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Similarity of Feeding Strategies of Two Mugilidae *Liza falcipinnis* (Linnaeus, 1758) and *Mugil cephalus* (Linnaeus, 1758) in Ebrié Lagoon (Ivory Coast)

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Abstract – **Food similarity of *Liza falcipinnis* and *Mugil cephalus* was studied in Ebrié lagoon from January 2006 to December 2007. The data were analysed according to size and hydrological seasons. A total of 762 stomachs were analyzed for 276 *L. falcipinnis* and 486 for *M. cephalus*. On the stomachs 276 *L. falcipinnis*, 92 did not contain a rate of prey emptiness of 33.33% for this species. *M. cephalus*, the rate of emptiness was 36.21 % for a total of 176 empty stomachs. Food similarity of Bray-Curtis indicates that there is no significant difference between the diets of different size classes of the both species. Multidimensional scaling (MDS) of food similarity between size classes indicates a stress of 0.1 indicating that the dietary overlap between *L. falcipinnis* and *M. cephalus* is satisfactory. Seasonal variation in diet similarity revealed that food similarity was more pronounced during the rainy season (16.74%) than the dry season (7.22 %). Cyanophyta species with a predominantly *Microcystis aeruginosa* and consumed Diatomophytes with a variety of species including *Gyrosigma balticum*, are the preferred prey of both species regardless of size classes and seasons.**

Keywords – **Mugilidae, Ebrié Lagoon, Diet, Similarity, Bray Curtis Index.**

I. Introduction

The Mugilidae are estuarine or lagoon permanent and abundant elements of coastal ecosystems. In Ivory Coast, the studies of Albaret & Legendre [1] have demonstrated the presence of five species of mullet. There are: *Liza dumerili*, *L. falcipinnis*, *L. grandisquamis*, *Mugil cephalus* and *M. cumera*. Among these, only two species are distinguished from others by their abundance and their aquaculture potential. There were *Mugil cephalus* and *Liza falcipinnis*. However, very little information is available on the feeding ecology of Mugilidae in Ivory Coast in general and particularly on these two species, including their eating habits. A brief description of the diet of each species was made by Albaret & Legendre [1], but in a global context. It is summed up in a simple inventory of prey ingested. The main of this study was to analyze the similarity feeding habits of these both species in the same lagoon depending. Also, this study does provide information on the feeding behavior of these two species in similarity diet depending on the middle, the size of individuals and hydrological seasons in Ebrié lagoon.

II. Materials and Methods

2.1 Study area

The studies were carried out in Ebrié lagoon at 566 Km^2 (longitude 3°47'- 5°29'W; latitude 5°02' - 5°42'N) with a maximum depth of 20 m. it has been permanently connected to the sea since the opening of a man-made channel. Freshwater input is primarily by the comoe river and two small coastal forest rivers, the Mé and the Agnebi (Figure 1). Hydroclimate, and on aquatic primary and secondary production, the fisheries in ebrie lagoon have been divided into six sectors [2]. The permanent linkage with Atlantic ocean produces typical estuarine characteristics, especially in sectors II, III and IV which are near the canal. Under the direct influence of both the Atlantic Ocean and the Comoe River outflow, these parts of the lagoon are seasonally variable and heterogeneous with salinity varying from zero in the rainy season to 35 in the dry season. Sectors V and VI are oligohaline (salinity 0-3), stable and homogeneous throughout the year [3]. According these authors, there is three seasons in ivorian lagoons: the dry season (January to April), which is characterized by high temperature and salinity, the rainy season (May to August) with low temperature and salinity and the flood season (September to December) with the arrival of water from rivers. It adds the effect of rainfall in the short rainy season and the second raw forest rivers.

2.2 Sampling

Monthly samples of *L. falcipinnis* were collected from the sites of Ebrié lagoon from January 2006 to December 2007 using three batteries gill nets with stretched mesh sizes of 10. 12. 15. 20. 25. 30. 35. 40 and 50 mm. Gill nets were set at the bottom during the afternoon (17:00), raised the following morning (7:00) [4] and immediately, they were put at once again and relieved at 1 pm for the day fishing. The fishes were caught have been identified by identification key of Albaret [5].

2.3 Laboratory examination

After capture, individual fish was measured to the nearest cm for the fork length (FL), total body weight (TW) and eviscerated body weight (EW) were measured to the nearest 0.01 g. The gut was measured to the nearest cm to determine the intestinal coefficient and vacuity indices where:

$$IC = \frac{IL}{FL} X\ 100$$ with IC= intestinal coefficient; IL= intestinal length and FL=fork length total stomach weight

$$\text{Vacuity Index } (\%VI) = \frac{\text{Number of empty stomachs}}{\text{Total number of stomachs}} \times 100$$

In the laboratory, each stomach once removed formaldehyde was drained on absorbent paper and weighed. It was then sectioned longitudinally and the contents were collected in a watch glass. 1 g of stomach contents was removed and diluted in 10 ml of distilled water (for the muddy condition of the stomach contents) in a watch glass and filtered through a series of sieves of 500, 250 and 100 microns in diameter. The various filtrates obtained were examined under a binocular microscope. At this stage, the zooplankton prey were identified and counted and the presence of phytoplankton prey has been demonstrated. As for the species identification of phytoplankton prey, the observation was made under a microscope. For numerical quantification, 1 g of stomach contents were collected and diluted in 10 ml distilled water. The mixture was stirred and 1 ml was mounted between slide and cover slip. To determine the number of assembly to be observed; the experiment was repeated several times and each assembly, the appearance of new species was noted as the number of already identified prey each mounting. It appears that from the 3rd mounting, the cumulative number of new taxa did not change significantly. Thus, the number of assembly has been set at three per stomach. The number of prey identified from 3 ml to 10 ml is reported for a sample of 1 g of stomach contents. The total number of prey found in the stomach contents is then determined by the rule of proportionality. Prey identification was carried out to the lowest possible taxonomic level using identification keys by Brunel [6], Brigitte [7], Methodological Guide for the Implementation of the biological diatom index Prygiel & Coste [8], Ouattara [9], Hürlimann [10] and Komoe [11]. For zooplankton keys used are: Pourriot *et al.* [12], Ridder [13] and Dumont *et al.* [14].

Numerous indices haves been used to describe the importance of different prey in the diet of fish. Numerical

$$\text{Percentage of abundance } (\% N) = \frac{N_i}{N_t} x\ 100$$

where N_i = number of prey items and N_t = total number of prey items. To study diet variation with fish size, specimens were divided into three categories according to gonad maturity: juveniles (SL < size of the smallest mature fish), sub-adults (size of the smallest mature fish to SL < L_{50}) and adults (SL > L_{50}).

2.4 Statistical analyses

The percentage of abundance contribution (%N) of each dietary category to the gut contents of each fish was calculated. After, the percentage contribution of each dietary category to the dietary abundance of each fish was used to calculate the mean percentage abundance contribution of each dietary category to the diets of (1) all fish (1), (2) fish in each length class and (3) fish of each length class in each season. The mean percentage of abundance contributions of the various dietary categories to the overall diets of each fish in length classes in the different seasons were square-root transformed and used to produce a similarity matrix employing the Bray-Curtis resemblance measure, as described in PRIMER v5 [15].

The abundance of prey in the stomach contents was used to calculate the similarity between size classes. The gradual consolidation of size classes according to the similarities of the stomach contents was performed by the method of classification. The hierarchical classification ancestry (HCA) was to group the closest species as a dendrogram, the length of the branches represents the average or total distance between species and groups of species. The resultant similarity matrix was then subjected to non-metric multidimensional scaling (nMDS) ordination. Depending on the value of stress, there are several cases:

> 0.5; representation is probably random; between 0.5 and 0.25 the quality of representation is poor; between 0.1 and 0.25 and the performance is satisfactory < 0.1 representation is excellent. One-way Analysis of Similarities (ANOSIM) tests were used to determine whether, overall, the diets of *L. falcipinnis and Mugil cephalus* in Ebrié lagoon were influenced significantly by habitat, body size and/or season. The magnitude of the associated Global R-statistic values was employed to explore the extent to which dietary composition was influenced overall by each of those factors. R-statistic values range from 0 (same regime) to 1 (different regime) [16]. The null hypothesis for ANOSIM tests that the dietary compositions were not significantly different was rejected if the significance level (P) exceeded 5%. It is accepted if the calculated absolute value of R is less than 0.15. If R > 0.75 then the groups are different and then well separated ; if R ≥ 0.75 > 0.5 then the groups are different ; if R ≤ 0.5 then the groups are not clearly separated and 0.5 > if R ≤ 0.25 then the groups are barely visible. The similarities percentages (SIMPER) were used to determine the percentage of similarity or dissimilarity and the level of contribution of each prey in the diet. The higher the percentage of similarity is high, more than 50 %, more prey is consumed in much the same way [16]. As habitat influenced the overall dietary composition of *L. falcipinnis* and *Mugil cephalus* to a far greater extent than either body length or season, the extents to which the diets of this species were influenced by body length or season were then explored separately. Thus, a separate matrix was constructed for the mean dietary data for fish in each length class in the different seasons after which matrix was subjected to nMDS ordination as described above and one-way ANOSIM tests were used to determine whether season and /or body size influenced dietary composition.

III. Results

3.1 Intestinal coefficient

Intestinal coefficients in *Mugil cephalus* and *Liza falcipinnis* are greater than 1. Averages of these coefficients for *L. falcipinnis* and *M. cephalus* are 2.96 ± 0.75 and 3.24 ± 0.79 respectively. Analysis of variance (ANOVA) performed on the intestinal coefficient (IC) indicates a significant difference between size groups in the both species between juveniles and adults (in *L. falcipinnis* (ddl = 2, F = 4.18, p = 0.017) and in *M. cephalus* (ddl = 2, F = 8.70, p = 0.0002)). The correlations between intestinal lengths and the fork lengths are relatively high in both species (Figures 2 and 3).

3.2 Rate of emptiness

A total of 276 stomachs *Liza falcipinnis* were analyzed of which 92 contained no prey; which gives a rate of emptiness 33.33% while it is 36.21% in *Mugil cephalus* is empty 176 from a total of 486 stomachs.

3.3 Composition and contribution of prey in the diet of Liza falcipinnis (A), Mugil cephalus (B) collected in the Ebrié lagoon

Food Bray-Curtis similarity between groups of size *L. falcipinnis* is 12.59%. Three preys are common to the different size classes in all seasons with a contribution of 91.03 % (Table I). These are *Gyrosigma balticum* with a contribution level of 45.88 %, *Microcystis aeruginosa* and copepods (Harpaticoïdes, *Microsetella sp*; Calanides, *Paracalanus sp*) for 42.71 and 2.43 % contribution respectively. Among these preys, the Diatomophyte *Gyrosigma balticum* and Cyanophyte *Microcystis aeruginosa* dominate the diet as indicated by their level of contribution. These cumulative prey alone 88.59 %. In *Mugil cephalus,* eight preys dominated the diet regardless of group size and season food similarity of 20.78% (Table I). Two preys distinguished from others by their level of contribution. These were *Microcystis aeruginosa* (41.76 %) and *Navicula sp* (15.99 %). Clustering in groups of preys shows that the group represented by Cyanophyta, *Microcystis aeruginosa* (one specie) contributes to 41.76 % the diet. The rest of the group represented by Diatomphytes (seven species) contributes to 48.92 % the diet. *Microcystis aeruginosa* dominated the diet of *Mugil cephalus* in the Ebrié lagoon in any season regardless of group size.

3.4 Food similarity Liza falcipinnis and Mugil cephalus according to size groups

In Ebrié lagoon, the dendrogram shows six major food groups to 50% similarity (Figure 3). Group 1 is composed entirely of adult *Liza falcipinnis*. Group 2 consists of adults *Mugil cephalus* of dry and rainy saisons. Group 3 includes juveniles and adults *Liza falcipinnis* of dry and rainy seasons. Group 4 is formed by juveniles and sub-adults *Liza falcipinnis* of rainy season and, juveniles and sub- adults *Mugil cephalus* in dry season. Group 5 consists only of subadult *Liza falcipinnis* captured during the dry season. Group 6 contained the juveniles and sub- adults *Mugil cephalus* which have the same diet during the rainy season (Figure 4).

The ANOSIM (Analysis of Similarity) overall calculated (R = 0.079) is less than the critical value of 0.15; hence no significant difference between diet of *Liza falcipinnis* and *Mugil cephalus* in the Ebrié lagoon. Multidimensional scaling (MDS) of food similarity of size groups indicates a stress of 0.11 (Figure 5). This value indicates that the representation of size groups in two dimensional space is satisfactory. The representation of Bray-Curtis similarity across the dendrogram reflects reality. The most important preys species for which this food is satisfactory similary are: *Microcystis aeruginosa*, *Gyrosigma balticum*, *Navicula sp.* and *Pleurosigma elongatum* (Figure 6).

However, the intra-group test (*Pairwise tests*) indicates overall R-value of 0.079 whatever the season. This value is less than R = 0.15. This means that there is no significant difference in diet within size groups of *Liza falcipinnis* and *Mugil cephalus* in Ebrie lagoon. Food similarity between the size groups of *Liza falcipinnis* and *Mugil cephalus* in Ebrié lagoon is very strong. The R values are - 0.25; 0.073 and 0.365 respectively between juveniles and sub-adults; juveniles and adults and sub-adults and adults *Liza falcipinnis* and *Mugil cephalus*. The SIMPER analysis within each group shows that Juvenile *Liza falcipinnis* and *Mugil cephalus* have food similarity of 18.16% for three preys; *Microcystis aeruginosa* contributes to 77, 87 % in the diet of the both species, followed by *Navicula sp* to 11.29 % and 5.71 % for *Gyrosigma balticum* (Figure 7);

Sub-adults *Liza falcipinnis* and *Mugil cephalus* have food similarity estimated at 26.59 % for two preys; *Microcystis aeruginosa* and *Navicula sp* with a contribution of 75.23 and 21.04 % respectively (Figure 7); adults *Liza falcipinnis* and *Mugil cephalus* have food similarity of 12.23% for five preys; *Nitzschia palea* (31.04 %) , *Nitzschia sigma* (23.80 %) , *Actinoptychus splendens* (21,36 %) *Surirella capronii* (11.90 %) and *Diploneis smithii* (11.90 %) (Figure 7).

The grouping of preys showned that adults *Liza falcipinnis* and *Mugil cephalus* consume exclusively Diatomophytes (100 %). From this set, *Nitzschia palea*, *Nitzschia sigma* and *Actinoptychus splendens* are the most consumed with a contribution estimated at 76.20 %. Clustering of groups of preys revealed that adults *Mugil cephalus* and *Liza falcipinnis* consume Diatomophytes exclusively (100%). As for juveniles and sub-adults, they consume both Cyanophyta as Diatoms varying proportions (Figure 8).

The SIMPER analysis shows that inter-group:

Juveniles and sub-adults *Liza falcipinnis* and *Mugil cephalus* a mean of 32.93 % similarity food with a more diverse diet. The two groups have in common ten (10) preys. Among these preys, three dominate the diet; *Microcystis aeruginosa*, *Gyrosigma Balticum* and *Navicula sp*. (Figure 9). Grouping shows that Cyanophyce was less represented with one specie *Microcystis aeruginosa* (31.64%). Diatomophyte group with 8 preys contributes to 52.66 % and the group of Zooplankton with ostracods which contribute to 5.30% (Figure 10);

Juveniles and adults *Liza falcipinnis* and *Mugil cephalus* displayed food similarity of 7.66 %. Thirteen preys of important variables are identified. The most consumed prey were *Microcystis aeruginosa* (22.39 %), *Gyrosigma balticum* (19.14%) and *Pleuosigma elongatum* (12.20 %). They contribute to 53.72 % of the food similarity (Figure 9). The combination has identified three main groups of preys: the Chlorophyta (1.58 %) with *Scenesdemus quadricauda*, Cyanophyta (24.14%) with *Microcystis aeruginosa* and *Chrococcus minutus* and, Diatomophytes (65.62 %) with a variety species (Figure 10);

Sub-adults and adults *Liza falcipinnis* and *Mugil cephalus* displayed food similarity of 1.29 % with fourteen preys. This food similar was low unlike that between juveniles and sub- adults. Four preys are distinguished from others by their level of contribution to the diet. They are: *Microcystis aeruginosa* (24.68 %), *Gyrosigma balticum* (12.02%), *Pleurosigma elongatum* (11.41%) and *Navicula sp.* (10.45%) (Figure 9)

3.5 Food similarity in relation to season in L. falcipinnis and M. cephalus in Ebrié lagoon

Food similarity between *Liza falcipinnis* and *Mugil cephalus* depending to season shows that in dry season, the value of Bray-Curtis is 7.22 % with five prey. This is *Microcystis aeruginosa* (67.21 %), *Navicula sp* (7.52%), *Nitzschia palea* (7.40 %) *Actinoptychus splendida* (6.06%) and *Gyrosima balticum* (5.74%). They contribute to 93.93 % of the diet (Figure 11). During the rainy season, food similarity was for two species with 16.74 % of similarity. It is twice higher than the previous season. Five preys contribute to this. This was *Microcystis aeruginosa* (55.01%), *Navicula sp* (15.02%), *Gyrosigma sp* (10.71%), *Cyclotella sp* (7.06%) and *Eunotia sp* (5.27%). In this season, the diet of *Liza falcipinnis* and *Mugil cephalus* whatever size group remains dominated by Cyanophyta (55.01%) against 38.06 % for Diatomophytes (Figure 12).

IV. Discussion

Intestinal coefficients are higher in *L.falcipinnis* and *M. cephalus*. This is due to relatively long intestines, suggesting that these two species have a herbivorous diet [17]. There is a relationship between the length of the intestine and the fish diet. According to this author, there is a relationship between the intestine length and fish diet. The intestine is longer in herbivores, is short in carnivores and medium in fish broad spectrum [18], [19]. *L. falcipinnis* and *M. cephalus* can be classified as species with a diet based on plant material or detritus. Similar results were found in *L. falcipinnis* and *Mugil curema* in Elmina lagoon in Ghana [20]. In addition, the studies of Bernardon & Mohamed [21] in Mauritania have firstly shown that the Mugilidae are equipped with a device developed gills that can extract the organic particles and secondly, they graze algae and small organisms on rocky bottoms. Significant differences between the intestinal coefficients of size groups are related to the selection of preys for achievement of certain physiological functions (growth, reproduction); digestibility of preys abundance and nutrient medium [22], [23]. Indeed, regime change can meet the metabolic needs between different size groups. The smaller sizes have increased nutritional needs for growth while more adults have needs -oriented body maintenance and reproduction [24]. The strong correlation between fork length and intestine length in both species imply the existence of a link between the two parameters. The relatively high rate of emptiness could be related to the residence time of food in the digestive tract of mullet would be 4 to 5 hours as meant by Soyinka [25]. This time is relatively short compared to 8 hours in this study. During this period, mullets caught had time to digest in the nets. In other species, it was found that the stress created by gillnets causes regurgitation of preys contained in the stomach [26].

The low percentage of similarity food stored in the lagoon Ebrié in these two species is due to the abundance and availability of prey in this environment. The studies of Diomandé *et al.* [27] showed that the availability and abundance of food in the Ebrié lagoon induce a selection of food by size classes in *Synodontis bastiani* and *S. shall* with no significant overlap index. The diet of *L. falcipinnis* and *M. cephalus* in the Ebrié lagoon consists of Diatomophytes and Cyanophyta. This is due to the specifics morphologicals characteristics of these preys to ensure their dominance in phytoplankton communities [28]. These characteristics include the presence of pseudo-gas vacuoles that allow them to adjust their density and to move vertically in the water column for maximum exploitation of the light intensity [29]. The presence of Diatomophytes in the diet of these two species of Mugilidae be explained by the fact that these preys have high nutritional value due to their fat content [30]. Similarly, the strong contribution of *Microcystis aeruginosa* Cyanophyte in the diet of *L. falcipinnis* and *M. cephalus* in the Ebrié lagoon could be explained by the behavior of the prey species. Indeed, in the day, *M. aeruginosa* migrates to the surface to make the most of the light energy. The presence of pseudo-vacuoles gas enables it to adjust its density and move vertically to optimize its position in the water column and enjoy the light intensity [28], [29]. Evening, however, it tends to migrate underground to exploit the nutrients that are found in large concentration [31]. *L. falcipinnis* and *M. cephalus* incidentally consume zooplankton. The presence of zooplankton in their diet can be explained by the fact that these species exploit a wider than other species trophic spectrum [32]. Besides the dominant preys in the diet, prey was listed, including Chlorophyte *Scenesdesmus quadricauda*. The level of contribution of the prey would indicate accidental presence in the diet of these species.

The overall ANOSIM R = 0.079 has shown that there is no significant difference between the diet of *L. falcipinnis* and *M. cephalus* in the Ebrié lagoon. The level of dietary overlap between classes is the perfect size; reflecting a high degree of similarity in the use of available food resources. Low specialization and food opportunism size classes were highlighted in the context of this study. These behaviors are characteristic of estuarine and lagoon environments in tropical waters [33]. Several studies have highlighted the great similarity of the diet of various species Mugilidae. These authors showed that the geographic location can not affect significantly the composition of diets. The results of similarity of the diet in the both species suggest a strong competition for food [1]. However, studies on species of Mugilidae in South African estuaries by Blaber [34], [35] and those in Ebrié lagoon by Albaret & Legendre [1] showed that different strategies are used by Mugilidae to reduce competition. Mention may be made of the maximum power offset hours, ingesting particles of different sizes and the differential use of the substrates (substrate selection and / or the specific operation of the same substrate). The studies of Nilson [36] showed that when two species are closely related coexist in the same environment, different mechanisms are used to allow the coexistence including resource partitioning. Seasonal study of food similarity between these two species regardless of size and medium showed that the similarity is high in dry season and low in rainy season. High food similarity observed in dry season

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could be explained by lower trophic resources during this period. By against, in rainy season, the opposite occurs. During this period, the overflowing floods inundate the surrounding vegetation which would offer different size groups a large number of prey. Availability and abundance of prey explain the fact that the preferential preys are not the same for both species and size classes.Which would result in a low dietary similarity. There is still a similarity between trophic compositions of the both species. This similarity is due to the fact that these fishes have in common a large number of preys [24].

V. Conclusion

Using Bray-Curtis index in this study showed that the food is great similarity between size classes of *Liza falcipinnis* and *Mugil cephalus* in Ebrié lagoon. Food similarity between the size groups of *Liza falcipinnis* and *Mugil cephalus* in Ebrié lagoon is very strong. Seasonal study of food similarity between these two species showed that the similarity is high in dry season and low in rainy season. The diet of *L. falcipinnis* and *M. cephalus* in the Ebrié lagoon consists of Diatomophytes and Cyanophyta.

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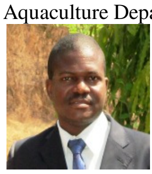

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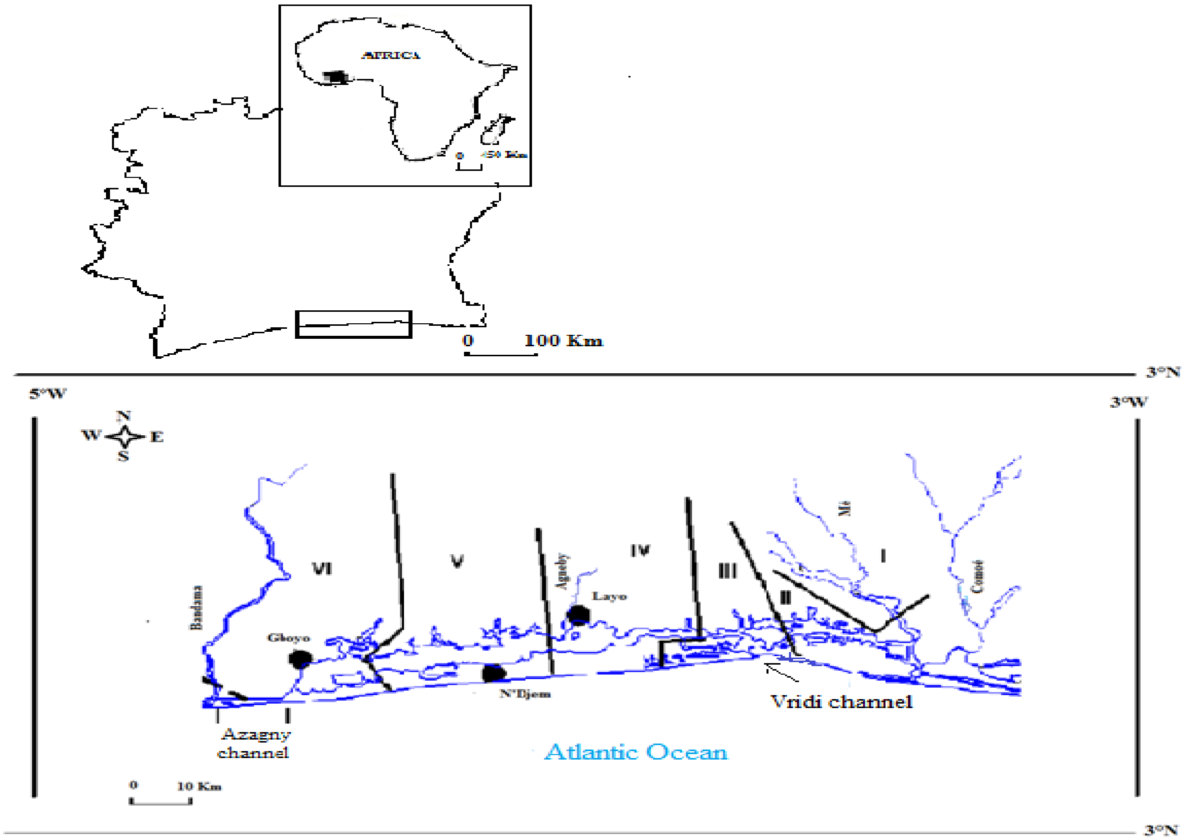

Fig.1. Map of Ebrié lagoon (I to VI) showing the different sampling sites (.)

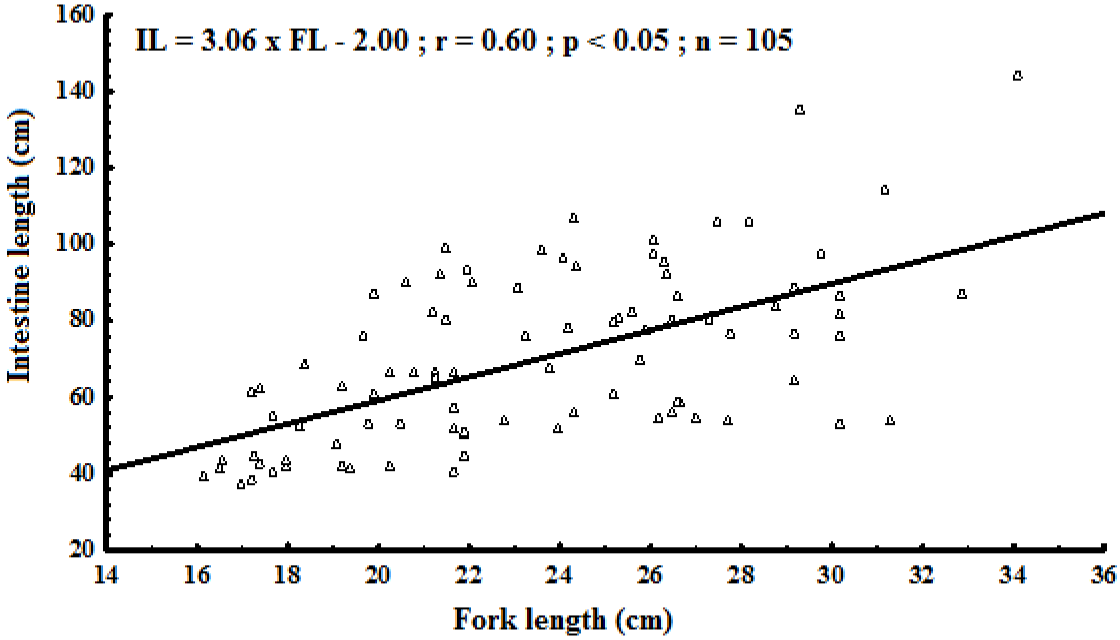

Fig.2. Relationship between intestine length (IL) and fork length of Liza falcipinnis in Ebrié lagoon.

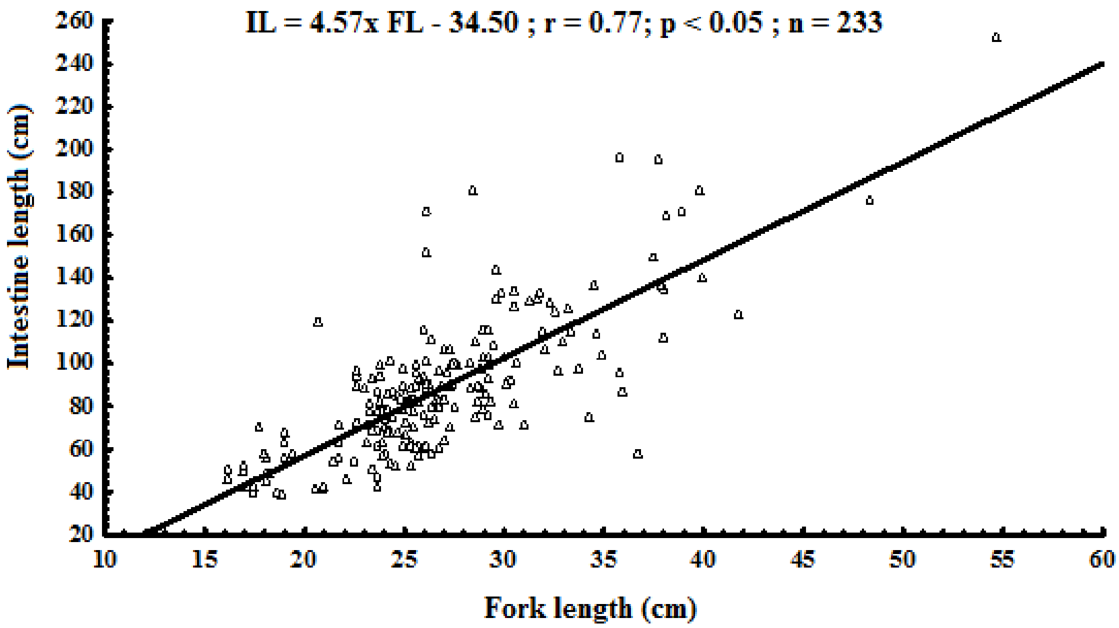

Fig.3. Relationship between intestine length (IL) and fork length (FL) of Mugil cephalus in Ebrié lagoon

Table 1: List of common preys consumed by L. falcipinnis and M. cephalus in Ebrie lagoon as defined by SIMPER analysis for average percentage similarity of 12.59 and 20.78 % respectively

Species	*Prey taxa*	*Mean abun*	*Mean Sim.*	*Ecart T.*	*% Contrib.*	*% Cum.*
Liza falcipinnis						
	DIATOMOPHYTE					**45.88**
	Naviculaceae					
	Gyrosigma balticum	30.27	5.78	0.26	45.88	
	CYANOPHYTE					**42.71**
	Borziaceae					
	Microcystis aeruginosa	27.88	5.38	0.26	42.71	
	LARVES DE MOLLUSQUES	1.62	0.31	0.26	2.43	**2.43**

Mugil cephalus					
CYANOPHYTE					**41.76**
Borziaceae					
Microcystis aeruginosa	32.16	8.68	0.46	41.76	41.76
DIATOMOPHYTE					**48.92**
Naviculaceae					
Navicula sp	13.90	3.32	0.38	15.99	15.99
Gyrosigma sp	5.77	1.71	0.47	8.23	24.22
Bacillariaceae					
Nitzschia sigma	7.95	1.28	0.29	6.16	30.38
Nitzschia palea	3.99	0.65	0.29	3.14	33.52
Thalassiosiraceae					
Cyclotella sp	3.33	1.27	0.53	6.13	39.65
Heliopeltaceae					
Actinoptychus splendens	7.00	1.04	0.26	5.03	44.68
Eunotiaceae					
Eunotia sp	4.94	0.88	0.26	4.24	48.92

Mean abun = mean abundance ; Mean Sim = Mean Similarity ; Ecart T. = Ecart Type; % Contrib = % Contribution, % Cum = % Cumulative

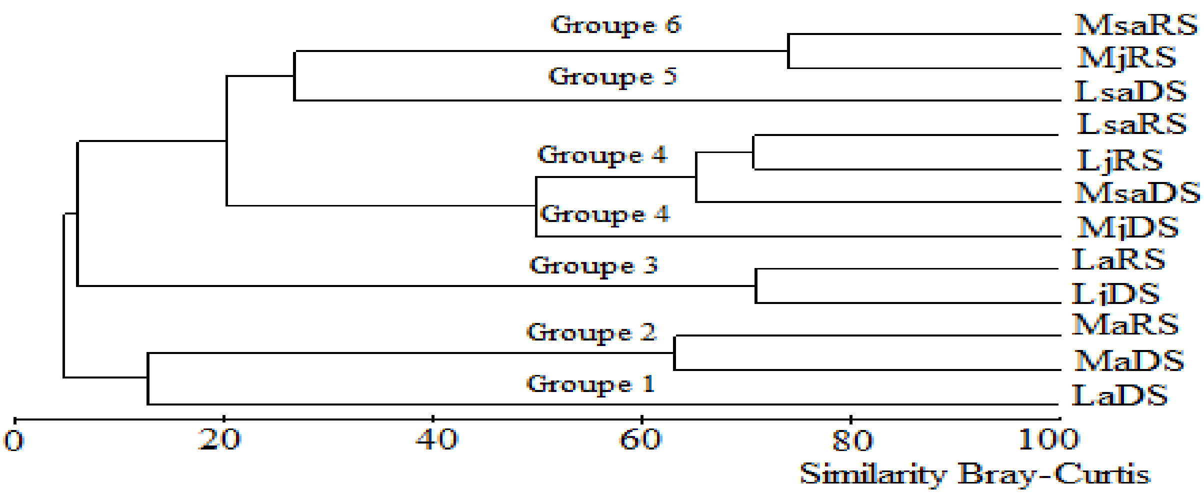

Fig.4. Dendogram of sizes groups (juveniles, sub-adults and adults) of Liza falcipinnis and Mugil cephalus in function seasons based on Bray-Curtis similarity after a square root transformation in numerical percentage prey consumed in the Ebrie lagoon.

Lj= Juveniles Liza falcipinnis, Lsa= Sub-adults Liza falcipinnis, La= Adults Liza falcipinnis, Mj= Juveniles Mugil cephalus,Msa= Sub-adults Mugil cephalus, Ma= Adults Mugil cephalus, SP= Rainy Saison and SS= Dry Saison

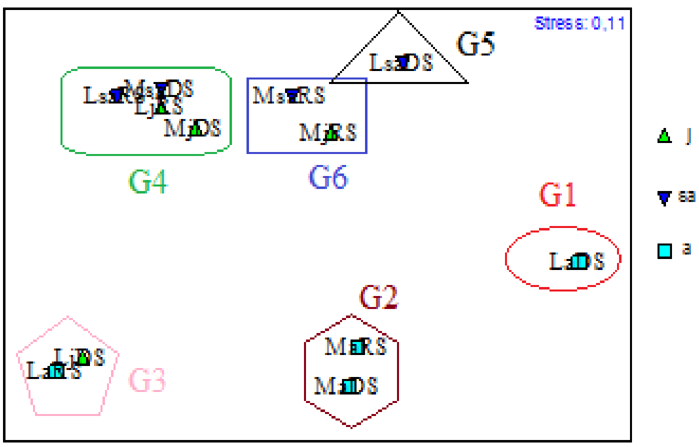

Fig.5. Multidimensional scaling of food similarity function size groups and seasons in Liza falcipinnis and Mugil cephalus in Ebrié lagoon

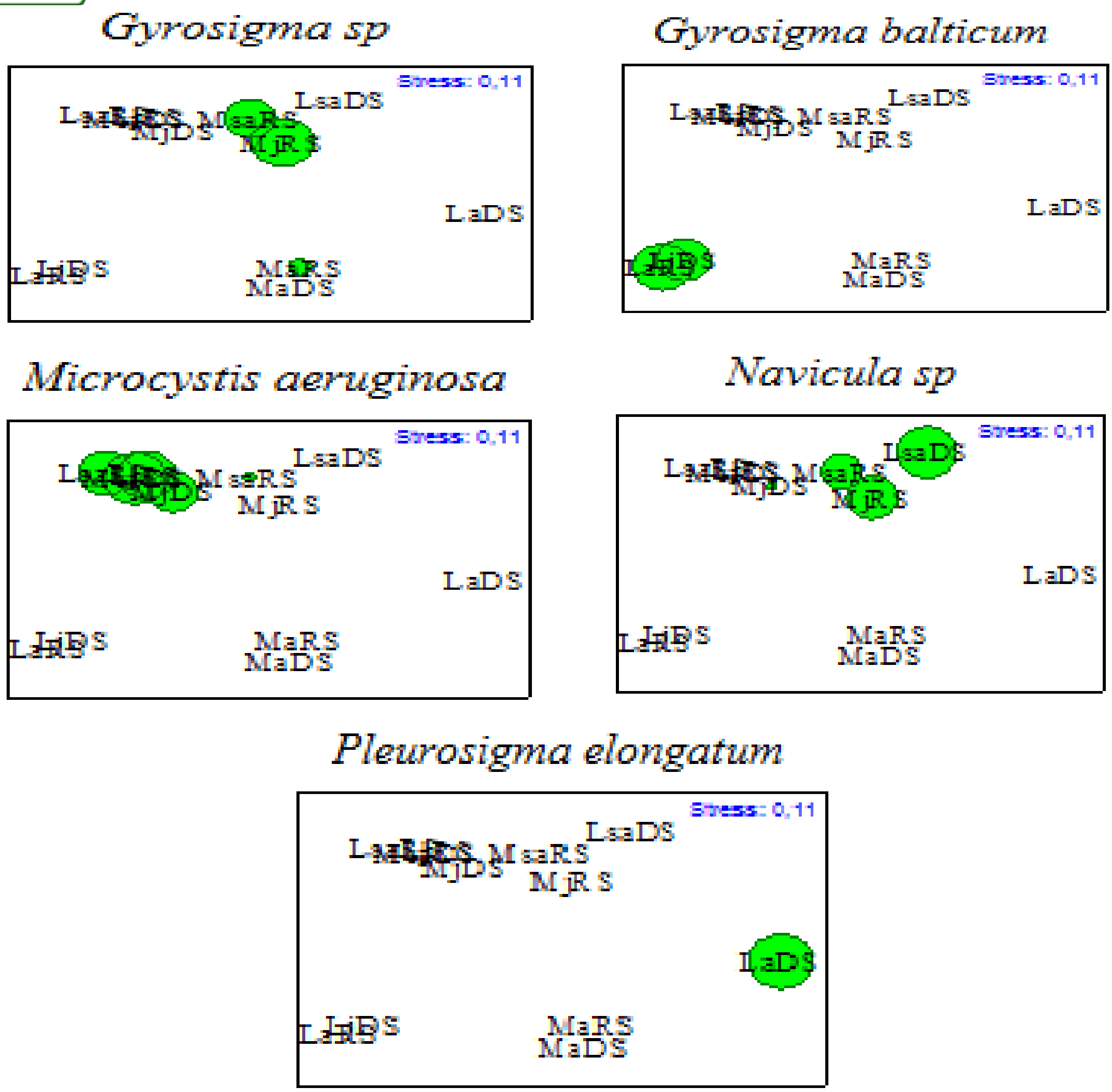

Fig.6. Food similarity of different size groups of the two species based on the most significant prey in Ebrié lagoon.

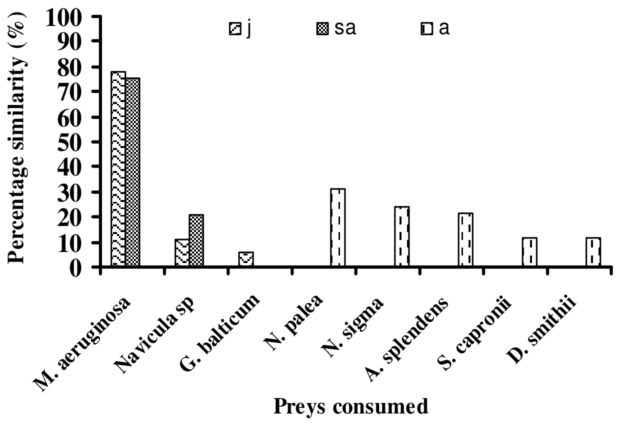

Fig.7. Percentage of food similarity function prey consumed in juveniles (j), sub-adults (sa) and adults (a) of Liza falcipinnis and Mugil cephalus in Ebrié lagoon

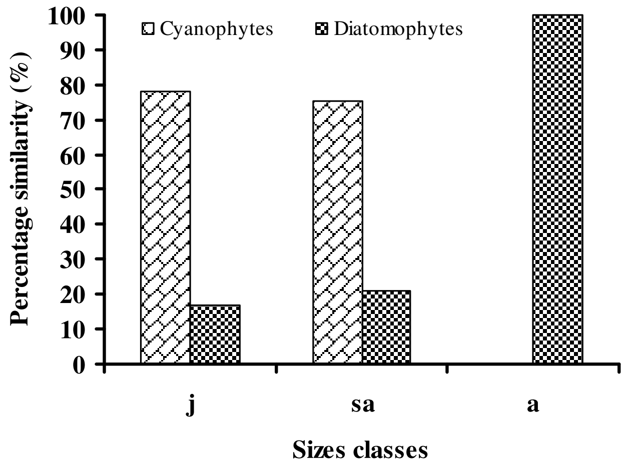

Fig.8. Percentage of food similarity based on sizes classes of Liza falcipinnis and Mugil cephalus in Ebrié lagoon

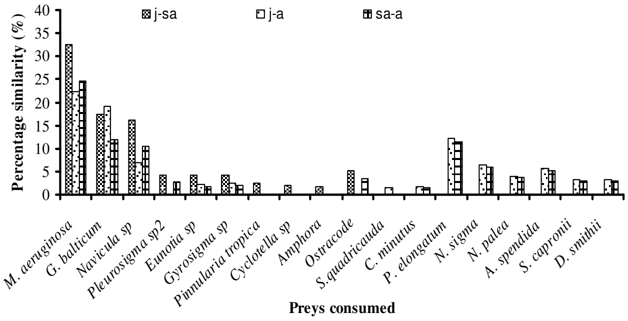

Fig.9. Percentage of food similarity in relation to preys consumed by juveniles and sub-adults (j-sa); juveniles and adults (j-a) and sub-adults and adults (sa-a) Liza falcipinnis and Mugil cephalus in Ebrié lagoon as defined by the SIMPER analysis

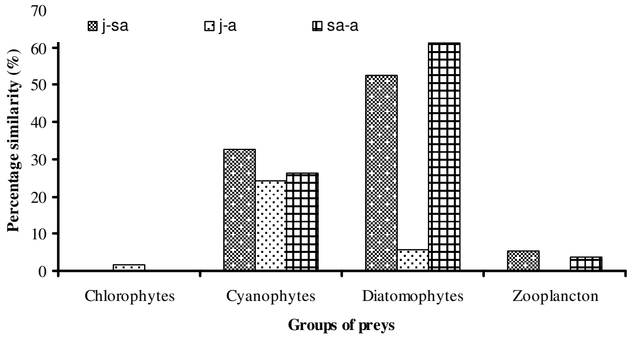

Fig.10. Percentage of food Similarity in relation to groups preys consumed by juveniles and sub-adults (j-sa); juveniles and adults (j-a) and sub-adults and adults (sa-a) Liza falcipinnis and Mugil cephalus in Ebrié Lagoon as defined by the SIMPER analysis

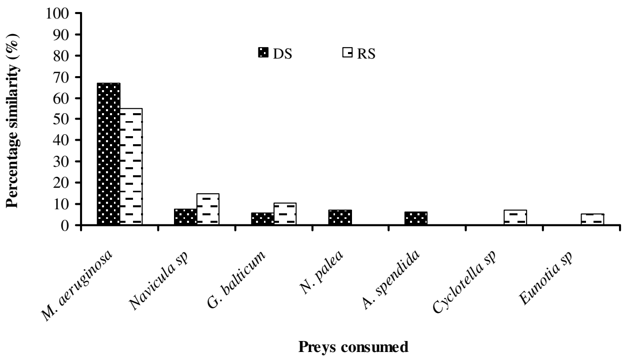

Fig.11. Percentage of food similarity in relation to prey consumed by season by Liza falcipinnis and Mugil cephalus in Ebrié lagoon as defined by the SIMPER analysis

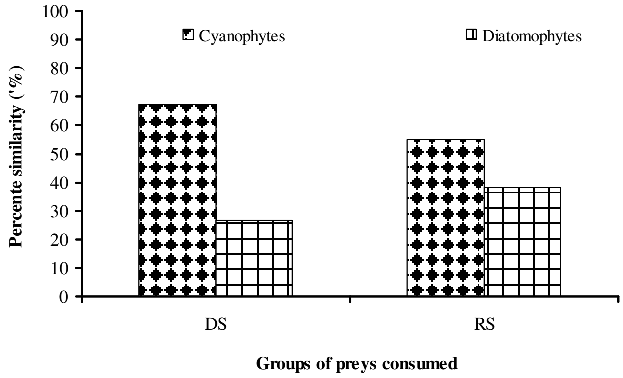

Fig.12. Percentage of food similarity in relation to groups prey consumed by seasons by Liza falcipinnis and Mugil cephalus in Ebrié lagoon as defined by the SIMPER analysis