International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869, Volume-2, Issue-11, November 2014

Diet of *Schilbe intermedius* Rüppell, 1832 in a coastal West African basin, Agnébi River in Côte d'Ivoire

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***Abstract*— Diet of *Schilbe intermedius* base on size, season and hydrological stations was studied by the analysis 710 stomachs among which 236 contained foods. Fishes were caught using gillnets in the basin of Agnébi River. The coefficient having the emptiness empty stomachs percentage relative to the total number of stomachs examined was calculated.**

The Importance Relative Index (IRI) combining the numerical percentages of occurrence and weight has been used.

The species has an eclectic diet trend with a tendency to piscivory and insects are the most diverse group of prey. A change in diet was observed depending on the season and hydrological stations.

***Index Terms*— Agnébi River, Feeding, *Schilbe intermedius*, Schilbeidae.**

I. INTRODUCTION

Mastery of the biology and ecology of animals including fish through the study of their diet as the main power source of energy acquisition plays a very important role in the reproduction of the species where the maintenance. According to [1], the animals choose food strategy requiring less energy and thus ensuring the highest reproductive success. Despite the global economic importance of Schilbe [2], the few studies of their diets are fragmentary [3]. In Côte d'Ivoire, three Schilbe present are: *Parallia pellucida*, *Schilbe mandibularius* and *S. intermedius*. The nutritional profile of the latter species has been cited little study. *Schilbe intermedius*, siluriforme fish of the family Schilbeidae is a species prized for the quality of its meat organoleptic point of view [4] and abundant in catches on the Agnébi River [5] merely the object of study plots [6]. To this end, a prelude to the knowledge of its biology and ecology, knowledge of its food caught our attention. Thus, we consider successively the overall diet profile and diet according to the season, habitat and age based on size classes of the specimens.

II. MATERIAL AND METHODS

Fig. 1 shows the location of sampling stations on Agnébi River after prospecting. This is Gbessé the upper, Pont-autoroute on the Northern Highway in the middle stream and Armébé at the lower stream.

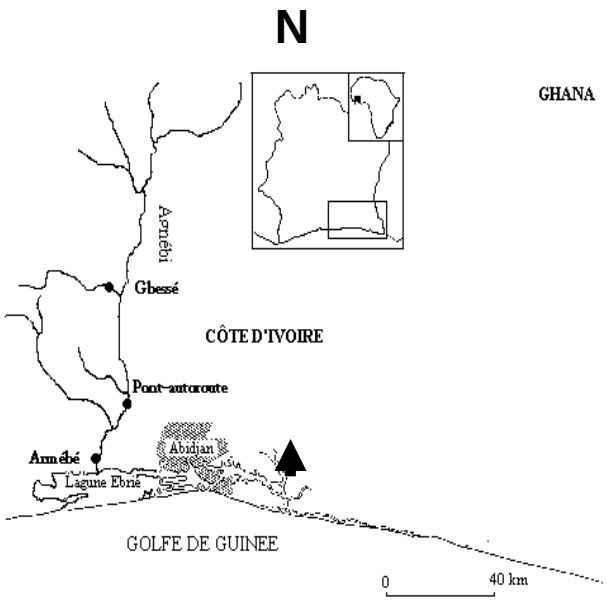

Fig. 1: Location of sampling stations on Agnébi the river (based [7]).

The characteristics of the three stations selected are:
- Gbessé (5 ° 50 'N and 4 ° 17' W): This station is located on the Kavi, a tributary of the Agnébi. It is subject to periodic drying during the long dry season.
- Pont-autoroute (5 ° 30'N and 4 ° 14 'W) in the middle stream, during the dry season, the river is reduced in this resort to a stream of water with a depth less than 30 cm. The substrate is strewn with pebbles and rocks.
- Armébé (5 ° 20 'N and 4 ° 19' W), on the lower stream is characterized by the permanence of water, probably related to greater depths (7 m on average).

The specimens used for the study of the diet were captured during experimental fishing using two batteries gillnets mesh 10, 12, 15, 20, 25, 30, 40 and 50 mm. The individuals selected were measured, weighed and dissected. The stomachs were kept in pill containing 5% formalin. In the laboratory, stomachs were drained on blotting paper, weighed and then gently open under a magnifying glass. Stomach contents were analyzed under the microscope OLYMPUS SZ model 30 and weighed with a precision balance 0.01g. A mechanical counter was used to count the items.

As we selected index:

- Coefficient of emptiness: the percentage of empty stomachs on the total number of stomachs examined. Its formula is:

$$cv = \frac{Number\ of\ empty\ stomachs}{Number\ of\ analyzed\ stomachs} * 100$$

Manuscript received November 23, 2014.

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- An Importance Relative index (IRI), which takes into account the numerical percentage (N), the volume percentage (V) and the percentage of occurrence (F) [8] and having the formula:

$$IRI = (N + V) * F$$

Upon application, we replaced the volumetric percentage (V) by the weight percentage (P).

III. RESULTS

General profile of the diet

Of a total of 710 stomachs of *S. intermedius*, 474 stomachs were empty, which is a coefficient of emptiness (CV) of 66.76%. From 236 stomachs containing prey, the diet is composed of 23 prey categories represented by 13 taxa. Insect orders are more diverse and have 10 taxa (Table I).

Fish and animal remains with 46.69 and 29.04% of relative importance index (IRI) respectively are the preferred prey. When the secondary prey, they are represented by insects (18.87%) among which the dominant orders are Hymenoptera (32.06%), Coleoptera (27.27%) and Diptera (20.12%).

Table I: General Diet expressed by the Importance Relative Index (IRI %) of *Schilbe intermedius* from the Agnébi River (Côte d'Ivoire): N = Numeric Percent; P = Percentage weight; F = Percentage of occurrence; XXX: preferred prey, XX secondary prey X: accidental prey.

Prey	N	P	F	% IRI	Classification
Insects orders					
Coleoptera	27.33	2.77	33.71	27.27	XXX
Diptera	16.67	24.98	17.98	20.12	XX
Ephemeroptera	3.33	0.89	5.62	0.64	X
Hemiptera	1.33	4.46	2.24	0.35	X
Hymenoptera	28	16.24	26.97	32.06	XXX
Lepidoptera	6	16.95	6.74	4.16	X
Mantodea	0.67	2.50	1.12	0.10	X
Odonata	4	4.64	5.61	1.30	X
Orthoptera	8.67	24.80	14.61	13.14	X
Tricoptera	4	1.79	5.62	0.87	X
Insects	14.11	8.89	37.71	18.87	XX
Amphibian	0.75	3.48	2.54	0.23	X
Annelida	0.37	0.10	1.70	0.02	X
Arachnida	8.65	1.31	2.12	0.46	X
Crustacea	6.77	3.50	5.93	1.32	X
Mollusca	0.09	0.21	0.43	0.002	X
Myriapoda	0.75	0.94	2.12	0.08	X
Fishes	11.85	59.50	30.08	46.70	XXX
Fruits	38.29	3.82	1.27	1.16	X
Animals debris	13.26	13.27	50	29.04	XXX
Vegetables debris	1.88	1.27	8.05	0.55	X
Indetermined	2.92	2.39	13.14	1.51	X
Authers preys	0.28	1.15	1.27	0.04	X

Change in diet according to the season hydrological

94 stomachs full of specimens caught in rainy seasons, the diet contains 19 prey taxa with 8 insects orders (Table II). The supply is dominated by Myriapoda (60.58%) which is the preferred prey and fruits (21.11%), secondary prey. Compared to insect orders, Coleoptera (48.91%) and Hymenoptera (31.55%) are the preferred prey. As for Tricoptera (11.50%), they are secondary prey.

Table II: Seasonal variation of the Importance Relative Index (IRI %) of prey taxa found in the stomachs of specimens of *Schilbe intermedius* from the Agnébi River (Côte d'Ivoire), n = number of specimens; xxx: preferred prey, xx: secondary prey x: incidental prey.

Prey	Rain season : n=94		Dry season	
Insects orders	% IRI	Classification	% IRI	Classification
Coleoptera	48.91	XXX	18.02	XX
Diptera	4.27	X	22.51	XXX
Ephemeroptera	0.25	X	0.89	X
Hemiptera			0.61	X
Hymenoptera	31.55	XXX	32.37	XXX
Lepidoptera	0.13	X	5.87	X
Mantodea			0.17	X
Odonata	2.16	X	1.12	X
Orthoptera	1.23	X	18.40	XX
Tricoptera	11.50	XX	0.05	X
Insects	9.08	X	24.41	XX
Amphibian	0.03	X	0.38	X
Annelida	0.03	X	0.01	X
Arachnida	0.01	X	1.11	X
Crustacea	1.95	X	0.67	X
Mollusca	0.07	X	0.01	X
Myriapoda	60.58	XXX	0.09	X
Fishes	3.83	X	38.51	XXX
Fruits	21 .11	XX	0.06	X
Animals debris	0.69	X	33.15	XXX
Vegetables debris	2.62	X	0.52	X
Indetermined	-		0.99	X
Authers preys	-		0.09	X

In the dry season, the 142 stomachs full of fish caught have a diet consisting of 23 prey taxa, including 10 insect orders (Table II). Fishes (38.51%) and animals debris (33.15%) are the preferred prey. Insects (24.41%) are secondary prey with the Hymenoptera (32.37%), Diptera (22.51%) as preferred prey and Orthoptera (18.40%), secondary prey.

Change in diet according to the study site

The upper stream of the Agnébi (Gbessé) for 58 full stomachs analyzed, *S. intermedius*, a diet consisting of 20 taxa of which there are 9 orders of insects (Table III). With 56.05%, insects are the preferred prey and are followed by animals debris 23.65% as secondary prey. In terms of insect orders, they are dominated by Hymenoptera (52.47%) preferential prey. Orthoptera (24.02%) are secondary prey.

Table III: Change in diet of *Schilbe intermedius* from the Agnébi River stations. XXX: preferred prey; XX: secondary prey; x: incidental prey.

Prey	Gbessé		Pont-autoroute		Armébé	
Insects orders	IRI %	Classifi	IRI %	Classifi	IRI %	Classifi
Coleoptera	9.37	X	35.66	XXX	29.06	XX
Diptera	8.36	X	37.76		1.44	X
Ephemeroptera	0.16	X	0.47	X	4.83	X
Hemiptera			1.36	X		
Hymenoptera	52.47	XXX	12.51	XX	49.89	XXX
Lepidoptera	4.67	X	4.38	X		
Mantodea	0.53	X				
Odonata	0.30	X	2.17	X	2.35	X
Orthoptera	24.02	XXX	4.81	X	6.66	X
Tricoptera	0.13	X	0.88	X	5.76	X
Insects	56.05	XXX	13.90	XX		X
Amphibian			0.50	X	4 .38	X
Annelida	0.02	X	0.01	X	0.05	X
Arachnida	0.02	X	1.52	X	0.05	X
Crustacea	3.06	X	0.06	X		
Mollusca	0.06	X			2.52	X
Myriapoda	0.16	X	0.12	X		
Fishes	5.29	X	47.68	XXX	74.06	XXX
Fruits	0.02	X			7.22	X
Animals debris	23.65	XX	35.23	XXX	11.16	XX
Vegetables debris	1.35	X	0.42	X	0.26	X
Indetermined	10.33	X	0.45	X	0.31	X
Authers preys			0.11	X		

At the station on the middle stream (Pont-autoroute) for 118 stomachs full of *S. intermedius*, diet is composed of 20 taxa 9 insects orders. Fishes (47.68%), animals debris (35.23%) are the preferred prey and insects (13.90%) were secondary prey. Diptera (37.76%), Coleoptera (35.66%) are the preferred prey of insect orders and Hymenoptera (12.51%) secondary prey.

At the station located at lower stream (Armébé), diet based on the analysis of 60 full stomachs indicates that *S. intermedius* has a diet consisting of 16 taxa 7 orders of insects. Fishes are the preferred prey with 74.05%, animals debris are secondary prey (11.16%). Compared to insect orders Hymenoptera (49.89%) are the preferred prey and Coleoptera (29.06%) were secondary prey.

Changes in the diet according to the size

For the nine size classes so age obtained from the rule of Sturge, with 14.04 mm apart, we selected seven merging the last two with only 8 specimens. By applying the method of Jaccard ascending classification (cluster analysis) is obtained indicating food similarity between different size classes selected. From the dendrogram thus obtained were formed five groups of size classes (Fig. 2): CLT1: 75≤LS<89.04 mm; CLT2: 89.04≤LS<103.08 mm; CLT3: 103.08≤LS<117.12 mm; CLT4: 117.12≤LS<145.20 mm and CLT5: LS≥ 145.20 mn used for qualitative and quantitative study of the diet.

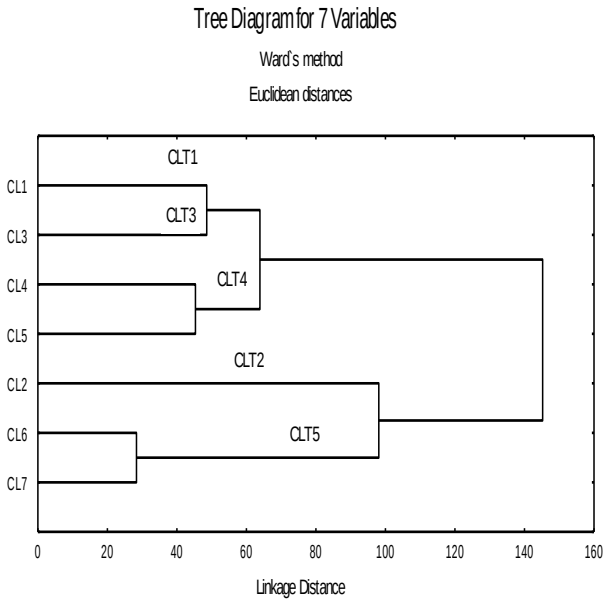

Fig. 2: Dendrogram showing the similarities between food samples of seven size classes *Schilbe intermedius* from the Agnébi River (Côte d'Ivoire). Analysis based on Euclidean distance and Ward's method: CLT1 (n = 17) 75≤LS <89.04 mm; CLT2 (n = 28): 89.04≤LS<103.08 mm; CLT3 (n = 43): 103.08≤LS<117.12 mm; CLT4 (n = 84): 117.12≤LS<145.20 mm; CLT5 (n = 64) LS≥145.20 mm; CLT1 = CL1; CL2 = CLT2; CLT3 = CL3, CL4 + = CLT4 + CL5; CLT5: CL5 = CL7 + CL6.

The first class of juveniles (75≤LS<89.04 mm; n = 17) consumed 13 prey taxa which 4 are insects orders (Table IV). Fishes (48.73%) and insects (29.99%) are the preferred prey. In terms of orders of insects, Hymenoptera (31.89%) and Coleoptera (30.02%) are the preferred prey. Odonata (29.05%) were the secondary prey.

Table IV: Diet according to the size classes of *Schilbe intermedius* in Agnébi River; XXX: preferred prey; XX: secondary prey; X: accidental prey.

Prey	CLT1 : n=17		CLT2 : n=28		CLT3 : n=43	
Insects orders	IRI %	Clas	IRI %	Clas	IRI %	Clas
Coleoptera	30.02	XXX	72.52	XXX	44.56	XXX
Diptera			6.36	X	35.88	XXX
Ephemeroptera					1.32	X
Hemiptera						
Hymenoptera	31.89	XXX			13.38	XX
Lepidoptera			17.49	XX		
Mantodea						
Odonata	29.05	XX			2.43	X
Orthoptera			3.63	X	2.43	X
Tricoptera	3.32	X				
Insects	29.99	XXX	14.96	X	11.67	X
Amphibian	1.77	X				
Annelida					0.21	X
Arachnida	1.66	X			0.05	X
Crustacea	0.68	X			0.05	X
Mollusca						
Myriapoda	1.28	X				
Fishes	48.73	XXX	23.81	XX	25.50	XX
Fruits						
Animals debris	16.82	XX	58.99	XXX	60.78	XXX
Vegetables debris	0.43	X	0.11	X	0.74	X
Indetermined	4.79	X	1.38	X	1.01	X
Authers preys			0.76	X		

Table IV…second part

Prey	CLT4 : n=84		CLT5 : n=64	
Insects orders	IRI %	Clas	IRI %	Clas
Coleoptera	11.62	X	14.80	XX
Diptera	25.07	XXX	9.30	X
Ephemeroptera	0.67	X	0.93	X
Hemiptera			2.27	X
Hymenoptera	34.03	XXX	49.22	XXX
Lepidoptera	1.53	X	9.84	X
Mantodea			0.61	X
Odonata	1.88	X		
Orthoptera	22.98	XX	13.02	X
Tricoptera	2.22	X	0.14	
Insects	19.67	XX	17.43	XX
Amphibian	0.66	X	0.14	X
Annelida	0.03	X		
Arachnida	0.01	X	1.76	X
Crustacea	4.81	X	0.30	X
Mollusca	0.02	X		
Myriapoda	0.28	X	0.02	X
Fishes	28.26	XXX	69.38	XXX
Fruits	4.12	X	0.16	X
Animals debris	39.97	XXX	8.44	X
Vegetables debris	0.40	X	0.97	X
Indetermined	1.76	X	1.31	X
Authers preys			0.09	X

As for the second group size class (89.04≤LS<103.08 mm; n = 28), diet consists of 10 taxa, including 4-prey insect orders. The preferred prey animals debris (58.99%) and 23.81%, Fishes are secondary prey. Relations to insect orders, Coleoptera (72.52%) are the preferred prey and Lepidoptera (17.49%) secondary prey.
Regarding the third component specimens size class (103.08≤LS<117.12 mm; n = 43), the diet has a diversity of 14 taxa prey with six orders of insects. Animals debris (60.78%) are the preferred prey.

Fishes (25.50%) were secondary prey. Relation to insects orders, Coleoptera (44.56%) and Diptera (35.88%) are the preferred prey. Hymenoptera (13.38%) are secondary prey.

Food specimens of the fourth size class (117.12≤LS<145.20 mm; n = 84) includes 20 prey taxa which 8 are orders of insects. Respectively 39.97 and 28.26%, animals debris and Fishes are the preferred prey while insects (19.67%) are secondary prey. At the orders of insects, Hymenoptera (34.03%) and Diptera (25.07%) are the preferential taxa. They are followed by Orthoptera (13.02%), secondary prey.

The fifth size class (LS≥ 145.20 mm; n = 64), nutrition has 19 taxa 8 insect orders. Fishes (69.38%) are the preferred prey and insects (17.43%) were secondary prey. In terms of orders of insects, they are dominated by Hymenoptera (49.22%); preferred prey and Coleoptera (14.80%) are secondary prey.

Generally speaking, there is a variation in the food of a variety of size class to another scheme. Fishes are essential prey of *Schilbe intermedius*. The Spearman rank correlation coefficients calculated from the values of Importance Relative Index (IRI) are shown in Table V.

Table V: Results Spearman rank correlation test comparing the diets of different specimens of size classes of *Schilbe intermedius* in Agnébi River. CLT1 (n = 17) 75≤LS <89.04 mm; CLT2 (n = 28): 89.04≤LS<103.08 mm; CLT3 (n = 43): 103.08≤LS<117.12 mm; CLT4 (n = 84): 117.12≤LS<145.20 mm; CLT5 (n = 64) LS≥145.20 mm; CLT1 = CL1; CL2 = CLT2; CLT3 = CL3, CL4 + = CLT4 + CL5; CLT5: CL5 = CL7 + CL6.

Variable	CLT1	CLT2	CLT3	CLT4	CLT5
CLT1		0.206*	0.689	0.522	0.298*
CLT2			0.463	0.489	0.659
CLT3				0.489	0.659
CLT4					0.544
CLT5					

With a threshold (p = 0.05) probability of a 22 degree of freedom the critical value is 0.425, on the whole, the values of p we get are significant in 8 cases out of 10. In fact, the major change focuses on the part of Fishes and animals debris in the diet of *S. intermedius*.
The major difference lies in the size classes 1 and 2 and 2 and 5. In fact, one size class is fish-eating and insectivorous while the size class 2 power supply dominated by animals debris. Against by size class 5 has a substantially piscivorous diet.

IV. DISCUSSION

The analysis of the general diet of *Schilbe intermedius* in Agnébi River indicates a tendency to piscivory. Indeed, this result coincides with the observations made by [9] for which *Schilbe mystus* (synonym *Schilbe intermedius*) in a temporary water course called Baule, upper basin of Sénégal, Mali. Also, with a coefficient of 1.06 means intestinal therefore less than 3 and [10] placed the species in the category of general fish diet defined by [9], among which are omnivorous species. Similarly to [11] and *S. uranoscopus* on *Schilbe mystus* (synonym with *S. intermedius*) and [12] and *S. uranoscopus Eutropius niloticus* (synonym *Schilbe intermedius*), as [13] on the *Eutropius niloticus* Schilbe are carnivores. What is clear with the balance of insects and fishes in the stomach contents with emphasis of piscivory in *S. intermedius* and animals debris constituting the secondary foods items. Similarly for [13], *S. intermedius* has a carnivorous diet eclectic trend from shrimp or small fish, to seeds and plants debris through aquatic insects or their larvae.

In the dry season, insects are the main prey in the diet of *S. intermedius* in the headwaters of the Agnébi (the station Gbessé). The species is ichthyophagous in middle stream (to the station Pont-autoroute) and lower (the station Armébé).
In the rainy season *S. intermedius* remains ichthyophagous at the middle (Pont-autoroute) and lower (Armébé) streams. It is insectivorous at the upper stream (Gbessé).
Thus, from one season to another, changes in diet are closely linked to the availability of prey. This finding is supported by [14] shows that many insects reproductions occur during the rainy season, which explains their dominance in the supply Schilbe studied at this time. 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 *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 general, changes in the supply of *S. intermedius* focused on the quantitative aspect, as the qualitative changes very little.

Concerning the variation in the diet as a function of the size, *Schilbe intermedius* has a tendency to become more pronounced with piscivory that size. This result confirms that of [16] 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. Similarly, [15] show that gender Schilbe is ichthyophagous and food trend that increases with the age of the specimens.

V. CONCLUSION

This study to characterize the piscivory of *Schilbe intermedius* and also the eclectic trend in Agnébi River, a West African coastal basin.

THANKS, We extend our sincere thanks to the Belgian Cooperation Agency (AGCD) for the financing of VLIR-KUL project "Evolution of fish diversity after construction of a dam: the case of the Bia River in Côte d'Ivoire."

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