times 100$$

n_i = number of stomachs containing a category of prey i ;

N_T = total number of full stomachs examined.

2.6. Preponderance Index

To quantify the relative importance of prey, the following indices were calculated (15): percentage of occurrence (normalized to 100) and weight percentage (25). To avoid bias in the use of these indices, the preponderance index (26) that incorporates these two indices has been determined:

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

% OC = Percentage of occurrence;

% W = Weight percentage;

I_p = Preponderance index.

The different types of preys are ranked according to the value of the preponderance index as follows:

$I_p \leq 10$: accessory preys;

$10 < I_p < 25$: secondary preys;

$I_p < 50$: important preys;

$I_p \geq 50$: main preys.

2.7. Schoener Index

The calculation of Schoener index (27) made it possible to evaluate the degree of similarity of the diet between stations, seasons and sexes, it is given by the relation:

$$\alpha = 1 - 0,5 \left(\sum_{i=1}^n |P_{xi} - P_{yi}| \right)$$

P_{xi} = proportion of preys consumed by individuals of a season x ;

P_{yi} = proportion of preys consumed by individuals in a season y .

Diets are considered significantly similar when the value of α is greater than or equal to 0.6 (28).

2.8. Statistical Analyzes

A Cluster analysis based on Euclidean distance is performed from matrix the preys occurrence - classes sizes, to identify the similarities between diets of individuals 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

3. RESULTS AND DISCUSSION

3.1. Description of the External Morphology of the Digestive Tract of *Schilbe Intermedius*

The digestive tract of *Schilbe intermedius* has an esophagus followed by a thick-walled stomach, 3 unequal size pyloric caeca and a short intestine (Figure 2).



Figure2. Digestive tract of *S. intermedius*

3.2. Intestinal Coefficient of *Schilbe intermedius*

The intestinal coefficient of *Schilbe intermedius* varies between 0.18 and 1.42, with an average of 0.55 ± 0.16 (Figure 3). This value of the intestinal coefficient less than 3 shows that the intestine is short, indicating that this species is omnivorous (8;29).The correlation between standard length and the intestinal length is quite good because the coefficient of determination r^2 is equal to 0.65 and the correlation coefficient r equal to 0.8 (Figure 4).

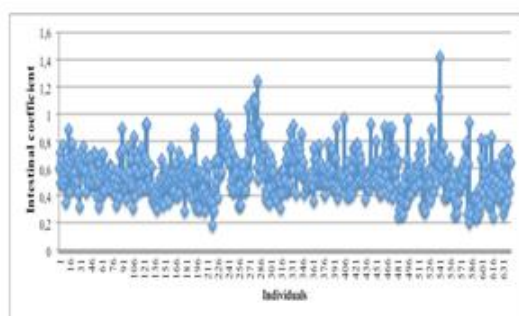


Fig3. Intestinal coefficient of *S. intermedius*

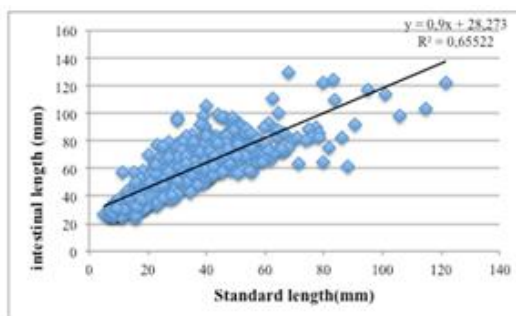


Fig4. Relation between intestinal length and the standard length of *S. intermedius*

3.3. Coefficient of Emptiness

The number of empty stomachs was 258 for a total of 942 *S. intermedius* individuals examined, representing a emptiness coefficient of 27%. At Kintélé, 69 stomachs out of 214 examined were empty, giving a emptiness coefficient of 32%. The number of empty stomachs at Chacona was 69 out of a total of 235, which corresponds to a emptiness coefficient of 25%. At Port Leon, the emptiness coefficient was 27%.

3.4. Global Composition of Trophic Structures

The overall composition of the trophic structures of *Schilbe intermedius* of Pool Malebo (Table 2), shows that fishes had the highest occurrence of 34%, followed by plant debris (14%), unidentified insects (13%), unidentified preys (11%), trichoptera larvae, sand grains and beetle larvae (8%), diptera (6%). Other preys had an occurrence between 3% and 0% (Table 2). Overall, fishes were the main preys consumed by *Schilbe intermedius* with a preponderance index equal to 64%; insects (13,17%), others preys (11,88%), plant debris (10,48%) are the secondary preys and others animal preys are accessory preys. The analysis of the general trophic structure of *Schilbe intermedius* on the right bank of the Malebo Pool (Congo River) showed that this species is omnivorous, a result in accordance with the length of the intestine which is less than 3. Many authors have obtained similar results showing that the diet of this species still includes fishes, insects and plants debris. Carey (30) has shown that *S. intermedius* of Kafue flood plain are partially piscivorous; they also eat insects, crustaceans and plant debris. Reynolds (22), who studied the diet of *Schilbe intermedius* in the Volta Basin, showed that specimens larger than 100 mm eat more ephemeroptera, fish and a few terrestrial insects. Results obtained by Mok (18) showed that the diet of *Schilbe intermedius* in the lake Chad basin is also composed mainly of fishes (80% to 90% of the total weight). The occurrence of aquatic insects was equal to 39.2% by volume and 25% of ostracodes. Olatunde (21) in lake Kainji, found also results close to those of the right bank of the Malebo Pool. In this lake, fishes and insects (adult beetles, orthopterans, odonate nymphs) were consumed; fishes were the most important preys item with 63%. This species consumes mainly fishes (15, 16, 17, 19, 20, 31, 32, 33), Cichlidae and Cyprinidae are mainly preys of *S. intermedius*. Others fishes like the genus *Synodontis* serve as preys (23). Welcomme (34) described this species as a meso-predator with a diet composed of crustaceans and insects.

Table 2. Composition of *Schilbe intermedius* diet in Pool Malebo Oc = % occurrence; % P = weight percentage; Ip = preponderance index

Preys	% Oc	%P	Ip
Fishes	34.23	32.42	64
Coleoptera	5.51	5.15	1.63
Diptera	1.99	1.02	0.12
Hymenoptera	2.70	0.42	0.07

Heteroptera	0.23	0.08	0.00
Lepidoptera	0.12	0.09	0.00
Odonata	0.47	0.48	0.01
Orthoptera	0.35	0.04	0.00
Coleoptera larvae	2.34	0.91	0.12
Diptera larvae	7.85	5.21	2.35
Ephemeroptera larvae	8.79	3.21	1.62
Trichoptera larvae	1.88	2.43	0.26
Unidentified insects	13.25	9.18	6.99
Arachnids Spiders	0.12	0.04	0.00
Crustaceans Shrimps	1.64	0.26	0.02
Nematodes unidentified	0.12	0.00	0.00
Annelida unidentified	1.76	5.28	0.53
Myriapoda unidentified	1.17	0.94	0.06
Planaria unidentified	0.59	0.13	0.00
Plants debris	13.60	13.40	10.48
Algae	0.35	0.01	0.00
Grains of sand	8.44	0.52	0.25
Preys unidentified	10.78	18.75	11.63

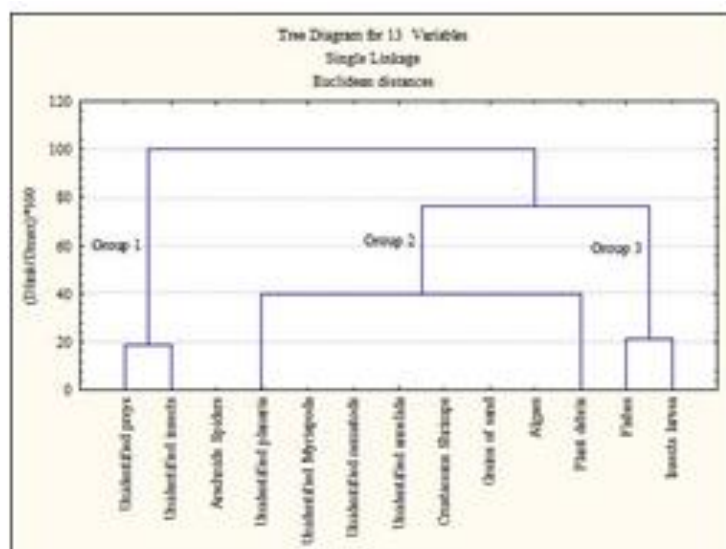
3.5. Seasonal Variation of Trophic Structures

Overall, the table 3 shows that the insects larvae were important preys in the rainy season with a preponderance index of 43% and become secondary preys in the dry season (11%). The fishes had the same profile where they are important preys with a preponderance index of 36% in the rainy season and an index of 11% in the dry season (Table 4). On the other hand, insects that are accessory preys (1%) become important preys in the dry season (36%); unidentified preys are also accessory preys in the rainy season (7%) and important preys in the dry season (37%). Plants debris were accessory preys during the rainy season (12%) and in the dry season (5%). The α index is equal to 0.35, which indicates a significant difference in diet according to the season. Another study (35) states that the stomach contents of this species vary with the season, with increasing rainfall, *S. intermedius*, which normally feeds fishes (preys that require effort for capture, consumes insects that have become more readily available. In contrary, during rainy season in one station of the Agnébi River, insects are the main preys in the diet of *S. intermedius* (14). Changes in diet are closely linked to the availability of preys. Insects reproduction occur during the rainy season, which explains their dominance in the supply *Schilbe* studied at this time (36). This explains the strong preponderance of insect larvae in the rainy season. Also, the eclectic trend confirmed by (15) explains the abundance of insects in the diet of *S. intermedius* especially during the rainy season because the headwaters flowing floods inundate the surrounding vegetation and make available to fish a large number of insects trapped by the water. Similarly, thanks to the rain, insects and other invertebrates drowning and would be easily accessible prey for *Schilbe intermedius*. This explains in part the amount of food present in the stomachs is higher during the rainy season than in the dry season. In the dry season, insects are the main preys in the diet of *S. intermedius* in the headwaters of the Agnébi (14).

Table 3. Composition of the dominant items in the diet of *Schilbe intermedius* in Pool Malebo according to season (Ip)

Preys	Rainy season (Ip)	Dry season (Ip)
Fishes (%)	36	11
Insects (%)	1	36
Insects larvae (%)	43	11
Plants debris (%)	12	5

The affinity of preys consumed between the two seasons dendrogram showed discrimination regime between the two seasons (Figure 5). Three groups of preys are discriminated, preys of high consumption (insect and insect larvae) forming group 1 and group 3 (fishes and plant debris), the low consumption form group 2 (nematodes, annelids, algae, myriapodes, planarias, spiders, crustaceans, unidentified preys et grains of sand).



Figur5. Affinity dendrogram of different food items according to season

3.6. Spatialvariation of Trophic Structures

In Kintélé, fishes were major preys in *S. intermedius*; their preponderance index is 73% (Table 4). Plants debris (8.5%), unidentified insects (9%), Ephemeroptera larvae (6%) and other preys (1.41%) are accessory preys. In Chacona, fishes represent also the main preys, the preponderance index was 65%. Plants debris is secondary preys with a preponderance index of 19.6%, unidentified insects are accessory preys with an index of 10% (Table 4). Ephemeroptera larvae (1.7%), unidentified preys (1.4%) and beetles (1%) and other preys are also accessory preys. In Port Leon, fishes remained main preys with a preponderance index of 68%, followed by plants debris, unidentified insects and Diptera larvae (9%), other preys (1.7%), unidentified preys (1.6%) and spiders (1%) which represent accessory preys (Table 4).

Table4. Composition of the dominant items in the diet of *Schilbe intermedius* in Pool Malebo according to station (Ip)

Preys		Kintélé	Chacona	Port Léon
Vertébrés	Fishes	72.84	65.36	68.21
Insects	Coleoptera	0.51	1.02	0.42
	Diptera	0.00	0.02	0.27
	Hymenoptera	0.03	0.06	0.13
	Heteroptera	0.00	0.00	0.00
	Lepidoptera	0.00	0.00	0.00
	Odonata	0.00	0.00	0.04
	Orthoptera	0.01	0.00	0.00
	Coleoptera larvae	0.01	0.01	0.11
	Diptera larvae	0.11	0.48	8.58
	Ephemeroptera larvae	6.02	1.72	0.69
	Trichoptera larvae	0.79	0.01	0.07
	Unidentified insects	8.50	10.24	8.79
Arachnids	Spiders	0.00	0.01	0.00
Crustaceans	Shrimps	0.03	0.00	0.04
Nematodes	Unidentified	0.00	0.00	0.00
Annelida	Unidentified	0.45	0.00	1.21
Myriapoda	Unidentified	0.00	0.00	0.26
Planaria	Unidentified	0.00	0.00	0.02
Macrophytes	Plants debris	9.26	19.62	9.50
Others preys	Algae	0.00	0.00	0.00
	Unidentified preys	0.86	1.41	1.59
	Grains of sand	0.58	0.04	0.07

Among fishes, insects and plants debris are most consumed in the three stations with different preponderance index values (Table 5).

Table5. Composition of the dominant items in the diet of *Schilbe intermedius* in Pool Malebo according to station (Ip)

Preys	Kintélé	Chacona	Port Léon
Fishes	72.84	65.36	68.21
Insects	15.98	13.56	19.1
Plant debris	9.26	19.62	9.50

The affinity dendrogram below is based on the different preponderance index of prey consumed by *S. intermedius* recorded at the three stations. The results show that the stations constitute two groups, the first of which is formed by the Chacona station whose trophic spectrum is different from that of the two others. The second group corresponds to the two stations Kintele and Port Leon which present similarities of the trophic spectrum (figure 6).

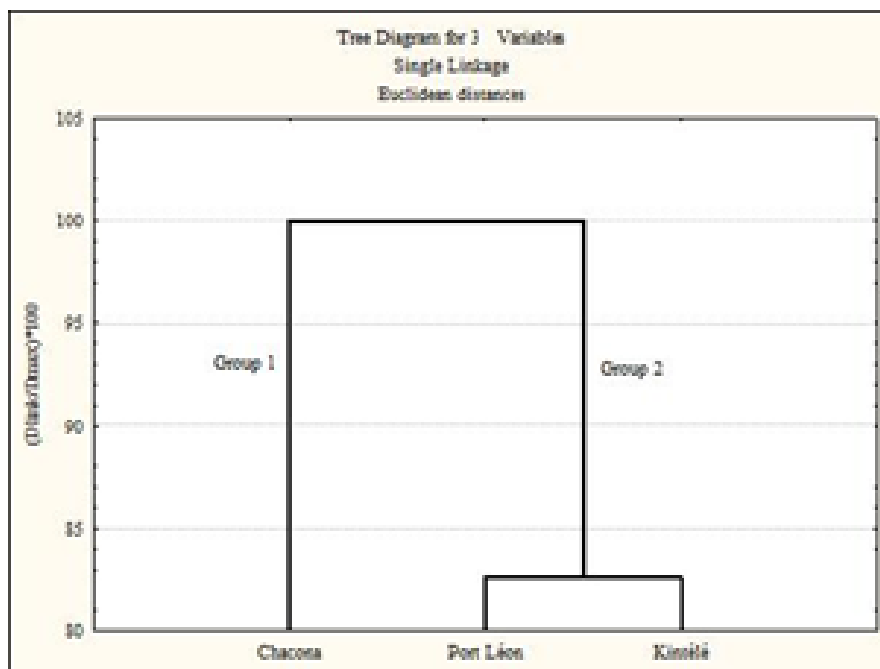


Figure6. Affinity Dendrogram of preponderance index of preys consumed by *S. intermedius* according to the station

3.7. Variation of Trophic Structures of *S. Intermedius* According To Size

Examination of the trophic structures of all individuals of *S. intermedius* showed that overall fish and invertebrates have the highest occurrences (Figures 6 and 7). The fishes are most consumed by classes 2, 3, 4, 5 and 6, the occurrences decrease from class 7. The low consumption of invertebrates observed in classes size 1 and 2 (1%), which reaches the maximum with class 3(12%) and decreases up to 5% in class 7. The occurrences are less than 5% for the last three classes. Plants debris and other preys are the least consumed with 4% for classes 4 and 6; in class 5, the occurrence is 3%, the rest of the classes have occurrences between 1% and 2%. The trophic spectrum differs according to size class, so that class 1-2 is mainly entomophagous. This entomophagy decreases as the specimensize increases. The fishes are the main preys of all specimens from size class 3 (43.74 -53.3 mm).(18) has shown that the diet of young *Schilbe* that is entomophagous becomes ichthyophagous in larger individuals. (31) found that lake Chad specimenswitch size is between 210 and 230 mm consume more fishes (66.2% by volume), for an occurrence of 39.3%.(19) show that *S. intermedius* has an ontogenetic diet where young fishes have greater selectivity for aquatic macroinvertebrates, while larger fishes are more piscivorous, which is consistent with observations of (37), (16) and (38). Therefore, *S. intermedius* is not simply an opportunist, generalized insectivore and piscivorous predator (17), but is rather an opportunistic, widespread insectivore in small-sized juveniles that turn into a relatively more specialized piscivorous predator in older specimens of larger size. Concerning the variation in the diet according to the size, *Schilbe intermedius* has a tendency to become more pronounced with piscivory that size. This result confirms results of(9) in which the upper part of the Ogun River in Nigeria, shows that juvenile *S. intermedius* have a tendency to piscivory with

increasing predator size. (15) Showed that genus *Schilbe* is ichthyophagous and food trend that increases with the age of the specimens.

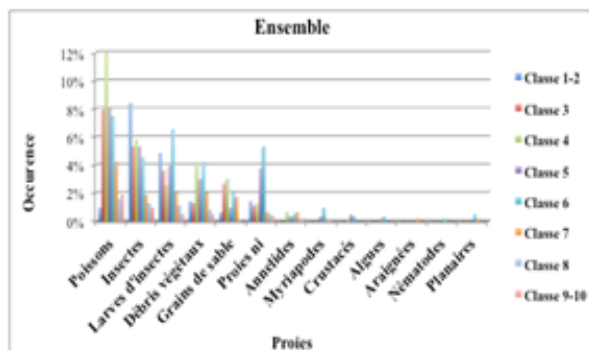


Figure 6: Global trophic spectrum of preys consumed by *S. intermedius* according to the size

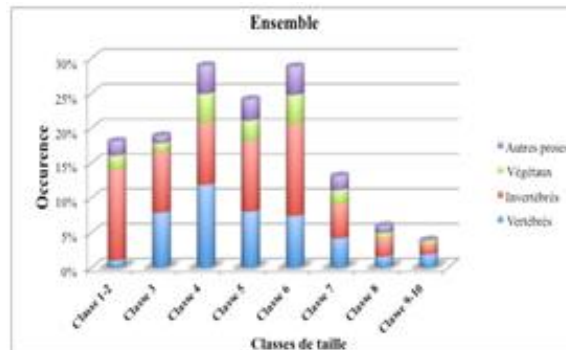


Figure 7: Global trophic spectrum of preys groups consumed by *S. intermedius* according to the size

The affinity dendrogram of the global trophic spectrum shows that specimens of *S. intermedius* form two groups of classes size (Figure 8). Group 1 is formed by the majority of classes: class 10, class 9, class 8, class 7, class 4, class 5, class 6, class 3. This group is divided into 3 subgroups, the first subgroup is formed by class 10, class 9 and class 8; the second subgroup is formed by class 4; the third subgroup has the classes 6, 5 and 3. The subgroup 4 has only the class 1-2.

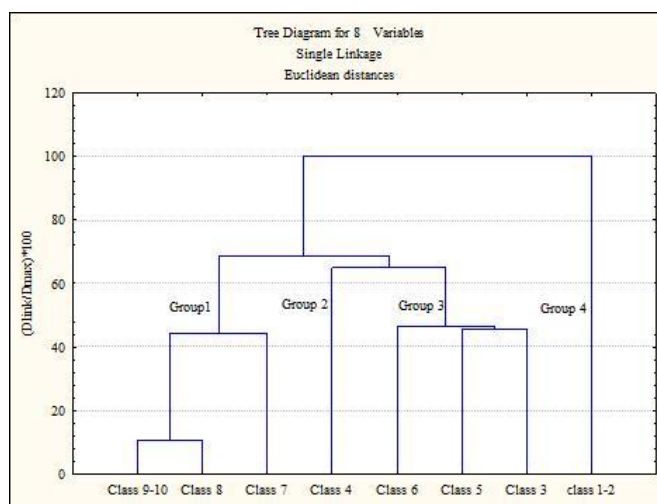


Figure 8. Dendrogram of affinity of the global trophic spectrum of *S. intermedius* according to the size

4. CONCLUSION

The trophic structures of *Schilbe intermedius* were composed of fishes (34%), followed by plants debris (14%), unidentified insects (13%), unidentified preys (11%), trichoptera larvae, grains of sand, coleoptera larvae (8%) and diptera (6%). On the whole, fishes are the main preys consumed by *Schilbe intermedius* with a preponderance index of 64%. Fishes are major preys species consumed by *S. intermedius* in Kintele station (Ip = 73%), Chacona station (Ip = 65%) and Port Léon station (Ip = 68%). The comparison of the preponderances indicates that there is no difference between the stations. Small specimens are entomophagous, we note the appearance of ichthyophagous specimens with a standard length greater than or equal to 43.7 mm.

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