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RESEARCH ARTICLE

FOOD AND FEEDING HABITS OF *Mugil cephalus* (LINNÉ, 1758) FROM GRAND-LAHOU LAGOON (CÔTE D'IVOIRE)

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Abstract

Mugil cephalus is a permanent and abundant fish species in coastal, estuarine or lagoon ecosystems. This species was sampled in the lagoon of Grand-Lahou (Côte d'Ivoire) for the study of its diet and its feeding ethology. Stomachs were removed and their contents identified using identification keys to determine the diet. 88 specimens of *M. cephalus* were examined for food and feeding habits. 42 (47.72%) of the fish had empty stomach. Analysis of stomach contents showed that phytoplankton is the most consumed with a numerical percentage of occurrence of 94.98% (Cyanobacteria, Chlorophytes, Diatoms) and a percentage of occurrence is 64.9%. The proportion of zooplankton is 4.98% (cladocerans, copepods, foraminifera, rotifers and nematodes) according to the numerical percentage and 18.77% according to the frequency of occurrence. Detritus has an occurrence percentage of 8.43 %. Diet is mainly composed of diatom.

Introduction:-

Brackish, estuarine and lagoon environments are areas of predilection for some species of fish, including Mugilidae. These fish are euryhaline and live in hypersaline environments and go up in the fresh waters of rivers (Albaret, 2003). This family is represented by two genera: *Liza* and *Mugil*.

In Côte d'Ivoire, these fish are unequally distributed in the three lagoon systems (Aby, Ebrié et Grand-lahou) (Albaret et Legendre, 1985). The only studies carried out on Mugilidae are those of Albaret et Legendre (1985) which focused on three species: *Mugil curema*, *Liza falcipinnis*, *Liza grandisquamis*. *Mugil cephalus*, rare in the Ebrié lagoon (Albaret et Legendre, 1985), is regularly unloaded by the artisanal fishery in the Grand-lahou lagoon It is a fish of great economic interest and constitutes an important food resource (Hassine, 1983). This fish is appreciated and very consumed by the Ivorian population.

We found it useful to take an interest in studying his food and feeding habits. Diets studies allow an estimate of the impact of a fish population on the structure of lower trophic level communities (Dubois et al., 1994). This study is part of the management of fishery resources in continental environments. It propose to identify the ecological niche of the species and its trophic level in relation to the nutritional resources available in the environment. It is especially about:

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1. Identify and describe stomach contents;
2. Compare the relative abundances of the various prey consumed;
3. Describe the variations in diet depending on the size of the fish.

Materials and methods:

Study area:

The Grand-Lahou lagoon (Figure 1) is localized in the southern part of Côte d'Ivoire.

It is localized between 5 ° 07 'and 5 ° 14' North latitude and between 4 ° and 5 ° 25 'West longitude (Durand et Skubich, 1979). The main basin has permanent communication with the ocean through the Grand-Lahou channel. The Grand-Lahou lagoon is a lagoon complex subdivided into two zones depending on the hydroclimate: an estuarine area which includes the Tagba (57 km²) and Mackey (28 km²) lagoons and a western zone, which includes the Tadio (90 km²) and Niouzoumou (15 km²) lagoons (Lae, 1982). Continental waters come from two main rivers: the Boubo and the Bandama.

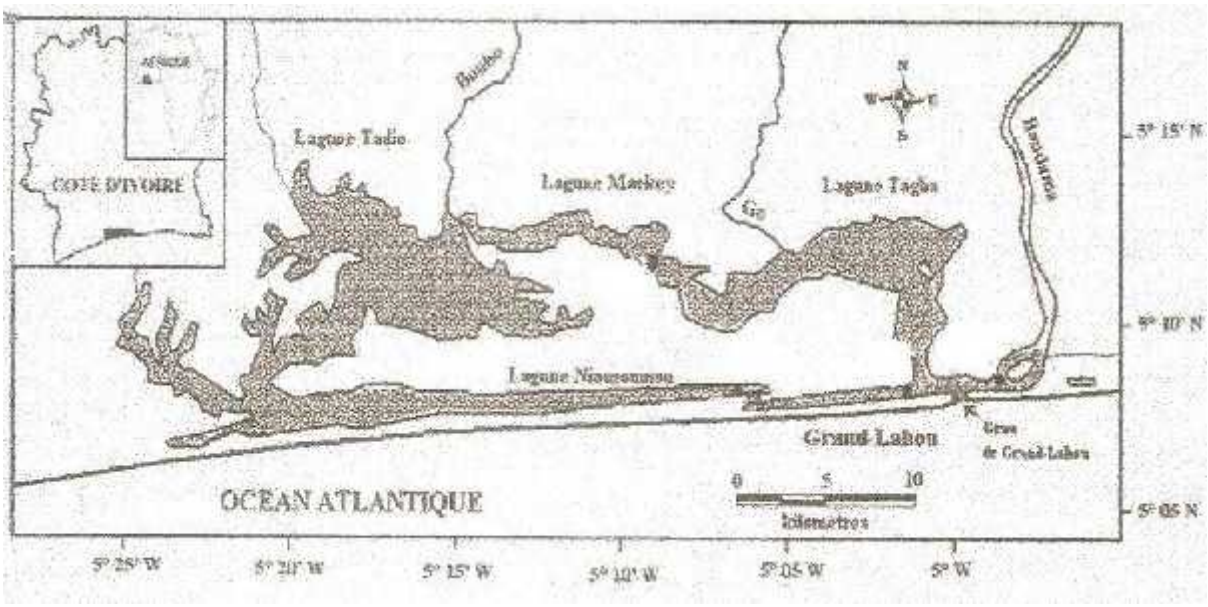


Figure 1:- Grand-Lahou lagoon system. (Komoé et al, (2009)).

Sampling and analysis of stomach contents:

The fish used in this study are collected monthly from October 2008 to August 2009. Mugil cephalus stomachs are obtained after dissection of fish in the laboratory. A total of 88 specimens of standard length between 22.5 cm and 56.5 cm are examined. The stomachs are kept in 5% of formol. The contents of stomach are collected after incision of the stomachs. A dilution of each contents stomach is done to facilitate the separation of the different foods. Mountings between slide and lamella are made to allow observation and identification of the different taxa. Assemblies are made under a binocular microscope, to allow the observation and identification of the different taxa.

The phytoplankton count is done using a BURKER cell and the zooplankton count is done using a DOLFUSS tank. Several indices were calculated to show the relative importance of each prey item. These were:

- Coefficient of vacuity = Number of empty stomach / Total of stomach examinated
- Frequency of occurrence = Number of stomachs contains prey i / Total number of stomach with some food

- Percentage by number = Number of particular food item i / Total number of food items
- Specific abundance index = Total abundance of prey i / Total abundance of only in all stomachs prey i

Feeding ethology:
The graphic method of Costello (1990), modified by Amundsen et al, (1996) is chosen to describe variations in diet.

Statistical analysis:
The Costello diagram (1990), modified by Amundsen et al, (1996) is carried out using the STATISTICA 7.1 program (Stat-Soft France, 2006).

Distribution of fish by size class:
The fish are grouped into three size classes according Pasquaud et al, (2004) and Soyinka (2008):
1. Small sized: size less than 35cm;
2. Medium sized: size between 35 and 45 cm;
3. Large sized: size greater than 45 cm.

Results:-

Food composition:
88 specimens of *M. cephalus* were examined for food and feeding habits. 42 (47.72 %) of the fish had empty stomach as shown in Table 1. Three major food groups are listed. There is also sand in the stomachs. These are phytoplankton (Cyanobacteria, Chlorophytes and Diatoms), zooplankton (Cladocerans, Copepods, Foraminifera, Rotifers and Nematodes) and detritus.

Phytoplankton is the most consumed food with a numerical percentage of 94.98% and a percentage of occurrence of 64.9%. The proportion of zooplankton is 4.98% according to the numerical percentage and 18.77% according to the frequency of occurrence. Detritus has an occurrence percentage of 8.43%.

Table1:- Food composition of *Mugil cephalus*.

Food Items	Percentage by Number (%)	Frequency of Occurrence (%)
PHYTOPLANKTON	**94.98**	**64.9**
Cyanobacteries	**11.17**	**27.29**
Chroococaceae	7.76	16
Oscillatoriaceae	3.41	11.29
chlorophytes	**0.09**	**0.33**
Senedesmus	0.09	0.33
Diatoms	**83.72**	**37.18**
Centric Diatoms	4.72	7.82
Penned Diatoms	79	29.36
DETRITUS	-	**8.43**
SAND	-	8.01
ZOOPLANKTON	**4.98**	**18.77**
Cladocerans	1.07	5.5
Copepods	0.64	1.8
Foraminifera	1.90	3.62
Rotifers	0.80	5.65
Nematodes	0.57	2.2

Diet according to size:
The diet of *M. Cephalus* according to height is shown in Table 2. Diatoms are the most consumed foods in all three size classes.

Small sized (< 35 cm): According to the numerical method, the proportion of Diatoms is 92.72%, and 37.65% for the frequency of occurrence. Cyanobacteria have a numerical percentage of 6.22% and a frequency of occurrence of 34.49%

Medium sized (35-45 cm): The numerical value for diatoms is 75.59% and 38.11% for frequency of occurrence. Cyanobacteria are in second place with a numerical percentage of 13.91% and a percentage of occurrence of 24.27%.

Large sized (> 45 cm): The numerical percentage of diatoms is 83.56% and the frequency of occurrence is 34.11%. Cyanobacteria come next with a numerical percentage of 11.12% and a frequency of occurrence of 27.97%. Zooplankton are less represented in the diet of the three size classes.

Table 2:- Food composition according sized.

	Small sized (< 35 cm)		Medium sized (35-45 cm)		Large sized (> 45 cm)	
Food Items	Percentage by Number (%)	Frequency of Occurrence (%)	Percentage by Number (%)	Frequency of Occurrence (%)	Percentage by Number (%)	Frequency of Occurrence (%)
PHYTOPLANKTON	**98.94**	**72.14**	**89.83**	**63.15**	**94.68**	**62.08**
Cyanobacteries	**6.22**	**34.49**	**13.91**	**24.27**	**11.12**	**27.97**
Chroococcaceae	5.02	19.75	8.04	15.62	8.18	17.73
Oscillatoriaceae	1.20	14.74	5.87	8.65	2.94	10.24
Chlorophytes	**0**	**0**	**0.33**	**0.76**	**0**	**0**
Senedesmus	0	0	0.33	0.76	0	0
Diatoms	**92.72**	**37.65**	**75.59**	**38.11**	**83.56**	**34.11**
Centric Diatoms	0.29	4.94	8.1	8.23	7.05	9.03
Pennate Diatoms	92.43	32.71	67.49	29.88	76.51	25.08
DETRITUS	-	**8.18**	-	**9.55**	-	**9.23**
SAND	-	8.18	-	9,06	-	9.23
ZOOPLANCTON	**1.06**	**11.5**	**10.17**	**18.25**	**5.32**	**19.46**
Cladocereans	0.3	4.91	0.83	3.15	1.5	6.09
Copepods	0.12	1.65	1.1	3.15	1.3	4.24
Foraminifera	0.17	3.27	4.6	3.9	0.7	3.04
Rotifers	0.47	1.67	2.3	3.55	1.32	3.69
Nematodes	0	0	1.34	4.5	0.5	2.4

Feeding ethology:

Tables 3 and 4 show the percentage of occurrence and the specific abundance index of the different prey categories.The Costello diagrams modified by Amundsen and al. (1996) represented in Figure 2A, 2B, 2C and 2D show the feeding strategy. Analysis of these diagrams reveals that the ecological niche is small. *M. cephalus* has a general diet with a large number of individuals specializing in the capture of one class of prey: Diatoms (Pennate Diatoms).

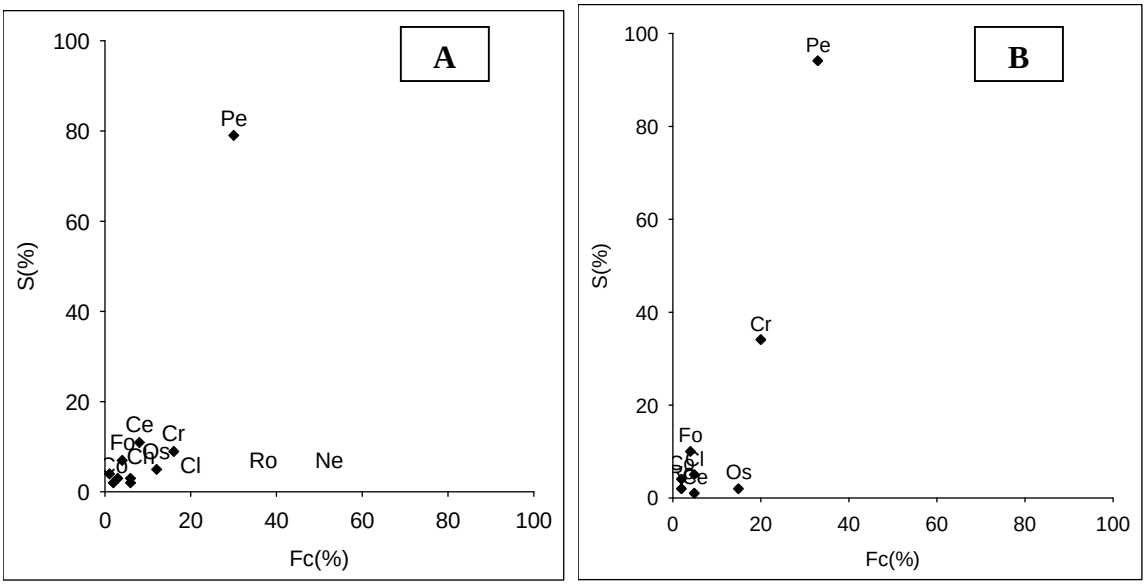
Table 3:- Feeding ethology of the whole population.

Food Items		Frequency of Occurrence (%)	Specific abundance index (%)
PHYTOPLANKTON	Chroococcaceae	16	8.78
	Oscillatoriaceae	11.29	4.63
	Chlorophyte	0.33	3.77
	Centric Diatoms	7.82	10.10
	Pennate Diatoms	29.36	78.52
	Cladocerans	5.5	2
	Copepods	1.8	1.94

ZOOPLANKTON	Foraminifera	3.62	6.78
	Rotifers	5.65	1.92
	Nematodes	2.2	2.72

Table 4:- Feeding ethology according sized.

		Small sized (< 35cm)		Medium Sized (35-45cm)		Medium Sized (35-45cm)	
Food Items		Frequency of Occur-rence (%)	Specific abundance index (%)	Frequency of Occur-rence (%)	Specific abundance index (%)	Frequency of Occur-rence (%)	Specific abundance index (%)
PHYTOPLANCTON	Chroococcaceae	19.75	33.13	15.62	8.68	17.73	8
	Oscillatoriaceae	14.74	1.5	8.65	10.3	10.24	4.2
	Chlorophyte	0	0	0.76	4	0	0
	Centric Diatoms	4.94	1	8.1	8.23	9.03	14.2
	pennate Diatoms	32.71	93.84	29.88	66.87	25.08	78.03
ZOOPLANCTON	Cladocerans	4.91	5	3.15	7	6.09	4.6
	Copepods	1.65	4	3.15	2.8	4.24	4.75
	Foraminifera	3.27	10	3.9	11.15	3.04	2.7
	Rotifers	1.67	2	3.55	4.64	3.69	3.45
	Nematodes	0	0	4.5	3.7	2.4	1.82



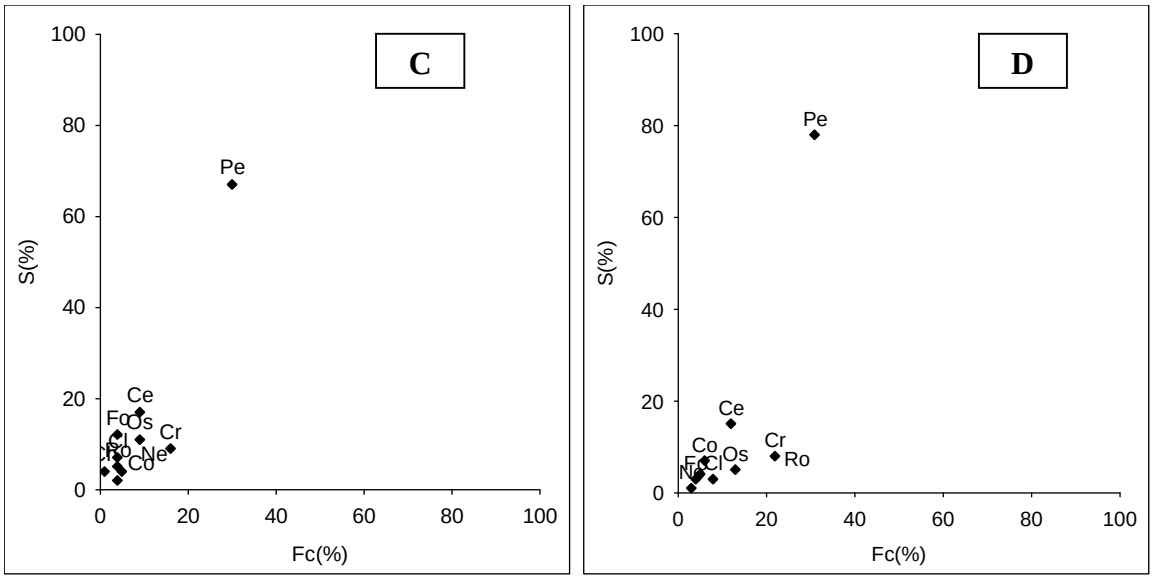


Figure 2:- Graphic of Amundsen and al. (1996) describing feeding ethology.

Fc (%): Frequency of Occurrence, **S (%):** Specific abundance index , **Pe** : pennate Diatoms, **Ce** : centric Diatoms, **Cr** : Chroococcaceae, **Os** : Oscillatoriaceae, **Ch** : chlorophyte, **Cl** : Cladocerans, **Co** : Copepods, **Fo** : Foraminifera, **Ro** : Rotifers, **Ne** : Nematodes.
A: The whole population
B: Specimens of small sized
C: Specimens of medium sized
D: Specimens of large sized

Discussion:-

The diet of *M. Cephalus* consists of Cyanobacteria, Diatoms, Chlorophytes, detritus, sand, Cladocerans, Copepods, Foraminifera, Rotifers and Nematodes. These results are similar to those obtained by Brulet (1974), Dankwa et al. (2005) and Farrugio (1976). The general diet profile of *M. Cephalus* indicates that his diet is mainly composed of phytoplankton. Among these preys, pennate diatoms are the majority foods (numerical frequency = 79%, percentage of occurrence = 29.36%). This result could be justified by the abundance of pennate diatoms in the lagoon or by a food preference of M. Cephalus for this type of algae. This fish is also a detritivore. Our results confirm those of Bernardon and Mohamed (2005), Soyinka (2008), Albaret et Legendre (1985). These authors mention that *M. Cephalus* eats mainly pennate diatoms.

The presence of sand in the stomachs of this fish can be explained by the fact that it swallows the mud. He sieves the mud using a branchial apparatus to extract organic particles. They also graze algae and small organisms on rocky bottoms (Bernardon et Mohamed, 2005). The presence of sand in the stomachs could also be explained by the role it plays in the digestion of food. The results also show that the diet does not vary with the size of the fish. This result is similar to that of Soyinka (2008). Regarding the feeding strategy, the analysis of the Costello diagram modified by Amundsen et al (1996) allows to say that the ecological niche of *M. Cephalus* is restricted. M. Cephalus presents a generalist diet with a large number of specimens that specialized in the consumption of pennate diatoms. This result is the same for the whole population according to the size of the fish. This could be explained by a preference of these fish for pinnate diatoms.

According to Koné et al. (2008), the dietary preference of fish is influenced by several factors such as accessibility, abundance and the energy contained in the feed. The low values of frequency of occurrence and specific abundance of prey such as Chroococcaceae, Oscillatoriaceae, Chlorophytes, Centric Diatoms, Cladocerans, Copepods, Foraminifera, Rotifers and Nematodes indicate that these are rare. These prey, which would be difficult to access, are therefore consumed by a small percentage of individuals.

Conclusion:-

Analysis of stomach contents showed that *M. cephalus* eats plankton and detritus. Its diet is dominated by Diatoms.

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